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Access to the Lumbosacral Spine: A Current View

Acesso à coluna lombossacral: Visão atual

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Abstract

The surgical approach to the lumbosacral spine has been the subject of experimental and scientific anatomical studies since the Hippocratic era. However, it was in the 20th century that, with the evolution of asepsis and antibiotic therapy, spine surgery began to evolve at breakneck speed, and the various possibilities of access roads became objects of development and discussion. As a result, pathologies of the lumbosacral spine can be accessed in different ways and positions, from the traditional posterior approach in the prone position to the anterior, oblique, lateral, and endoscopic approaches. The current article brings state-of-the-art access routes to the lumbosacral spine. This article objective is to elucidate the possibilities of accesses the lumbar spine for any purposes, as decompression, fusion, tumour resections, reconstruction or deformity correction, despites type of implants or implants positioning.

Keywords
- arthrodesis
- lumbosacral region/surgery
- spine/surgery
- spinal fusion

Resumo

A abordagem cirúrgica da coluna lombossacral tem sido objeto de estudos anatômicos experimentais e científicos desde a era hipocrática. Contudo, foi no século XX que, com a evolução da assepsia e da antibioticoterapia, a cirurgia da coluna começou a evoluir em velocidade vertiginosa e as diversas possibilidades de vias de acesso tornaram-se objetos de desenvolvimento e discussão. Desta forma, as doenças da coluna lombossacral podem ser acessadas de diferentes maneiras e posições, desde a abordagem posterior tradicional em decúbito ventral até as abordagens anterior, oblíqua, lateral e endoscópica. O presente artigo traz vias de acesso de última geração para a coluna lombossacral. O objetivo deste artigo é elucidar as possibilidades de acesso à coluna lombar para quaisquer finalidades, como descompressão, fusão, ressecções tumorais, reconstrução ou correção de deformidades, independentemente do tipo de implante ou seu posicionamento.

Palavras-chave
- artrodese
- coluna vertebral/cirurgia
- fusão vertebral
- região lombossacral

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Introduction

Spine surgery is one of the areas with the most remarkable development among surgical specialties concerning the technologies employed in the equipment for obtaining images, navigators, implants, and materials, as well as the surgical techniques and access routes. Less traumatic retractors, tubes, and endoscopes have evolved, thus providing increasingly less invasive accesses and promising results.[1] Spinal fusion surgery was described for the first time in 1911 by Hibbs, who described the technique of decortication and morselization of the autologous graft in a case of chronic osteomyelitis caused by Pott's disease.[2]

In 1933, Burns and Capener found the possibility of approaching the spondylolisthesis of L5-S1 through the anterior route after several cadaveric studies.[3] They performed the surgery on a 14-year-old boy, performing anterior route access to the region of the retroperitoneum with a left paramedian incision and transperitoneal access where they accessed the spine, placing an autologous graft. After two months of plastered immobilization, the boy recovered.[4]

The first descriptions of percutaneous intradiscal procedures were described in the 1960s by Lyman Smith, such as chemonucleolysis with papain, shortly after Hijikata described the possibility of removing the nucleus pulposus percutaneously with the aid of small tubes and a pituitary tweezers using the same parameters that he used to perform his discographies.[5]

In 1986 Kambin described the safe anatomical corridor to access the intervertebral disc, between the nerve root and the superior facet, receiving the name "Kambin's triangle" his pioneering work allowed the development of the first endoscopic surgeries.[5]

The different accesses to the lumbar and lumbosacral spine allowed us a significant evolution in surgical techniques and methods, as well as the development of technologies for the resolution of the main pathologies, which continue to be objects of discussions and studie[6] (►**Fig. 1**).

Posterior Approach

The posterior access routes to the vertebral column allow a direct approach to the vertebral canal without manipulating larger vascular or neural structures. They are, therefore, the first to be discovered by ancient surgeons, despite little anatomical knowledge and frank discouragement of the surgical approach.

The posterior access to the spine appears in some descriptions of antiquity, mainly intending to remove fragments of fractures from the vertebral canal. However, the lack of knowledge of antisepsis and hemostasis only allowed the flourishing of spinal surgery from the 19th century onwards.[7]

We consider the median subperiosteal and paravertebral options when considering the posterior approaches. For this, it is essential to know the posterior muscular anatomy of the lumbosacral spine, which is formed by the following muscles: Multifidus (M), Longissimus (L), and Iliocostalis (Il).

The multifidus is the largest and most medial posterior muscle, poly segmental and multiplies innervated. It has intimate contact with the lamina and the spinous and transverse processes and is considered the most critical posterior stabilizer of the lumbosacral, commonly presenting itself atrophic in lumbar degenerative pathologies.[8]

The three muscles run longitudinally along the spine, inserting into the sacrum, the sacroiliac joint, and the iliac wing, but the multifidus has a unique short, robust shape. Its

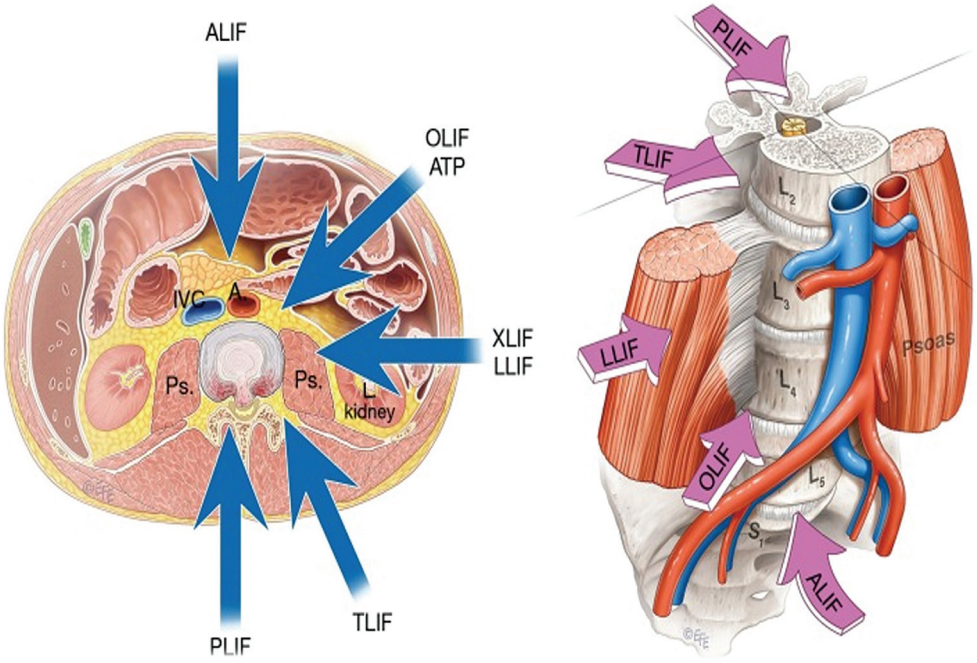


Fig. 1 Possible approaches to lumbar intervertebral fusion.

architecture allows the creation of large forces in short distances, producing more forces with the spine in anterior flexion, protecting it in its most vulnerable position.[8]

Posterior median approach: in this access route, an incision is made in the skin over the spinous processes, continued by the subperiosteal bone dissection with the detachment of the multifidus muscle from the spinous processes, laminae and reaching the region of the transverse processes using Cobb instruments and electrocautery, being able to offer complete exposure of the posterior bone elements of the spine, allowing extensive decompression surgeries through a laminectomy, resection of bone or intracanal tumours, in addition to allowing posterolateral and inter somatic fusion through the PLIF (posterior inter somatic fusion) and TLIF (transforaminal inter somatic fusion) techniques, in addition to surgical correction of scoliosis.[9]

The disadvantage of this method is the surgical aggression to the paraspinal musculature, which leads to postoperative muscular atrophy, mainly of the multifidus muscle, reducing up to 27% of its area below the arthrodesis site, which may lead to less satisfactory surgical results, when compared to with techniques that preserve more posterior musculature.[10,11]

The mechanisms by which muscle injuries occur are dissection, which tears the tendon insertions, and the excessive use of electrocautery, causing thermal injury and tissue necrosis. However, the most associated factor is the use of self-static retractors for prolonged periods. The degree of injury is linked to the time of retraction, and the intermittent loosening of the retractors reduces the area of muscular injury.[12,13]

Paraspinal Approach: This approach uses the dissection of the intermuscular plane between the multifidus muscle and the longissimus muscle, described by Wiltse in 1968 as a modification of the approach described by Watkins, used an approach between the sacrospinatus muscle and the quadratus lumborum.[14,15]

This access has a lower rate of bleeding and less muscle destruction, in addition to allowing direct access to the transverse processes, pedicle, and intervertebral discs, being advantageous in approaching mainly hernias in the region of the vertebral recess, foraminal and extraforaminal.[16]

The access can be performed as the original description with two paramedian incisions or a single central incision and two in the subfascial plane, as modified by Wiltse himself in 1988.[17] However, the original technique with two incisions seems more advantageous with a lower rate of complications such as suture dehiscence and seroma.[16] This access allows several surgical approaches, with TLIF transforaminal inter somatic fusion being one of the most popular, as it is a less invasive approach par excellence. Compared with the traditional media approach, it has several advantages, such as less postoperative muscle atrophy, lower incidence of adjacent degeneration level, lower infection rate, and less intraoperative bleeding.[18,19]

Lateral Access

The lateral approach to the spine was first described by Ozgur et al.[20] as a less invasive alternative to vertebral inter somatic fusion, and its use has become popular in the treatment of a variety of pathologies of the spine, more recently being adapted for the L5-S1 use in an anterolateral approach, anterior to the iliopsoas muscle, also called the iliopsoas access oblique.[21,22]

According to the original description of the technique, the positioning is in lateral decubitus on an inverted radiolucent table, with the greater trochanter positioned on the fold of the table, placed in an orthogonal position with the radioscopy. The table is flexed to facilitate the dissection by moving away the ribs of the iliac crest. The skin incision should be made towards the disc for one level or towards the vertebral body for two levels; for three levels or more, more than one incision is required, the dissection of the external oblique, internal oblique, and transversus abdominis muscle, it must be done bluntly, without the use of electrocautery. In order to avoid injury to peritoneal structures, the index finger must clear the retroperitoneal space before inserting the guide wire, dilators, and retractor that cross the iliopsoas directly with the aid of a magnifying glass or microscope. This approach is used for lateral intersomatic fusion called LLIF (Lateral Lumbar Intersomatic Fusion) or XLIF (Extreme Lateral Intersomatic Fusion), they are synonyms , but XLIF were patented by a company as the implant name too, so is more correct to use LLIF for the Lateral approach of intersomatic fusion.

Multimodal neurophysiological monitoring is mandatory to avoid lumbar plexus and genitofemoral nerve injuries.[23] Knowledge of the regional neuroanatomy, the time of retraction of the iliopsoas muscle, and appropriate training in the technique allow its performance without needing an access surgeon.[24]

Anterior Access

Anterior approaches to the lumbar spine (ALIF) first emerged in the 1930s for the treatment of spondylolisthesis by Capener[3] and Pott's disease by Ito et al.[25]

Since then, various surgical techniques, including open or laparoscopic transperitoneal approaches and retroperitoneal exposures, have been developed. Since the end of the 1990s, the preferred and most used surgical technique has been the minimally invasive, popularized by Brau[26] The ALIF approach provides direct midline exposure of the lumbar disc, thereby allowing for a wide discectomy and placement of a sizeable interbody graft that maximizes coverage of the vertebral plateau. L5-S1 is the preferred level of treatment as it avoids the complexity of the aorta/caval/iliac bifurcation. However, higher levels from L2 to S1 have already been performed by experienced surgeons.[27]

The anterior access technique to the lumbosacral spine is helpful in degenerative disc disease, isthmic or degenerative spondylolisthesis, spondylodiscitis, pseudarthrosis, removal of mispositioned or migrated TLIF or PLIF cages, disease, or degeneration of the adjacent level.[28]

The posterior approach has a higher risk of neurological damage and dural tear due the presence of fibrosis, with the anterior access being preferred and with less morbidity.[27] Restoration of sagittal balance allows using hyper lordotic

implants (up to 30 degrees) and the desired rebalancing of vertebral body injuries from fractures or tumours.

Some advantages of this technique include the direct view of the midline of the disc space and the extensive lateral exposure of the vertebral bodies, which allows an efficient release of the disc space, adequate access to the entire ventral surface of the disc exposed, allowing complete discectomy, restoration of disc space, automatically reducing deformity through ligamentotaxis, leading to indirect decompression. It allows the sparing of the spine and muscles anterolateral posterior muscles to the psoas, which can reduce postoperative pain and disability.[6,27,28]

Disadvantages of the ALIF technique include approach-related complications such as vascular injuries, retrograde ejaculation, and visceral injuries.[29,30] The ALIF technique is suitable for the L4/L5 and L5/S1 levels due to the vascular anatomy that provides a large working corridor between the iliac vessels. Higher levels, such as L2/3 and L3/L4, can be explored by teams with experienced and trained access surgeons due to the need for extensive vascular mobilization of the aorta and iliac arteries and retroperitoneal viscera, such as the pancreas and kidneys.[6]

The contraindication for any anterior approach includes previous major abdominal surgeries, severe peripheral vascular disease, patients with a history of radiotherapy, stents, and endoprostheses of abdominal vessels. In addition, specific contraindications include the need for direct posterior decompression, acute infection, severe osteoporosis due to the risk of subsidence (fracture and sinking of the plateau), extruded disc herniation, migrated, especially if calcified, requiring posterior approach.[6,31] Obesity is a relative contraindication showing similar intraoperative morbidity, postoperative complications, and arthrodesis similar to patients with BMI within the normal range.[32]

Oblique Access

The first description of an OLIF approach was published in 1997 by Mayer.[33] However, the official name and acronym were not coined until 2012 when Silvestre et al.[34] used a minimally invasive retroperitoneal approach similar to the Mayer approach for anterior lumbar intervertebral fusion. This technique is reported by Silvestre et al.[34] as OLIF and accesses the anterolateral surface of the disc space before the psoas muscle, which is mobilized posteriorly. After preparing the disc space, the inter somatic device is inserted at an oblique angle and rotated in a lateral position.

The evolution of technique and instrumentation provided adequate access to the lumbar spine, with low rates of perioperative complications, short surgical times and low morbidity and mortality, little postoperative pain, and early return to daily activities. Indications include degenerative disc diseases, discogenic lumbar pain, degenerative lumbar scoliosis, low-grade spondylolisthesis, lumbar instability, revision, mild to moderate canal stenosis, sagittal deformity, fractures, tumours, adjacent level disease.[28]

The oblique device can raise the intervertebral space's height and expand the intervertebral foramen's size, indirectly achieving decompression.[35] Regarding anatomical accessibility, the OLIF technique can reach L1 to S1 using an oblique corridor between the aorta, inferior vena cava, and psoas muscles to access the disc space.

There is adequate operating space with the left oblique corridor from levels L2 to L5, with the additional ability to be extended during surgery with lateral positioning and retraction of the psoas muscle. The ribcage can limit access at the level of L1-L2 and the iliac crest and iliac vessels at the level of L4-L5.[27,31]

The advantages are less invasive operative technique, reduced operative time, and less chance of injury to the lumbar plexus, allowing direct access to the disc. Without injury to the lamina, it leads to less damage and bleeding, lower rate of nerve injury, faster postoperative recovery, less pain, short hospital stay, and increased rates of inter somatic fusion caused by a large amount of disc removal, promoting a large area of contact with the plateaus, and suitable correction of the deformities.[6,36,37]

There is also the possibility of approaching greater levels through the same access without enlarging the operative window. Disadvantages include anatomical alterations that limit the procedure and the potential risks involved, such as sympathetic dysfunction and vascular injury.[21,31]

We can observe that in the aorta/cava/high iliac bifurcations (those that occur above the upper 1/3 of L-4), the iliac vessels are already well open and with an almost lateral trajectory at the level of the L4-5 disc, the which would lead to vascular damage in the supposed OLIF access corridor.

Considering the report above, in positioning the lower blade of the retractor/retractor, we must avoid its fixation in the vertebra of L-5 with the fixation screw.[6,21,31]

There are several limitations to the oblique access approach.

There is the risk of canal stenosis caused by the intersomatic device in the posteromedial trajectory, leading to the disc or ligament material displacement towards the central canal or the contralateral foramen. A second limitation relates to patients with high-grade spondylolisthesis because there is not enough "overlapping" of the two vertebral plateaus to accommodate the inter somatic device in an oblique trajectory.

The procedure may also be affected in congenital vertebral canal stenosis and for injuries that occupy the intervertebral space, in a spontaneous fusion of intervertebral space or posterior facets, and by the shape of the psoas muscle. Therefore, on the concave side of scoliosis patients, the space between the vessels and the psoas muscle decreases, which is not conducive to the OLIF pathway.

Psoas sign interiorized, that is, on axial images at the level of L4-L5, the psoas muscle in the area of entry into the lateral annulus of the vertebral disc. The space between the psoas muscle and the quadratus lumborum muscle increases in some patients, which could lead to misunderstanding the distance gap between the artery and the psoas muscle. The different positions influence the shape of the psoas muscle. In the right lateral decubitus position, the left psoas major muscle is affected by gravity and is close to the vertebral body.[6,31,38]

Endoscopic Approach

For a spinal approach to be considered a fully endoscopic surgery, it needs to meet the following criteria: the use of an endoscope that has a working channel and endoscopic system, an utterly percutaneous approach with a small incision like a skin puncture ("stab incision"), a single-portal technique performed under constant saline irrigation.[39,40]

There are other methods of endoscopic approach to the spine, such as bi-portal endoscopy, microendoscopy, epiduroscopy, and video-assisted tubular surgery. However, endoscopic or completely endoscopic percutaneous spine surgery (►**Fig. 2**) is the most commonly used in our setting.[39,40]

When considering the lumbar spine, the main endoscopic access routes can be divided into the transforaminal and interlaminar approaches.[41,42]

Transforaminal Approach

It can be performed with the patient in a prone position with flexion of the hips and knees under local anesthesia, sedation, or general anesthesia. In the latter case, it may be accompanied by neurophysiological monitoring to allow the surgeon to monitor the function of the emerging root and passer-by of the approached level.[41,42]

The principles of the endoscopic transforaminal route are to seek access as close as possible to the disc pathology and to avoid irritation of the emerging root. To achieve these principles, the foraminoplasty can be associated with the procedure, which is the recalibration of the approached intervertebral foramen using ways to remove or thin the bone edges.[42,43] This can be done with shaver burs, foraminoplasty burs, or percutaneous refers.

The angle of access and the access point in the foramen is essential for the technique's success. They can be adjusted according to the patient's body size, disc level, and pathology site to be approached. Generally, at lower lumbar levels (L4-L5 and L5-S1), a distance from the midline of 10-12 cm is used, and at higher levels, a progressively closer approach to the midline is used due to renal topography.

After a posterolateral incision, a guide wire is inserted, seeking to reach the space of Kambin's triangle. This approach safety triangle is defined as the space between the laterally emerging root, medially dura mater, and the base, the superior portion of the pedicle of the inferior vertebra.

The access route is dilated with progressive blunt dilators until the working sleeve is placed. After the work jacket is securely positioned, the endoscope is positioned. The ideal way to guarantee the correct positioning is to adequately visualize the structures that make up the intervertebral foramen to allow a safe surgery.[42,43]

There are some divergences in the literature regarding the disc approach. Initially, the transforaminal endoscopic approach was performed from the central portion of the disc and progressed towards the outer part of the disc, a technique known as inside-out.

With the evolution of surgical techniques and equipment technologies for disc pathologies emerged the technique of approaching from the outside, known as outside-in.[42–44]

More recently, with the transforaminal approach to approach bone pathologies of the foramen, without the need

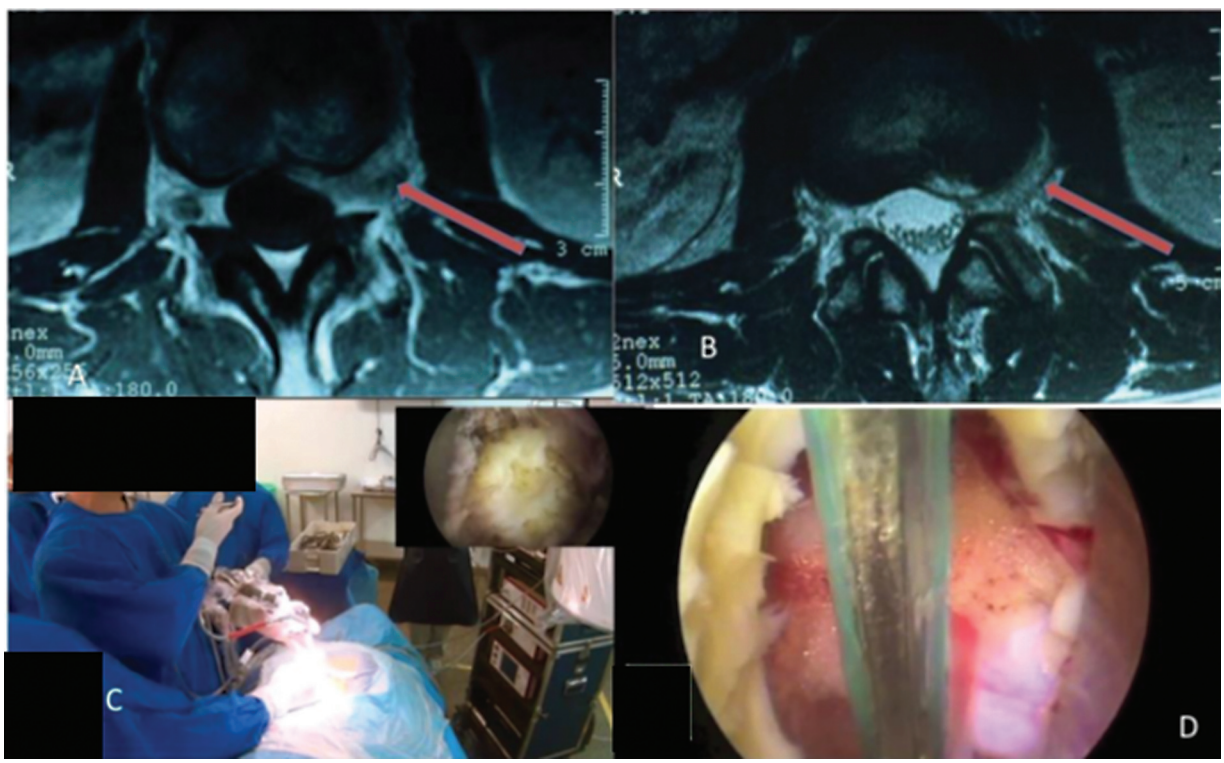


Fig. 2 Transforaminal endoscopic approach. (A) location of the nerve root ganglion, (B) direct access to the disc abscess, (C) positioning of the team, (D) endoscopic view of the neural root.

to approach the disc, the outside-out technique corresponds to techniques of bone decompression of the foramen. This approach offers risk of residual pain due root manipulation of the procedure, especially during surgeons learning curve, even so neurologic complications are lower in percutaneous endoscopic techniques when compared to open approach.[45]

Interlaminar Approach

Like transforaminal endoscopy, it can be performed under sedation or local or general anesthesia. The approach's target point is the interlaminar window's lateral edge.[41,43] This window is usually more prominent at more caudal levels, progressively decreasing in the cephalad direction. Thus, the L5-S1 is the level with the largest interlaminar window. Initially, the interlaminar access route required good-sized windows to ensure a safe approach.

The evolution of the surgical technique and bone decompression equipment made it possible to approach even smaller interlaminar windows after adequate bone decompression.[43,46] In the interlaminar approach, the guide wire can be used initially or even the direct approach with the blunt dilator due to the risk of inadvertent introduction of the guide wire into the vertebral canal through the ligamentum flavum.

After the dilator, the working cannula is positioned with the bevel resting on the most lateral portion of the window. Next, the endoscope is introduced to ensure visualization of the ligamentum flavum.[41,46] This can be removed using appropriate tweezers and scissors, allowing visualization of the epidural space.

After the flavectomy, the surgical field is prepared with more effective bone decompression and/or soft tissue removal until it is possible to visualize and dissect the neural structures.[41,46] Through this route, it is possible to treat disc or bone compressive pathology, depending on the origin of the symptoms. At the end of the surgery, decompression can be confirmed with a blunt probe used through the working channel and visualization of free and pulsatile structures with the serum flow.[41,46]

Final Considerations

The various access routes and surgical approaches described here continue to be objects of study, generating dozens of publications annually. There is no consensus on the best approach for each pathology. However, a trend seeks a reduction in tissue damage, especially muscle, effectiveness in the decompression of neural structures, and greater safety with minimization of the risks of neurological damage and postoperative infections. In addition, advances in imaging and magnification techniques allow smaller, more effective, and safer accesses.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Update on Musculoskeletal Pain Management

Atualização no manejo da dor musculoesquelética

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Abstract

Pain is the most common complaint reported to orthopedists in the outpatient clinic, emergency room, or booth. Numerous publications report the inadequate management of both acute and chronic pain by health professionals. This updated article aims to provide information about musculoskeletal pain, its classification, evaluation, diagnosis, and the multimodal therapeutic approach for each case. For acute pain, adequate control allows for earlier rehabilitation to work and reduces the rates of pain chronification. For chronic pain, the goal is to reduce its intensity and improve the quality of life. Currently, some procedures are increasingly used and aided by imaging tests for diagnostic and therapeutic purposes.

Keywords
- acute pain
- chronic pain
- musculoskeletal pain
- pain management
- postoperative pain

Resumo

A dor é a queixa mais comum recebida pelo ortopedista no ambulatório e/ou emergência. Inúmeras publicações relatam o manejo inadequado tanto da dor aguda quanto da dor crônica pelos profissionais da saúde. O objetivo desse artigo de atualização é trazer informações sobre a dor musculoesquelética, sua classificação, avaliação, diagnóstico e abordagem terapêutica multimodal para cada situação. Desta maneira, nas dores agudas seu controle adequado possibilita um trabalho de reabilitação mais precoce, bem como diminui os índices de cronificação da dor. Nas dores crônicas sua abordagem além da diminuição de sua intensidade, visa também melhorar a qualidade de vida. Atualmente alguns procedimentos estão sendo cada vez mais utilizados com auxílio de aparato de imagem com objetivo diagnóstico e terapêutico.

Palavras-chave
- dor aguda
- dor crônica
- dor musculoesquelética
- manejo da dor
- dor pós-operatória

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Introduction

One in every five adults in the world experiences pain. Pain is the chief complaint leading subjects to seek medical services at an outpatient and emergency level. It results in disability on an individual level and a high economic impact on society.[1,2]

According to the International Association for the Study of Pain (IAPS), pain is an unpleasant sensory and emotional experience resulting from actual or potential tissue damage or similarly associated with it.[3] Pain classification relies on time (acute or chronic) and its pathophysiology (nociceptive, neuropathic, nociplastic, or mixed). The principles for treating cancer and non-cancer pain are different. Therefore, this article discusses the assessment and management of non-cancer musculoskeletal pain.

Pathophysiology of Pain

Pain is an experience perceived by the central nervous system. This perception requires information to reach the brain through neuronal pathways and circuits. Thus, pain perception by the somatosensory cortex begins in the periphery. The painful stimulus transforms into mechanical, thermal, or chemical stimuli through neuronal signaling (*transduction*). These stimuli, in turn, are preferentially relied on by type A-delta or C neural (*transmission*) for the first synaptic connection with neurons from the posterior horn of the spinal cord (PHSC). In PHSC, inhibitory and excitatory stimuli (*modulation*) from the peripheral and central nervous system influence pain information (descending inhibitory system).[4]

To understand this pathophysiology, we must define nociception as the perception of a painful stimulus depending on the integrity of the previously mentioned pathways. In contrast to nociception, pain is a complex experience involving several neuronal modulation phenomena.[5]

Patients often present painful complaints with no correlation with complementary tests despite the lack of structural changes in imaging. The justification for their complaints may lie in a phenomenon known as sensitization, defined as an increase in the excitability of the cell membrane of sensory neurons in the face of painful stimuli, which may be peripheral (nerve ending) or central (PHSC and the entire neuroaxis).[6]

Epidemiology

Chronic pain prevalence rates range from 11% to 40% in the American population (average, 20.4%). In the United Kingdom, the prevalence of chronic pain is 43.5%, and the rate of moderate to disabling pain ranges from 10.4% to 14.3%. Brazilian data indicate that the prevalence of chronic pain ranges from 23.02 to 76.17% (average rate, 45.59%), affecting more females. The highest prevalence in Brazil occurs in the Midwest region (56.25%). Regarding the IASP mechanism classification, nociceptive, neuropathic, and nociplastic pain prevalence is 36.70%, 14.5%, and 12.5%, respectively.[7]

Pain Classification

The correct identification of the type of pain is essential for the appropriate therapeutic choice since each has a different treatment.[8] IASP reformulated the international classification of diseases (ICD- 11) to favor research and diagnoses and improve the interpretation of several chronic pain syndromes. ►**Fig. 1** and **2** show the new division.[9]

Regarding Evolution Time

Acute pain is a normal physiological response of the body to painful stimuli. It is a self-limited and short-lasting

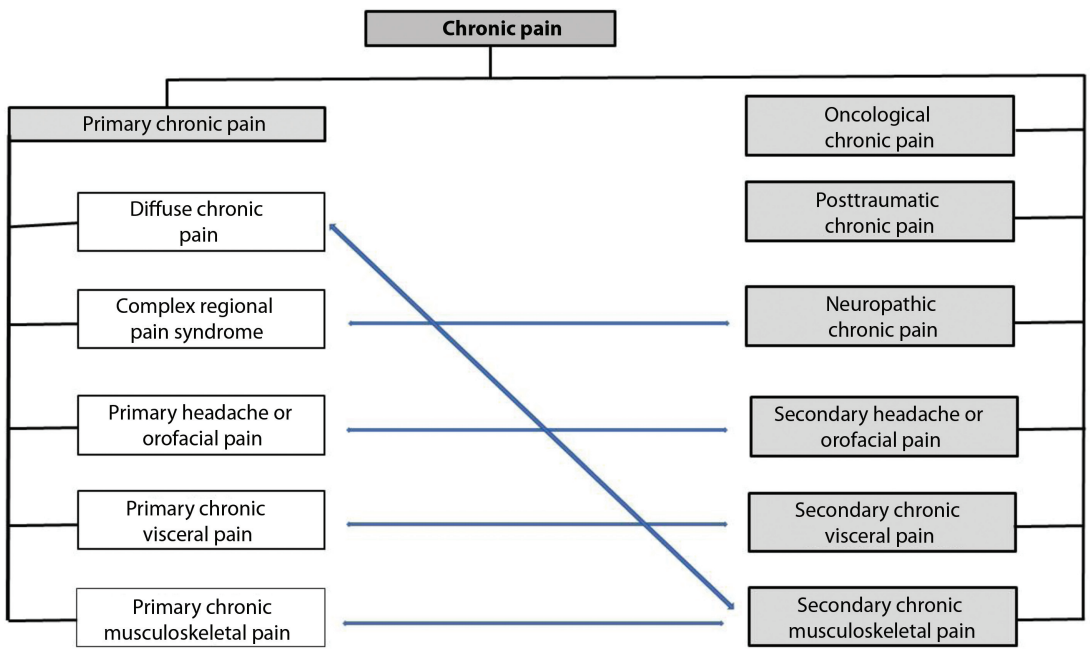


Fig. 1 CID-11 classification of chronic pain.[11]

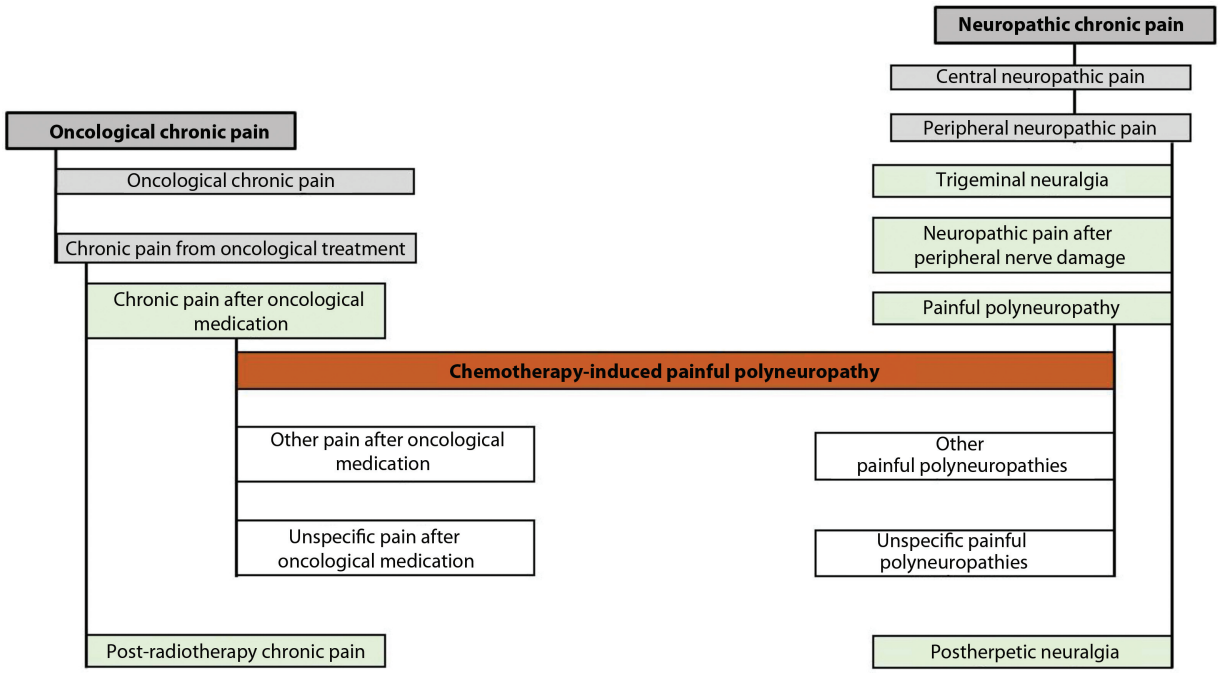


Fig. 2 Subdivision of chronic pain syndromes per CID-11.[11]

condition, often for less than three months, ceasing at the end of affected tissue healing and repair.[8,10]

Chronic pain persists beyond the regular healing time or more than three months and presents all the repercussions potentially associated with it.

Regarding the Type of Pain

- Nociceptive pain arises from actual or potential damage to non-neural tissues.[11] It occurs in acute traumatic and postoperative pain. The most commonly used medication classes for its treatment are simple or opioid analgesic agents, non-steroidal anti-inflammatory drugs (NSAIDs), and muscle relaxants (►**Table 1**).[6]
- Neuropathic pain (NP) results from an injury or dysfunction of peripheral or central nervous system structures, as in disc herniation with root compression and carpal tunnel syndrome (►**Table 2**).[12] The clinical manifestations include burning pain, painful cold, electric shock, itching, and pins and needles sensation. In addition, the neurological examination reveals hyperalgesia, hyperpathy, and allodynia. The leading treatment for this pain consists of adjuvant medications (tricyclic antidepressants, dual antidepressants, and gabapentinoid anticonvulsants). Opioids are reserved for analgesia at the beginning of treatment until the adjustment of the adjuvant dose and to allow rehabilitation when analgesia is insufficient.[8] Please refer to ►**Fig. 3.**–[12]
- Nociplastic pain is the more recently described pain. It has no association with any tissue injury (neural or not). Examples of nociplastic pain include migraine and fibromyalgia. Its treatment relies on multimodal and interdisciplinary approaches.[12]
- Mixed pain combines the pain types described above in a single subject.[4]

Pain Assessment and Diagnosis

Patient assessment must be complete, with anamnesis, physical examination, and subsidiary tests. It is critical to determine when, how, and any factors improving or worsening pain, and the previously prescribed treatments and their outcomes. It is also fundamental to describe the actual definition of whether or not a clinical-radiological correlation can establish a causal relationship to pain. Some patients, especially those with chronic pain, already tried many treatments, and several life dimensions have been affected (quality of life, functionality, social relationships, etc.). Scales can facilitate the subjective measurement of pain (numeric verbal scale and analog verbal scale [VNS, VAS]). Neuropathy pain screening tools may help, including DN4, LANSS, and painDetect. The assessment must clarify the main mechanisms involved in pain and any causal relationship.[13–16]

Treatment

Pharmacological Treatment

Diagnosis and specific causal treatment are essential for acute pain since this is a physiological function of warning of an active injury or disease. Symptomatic pain treatment adopts the World Health Organization (WHO) analgesic ladder[17] per pain intensity (VAS or VNS). The first step of the WHO analgesic ladder (►**Fig. 4**) refers to mild pain, using simple analgesics combined with an NSAID and considering any contraindication to their use. The second step (moderate pain) employs weak opioids. The third step (severe pain) uses potent opioids. An adapted WHO analgesic ladder adds a

Table 1 Main medications recommended for nociceptive pain in adults.

		Initial dose	Posology	Therapeutic dose	Notes
Simple analgesic agents					
Dipyrone (metamizole)		500 mg to 1 g	6/6 hours	Up to 4 g/day	Agranulocytosis risk[24]
Paracetamol		500 to 750 mg	6/6 hours	Up to 3 g/day	Hepatotoxicity[23]
Non-steroidal anti-inflammatory drugs: recommended for acute pain in minimal doses and for short courses					
Non-selective		Variable	Variable	Variable	Gastrointestinal and renal effects[28]
Cox-2 selective		Variable	Variable	Variable	Cardiovascular effects[32]
Opioid analgesic agent (per os)					
Weak	Codeine	15 to 30 mg	Up to 6/6 hours	Variable Maximum dose: 360 mg/day	Dose-dependent: euphoria, nausea, obstipation, addiction, sedation, and respiratory depression[36]
	Tramadol	50 to 100 mg	Up to 4/4 hours	Variable Maximum dose: 400 mg/day	
Strong	Morphine	5 to 30 mg	Up to 4/4 hours	Variable No maximum dose	
	Oxycodone	10 mg	12/12 hours	Variable No maximum dose	
	Methadone	2.5 to 5 mg	Up to 4/4 hours	Variable No maximum dose	
	Buprenorphine	5 mg	Every 7 days	Variable No maximum dose	
Antispasmodic muscle relaxant agents					
Carisoprodol		350 mg	Up to 6/6 hours	Maximum dose: 1.400 mg/day	Postural hypotension, drowsiness, and dizziness[45]
Cyclobenzaprine		5 mg a 10 mg	Up to 8/8 hours	20 to 40 mg Maximum dose: 60 mg/day	Drowsiness, dizziness, and dry mouth[46]

fourth step, consisting of interventional procedures for pain control.[18]

Several factors result in the progression of acute to chronic pain, including pain intensity, social and psychological aspects, and even genetic factors. However, proper treatment of acute pain is essential to prevent its progression. In the orthopedic context, the type of anesthesia and the drugs used in the perioperative period can reduce the risk of chronic pain.[8] Failure in medical training in pain remains a leading cause of inadequate pain management.[8]

All chronic pain treatment requires a multimodal approach, using pharmacological and non-pharmacological strategies and different mechanisms of action with synergistic potential.[19]

Simple Analgesic Agents

Dipyrone (metimazole) and paracetamol are the most used medications in clinical practice. Both are analgesics and antipyretics with similar efficacy and little anti-inflammatory effects by inhibiting cyclooxygenases type 1 (COX-1) and type 2 (COX-2).[20,21] They present different side effect profiles. Paracetamol can be hepatotoxic in high doses and is the leading cause of acute liver failure in the USA.[22] Paracetamol is safe in dosages of up to 4 g/day. In turn, dipyrone may cause agranulocytosis as an adverse effect. Nevertheless, the incidence of this side effect is very low in Latin America.[23] Dipyrone and paracetamol treat acute and chronic pain and do not require dose adjustment in subjects with renal failure.[24]

Non-steroidal Anti-Inflammatory Agents

NSAID indications include acute pain, chronic pain exacerbation, and inflammatory pain from nociceptive causes. The current recommendation is to use the lowest dose possible for a few days due to the risk of side effects, especially with prolonged treatment.[25]

NSAIDs block prostaglandin synthesis by inhibiting the constitutive enzyme COX-1, generating adverse gastrointestinal effects, and COX-2, induced by the inflammatory process.[26] The lower COX-2 selectivity reduces the risk of adverse gastrointestinal events and bleeding, whereas the higher COX-2 selectivity increases the chance of cardiovascular effects. NSAIDs are the most commonly used medications to treat chronic pain, even though there is no recommendation for this indication. They are contraindicated subjects with renal and hepatic insufficiency.[26]

Opioid Analgesic Agents

Opioids can be typical or atypical, weak or strong (►**Fig. 5**). Weak opioids may treat acute moderate or severe pain and

Table 2 First-line drugs for neuropathic pain treatment according the main guidelines[49]

		Initial dose	Posology	Therapeutic dose	Adverse effects
Antidepressant agents					
Tricyclic	Amitriptyline Imipramine Nortriptyline	10 to 25 mg	Once per day, 3 hours before sleeping	25 to 150 mg/day	Drowsiness, dizziness, tremors, headaches, postural hypotension, dry mouth, nausea, constipation, weight gain, decreased libido, hyperhidrosis, urinary retention, and suicidal ideation[47]
Dual	Duloxetine	30 mg	Once a day, in the morning	60 to 120 mg/day	Nausea, dry mouth, drowsiness, increased blood pressure, and suicidal ideation[48]
	Venlafaxine	37.5 to 75 mg	Once a day, in the morning	150 to 225 mg/day	
Anticonvulsant agents					
Gabapentin (GBP)		300 mg	8/8 hours	1,200 to 3,600 mg/day	Dizziness, nausea, drowsiness, edema of extremities, weight gain, blurred vision, and suicidal ideation[48]
Pregabalin (PGL)		50 to 75 mg	12/12 hours	150 to 600 mg/day	
Topical					
5% lidocaine patch		1 to 3 patches	12 hours without the patch/12 hours with the patch	1 to 3 patches	

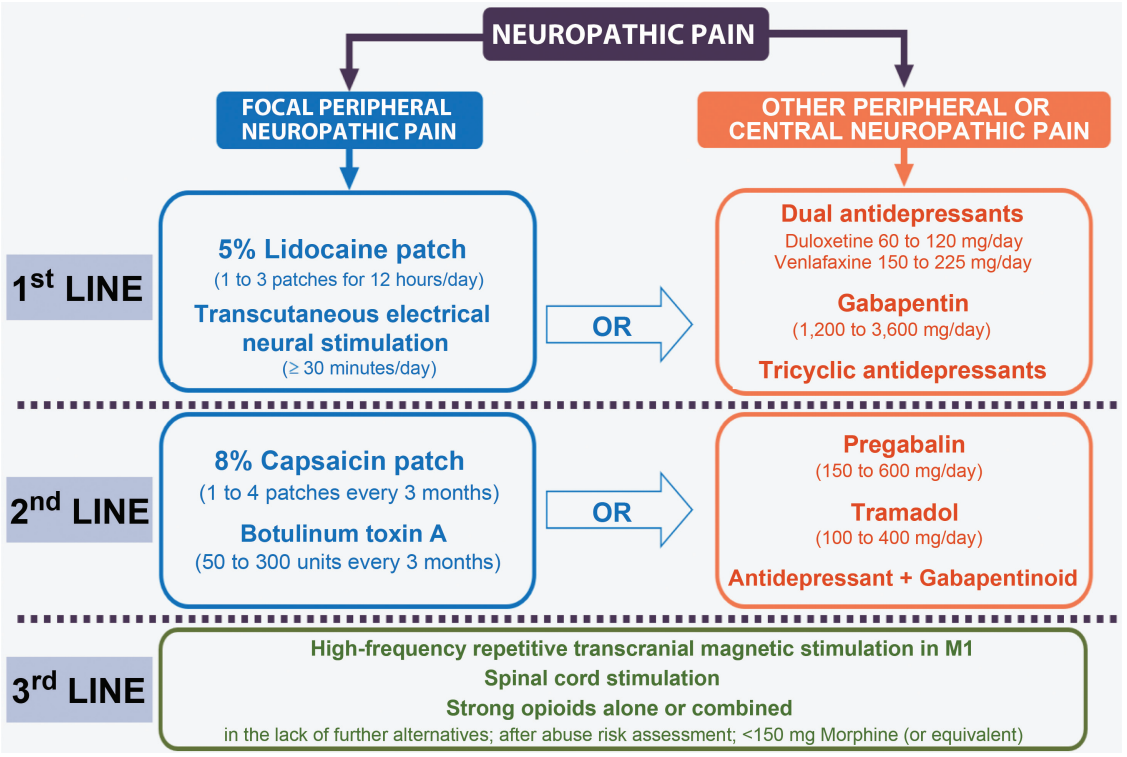


Fig. 3 Guidelines from the 2020 French recommendations for neuropathic pain treatment.[17]

chronic pain exacerbations. Strong opioids are precisely indicated in acute and severe pain and eventually for cases of difficult pain control.[27]

Despite fears on the part of orthopedists, the rational use of opioids makes prescriptions safe. Adequate titration, research into the risk of addiction, and administration for the shortest possible time until adjuvant medications or specific treatments produce the desired effect are good practice.[28]

In practice, use a short-acting opioid such as morphine titrated to the lowest effective dose with successive increases

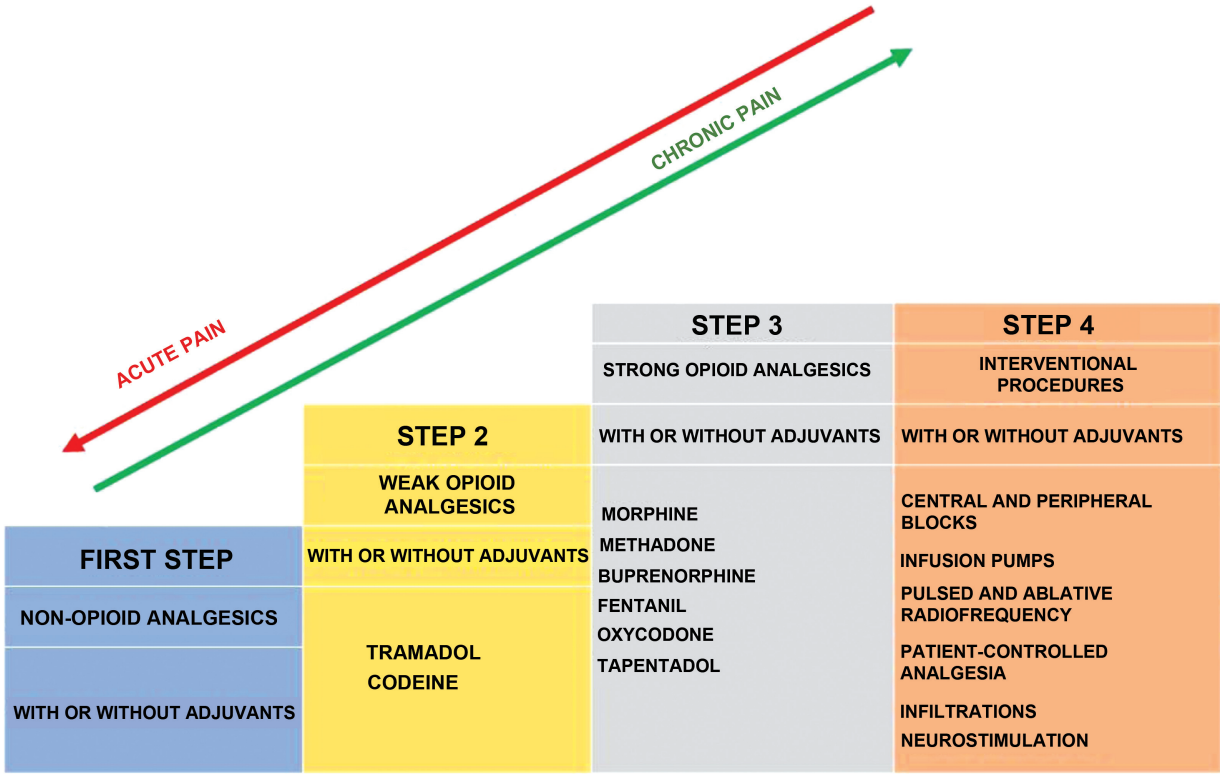


Fig. 4 Adaptation of the WHO analgesic ladder for stepped analgesia. Medications in the first step are indicated for mild pain; those in the second step are used for moderate pain, and those in the third step treat severe pain. Later, a fourth step was added to the original ladder to address drug treatment-refractory pain.[22,23].

until pain relief. From this dose, adjust rotation calculations or even rescue doses. Rescue uses 1/10 to 1/6 of the total daily dosage for pain between intervals, as well as for controlled release presentations and equianalgesic dose for opioid rotation. Several empirical conversion tables serve as guidance. Cross-tolerance, opioid-induced hyperalgesia, or intolerable effects are criteria for opioid rotation.[29]

Other side effects of opioids include constipation, nausea, vomiting, hyperalgesia, tolerance, and withdrawal. Constipation is intolerable and must receive prophylactic

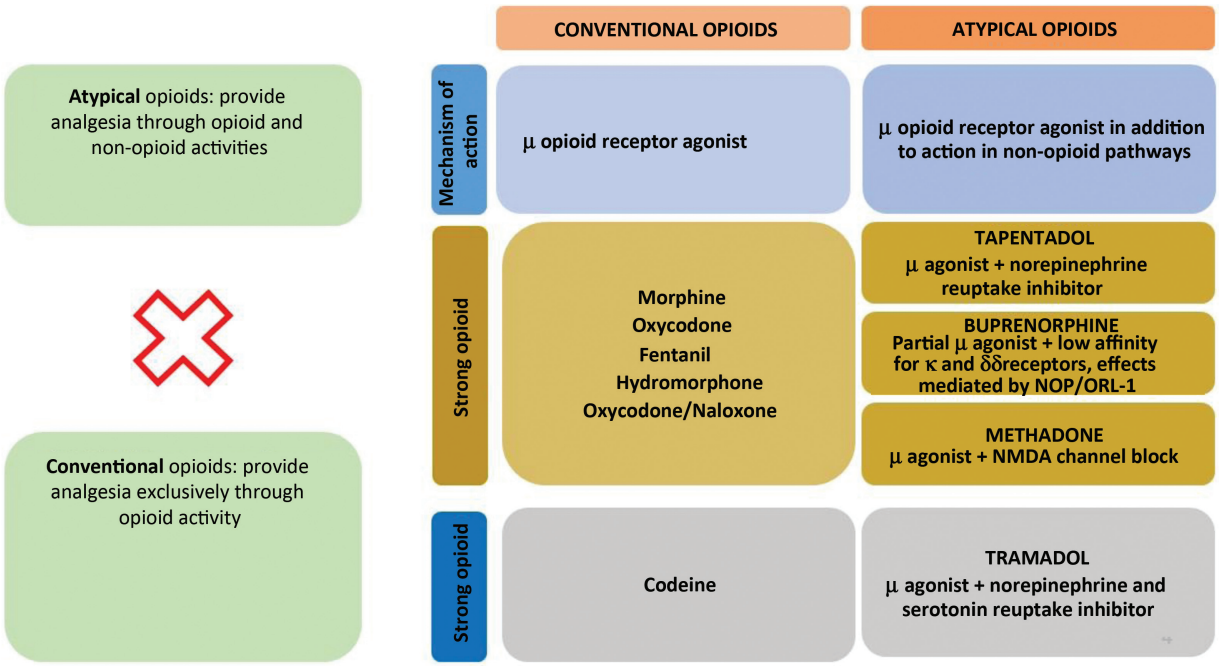


Fig. 5 Opioid classification per potency and mechanism of action.[35–41,49]

treatment, as it increases morbidity and mortality and worsens the quality of life. Constipation treatment may employ laxatives, such as lactulose, bisacodyl, senna, and polyethylene glycol, in addition to dietary changes and hydration. Older subjects warrant special care during opioid use due to the increased risk of adverse effects and falls.[30]

Continued medical education is essential for what happened in the United States does not occur in Brazil.[31]

Tramadol

Tramadol is a weak opioid with agonist activity at opioid receptors (μ) and dual action by inhibiting serotonin and norepinephrine reuptake. It helps treat nociceptive and neuropathic pain.[32]

Its disadvantage is the decrease in the seizure threshold. Concomitant use with antidepressants, especially selective serotonin reuptake or dual antidepressants, can result in serotoninergic syndrome. It causes less constipation than codeine.

Dose adjustment is required in subjects with advanced renal failure, as it is dialyzable and safe for dialysis patients.[32]

Codeine

Codeine is a morphine derivative undergoing liver metabolization into codeine-6-glucuronide and demethylation into morphine, forming active metabolites acting on opioid receptors (μ).[33] Some patients do not have the codeine-converting enzyme and are insensitive to the medication. As its elimination is renal, it requires care in patients with renal insufficiency. Since codeine removal through dialysis is complicated, it is best to avoid it in dialysis patients.[34]

Morphine

Morphine is a natural opioid with agonist activity at opioid receptors (μ). It is a reference for titration and calculation of equianalgesic doses for opioid rotation. Morphine is available in immediate and controlled-release presentations.

It undergoes hepatic metabolism into morphine-3-glucuronide, morphine-6-glucuronide (M6G), diamorphine, and normorphine.[35] he metabolites and part of intact morphine are eliminated by the kidney, requiring dose adjustment in renal failure due to the accumulation of M6G, a component ten times more potent than the original morphine. As such, avoid it in subjects with renal failure.[35]

Fentanil

Fentanil is a fat-soluble synthetic opioid with agonist activity at opioid receptors (μ). Its potency is approximately 80 times higher than morphine. It is available for intravenous, neuraxial, intramuscular, and transdermal administration. In the transdermal route, the peak of action occurs in 24 to 48 hours, and the total duration of effect lasts up to 72 hours when it requires change. As it has a slower titration, avoid it in acute postoperative pain needing faster dosage adjustment.[33]

It is metabolized in the liver, generating inactive metabolites; therefore, it is safe for patients with renal failure and on dialysis.[35] In addition, avoid it in subjects with severe liver failure.[35]

Methadone

Methadone is a lipid-soluble synthetic opioid with a potency about ten times higher than morphine. Since it is an agonist for opioid receptors (μ) and an antagonist for N-methyl-D-aspartate (NMDA) receptors, methadone is a good alternative for treating neuropathic pain. It has good oral bioavailability and diffuse tissue distribution, explaining its long half-life of 8 to 59 hours. Its pharmacokinetics presents interindividual variation and erratic metabolism, with a variable conversion rate according to the dosage. Therefore, its management requires experience and care, with frequent assessment during increasing doses and longer intervals due to the risk of accumulation and respiratory depression.[25,29] Nausea is a warning sign of methadone intoxication.[36] In patients with heart disease, increased QT interval or previous long QT intervals warrant investigation because of the risk of arrhythmia, torsades de pointes, and sudden death.[25,29]

Methadone metabolization occurs in the liver and intestine, and the bile eliminates its inactive metabolites. It is safe for patients with nephropathy, under dialysis, or with liver failure, but it requires careful monitoring of side effects.[29,36]

Oxycodone

Oxycodone is a semi-synthetic opioid with agonist activity at opioid receptors (μ). It is available in a controlled-release formulation for dosage every 12 hours. It has twice the analgesic potency of morphine. In a 20 mg dose per day, oxycodone is a weak opioid. In Brazil, there is no immediate-release oxycodone available, so morphine is the rescue medication.[37]

Oxycodone metabolism occurs in the liver, and the drug depends on the kidney to excrete active metabolites and part of the intact compound. It is best to avoid it in patients with renal failure.[37]

Buprenorphine

Buprenorphine is an atypical strong opioid with partial agonist activity at opioid receptors (μ). It is 30 to 60 times more potent than morphine. The transdermal form, the only presentation available in Brazil, is a patch for application every 3 or 7 days. Patches are available in doses ranging from 5 to 40 mg. It has fewer side effects, and it is safe for older subjects.[38]

Tapentadol

Tapentadol is a strong atypical opioid with central action for pain relief. It has a dual mechanism of action: opioid receptor agonism (μ) and inhibition of norepinephrine reuptake in PHSC. Therefore, tapentadol offers an advantage over classic opioids in chronic pain control, either nociceptive or neuropathic. Compared to other opioids, tapentadol has fewer adverse effects, especially constipation. Tapentadol is the first-line treatment option for severe chronic low back pain with a neuropathic component. It is available in sustained-release presentations for administration every 12 hours in 50 to 250-mg doses. The maximum dosage reported in studies is 500 mg/day.[39]

Muscle Relaxing Agents

Several drugs act as central or peripheral muscle relaxants (including tizanidine, baclofen, benzodiazepines, carisoprodol, and cyclobenzaprine). Carisoprodol and cyclobenzaprine are the most prescribed muscle relaxant agents today. Carisoprodol metabolism gives rise to a toxic barbiturate known as meprobamate and, as a result, some countries have discontinued it. Cyclobenzaprine action is similar to tricyclic antidepressants, with equivalent indications and contraindications. There is evidence for its use in acute low back pain for a short period.[40,41]

Tricyclic and Dual Antidepressants and Gabapentinoid Anticonvulsant Agents

The main NP guidelines indicate tricyclic antidepressants, dual antidepressants, gabapentinoid anticonvulsant agents, and 5% lidocaine patches as first-line treatments. It is worth noting that the analgesic effect of these antidepressants begins in 3 to 7 days. For these indications, such drugs cause no mood improvement, which requires higher doses of tricyclic agents and would have a later action. ►**Fig. 6** illustrates the recommended dosage, most common adverse effects, number needed to treat (NNT), and number needed to harm (NNH) for first and second-line drugs to manage localized and systemic NP.[12,36,42–44]

Tricyclic Antidepressants

Tricyclic antidepressants (amitriptyline, imipramine, nortriptyline, etc.) are first-line drugs to treat neuropathic pain.[12,36]

Amitriptyline inhibits several receptors, including muscarinic cholinergic, H1 histamine and alpha-adrenergic receptors, and norepinephrine and serotonin reuptake. Its side effects include xerostomia, weight gain, urinary retention, constipation, increased eye pressure, abnormalities in cardiac conduction, sedation, and orthostatic hypotension. Therefore, avoid amitriptyline in older patients.[45] Monitor its use in patients with angle-closure glaucoma due to the anticholinergic effects of tricyclic antidepressants. These drugs are contraindicated in the subjects with a left bundle branch block.[36]

Nortriptyline predominantly inhibits the norepinephrine reuptake, causing fewer side effects than amitriptyline but with better tolerance.[36] It does not require dose adjustment in renal and hepatic insufficiency patients, and nortriptyline is preferable to amitriptyline.[36]

Dual Antidepressants

Dual antidepressants are first-line drugs for treating neuropathic pain.[12,36,42–44] Venlafaxine can increase blood pressure and cause hyponatremia. In doses lower than 150 mg/day, it acts as a selective serotonin reuptake inhibitor, but pain treatment requires a higher dosage.[36] Avoid duloxetine in patients with a glomerular filtration rate lower than 30 mL/min/1.73 m^2 and in those with a history of angle-closure glaucoma. Dual antidepressants are safer than tricyclic antidepressants in treating pain in older subjects.[36]

Gabapentinoid anticonvulsant agents

Gabapentinoid anticonvulsant agents are first-line drugs for the treatment of neuropathic pain.[46,47] Gabapentin and pregabalin are gamma-aminobutyric acid (GABA) analogs but do not interact with this neurotransmitter. They bind to

Medication	Start	Target	Maximum	Number needed to treata	Number needed to harm	Contraindications and precautions	Adverse effects
Tricyclic antidepressants							
Amitriptyline	10 - 25 mg	50 - 100 mg	150 mg	3.6 (3-4.4)	3.6 (3-4.4)	Heart disease Glaucoma Seizures	Drowsiness Weight gain Dry mouth
Nortriptyline							Anticholinergic effects
Dual antidepressants							
Duloxetine	30 mg	60 mg	120 mg	6.4 (5.2-8.4)	11.8 (9.5-15.2)	Liver disease Tramadol use	Nausea/vomiting Abdominal pain Hypertension Sexual dysfunction
Venlafaxine	37.5 mg	150 mg	225 mg			Severe or uncontrolled arterial hypertension	
Gabapentinoid agents							
Gabapentin	300 mg	900 mg	3600 mg	6.3 (5-8.4)	25.6 (15.3-78.6)	Reduce dose in renal failure	Peripheral edema Sedation Dizziness Mental confusion
Pregabalin	75 mg	150 mg	600 mg	7.7 (6.5-9.4)	13.9 (11.6-17.4)		
Opioids							
Tramadol	50-100 mg 6/6h		400 mg	4.7 (3.6-6.7)	12.6 (8.4-25.3)	Risk of addiction Seizure	Nausea/vomiting Constipation Dizziness
Topical medications for localized neuropathic pain							
5% Lidocaine patch	-3 units for 12 h/day			2	Insignificant	Skin lesions	Skin reactions Itching
8% Capsaicin patch	1 unit applied for 30-60 minutes			10.6 (7.4-19)	16 (11-31)	Care in progressive neuropathies	Pain Erythema Itching
Botulinum toxin A	50-200 units at the pain site			1.9 (1.5-2.4)	Insignificant	Infection on pain site	Pain at application site

Fig. 6 First- and second-line medications nociceptive pain treatment. [a]Number of treatments to achieve 50% pain relief with a 95% confidence interval (82-86).

	GABAPENTIN	PREGABALIN
ABSORPTION	Variable Non-linear Less predictable Saturation-dependent	Faster Linear
PLASMA CONCENTRATION	Non-dose proportional increase	Dose proportional increase
BIOAVAILABILITY	Decreasing with dose increase > 60% with 600 mg → 33% with 3,600 mg	≥ 90%, dose-independent
MAXIMUM DOSE/DAY	3,600 mg	600 mg
POSOLOGY	8/8 hours	12/12 hours
POTENCY	Lower	Higher

Fig. 7 Differences between the gabapentinoid drugs available in Brazil.[47,56,57]

the alpha-2-delta subunits of calcium channels, blocking calcium entry into nerve endings and the release of excitatory neurotransmitters.[46,47] Pregabalin has a more linear and rapid absorption with good oral bioavailability.[46,47] These drugs may cause sedation, dizziness, and peripheral edema.[46,47] Patients with renal failure require dose adjustments. ►**Fig. 7** shows the main differences between gabapentinoid agents.[36,46,47]

Topical medications

Topical medications play a significant role in nociceptive and neuropathic pain, as discussed below:

5% Lidocaine Patch

Topical lidocaine helps treat peripheral nociceptor sensitization and central nervous system hyperexcitability by blocking voltage-dependent sodium channels if used in recommended doses. Other effects on keratinocytes and immune cells or TRPV1 and TRPA1 receptor activation may contribute to the analgesic action of lidocaine.[45]

It is a first-line medication for localized NP, such as postherpetic neuralgia and traumatic peripheral nerve injury. The lack of systemic side effects makes it a great option (►**Table 3**).[12] The patient uses a 5% lidocaine patch for 12 hours daily (maximum, three concomitant units) for two to four weeks when response reassessment occurs.[45] In addition to the local anesthetic effect, the patch protects against mechanical stimulation (dynamic allodynia), a common problem in neuropathic pain. It presents a good safety profile since only 3% (21 mg/unit) of the drug in each patch undergoes systemic absorption.[48] It also has a more favorable risk-benefit ratio than pregabalin (300 and 600 mg daily).[49] Data from a real-world study showed the efficacy and good tolerability of the 5% lidocaine patch, revealing that the treatment was significantly more effective when compared with first-line oral systemic medications.[49]

Capsaicin

Capsaicin is the active compound from pepper, making it spicy. Its mechanism of action is via binding to nociceptors (sensory receptors sending signals for pain perception) in the skin and, specifically, to the TRPV1 receptor, which controls the flow of sodium and calcium ions across the cell membrane. Capsaicin binding opens the ion channel (influx of sodium and calcium ions), causing depolarization and the production of action potentials, perceived as itching, tingling, or burning sensations. In repeated applications or high concentrations, capsaicin has a long-lasting effect known as "desensitization," probably due to a series of distinct actions that overload normal cell functions and can lead to the reversible degeneration of nerve terminals. Capsaicin is available in creams with low concentrations (0.025% and 0.075%). The guidelines for neuropathic pain management recommend the 8% capsaicin patch for treating localized neuropathic pain.[12,36]

Topical NSAIDs

Topical NSAIDs have good potential in acute pain, with acceptable NNT. NSAIDs are among the first-line treatment for chronic pain, including hand and knee osteoarthritis. Their prolonged use is safe because of their low systemic absorption.[50,51]

Non-pharmacological treatment

Non-pharmacological treatments comprise a diverse group of options to reduce pain intensity. Their primary goal is the functional improvement of the affected segment, promoting the quality of life and reintegrating the patient into social life. These treatments are frequently associated with

Table 3 Main medications used in the treatment of acute and chronic nociceptive pain[24,49]

		Initial dose	Posology	Therapeutic dose	Notes
Simple analgesic agents					
Dipyrone (metimazole)		500 mg to 1 g	6/6 hours	Up to 4 g/day	Agranulocytosis risk[24]
Paracetamol		500 to 750 mg	6/6 hours	Up to 3 g/day	Hepatotoxicity[23]
Non-steroidal anti-inflammatory drugs: recommended for acute pain in minimal doses and for short courses					
Non-selective		Variable	Variable	Variable	Gastrointestinal and renal effects[28]
Cox-2 selective		Variable	Variable	Variable	Cardiovascular effects[32]
Opioid analgesic agent (per os)					
Weak	Codeine	15 to 30 mg	Up to 6/6 hours	Variable Maximum dose: 360 mg/day	Dose-dependent: euphoria, nausea, obstipation, addiction, sedation, and respiratory depression[36]
	Tramadol	50 to 100 mg	Up to 4/4 hours	Variable Maximum dose: 400 mg/day	
Strong	Morphine	5 to 30 mg	Up to 4/4 hours	Variable No maximum dose	
	Oxycodone	10 mg	12/12 hours	Variable No maximum dose	
	Methadone	2.5 to 5 mg	Up to 4/4 hours	Variable No maximum dose	
	Buprenorphine	5 to 40 mg	Every 3 or 7 days	Variable No maximum dose	
	Tapentadol	50 to 250 mg	12/12 hours	500 mg/day	
Antispasmodic muscle relaxant agents					
Carisoprodol	350 mg	Up to 6/6 hours	Maximum dose: 1.400 mg/day	Postural hypotension, drowsiness, and dizziness[45]	
Cyclobenzaprine	5 mg a 10 mg	Up to 8/8 hours	20 to 40 mg Maximum dose: 60 mg/day	Drowsiness, dizziness, and dry mouth[46]	

pharmacological and interventional pain therapies within the context of a multimodal approach, seeking synergism of the positive effects of each technique. Physical activity is the leading non-pharmacological treatment, but the literature describes many others with a greater or lesser degree of evidence and good levels of biological plausibility. Non-pharmacological treatments are adjuvants in pain relief, mainly in chronic pain or patients using medications with intolerable adverse effects or contraindications. However, they require a way to interrupt pain or at least reduce it.[52]

We must highlight that pain is multidimensional, requiring addressing within the biopsychosocial model. Further search for better evidence to support these practices and the development of new techniques for pain treatment are required.[52]

Interventional Pain Treatment

Pain refractory to conventional multimodal and interdisciplinary treatment may require interventional procedures for control. The interventional pain treatment is the fourth step of the adapted WHO analgesic ladder.[18] Some techniques are imaging-guided to reach a specific target (including nerves, intervertebral discs, and joints). These procedures may use chemicals (drugs), physical methods (radiofrequency), or biological products (platelet-rich plasma or concentrates of medicinal mesenchymal cells from bone marrow or fat), alone or in combination.[53–57]

Blocks and infiltrations can be diagnostic or therapeutic. The advent of better imaging methods and the rise of ultrasonography (with no radiation and easily accessible) as a diagnostic tool to assist orthopedists in medical practice resulted in the potential performance of many of these blocks on an outpatient basis, helping pain control and bridging conservative and surgical treatment. These interventions are minimally invasive, present a low incidence of adverse effects, do not require hospital admission, and have satisfactory outcomes in pain control when properly indicated. In addition, in some cases, they can postpone and avoid surgeries.[53–57]

The blocks can target the most varied structures of the human body, including the bursa, muscles, and joint sensory

nerve endings and branches, such as the genicular branches of the knee in patients with osteoarthritis.[53–57]

Final considerations

The accurate diagnosis of the type of pain is paramount for its successful management Multimodal treatment, including pharmacological and non-pharmacological methods, is indicated for both acute and chronic pain to optimize analgesia and reduce adverse effects from using smaller doses of each medication.[36]

The "start low and go slow" approach is essential for all medications to minimize adverse effects and increase treatment acceptance and adherence. It is critical to warn the patients of the risk of the most significant side effects, especially at the beginning of treatment. Most drugs, especially for NP treatment, act on the central nervous system, causing adverse events, particularly in the early titration phases.[36]

To choose a treatment, consider the main therapeutic actions of each medication/intervention and their side effects. Selecting a medication within the first line requires conditioning the drug to the patient's demand. Remember that topical therapy can be an option due to its low side effect profile and effectiveness comparable to systemic drugs; a medication with sedative effects can help treat insomnia; and a drug with anxiolytic or non-sedating antidepressant action can help minimize the fatigue and lack of daytime motivation.[36]

In acute or chronic pain refractory to conventional treatment, interventional procedures can help with analgesia. However, regardless of the selected treatment, the goal must be pain control to allow rehabilitation and improve function and quality of life.[36] Thus, aligning patients' expectations on treatment will lead to better outcomes.

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Conflicts of Interest
The authors declare no conflict of interests.

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Functional Outcome of ACL Reconstruction Following Pre-reconstruction Rehabilitation vs. None Rehabilitation: A Systematic Review and Meta-analysis

Resultado funcional da reconstrução do LCA após habilitação pré-reconstrução vs. nenhuma pré-habilitação: Revisão sistemática e metanálise

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Abstract

Objective The aim of this study is to analyse the needs for pre-operative rehabilitation in patients undergoing ACL reconstruction.

Methods The database reports were searched within 2018 to 2023, using PubMed, Cochrane library database, Medline, and other published trials. A statistical analysis was made from Review Manager.

Results Pre-operative rehabilitation group shows significantly higher 2 years post-operative KOOS score in all subscore and the total mean of the score, pain ($p < 0.0001$), symptoms ($p < 0.0001$), ADL ($p < 0.0001$), sports and recreations ($p < 0.0001$), QoL ($p < 0.0001$), and the total mean of the KOOS score ($p < 0.0001$). In contrary, pre-operative rehabilitation group shows insignificantly higher score on 3 months post-operative Lysholm score ($p = 0.12$).

Conclusion This meta-analysis conclude pre-operative rehabilitation may provide better long-term post-operative outcome, however it may not provide much of a short-term outcome. It is recommended to add pre-operative rehabilitation as a guideline for ACL injury management to improve long-term outcome of patients with ACL injury undergoing ACL reconstruction procedure.

Keywords

- anterior cruciate ligament injuries
- anterior cruciate ligament reconstruction
- pre-operative rehabilitation

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Resumo

Objetivo O objetivo deste estudo é analisar as necessidades de pré-habilitação cirúrgica em pacientes submetidos à reconstrução do LCA.

Métodos Os relatórios das bases de dados foram pesquisados entre 2018 e 2023, utilizando PubMed, base de dados da biblioteca Cochrane, Medline e outros artigos publicados. Uma análise estatística foi feita utilizando-se o Review Manager.

Resultados O grupo de pré-habilitação cirúrgica apresenta pontuação KOOS pós-operatória de 2 anos significativamente maior em todos os subescores e na média total da pontuação, dor ($p < 0,0001$), sintomas ($p < 0,0001$), AVD ($p < 0,0001$). 0,0001), esportes e recreação ($p < 0,0001$), QV ($p < 0,0001$) e média total do escore KOOS ($p < 0,0001$). Em contrapartida, o grupo de habilitação pré-operatória apresenta pontuação insignificantemente maior no escore de Lysholm pós-operatório de 3 meses ($p = 0,12$).

Conclusão Esta metanálise conclui que a pré-habilitação cirúrgica pode proporcionar melhores resultados pós-operatórios a longo prazo, no entanto, pode não proporcionar um resultado significativo a curto prazo. Recomenda-se adicionar a pré-habilitação cirúrgica como uma diretriz para o manejo da lesão do LCA para melhorar o resultado a longo prazo dos pacientes com lesão do LCA submetidos ao procedimento de reconstrução do LCA.

Palavras-chave

- lesões do ligamento cruzado anterior
- reabilitação pré-operatória
- reconstrução do ligamento cruzado anterior

Introduction

ACL reconstruction remains the mainstay of treatment for ACL ruptures worldwide. The rate of ACL reconstruction keeps trending consistently with the growing number of ACL ruptures.[1,2] It could reach as high as 68,6 cases per 100,000 persons annually.[3] Lately, a more active and younger population has been affected. Thus the demands for quicker recovery and optimal knee functions are significant.[4] Researchers aim to obtain the best strategies for managing ACL rupture cases.[5]

Though seems insubstantial; a rehabilitation program serves as an excellent supplementary treatment plan enhancing the better outcome of ACL reconstruction.[6] Eitzen et al.[7] mentioned a pre-operative quadriceps muscle strength produces better knee functional outcomes. In contrast to the none rehabilitative group pre-operatively, it yields less-satisfactory functional outcomes.[8] This study aims to answer the question "is pre-rehabilitation necessary to enhance the outcome of ACL reconstruction?" by comparing pre-reconstruction rehabilitation vs. non-rehabilitation with the functional outcome of ACL reconstruction through recent publication.

Methods

This systematic review and meta-analysis were performed following PRISMA guidelines, QUOROM checklist, and flow diagram for meta-analysis for Randomized Controlled Trials (RCTs).

Search Strategy and Selection Criteria

We performed a systematic search of English language literature on PubMed/MEDLINE, ZETOC, EMBASE, AMED, CINAHL, Cochrane Central Register of Controlled Trials (CENTRAL), and ClinicalTrials.gov, published from January 2018 to January 2023. Search terms include, but are not limited to, "pre-reconstruction rehabilitation," "pre-operative rehabilitation," "pre-operative exercise", "pre-rehabilitation", "none rehabilitation", "anterior cruciate ligament", "ACL rupture", "ACL tear", "treatment", "quality of life", "functional score", "KOOS".

All types of randomized controlled trials, cohort and case series published as a full article were included in this study. The pieces were selected based on the stated inclusion and exclusion criteria according to the PICO (Population, Intervention, Comparison, Outcome) method as depicted in ►**Table 1**.

Data Extraction

The data were extracted using a standardized data collection form by a research team with each chosen article screened independently by two reviewers. Disagreements between reviewers regarding whether to include or exclude a study will be resolved by consensus and consultation with a third reviewer if necessary. Variables collected include the KOOS score and Lysholm score.

Data Analysis

The extracted data were assessed for clinical heterogeneity. Due to the differences in exercise interventions investigated, study populations, and outcome measures, it was deemed that included studies were not homogenous. Thus, a meta-analysis could not be completed. The data analysis and forest plot generated were made by using Review Manager (RevMan), The Cochrane Collaboration, 2020

Quality Assessment

Included studies were assessed in terms of quality by two independent reviewers based on the 13-item of the 2015

Table 1 PICO Table for Inclusion dan Exclusion Criteria

	Inclusion criteria	Exclusion criteria
Population	• Age 18-40 • Planned for reconstructive surgery • Attending pre-operative rehabilitation	• Age < 18 or >40 • Acute ACL tear • Complex injury
Intervention	Pre-reconstruction rehabilitation program.	• Patients undergo conservative treatment
Control	Only post-operative rehabilitation No rehabilitation program	
Outcome	• KOOS score • Lysholm score	• Outcome measures not reported in completion. • Outcome measures only report the difference. • Outcome measures collected at different. • Outcome measures are not comparable to one another
Design	Randomized Controlled Trial, Cohort, Case Series	Case Report, Systematic Review, Meta-analysis

Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group.

Results

The study selection process is presented in the PRISMA flow. Records identified through database searches are 206, while additional records identified through other sources are 174. Duplicates of 63 studies were removed. Records were screened by the research team and 125 records were excluded. Full-text articles assessed for eligibility of 29 articles. Full-text articles excluded due to design or data collection time point. Hence there are 5 studies included in qualitative synthesis (►**Fig. 1**). The included studies are presented in ►**Table 2**.[5,9–12] Population characteristics of the included studies are presented in ►**Table 3**–[5,9–12] while outcome characteristics of the included studies are presented in ►**Table 4**.[5,9–12]

From the data gathered from included studies, there are two main outcomes representing patients' subjective functional outcomes observed, the first one is KOOS score and the second one is Lysholm score. The timing of these two are also different where Lysholm score analyze short term functional outcome on three months post operative period, while KOOS score analyze long term outcome on two years post operative period. KOOS score subscales were separated to highlight which subgroup affected by pre operative rehabilitation the most.

KOOS are divided into five subscales, which in total encompases 42 items that represents patients opinion and associated problems. These five subscales are pain, other symptoms, activity of daily living, sports and recreations, and knee related quality of life.

This meta-analysis analyze 2 years post-operative KOOS score, which divided into 5 subscales and 1 mean of the KOOS score.Pain subscale explains knee and pain related to their knees. In the pain subscale, pre-operative rehabilitation significantly affect the patients' outcome ($P < 0.00001$, I2: 97%, MD: 12.24) (►**Fig. 2a**). The symptoms subscale explains other symptoms of patient's knee that other subscale failed to mention. It is shown that pre operative rehabilitation significantly affect the patients' outcome ($p < 0.00001$, I2: 89%, MD: 14.86) (►**Fig. 2b**). The ADL subscale explains ADL of the patients, especially activities that involve their knee. It is shown that pre operative rehabilitation significantly affect the patients' outcome ($p < 0.00001$, I2: 99%, MD: 9.49) (►**Fig. 2c**). This subscale explains the sports and recreational function of patients' knee. It is concluded that pre operative rehabilitation significantly affect the patients' outcome ($p < 0.00001$, I2: 10%, MD: 16) (►**Fig. 2d**). This QoL measures the quality of living of patients involving their knee function. It is concluded that pre operative rehabilitation significantly affect the patients' outcome ($p < 0.00001$, I2: 0%, MD: 11.63) (►**Fig. 2e**). The total or mean KOOS score represents whole knee function of the patient. It is inferred that pre operative rehabilitation significantly affect the patients' outcome ($p < 0.00001$, I2: 100%, MD: 13.73) (►**Fig. 2f**).

The forest plot below analyses short term outcome of 3 months post ACL reconstruction (►**Fig. 3**). The parameter used to analyze patients' knee function is the Lysholm score. It is shown that pre operative rehabilitation does aid post operative knee function in the short term period, however it doesn't show statistical signicance as good as the long term assessment ($p = 0.12$, I2: 93%, MD: 3.67).

Discussion

It has been inferred from multiple studies that pre-operative exercise aids in the outcome of ACL reconstructions. Pre-operative rehabilitation and exercise prepare the patient for surgery physically and mentally.[13] Pre-operative rehabilitation is believed to be able to enhance recovery of the patients due to the preservation of muscle strength and neuromuscular habitation through exercise and other exercises.[5,14] The three muscle group needs to be concentrated regarding the post-operative outcome of ACL surgeries are quadriceps, hamstrings, and gluteal.[14] In a more microscopic and biomolecular level of muscle properties in post ACL reconstruction patients, Shaarani et al.[6] found that muscle cross sectional area are bigger in pre-operative rehabilitation

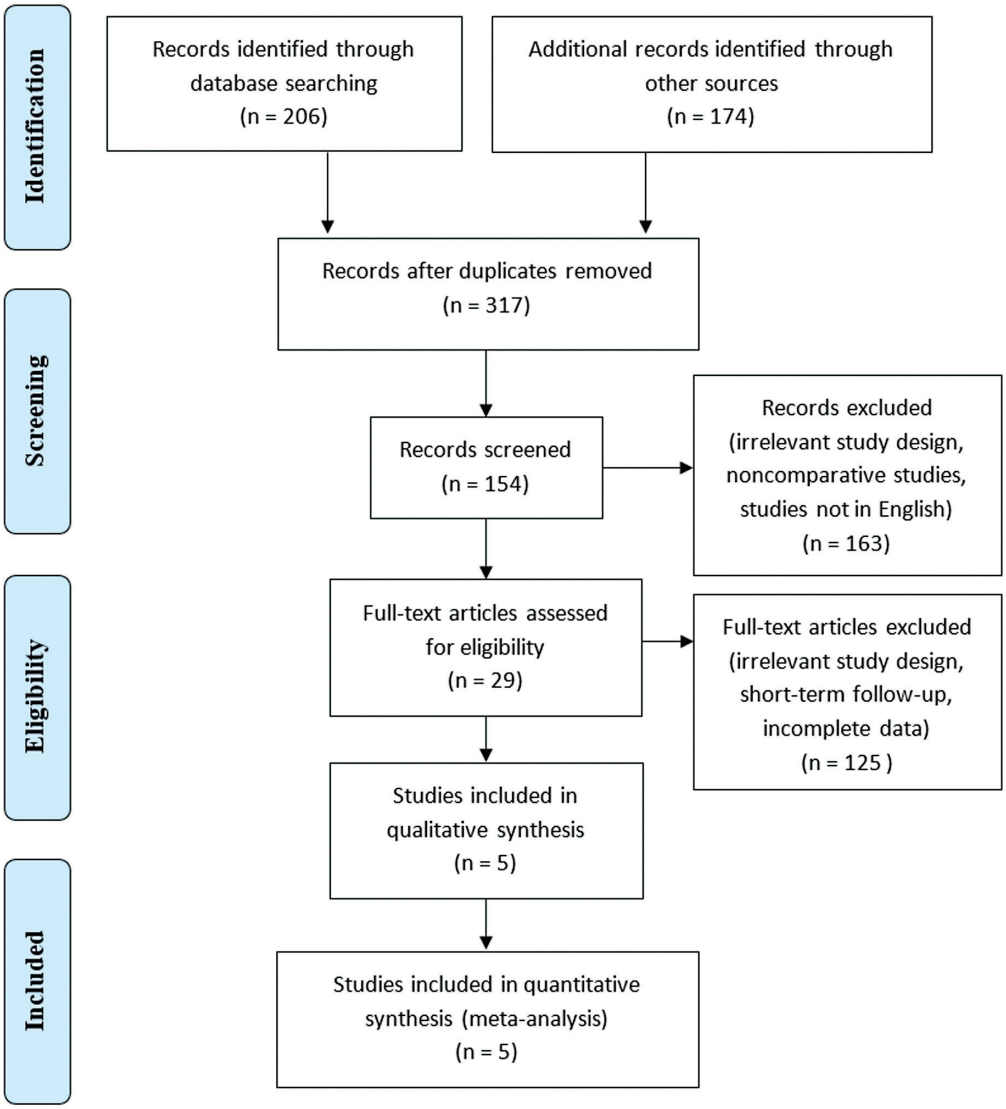


Fig. 1 Research Screening Guided by the PRISMA Flow Chart.

Table 2 Studies included in the meta-analysis

No	Author (year)	Journal	Studi Design	Level of Evidence
1	Amaravati et al. (2013)[10]	ISAKOS	Single blind prospective RCT	2a
2	Failla et al. (2016)[5]	American Journal of Sports Medicine	Cohort	3
3	Grindem et al. (2015)[9]	British Journal of Sports Medicine	Cohort	2a
4	Reddy et al. (2020) [11]	Ambulatory Surgery	prospective randomised study	2a
5	Aiyanna, et al. (2022)[12]	International Journal of Recent Scientific Research	Prospective study	2a

group. Genes contributing to muscle atrophy, MuRF-1, decreased significantly after rehabilitation.[6] Our research conclude that pre-operative rehabilitation improve patients's post-operative outcome through KOOS score.

Research by Kim et al.[15] also conclude that pre-operative rehabilitation and exercise does strengthen lower extremity muscles on their post-operative state. Logerstedt et al.[16] found that quadriceps strength correlates with IKDC 2000 scores in 6 months post ACL reconstruction, hence concluding pre-operative quadriceps strengthening has positive effect on post-operative functional outcome. Regarding muscular activity imbalance of lower extremity function, Ficek

Table 3 Population Characteristics of the Studies

No	Author (year)	Intervention	Control	Sample size (n)	Gender (Male/Female)	Age (years)	Follow-up (months)
1	Amaravati et al. (2013)[10]	R	NR	I: 32 C: 31	NA	NA	ROM: 6w, 3m, 6m, 1y Pain, Grith, Lysholm, Tegner activity, LEFS, IKDC, Hop test
2	Failla et al. (2016)[5]	R	NR	I: 192 C: 1995	Male 55%	24,3 ±10	IKDC and KOOS pre and 2 years post
3	Grindem et al. (2015)[9]	R	NR	I: 84 C: 2690	Male 54%	24,7 ±9	KOOS pre op (post rehab), 2 years post op
4	Reddy et al. (2020)[11]	R	NR	I: 20 C: 21	M: 38 F: 3	I 27,48 C 28,17	IKDC Grade, Lysholm, ROM pre, 3w, 6w, 3M,6M post op
5	Aiyanna, et al. (2022)[12]	R	NR	I: 15 C: 15	M: 25 F: 5	0-20: (27%)20-40: (67%)40-60 (6%)	IKDC, KOOS, Lysholm score3, 6, and 12 months

Abbreviations: C, Control; **I**, Intervention; **IKDC**, International Knee Documentation Committee; **KOOS**, Knee Injury and Osteoarthritis Outcome Score; **LEFS**, Lower extremity functional scale; **NR**, No Rehabilitation; **R**, Rehabilitation; **ROM**, Range of motion.

et al.[14] shows that pre-operative rehabilitation combined with post-operative rehabilitation significantly reduced imbalance of activity especially in hamstring and gluteal muscle group.

There's only one systematic review which suggests pre-operative rehabilitation contributes to only small portion to improve patients' short-term outcome in ACL reconstruction.[13] Pre-operative rehabilitation aid patients in long term outcome of ACL reconstruction much more compared to short term outcome. As seen in our meta-analysis, where significance are observed on two-years post-operative period, while insignificant outcome improvement are seen on three-months post-operative period.

Multiple protocols regarding pre-operative rehabilitation does concentrate on muscular strength of the patients. Grindem et al.[9] suggests that the goal of pre-operative rehabilitation is to gain 90% of quadriceps and hamstrings strength, as well as hopping performance. This goal is achieved by multiple rehabilitation method such as heavy resistance strength training, plyometrics and neuromuscular exercises, while initiated as soon as joint effusion and ROM deficits were resolved.

Post-operative rehabilitation regimen has been widely used with varieties of methods and goals. Grindem et al.[9] divide post-operative rehabilitation in three phases, first phase (0-2 months) aims to eliminate effusion, restore ROM, and prevent muscular atrophy. This is achieved by applying daily quadriceps contractions, ROM exercises, and cycling as tolerated by the patients. The second phase (2-6 months) aims to regain full control of weight beaing during knee extension, at least 80% of muscle strength, and the ability to hop. The last phase aims to regain at least 90% muscle strength and hopping ability, while transitioning to sports. Regarding the duration of physical therapy, all included studies mention variable duration of rehabilitaion while Failla et al.[5] didn't mention the duration (►**Table 4**). Further research may be needed to determine the optimal rehabilitation duration for ACL injured patient before having their reconstruction.

Conclusion

Multiple researches have advocated in applying pre-operative rehabilitation in ACL injured patients who will be treated by ACL reconstruction. In multiple parameters such as muscle strength, surface area, atrophic gene expression, and functional scores (IKDC, Lysholm, and KOOS score), the outcome of patients undergoing pre-operative rehabilitation is much more favorable significantly, compared to patients who did not attend a pre-operative rehabilitation program. In our study, the authors concluded that short-term outcome may not be that much significant, however in all KOOS sub group, pre-operative rehabilitation significantly improve the functional outcome of ACL reconstruction procedure.

Through this research, the authors recommend adding a recommendation of pre-operative rehabilitation in ACL injury management protocol to improve patients' outcomes. Further research may be needed to decide a standardised

Table 4 Outcome Characteristics of the Studies

No	Author (year)	Conclusion	Group (N)	Period of Rehab	KOOS Mean	KOOS Pain	KOOS Symptoms	KOOS ADL	KOOS Sports	KOOS QOL	Lysholm Score
1	Amaravati et al. (2013)[10]	Pre op Exercise resulted in better Post op functional outcomes at the long term	I (32)	3W	NA	NA	NA	NA	NA	NA	95,5 (3,4)
			C (31)	NA							89,32 (5,6)
2	Failla et al. (2016)[5]	Preoperative rehabilitation (progressive strengthening and neuromuscular training) had greater functional outcomes and RTS rates 2 years after ACLR	I	NA	88,52	94 (10)	89 (12)	98 (5)	85,6 (18)	76 (20)	NA
			C	NA	73,32	78 (33)	72 (32)	82 (34)	70,6 (33)	64 (32)	
3	Grindem et al. (2015)[9]	Progressive pre operative rehab showed superior patient reported outcomes at 2 years postoperatively	I	6M	88,88	93,5 (10,3)	89,2 (11,9)	98 (5,6)	85,1 (16,2)	78,6 (20,4)	NA
			C	NA	78,24	86 (15,1)	77,4 (18)	92,5 (12,8)	67,6 (25,9)	67,7 (22,7)	
4	Reddy et al. (2020)[11]	Pre op rehab improve early functional outcome at 3 weeks and 6 weeks	I (20)	3W	NA	NA	NA	NA	NA	NA	93,86
			C (21)	NA							92,43
5	Aiyanna, et al. (2022)[12]	Pre op rehab enhance post op outcome as measured up to 1 year.	I (15)	3M	91,87	NA	NA	NA	NA	NA	NA
			C (15)	NA	78,67						

Abbreviations: C, Control; **I**, Intervention; **M**, Months; **NA**, Not Available; **W**, Weeks.

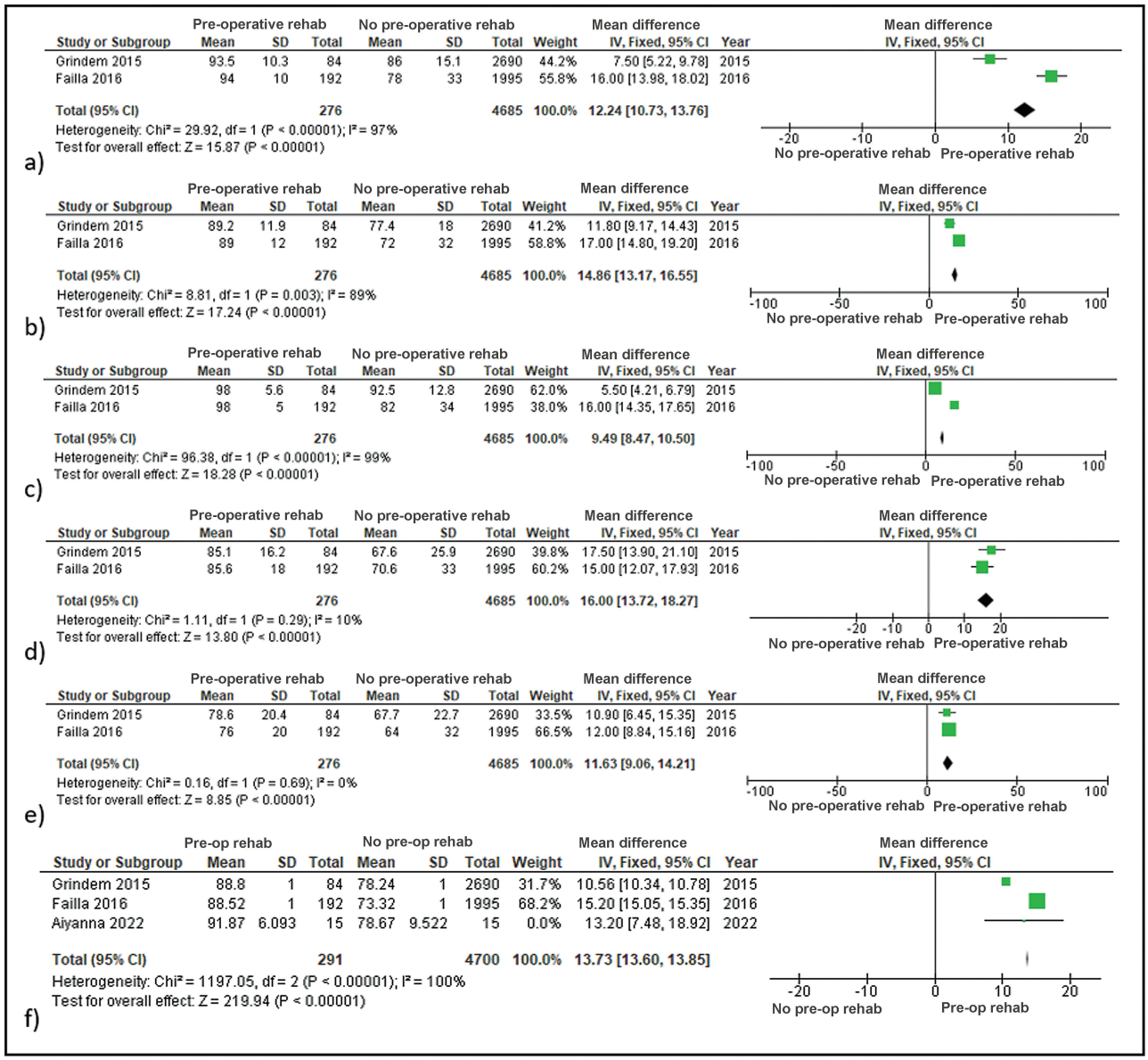


Fig. 2 a) Forest Plot of Pain Subscale of the KOOS Score; b) Forest Plot of Symptoms Subscale of the KOOS Score; c) Forest Plot of ADL Subscale of the KOOS Score; d) Forest Plot of Sports and Recreation Subscale of the KOOS Score; e) Forest Plot of QoL Subscale of the KOOS Score; f) Forest Plot of the Total Mean of the KOOS Score.

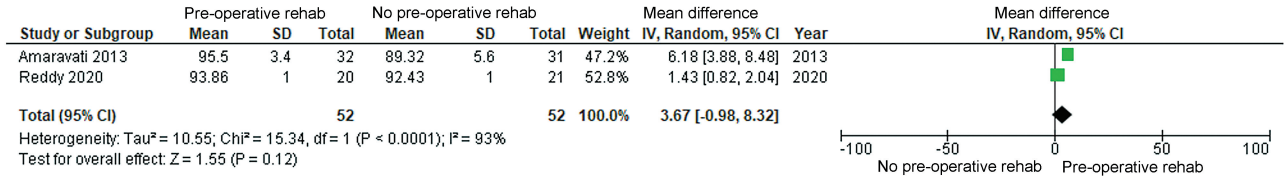


Fig. 3 Forest Plot for 3 month post-operative Lysholm Score.

protocol of rehabilitation that may improve patients' undergoing ACL reconstruction outcome.

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Conflict of Interests
The authors have no conflicts of interest to declare.

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Combined Anterior Cruciate Ligament Reconstruction (ACLR) and Lateral Extra-articular Tenodesis through the Modified Lemaire Technique versus Isolated ACLR: A Meta-analysis of Clinical Outcomes

Reconstrução combinada do ligamento cruzado anterior (RLCA) e tenodese extra-articular lateral pela técnica de Lemaire modificada versus RLCA isolada: Uma metanálise dos resultados clínicos

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Abstract

Objective Lateral extra-articular tenodesis (LET) has been proposed to resolve rotatory instability following anterior cruciate ligament reconstruction (ACLR). The present meta-analysis aimed to compare the clinical outcomes of ACLR and ACLR with LET using the modified Lemaire technique.

Materials and Methods We performed a meta-analysis following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) staement. The literature search was performed on the PubMed, EBSCOHost, Scopus, ScienceDirect, and WileyOnline databases. The data extracted from the studies included were the study characteristics, the failure rate (graft or clinical failure) as the primary outcome, and the functional score as the secondary outcome. Comparisons were made between the patients who underwent isolated ACLR (ACLR group) and those submitted to ACLR and LET through the modified Lemaire technique (ACLR + LET group).

Keywords
- anterior cruciate ligament reconstruction
- joint instability
- knee joint
- tenodesis
- treatment outcome

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Results A total of 5 studies including 797 patients were evaluated. The ACLR + LET group presented a lower risk of failure and lower rate of rerupture than the ACLR group (risk ratio [RR] = 0.44; 95% confidence interval [95%CI]: 0.26 to 0.75; $I^2 = 9\%$; $p = 0.003$). The ACLR + LET group presented higher scores on the Knee Injury and Osteoarthritis Outcome Score (KOOS) regarding the following outcomes: pain, activities of daily living (ADL), sports, and quality of life (QOL), with mean differences of 0.20 (95%CI: 0.10 to 0.30; $I^2 = 0\%$; $p < 0.0001$), -0.20 (95%CI: -0.26 to -0.13; $I^2 = 0\%$; $p < 0.00001$), 0.20 (95%CI: 0.02 to 0.38; $I^2 = 0\%$; $p = 0.03$), and 0.50 (95%CI: 0.29 to 0.71; $I^2 = 0\%$; $p < 0.00001$) respectively when compared with the ACLR group.

Conclusion Adding LET through the modified Lemaire technique to ACLR may improve knee stability because of the lower rate of graft rerupture and the superiority in terms of clinical outcomes.

Level of Evidence I.

Resumo

Objetivo A tenodese extra-articular lateral (TEL) foi proposta para resolver a instabilidade rotatória após a reconstrução do ligamento cruzado anterior (RLCA). Esta metanálise teve como objetivo comparar os resultados clínicos da RLCA e da RLCA com TEL por meio da técnica de Lemaire modificada.

Materiais e Métodos Esta metanálise foi feita de acordo com a declaração dos Itens Principais para Relatar Revisões Sistemáticas e Metanálises (Preferred Reporting Items for Systematic Reviews and Meta-Analysis, PRISMA, em inglês). A pesquisa bibliográfica foi realizada nos bancos de dados PubMed, EBSCOHost, Scopus, ScienceDirect e WileyOnline. Dos estudos incluídos foram extraídas informações sobre as características do estudo, a taxa de falha (falha clínica ou do enxerto) como resultado primário, e o escore funcional como resultado secundário. Foram feitas comparações entre os pacientes submetidos apenas à RLCA (grupo RLCA) e à RLCA e TEL pela técnica de Lemaire modificada (grupo RLCA + TEL).

Resultados Foram avaliados 5 estudos que incluíam 797 pacientes. O grupo RLCA + TEL apresentou um risco menor de falha e menor taxa de rerruptura do que o grupo RLCA (razão de risco [RR] = 0,44; intervalo de confiança de 95% [IC95%] 0,26 a 0,75; $I^2 = 9\%$; $p = 0,003$). O grupo RLCA + TEL obteve pontuações maiores no Escore de Desfechos de Osteoartrite e Lesão no Joelho (Knee Injury and Osteoarthritis Outcome Score, KOOS, em inglês) com relação aos seguintes desfechos: dor, atividades cotidianas (AC), esportes, e qualidade de vida (QV), com diferenças médias de 0,20 (IC95%: 0,10 a 0,30; $I^2 = 0\%$; $p < 0,0001$), -0.20 (IC95%: -0,26 a-0,13; $I^2 = 0\%$; $p < 0,00001$), 0,20 (IC95%: 0,02 a 0,38; $I^2 = 0\%$; $p = 0,03$) e 0,50 (IC95%: 0,29 a 0,71; $I^2 = 0\%$; $p < 0,00001$), respectivamente, quando comparado com o grupo RLCA.

Conclusão O acréscimo de TEL pela técnica de Lemaire modificada à RLCA pode melhorar a estabilidade do joelho devido à menor taxa de rerruptura do enxerto e à superioridade dos resultados clínicos.

Nível de evidência I.

Palavras-chave
- reconstrução do ligamento cruzado anterior
- instabilidade articular
- articulação do joelho
- tenodese
- resultado do tratamento

Introduction

Anterior cruciate ligament (ACL) ruptures are among the most commonly studied injuries in orthopedic research, and their incidence is estimated to range from 30 to 78 cases per 100 thousand people a year.[1] After ACL reconstruction (ACLR), 61% to 89% of athletes successfully return to sports, typically between 8 and 18 months after the reconstruction, depending on the level of play.[1] Under certain conditions, a rerupture can occur, which may be devastating. The reported rate of ACL rerupture ranges from 1% to 11%, and they may be caused by traumatic reinjuries, biological graft failure, or technical surgical errors.[1,2]

The management of ACL injury in patients at a higher risk of rerupture remains controversial. It has been shown that the risk factors for graft rupture include younger patients (< 20 years of age), those with generalized hypermobility and physiologic

knee hyperextension, and those returning to high-risk (pivoting) sports.[3] Further, Saita et al.[4] showed that knee hyperextension and a small lateral condyle are associated with greater anterolateral rotatory instability, which is difficult to manage in patients who continue to show a positive pivot shift after isolated ACLR. In the literature,[3,5–7] the MacIntosh, Lemaire, and anterolateral ligament (ALL) reconstruction techniques have been shown to resolve anterolateral rotatory instability. Reconstruction of the ALL was found to reduce the graft failure rate in large series of patients at 2 years of follow-up.[8] The modified Lemaire technique has been shown to present a low complication rate and to cause a reduction in pivot-shift instability.[6]

One of the reasons to favor lateral extra-articular tenodesis (LET) rather than ALL reconstruction is because of the evidence indicating that ALL reconstruction could overconstrain the lateral joint while not being as mechanically advantageous in resisting rotation.[9,10] The aim of LET is to decrease the rerupture rate by providing more stability to the knee joint. A cohort study by Cavaignac et al.[11] reported that ACLR with LET showed better graft maturity on magnetic resianace imaging (MRI) scans after one year of the procedures. Mayr et al.[12] focused on the modified Lemaire technique, which has recently been used to perform LET, and they showed that it may decrease the strain on the graft as well as residual rotational laxity, thus improving the clinical outcomes. Therefore, we conducted a meta-analysis to determine the impact of ACLR and LET through the modified Lemaire technique compared with ACLR on patients with ACL rupture in terms of the rerupture rate and clinical outcome. The objective of the present study was to determine the surgical outcome of ACLR with modified Lemaire LET for ACL rupture, which is be represented by the rerupture rate and clinical outcomes.

Materials and Methods

Search Strategy

We conducted a systematic review and meta-analysis based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[13] The study protocol was registered in the Open Science Framework. The literature search was conducted in June 2022 on several databases, including PubMed, EBSCOHost, Scopus, ScienceDirect, and WileyOnline, focusing on the Population, Intervention, Control, and Outcome (PICO) strategy. The population consisted of patients with ACL tears, the intervention was ACLR and LET through the modified Lemaire technique, and isolated ACLR was the comparator. The outcomes assessed were the rerupture rate as the primary outcome, and the patient-reported outcome measures (PROMs) and functional scores as secondary outcomes.

Study Selection

The exclusion criteria were animal studies, revision cases of ACLR, concomitant posterior cruciate ligament (PCL) or meniscus reconstruction, underlying congenital condition or neoplasm, ACLR with ALL reconstruction, patients treated with pharmacologic treatment, nutrition treatment, physical therapy or isolated rehabilitation, and ACLR with LET not through the modified Lemaire technique. Only studies published in English within the last twenty years were included.

Quality Appraisal and Risk of Bias Assessment

Two authors (ED and LC) performed the identification and selectionof studies, as well as data extraction. The quality assessment was performed by two other authors (MS, IJA). Differences in opinion between the two reviewers were resolved by reassessment and discussion with another author (EK). The selected studies were assessed using the Joanna Briggs Institute's tools for critical appraisal.[14]

Data Extraction and Analysis

The data extracted from the included studies were characteristics such as author and year of publication, location, design, sample characteristics (age, gender, injury type), failure (graft or clinical failure), and outcome (Knee Injury and Osteoarthritis Outcome Score [KOOS], functional outcome, and clinical outcome). The studies were assessed qualitatively and quantitatively using the Review Manager (RevMan, The Cochrane Collaboration, London, United Kingdom) software, version 5.4. The random-effects model was used to calculate pooled ratio from each study based on the heterogeneity. The Cochrane I-squared (I^2) test was conducted to determine the heterogeneity. The results of the studies are presented in a forest plot with the pooled risk ratio (RR).

Results

In the initial screening, 163 studies were retrieved (►**Fig. 1**). Among the ten remaining studies, two did not have a primary outcome (success rate),[12,15] one included skeletally-

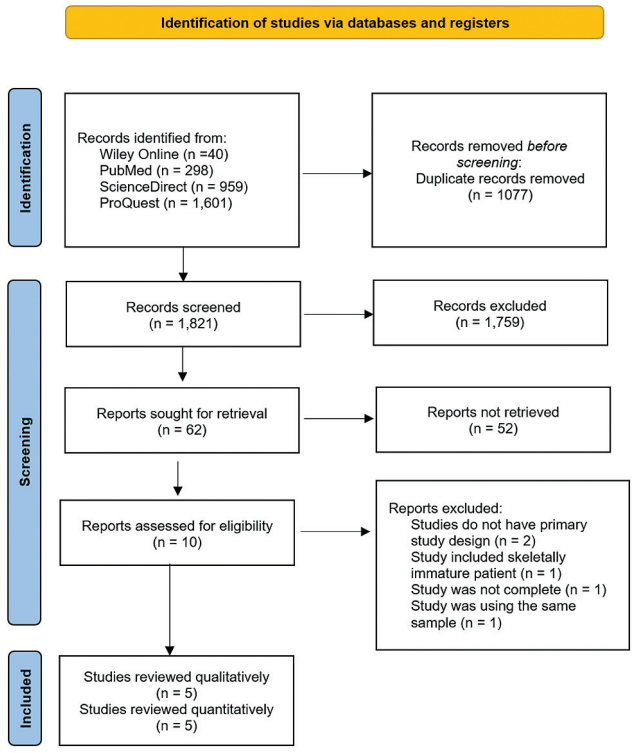


Fig. 1 PRISMA flowchart.

immature patients,[16] and one did not have adequate control.[17] In the end, we found five studies[18–22] eligible for qualitative and quantitative analysis after the searching strategies were applied. Two studies were randomized controlled trials (RCTs)[18,19] and three were cohort studies.[20–22]

The appraisal of the studies using the Joanna Briggs Institute's critical appraisal tools showed that all of them were considered good in terms of methodological quality and lack of the possibility of bias in their design, conduct and analysis (►**Table 1**). ►**Table 2** shows the characteristics of the studies. including the intraoperative details. ►**Table 3** shows the outcome parameters measured for each study.

In the present study, we found that the RR for failure was lower in the ACLR + LET group with the modified Lemaire rechnique than in the ACLR group, with low heterogeneity among the studies (RR = 0.44; 95% confidence interval [95% CI]: 0.26 to 0.75; $I^2 = 9\%$; $p = 0.003$) (►**Fig. 2**).

The meta-analysis showed a superiority of the ACLR + LET group with the modified Lemaire Technique regarding of the following outcomes on the KOOS: pain, activities of daily living (ADL), sports, and quality of life (QoL), with mean differences of 0.20 (95%CI: 0.10 to 0.30; $p < 0.0001$), -0.20 (95%CI: -0.26 to -0.13; $p < 0.00001$), 0.20 (95%CI: 0.02 to 0.38; $p = 0.03$) and 0.50 (95%CI: 0.29 to 0.71; $p < 0.00001$) respectively. However, there was no significant difference between the groups in the symptom scores on the KOOS, with a mean difference of 0.10 (95%CI: -0.03 to 0.2; $p = 0.13$). Neither were there were differences between the groups regarding the scores on the Tegner Activity Scale (TAS) and Lysholm Knee Scoring Scale (LKSS), with mean differences of 0.19 (95%CI: -0.49 to 0.87; $p = 0.58$) and 3.45 (95%CI: -6.22 to 13.22; $p = 0.48$) respectively. However, there was a significant difference regarding the scores on the International Knee Documentation Committee (IKDC) Subjective Knee Form, with a mean difference of 0.70 (95%CI: 0.57 to 0.83; $p < 0.00001$). Low heterogeneity was found in the scores on the KOOS and IKDC Subjective Knee Form , but high heterogeneity was found in TAS and LKSS scores. (►**Fig. 3**).

Discussion

The most important findings of the current research were that, when compared with the ACLR group, the ACLR + LET with modified Lemaire presented a lower failure rate and significant superiority regarding the functional outcome based on the mean differences in pain, ADL, sports, and QoL domains.

When compared with the ACLR group, the ACLR + LET with modified Lemaire group was found to present a lower failure rate (RR = 0.44; $I^2 = 9\%$; $p = 0.003$). The ACLR + LET with modified Lemaire group showed a significant superiority regarding the functional outcome based on the mean differences in the scores on the KOOS domains of pain, ADL, sports, and QoL ($p < 0.00001$; $p < 0.03$; $p < 0.00001$; and $p < 0.00001$ respectively) and the scores on the IKDC Subjective Knee Form ($p < 00001$).

Rotational stability was not recovered with isolated ACLR in a certain population.[23] Therefore, both intra- and extra-

Table 1 Critical appraisal the results of the selected studies

Study	Items on the Joanna -Briggs Institute's tools for critical appraisal												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Castoldi et al.[18] (2020)	Y	Y	Y	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Getgood et al.[19] (2020)	Y	Y	Y	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Eggeling et al.[21] (2022)	Y	Y	Y	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Rowan et al.[22] (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Dejour et al.[20] (2013)	Y	Y	Y	NA	NA	Y	Y	Y	Y	Y	Y		

Abbreviations: NA, not available; Y, yes.

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Table 2 Characteristics of the included studies

Study	Type	Level of evidence	No. of patients						Mean Age (years)		Mean/ minimum follow-up (years)	Mean Time from Injury to Surgery (months)		Graft		Tensioning method	LET fixation	ACL fixation
			LET			Non-LET			LET	Non-LET		LET	Non-LET	ACL	LET			
			M	F	T	M	F	T										
Castoldi et al.[18] (2020)	RCT	2	47	13	60	43	18	61	26.2	25.9	19.4	NR	NR	BPTB	G	30 degrees of knee flexion	Suture fixation	Femoral/tibial side: absorbable interference screw
Getgood et al.[19] (2020)	RCT	2	151	155	306	151	161	312	19.1	18.8	2	9.3	8.1	H	ITB	60–70 degrees of knee flexion	Barbed Richards fixation staple	Femoral side: femoral cortical suspensory fixation; tibial side: tibial interference screw
Eggeling et al.[21] (2022)	C	3	13	10	23	35	20	55	33.3	31.9	2.4	NR	NR	BPTB, H, Q	ITB	45 degrees of knee flexion	Suture fixation	Femoral/tibial sides: interference screw
Rowan et al.[22] (2019)	C	3	34	21	55	120	98	218	26	33	2	NR	NR	ST + G	ITB	30 degrees of knee flexion	Fixation staple with spike	Femoral/tibial sides: absorbable interference screw
Dejour et al.[20] (2012)	C	3	20	5	25	17	8	25	21.4	27.5	2	10.78	12.96	BPTB	G	Full extension	Suture fixation	Femoral/tibial sides: interference screw

Abbreviations: ACL, anterior cruciate ligament; BPTB, bone-patellar tendon-bone; C, cohort; F, female; G, gracilis; H, hamstring; ITB, iliotibial band; LET, lateral extra-articular tenodesis; M, male; NR, not reported; Q, quadriceps; RCT, randomized controlled trial; ST, semitendinosus; T, total.

Table 3 Outcomes of the included atudies

Study	Failure (%LET vs. %control)	Outcome								
		KOOS pain score	KOOS symptom score	KOOS ADL score	KOOS sports score	KOOS QoL score	Tegner score	International Knee Documentation Committee score	Lysholm score	Marx score
Castoldi et al.[18] (2020)	Graft failure: 5/38 (13%) vs. 12/42 (29%)	–	–	–	–	–	–	82.4 ± 11.2 vs. 81.1 ± 14.38	–	–
Getgood et al.[19] (2020)	Clinical failure: 72/291 (25%) vs. 120/298 (40%) (RR: 0.38; 95%CI: 0.21–0.52; $p = 0.0001$)	92.1 ± 0.6 vs. 91.9 ± 0.6	84.7 ± 0.8 vs. 84.6 ± 0.8	97 ± 0.4 vs. 97.2 ± 0.4	85.3 ± 1.1 vs. 85.1 ± 1.1	63.8 ± 18.9 vs. 58.4 ± 19.7	–	87.3 ± 0.8 vs. 86.8 ± 0.8	–	12.1 ± 5.5 vs. 12.7 ± 4.7
	Graft ailure: 11/291 (4%) vs. 34/298 (11%) (RR: 0.67; 95%CI, 0.36–0.83; $p = 0.001$)						–	–	–	–
Eggeling et al.[21] (2022)	Clinical failure: 3/23 (13%) vs. 6/55 (10.9%)	87.9 ± 14.6 vs. 87.9 ± 14.1	87.6 ± 15.4 vs. 87.3 ± 14.8	95.2 ± 8.2 vs. 93 ± 10	72.6 ± 25.9 vs. 76 ± 22.7	75.4 ± 1.3 vs. 74.9 ± 1.3	5.7 ± 1.3 vs. 5.9 ± 1.5	80.1 ± 14.9 vs. 77.5 ± 16.2	81.9 ± 14.2 vs. 83.8 ± 14.5	–
Rowan et al.[22] (2019)	Clinical failure: 0/46 (0%) vs. 13/125 (10.4%)	–	–	–	–	–	8.04 ± 1.35 vs. 75.4 ± 1.35	–	98 ± 11.2 vs. 90 ± 16.2	–
Dejour et al.[20] (2012)	Clinical failure: 0/25 (0%) vs. 2/25 (8%)	–	–	–	–	–	–	–	–	–

Abbreviations: 95%CI, 95% confidence interval; ADL, activities of daily living; KOOS, Knee Injury and Osteoarthritis Outcome Score; LET, lateral extra-articular tenodesis; QoL, quality of life; RR, risk ratio; vs., versus.

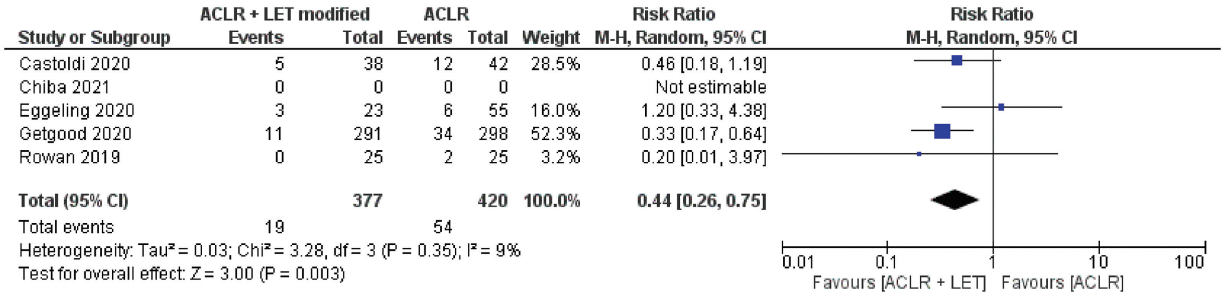


Fig. 2 Risk ratio for failure in the group of ACLR + LET through the modified Lemaire technique and the ACLR group.

articular procedures were necessary to improve ACL stability, thus improving the ability to perform sports in this population. It is known that LET is one of the extra-articular procedures that preserves knee stability. Na et al.[23] compared isolated ACLR to ACLR combined with anterolateral extra-articular procedures, and they noticed that both techniques improved pivot-shift grades and graft failure rates. However, in the ACLR + LET group, there was an increased risk of knee stiffness and adverse events.[23] These findings explain the significantly better KOOS and IKDC scores in the group submitted to ACLR + LET with the modified Lemaire technique.

Various LET procedures, namely Lemaire, MacIntosh, and ALL reconstruction, are the choices to manage rotatory instability. However, a in a kinematic study published by Inderhaug et al.[10] in 2017, the authors found that ALL reconstruction is underconstrained procedure. Compared with ALL reconstruction, the modified Lemaire technique has been shown to present a low complication rate and to cause a reduction in pivot-shift instability. The modified Lemaire technique also showed good graft survival and PROMs in a high-risk population.[1] This may suggest that LET is an effective technique to restore joint stability to a knee with additional features of laxity.[2,10]

In a meta-analysis, Onggo et al.[24] compared ACLR and ACLR + LET through any method, and the inclusion of studies with a minimum of two years of follow-up. They found improved stability (RR = 0.59; 95%CI: 0.39 to 0.88) and improved clinical outcomes in the ACLR + LET group, shown by mean differences in the IKDC and Lysholm scores of 2.31 (95%CI: 0.54 to 4.09) and 2.71 (95%CI 0.68 to 4.75) respectively. In addition, there was less likelihood of graft rerupture in the ACLR + LET group, with an RR of 0.31 (95%CI: 0.17 to 0.58).[24] In a single-armed systematic review involving 851 patients who underwent ACLR + LET, Grassi et al.[25] showed favorable results in terms of KOOS scores, with 74% of the patients returning to their previous sports activities, as well as complication and failure rates of 8.0% and 3.6% respectively.

The combination of ACLR and LET has also been considered safe for the patients. Feller et al.[26] reported that, at the 12-month follow-up, a contact-related graft rupture occurred in one patient, accounting for 4% of the total. Two additional ACL injuries in the opposite knee were observed, making up 9% of the cases, with 1 of them being an ACL graft rupture at 11 months postoperatively and another occurring at 22 months. Furthermore, a separate incident of contralateral ACL graft rupture took place at the 26-month follow-up.[26] Concerns were raised about the potential for excessive restriction of the lateral compartment of the knee and the subsequent development of lateral compartment osteoarthritis in relation to LET. However, a meta-analysis by Devitt et al.[27] provided strong evidence that the addition of LET reduces the movement of the lateral compartment. Biomechanical studies support these clinical findings, showing that both anatomic ALL reconstruction and LET procedures can overly restrict the lateral compartment. On the contrary, a recent systematic review indicated that adding LET to ACLR does not increase long-term osteoarthritis rates. While there is insufficient evidence to determine whether adding LET to primary ACLR improves various outcomes, there is strong evidence that LET effectively reduces laxity in the lateral compartment, as demonstrated by stress radiography.[28,29]

In the biomechanics study, there is still a controversy regarding ACLR + LET with the modified Lemaire technique. A laboratory study[10] with a fresh frozen cadaver found that this technique might have overconstrained knee kinematics. However, a pilot study by Di Benedetto et al.[30] on 16 patients aged 21 to 37 years who underwent ACLR + LET revealed reacquisition of sagittal knee stability and gait dynamics to the preoperative level. These findings are also supported by a meta-analysis by Feng et al.,[31] who reported that, in 1,745 patients, ACLR + LET provided reduced pivot-shif,t with an odds ratio of 0.48 (95% CI: 0.31 to 0.74), and better graft failure rate, with an odds ratio of 0.34 (95%CI: 0.20 to 0.55).

As a limitation of the present study, there is still a lack of raw data to make a more comprehensive functional outcome analysis. Therefore, future studies with large samples might be needed to find better evidence regarding the effectiveness of ACLR combined with LET through the modified Lemaire technique.

Conclusion

The combination of LET through the modified Lemaire technique and ACLR showed a reliable result to minimize the rate of graft rerupture, as well as superiority in terms of clinical outcomes compared with isolated ACLR due to its role in improving knee stability.

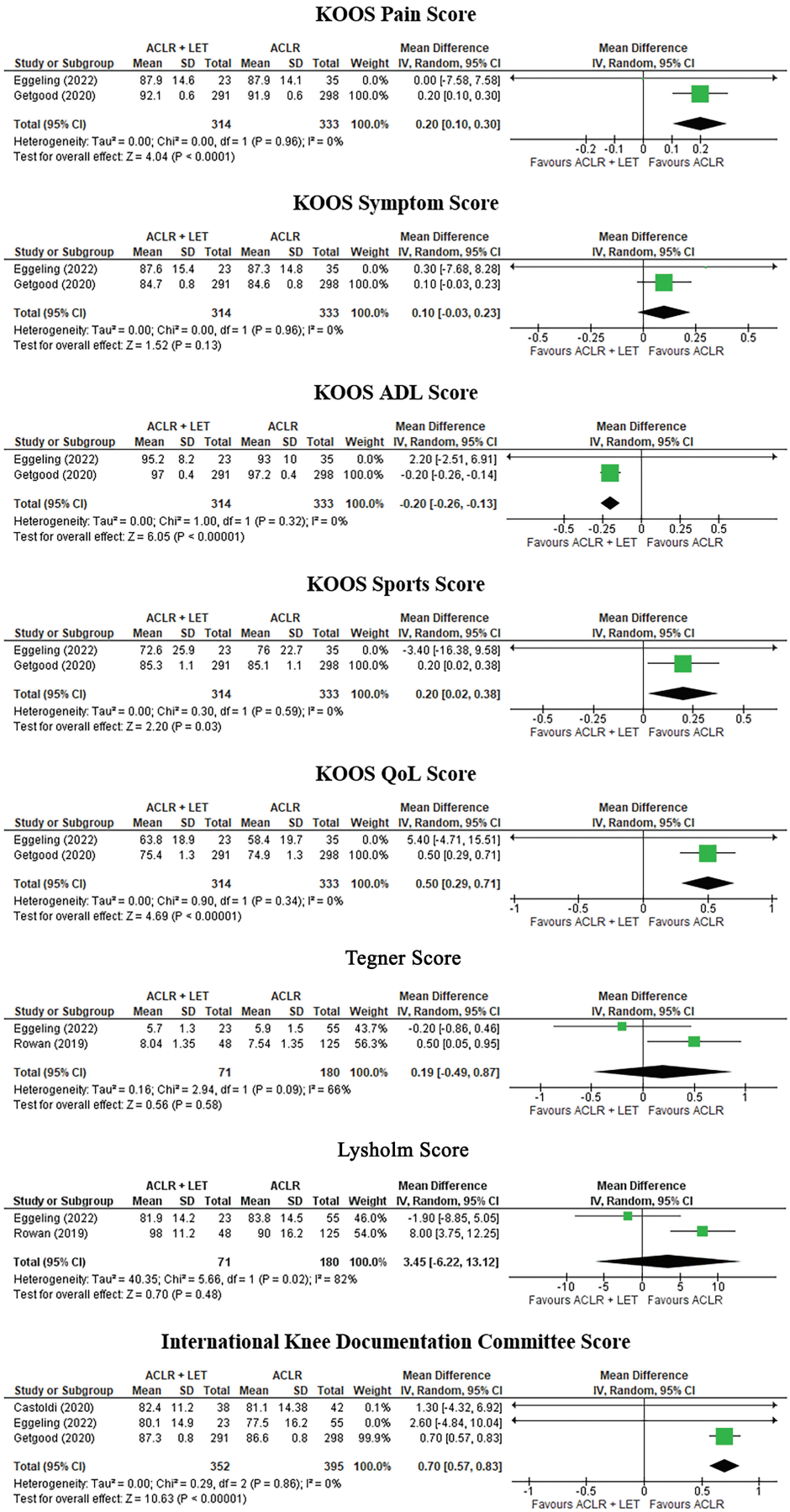


Fig. 3 Forest Plot of the secondary outcome of the included studies.

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Conflict of Interests
The authors have no conflict of interests to declare.

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The Influence of Tunnel Parameters and Graft Inclination Angle on Clinical and Radiological Outcome at Long-term Follow-up after Arthroscopic Anterior Cruciate Ligament Reconstruction

Influência dos parâmetros do túnel e do ângulo de inclinação do enxerto no desfecho clínico e radiológico no acompanhamento de longo prazo após a reconstrução artroscópica do ligamento cruzado anterior

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Abstract

Objective To study the influence of various tunnel parameters and graft inclination angle (GIA) on the clinical and radiological outcome after anterior cruciate ligament reconstruction (ACLR) at long-term follow-up.

Methods In this retrospective study, 80 patients with isolated anterior cruciate ligament (ACL) injury treated by single bundle ACLR using bone patellar tendon bone (BPTB) and hamstring (HT) autografts were evaluated clinically and radiologically at their long-term follow-up. The study population were divided into two groups based on ideal and nonideal tunnel parameters as well as ideal and nonideal GIA. The various tunnel parameters and GIA were interpreted with clinical and radiological outcome at long-term follow-up.

Results Eighty patients, 36 (45%) using BPTB and 44 (55%) using HT autografts, were available to complete the study. Patients with ideal coronal tibial tunnel angle (CTTA) and coronal femoral tunnel angle (CFTA) show superior clinical outcome (pivot shift test) than nonideal CTTA and CFTA, which was found to be statistically significant (p-value < 0.038 and 0.024, respectively). Similarly, patients with ideal coronal tibial

Keywords
- anterior cruciate ligament reconstruction
- knee joint
- osteoarthritis

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tunnel position (CTTP) show superior clinical outcome (International Knee Documentation Committee - IKDC objective) over nonideal CTTP (p-value < 0.017). All other tunnel parameters and GIA were not found to have influence on clinical outcome. None of the tunnel parameters have influenced osteoarthritis (OA) change. There was no progression of OA change in the study population at long-term follow-up after ACLR.
Conclusion Ideal coronal tunnel parameters produced a better clinical outcome at long-term follow-up after ACLR. There was no progression of OA change at long-term follow-up after isolated ACLR.

Resumo

Objetivo O objetivo deste estudo foi analisar a influência de vários parâmetros do túnel e do ângulo de inclinação do enxerto (GIA, do inglês *graft inclination angle*) nos desfechos clínicos e radiológicos da reconstrução do ligamento cruzado anterior (RLCA) no acompanhamento de longo prazo.
Métodos Neste estudo retrospectivo, 80 pacientes com lesão isolada do ligamento cruzado anterior (LCA) submetidos à RLCA de feixe único com autoenxertos de tendão patelar ósseo (TPO) e isquiotibiais (IT) foram avaliados clínica e radiologicamente durante o acompanhamento em longo prazo. A população do estudo foi dividida em dois grupos com base nos parâmetros ideais ou não ideais do túnel, bem como no GIA ideal e não ideal. Os vários parâmetros do túnel e o GIA foram interpretados com os desfechos clínicos e radiológicos no acompanhamento em longo prazo.
Resultados Oitenta pacientes, sendo 36 (45%) submetidos ao procedimento com autoenxertos de TPO e 44 (55%) com autoenxertos IT, puderam completar o estudo. Pacientes com ângulo do túnel tibial coronal (ATTC) e ângulo do túnel femoral coronal (ATFC) ideais apresentam resultados clínicos superiores (teste de *pivot shift*) do que aqueles com ATTC e ATFC não ideais, sendo a diferença estatisticamente significativa (valor de $p < 0{,}038$ e 0,024, respectivamente). Da mesma forma, pacientes com posição do túnel tibial coronal (PTTC) ideal apresentam resultado clínico superior (*International Knee Documentation Committee* [IKDC] objetivo) em relação àqueles com PTTC não ideal (valor de $p < 0{,}017$). Os demais parâmetros do túnel e o GIA não influenciaram o desfecho clínico. Nenhum dos parâmetros do túnel influenciou a alteração associada à osteoartrite (OA). Não houve progressão da alteração da OA na população do estudo no acompanhamento em longo prazo após a RLCA.
Conclusão Os parâmetros ideais do túnel coronal produziram um melhor desfecho clínico no acompanhamento de longo prazo após a RLCA. Não houve progressão da alteração da OA no acompanhamento em longo prazo após a RLCA isolada.

Palavras-chave
- articulação do joelho
- osteoartrite
- reconstrução do ligamento cruzado anterior

Introduction

Arthroscopic anterior cruciate ligament reconstruction (ACLR) is the standard of treatment for anterior cruciate ligament (ACL) insufficiency. The goal of ACLR is to restore normal knee anatomy and kinesiology, which will improve knee stability. Recent literature states that early osteoarthritis (OA) changes may be aborted in ACL injured knee by anatomical ACLR.[1] The tibial and femoral tunnel placements primarily are important in achieving knee stability. Improper femoral or tibial tunnel placement were the most commonly argued cause for failure of ACLR.[2] Cadaveric studies have shown that the location of the center of native ACL in the femur, on lateral radiograph, is present at a mean of 66% of the anterior edge of the Blumensaat line. On the tibial side, the center of native ACL is located at the junction of the anterior and middle third of the tibial plateau.[3] Supporting the cadaveric studies, recent clinical studies show that anatomical ACLR would result in better clinical outcome than non-anatomical reconstruction.[4] Traditional transtibial (TT) technique would cause more vertical orientation of graft, decreased rotational stability, and graft failure.[5] It was argued that anteromedial (AM) portal aids in more anatomical femoral tunnel placement compared to traditional TT portal. The grafts in anatomical ACLR lie in more horizontal position in coronal plane resulting in improved rotational stability and decreases the pivot shift phenomenon.[6] Though ideal tunnel parameters and GIA representing

anatomical ACLR has been emphasized in many studies in the past, their influence on long-term outcome has not been validated. Further, a few authors are of the opinion that there is no correlation between tunnel position and long-term clinical outcome.[7] Also, recent studies show non-anatomical femoral tunnel placement prevails equally among TT as well as in AM portal techniques.[8] In spite of extensive literature studies on tunnel placement, the ideal tunnel placement has not been found in many patients due to some variables. The commonly used tunnel parameters include coronal femoral tunnel position (CFTP), sagittal femoral tunnel position (SFTP), coronal tibial tunnel position (CTTP), sagittal tibial tunnel position (STTP), coronal femoral tunnel angle (CFTA), sagittal femoral tunnel angle (SFTA), coronal tibial tunnel angle (CTTA), sagittal tibial tunnel angle (STTA), and graft inclination angle (GIA).

Hence, we proposed to study, retrospectively, the influence of various tunnel parameters and GIA on the clinical and radiological outcome after ACLR at long-term follow-up.

We hypothesize that:

1) Ideal coronal tunnel parameters would result in better clinical outcome.
2) Progression of knee osteoarthritis (OA) would be retarded by ACLR in isolated ACL injury.

Materials and Methods

This retrospective study was conducted in a tertiary care center in South India. Institutional review board approval was obtained, and all patients in the study signed the written informed consent.

From January 2013 to august 2016, 80 patient's data were collected from hospital registry comprising 36 patients who underwent ACLR with bone-patellar tendon-bone (BPTB), and 44 patients with hamstring tendon (HT) autografts.

Inclusion criteria:

- Age $>$ 18 years and $<$ 45 years
- Sex: males and females
- Isolated ACL injury
- Willingness to participate in the study

Exclusion criteria:

- Associated meniscal and chondral injuries
- Multiligamentous injury
- Previous surgeries in ipsilateral limb or knee
- Concomitant fractures in ipsilateral or opposite limb
- Reinjury to operated knee
- Patients with generalized ligament laxity
- Patients not willing to participate in the study

Surgical Procedure

All the patients in this study underwent arthroscopic ACLR by a single fellowship trained arthroscopic surgeon. AM portal technique was used in all cases for femoral tunnel creation. Patients received either BPTB or HT autograft. Both femoral and tibial side graft fixation was done using titanium interference screw (Nebula, India).

Postoperative rehabilitation:

Week 1	Isometric quadriceps, ankle pumps, active straight leg raise (SLR) exercise with knee brace support.
Week 2	Previous exercise+ patellar mobilization and closed chain knee range of movement exercise restricting to 90 deg flexion.
Week 3–6	Previous exercise + progressive hamstring and quadriceps strengthening exercise.
Week 6–3 Months	Previous exercise + progressive knee flexion + proprioception and core strengthening exercise.
3–6 Months	Swimming, progressive squatting, and sports-specific agility training exercises.

Radiological Evaluation

Preoperative plain radiographs of injured knee were compared with postoperative x-rays. Standing AP view with 0^o knee flexion, PA view with 30^o knee flexion, and lateral view with 30^0 knee flexion were taken to analyze. All radiograph images were interpreted in DICOM format in Picture Archiving and Communication Systems (PACS) (version 8.2). Various tunnel parameters, GIA, and OA change measurements were analyzed. The tunnel parameters and radiological measurements analyzed in the study were CFTA, SFTA, CTTA, STTA, CFTP, SFTP, CTTP, STTP, and GIA (►**Figs. 1** and **2**). For OA change analysis, we used the Kellegran and Lawrence (KL) score.[9] Radiological assessment was done by two persons (radiologists) with reliable inter and intra observer correlation.

Clinical Evaluation

This includes International Knee Documentation Committee (IKDC)-subjective and objective, Lysholm scoring, single leg hops testing (SLHT), pivot shift test, anterior drawer test (ADT), and Lachman test (LT).

The study population was divided into two groups based on ideal vs nonideal tunnel parameters and ideal GIA vs nonideal GIA.

Ideal tunnel parameters and ideal GIA were those patients in whom the tunnel measurements were within the reference range recommended by previous studies.[10–14] Nonideal tunnel parameters and nonideal GIA were those patients in whom the measurements were outside the reference range as recommended by previous studies (►**Figs. 3** and **4**). The Pivot shift test was dichotomized into two subgroups for statistical analysis. In one group grade 0, and another with grades 1, 2, and 3. Similarly, ADT and LT were dichotomized into two groups. In one group grade 1, and in another group grades 2 and 3. Likewise, IKDC (objective) and single leg hop test were dichotomized. In one group grades A and B, and another with grades C and D.

The clinical and radiological outcome were interpreted in both ideal and nonideal tunnel groups as well as in both ideal and nonideal GIA groups at long term follow-up.

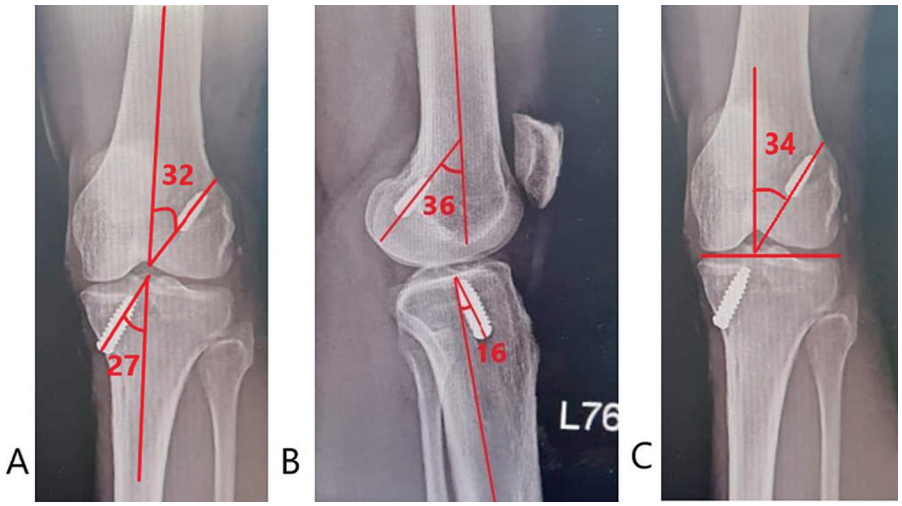


Fig. 1 Radiological assessment of tunnel angles in postoperative x-rays. A) Coronal femoral and tibial tunnel angles. B) Sagittal femoral and tibial tunnel angles. C) Graft inclination angle.

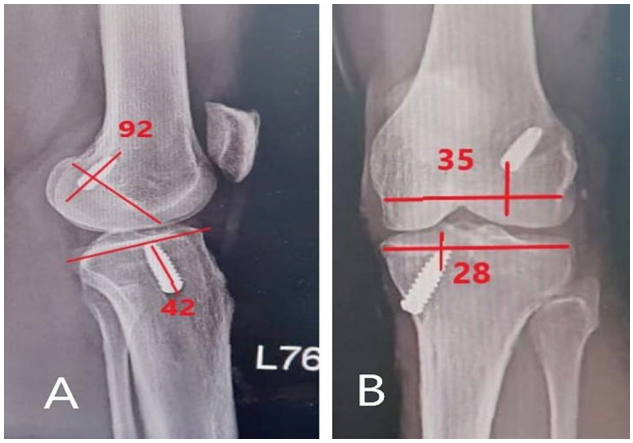


Fig. 2 Radiological assessment of tunnel positions in post operative x-ray. A) Coronal femoral and tibial tunnel positions. B) Sagittal femoral and tibial tunnel positions.

Statistical Analysis

The statistical analysis was done using IBM SPSS Statistics for Window version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive data like mean, median, and standard deviation (SD) were entered as numbers and percentage. Analytical statistics were done using the chi-square test, Man-Whitney test and coupled t-test after dichotomization. *P*-value was significant if < 0.05.

Results

Eighty patients, comprising 36 (45%) using BPTB and 44 (55%) using HT autografts, were taken in the study. The mean (SD) age of the subjects was observed to be 31.25 (6.83). Around 34 (42.5%), 32 (40%), and 14 (17.5%) belonged to the age group 20 to 29 years, 30 to 39 years and 40 to

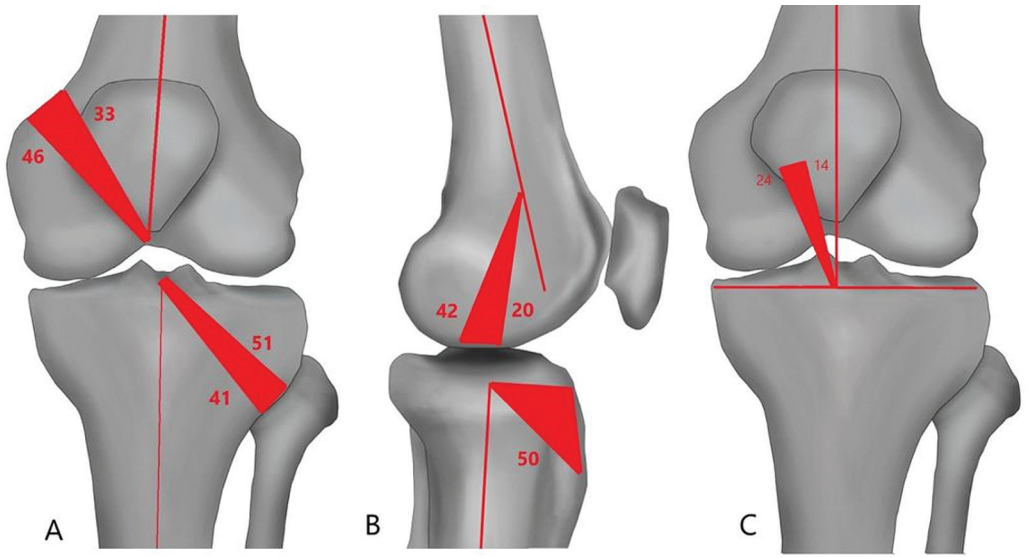


Fig. 3 Schematic diagram showing ideal tunnel angle range. A) Ideal coronal femoral and tibial tunnel angle range. B) Ideal sagittal femoral and tibial tunnel angle range. C) Ideal graft inclination angle range.

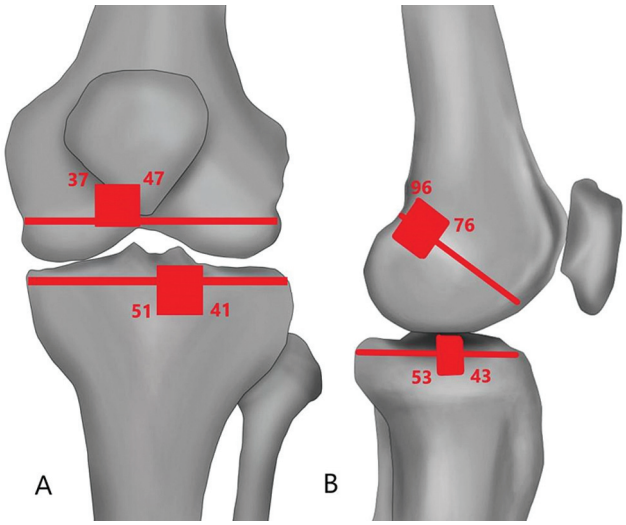


Fig. 4 Schematic diagram showing ideal tunnel position range. A) Ideal coronal femoral and tibial tunnel position range. B) Ideal sagittal femoral and tibial tunnel position range.

49 years, respectively. Male and female subjects accounted for 71 (88.8%) and 9 (11.3%), respectively. Road traffic accidents (34 [42.5%]), fall from one's own height (24 [30%]), and sports injury, (22 [27.5%]), were reported to be the different modes of injury among the subjects. The median (interquartile range - IQR) time from injury was found to be 90 (30–180) days. The mean (SD) follow-up time for the patients was 98.59 (+/-13.78) months. The distribution of ideal/nonideal tunnel parameters and ideal/nonideal GIA among the study subjects is shown in ►**Figs. 5**–**7**.

The mean of ideal tunnel parameters and GIA of our study was compared with literature reference values, as shown in ►**Table 1**.

With regard to subjective clinical outcome, the mean values (SD) of preop and postop IKDC (subjective) were 49.15 (9.86) and 91.10 (6.97), respectively. Whereas the mean (SD) preop and postop Lysholm scores were found to be 38.30 (11.52) and 94.06 (4.81), respectively. There was no significant difference between ideal and nonideal tunnel parameters as well as GIA with regard to subjective clinical outcome.

The distribution of clinical and radiological outcome in the study subjects is shown in ►**Table 2**. The current postoperative KL score remains the same as that of preoperative KL scores in the study population. The statistical association between various tunnel parameters and clinical outcome (objective) is shown in ►**Table 3**. There was no significant difference between ideal and nonideal GIA on clinical (objective) and radiological outcome, as shown in ►**Table 4**. Similarly, there was no significant association between other tunnel parameters on radiological outcome as shown in ►**Table 5**.

Patients with ideal CTTA and CFTA show superior clinical outcome (pivot shift test) than nonideal CTTA and CFTA, and it is found to be statistically significant (p-value < 0.038 and 0.024, respectively). Similarly, patients with ideal CTTP show superior clinical outcome (IKDC objective) over nonideal CTTP (p-value < 0.017), as shown in ►**Table 6**.

Discussion

The primary finding in our study is that patients with ideal CFTA and CTTA were associated with better rotational

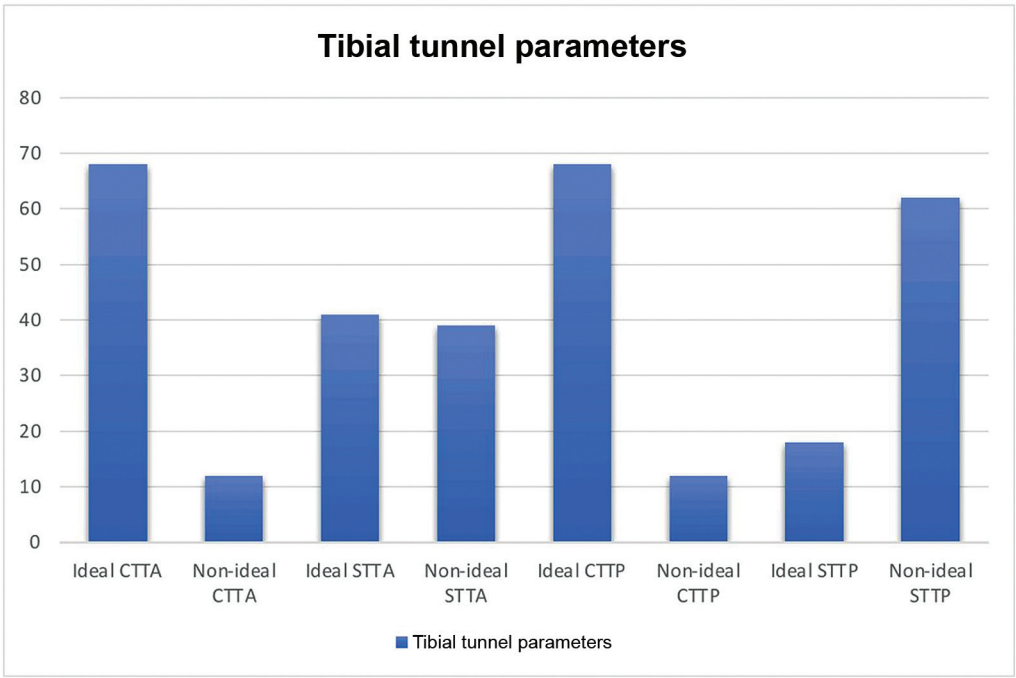


Fig. 5 Distribution of ideal/nonideal tibial tunnel parameter among study population.

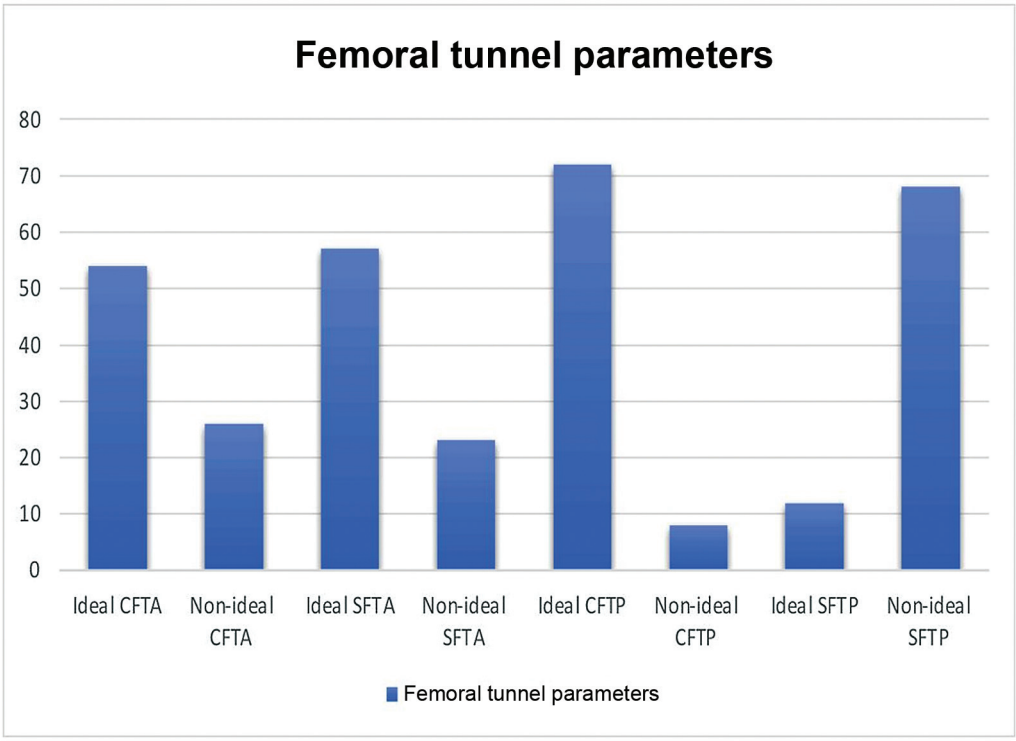


Fig. 6 Distribution of ideal/nonideal femoral tunnel parameters among study population.

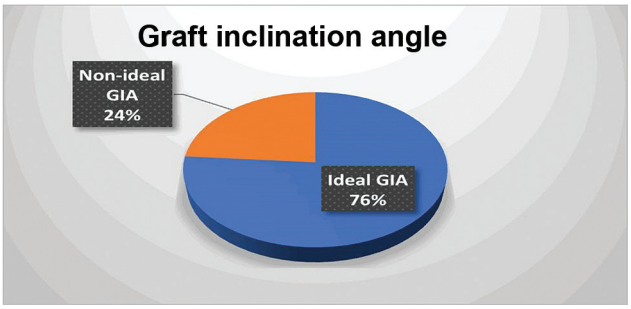


Fig. 7 Distribution of ideal/nonideal GIA among study population.

stability in the form of decreased pivot shift grade. This implies that ideal CFTA and CTTA, which would produce more oblique femoral and tibial tunnels, result in better rotational stability. Similarly, patients with ideal CTTP have better IKDC (objective) score. Other tunnel parameters and GIA were not found to have any significant impact on the clinical outcome.

Hence, our first hypothesis is proved to be correct as ideal coronal tunnel parameters produced better clinical outcome in the form of improved pivot shift grade and significantly better IKDC (objective) score. Similarly, our second hypothesis is also proved to be correct as there was no progression of knee OA after isolated ACLR in the study population on long-term follow up. From the present study, it is clear that accurate coronal placement of grafts, both on the femoral and tibial sides, is essential to get better long-term clinical outcome after ACLR.

According to various studies, placement of graft more vertically in the coronal plane would cause the graft to impinge on the lateral part of the posterior cruciate ligament (PCL) causing loss of flexion and decreased anterior stability resulting in poor clinical outcome.[5,11,15,16] A femoral tunnel placed more obliquely in the coronal plane is important for rotational stability of the knee.[10]

Although it was believed that the anteromedial (AM) portal technique would aid in low position and more oblique coronal femoral tunnel angle, there is still controversy regarding its superiority over the TT technique. Ruhr-Wagner et al.[17] reported increased risk of revision surgeries with the AM portal technique compared to the TT technique. Similarly, Jaecker et al.[8] found in their study high rates of nonanatomic femoral and tibial tunnel positions in ACL revisions with both AM and TT femoral drilling techniques. In our study, too, we used only AM portal technique for femoral drilling in all cases. We did find nonanatomical tunnel positions and angles in many of our study population. This may be attributed to individual distal femoral anatomic variations such as narrow femoral notch, which may not allow for an obliquely drilled tunnel, which, in turn, can lead to anteriorly placed nonanatomical tunnel with a decreased CFTA, as postulated by Illingworth et al.[11]

In our study, the mean CFTA was 35.13^{o}. Illingworth et al.[11] evaluated coronal femoral tunnel angle in 45^{o} knee flexion weight-bearing PA radiographs in postoperative ACLR and found that a CFTA of $< 32.7^{o}$ is likely to have ACLR that falls outside an anatomic range. In our study, patients with nonideal femoral tunnel angles, $< 32^{o}$, presented increased

Table 1 Comparison of Mean of the tunnel parameters and GIA of our study with Literature values

Tunnel parameters	Our study Mean (SD)	Reference value Mean (SD)	Literature
CFTA	35.13 (7.61)	39.5 (6.5)	Illingworth et al. (2011)
SFTA	23.85 (11.315)	31 (11)	Takeda et al. (2013)
CTTA	19.4 (8.824)	28 (18)	Kondo et al. (2007)
STTA	31.33 (7.202)	69.5 (19.5)	Kondo et al. (2007)
CFTP	41.76 (3.135)	42 (5)	Pinczewski et al. (2008)
SFTP	59.14 (16.834)	86 (10)	Pinczewski et al. (2008)
CTTP	44.86 (4.469)	46 (5)	Pinczewski ET AL. (2008)
STTP	37.98 (8.35)	48 (5)	Pinczewski et al. (2008)
GIA	15.81 (7.621)	19 (5)	Pinczewski et al. (2008)

Abbreviations: CFTA - coronal femoral tunnel angle; SFTA - sagital femoral tunnel angle; CTTA - coronal tibial tunnel angle; STTA - Sagital tibial tunnel angle; CFTP - coronal femoral tunnel position; SFTP - sagital femoral tunnel position; CTTP - coronal tibial tunnel position; STTP - sagital tibial tunnel position; GIA - graft inclination angle.

pivot shift grading postoperatively. This contrasts with the studies by Sundemo et al.[7] and Moghtadaei et al.,[18] in which they found no influence of CFTA on clinical or radiological outcome. In the current study, we found that ideal CFTA patients have significantly improved pivot grading compared to nonideal CFTA patients. In our study, the mean CTTA was 19.40^0. The ideal CTTA described in the literature was between 60 and 65^o (measured between the tibial plateau and the tunnel).[19] This will prevent PCL impingement and decrease anterior laxity. In our study, the CTTA was measured between the anatomical axis of the tibia and the tibial tunnel, as described by Kondo et al.[13] A similar measurement was done by Mightadaei et al.[18] In their study, CTTA did not influence the ACLR outcome. In our study, we found ideal CTTA patients had significantly better rotational stability than nonideal CTTA patients. According to Pinczewski et al.[10] and Topliss and Webb,[20] the tibial tunnel should be at 47% from the medial cortex across the tibial plateau in the coronal plane. They state that a more medial placement could cause impingement. In our study, the mean CTTP was 44.86 (+/- 4.46). Patients with ideal CTTP in our study had better IKDC (objective) score than those with nonideal CTTP.

Debnath et al.[21] did a radiological evaluation of the tunnel position in single-bundle ACLR in the Indian population and correlated with clinical outcome. They found that the "ideal clinical outcome" was significantly associated with placement of the femoral tunnel along the sagittal plane. They also recommend that the femoral tunnel should not be placed beyond the 85% mark along the Blumensat line from the anterior most point. Xu et al.,[22] in a systemic review, found the mean position of the native femoral insertion was 28.4% (+/- 5.1%) from the posterior border when using the quadrant method. Sundemo et al.[7] reported mean SFTP by the quadrant method was 40% (+/- 6.4%) from posterior to anterior. In our study, the mean SFTP was 59.14 (+/-16.83). We found no influence of SFTP on the clinical or radiological outcome. According to Ristić et al.,[14] the acceptable STTA was 50 to 89^o (avg 68^o). These authors state that a significant deviation from these values may potentially lead to failure of the ACLR. In our study, the mean STTA was 31.33^o (+/- 7.20). There was no difference in outcome between ideal and nonideal STTA in our study.

Moisala et al.[23] stated that the optimal tibial tunnel location on the sagittal plane is between 32 and 37% of the length of the tibial plateau from the anterior corner for better clinical outcome. In our study, STTP was 37.98 (+/- 8.35). We could not find any impact of STTP on clinical outcome.

We analyzed the impact of various tunnel parameters and graft inclination angle on the outcome of ACLR using the two commonly used autografts. Only very few authors have done similar studies on tunnel parameters in the past using these two grafts with variable results.[7,24,25]

Pinczewski et al.[10] and Struewer et al.[26] reported the progression of the OA in their study population after ACLR in the long term. Contrary to their findings, in our study there was no influence of tunnel parameters or GIA in the long-term OA changes in the study population. Our results were similar to those of Sundemo et al.[7] Surprisingly, in our study, we found that patients with preexisting OA also did not show worsening in the long term. This implies that more than tunnel parameters and GIA, other factors, like concomitant meniscal or chondral injuries, could contribute more for the progression of OA changes in the long term after ACLR.

Limitations

Our study has a few limitations. We have performed the study only in isolated ACL patients. In order to have adequate study population inclusion of two types of autografts was unaviodable. Though this made the study population heterogenous, it did not influence the outcome. Being a retrospective study, a potential selection bias was unavoidable. We used only plain radiography for assessing tunnel parameters. The anteroposterior and pivot shift test grading were performed manually instead of with instrumented arthrometers.

Table 2 Distribution of clinical outcome and radiological outcome in the study subjects

Clinical objective outcome parameters	Preoperative N (%)	Current postoperative N (%)
Pivot shift test		
Grade 0	0 (0)	36 (45)
Grade 1	2 (2.5)	42 (52)
Grade 2	50 (62.5)	2 (2.5)
Grade 3	28 (35)	0(0)
Objective IKDC score		
A	0 (0)	48 (60)
B	0 (0)	31 (38.8)
C	74 (92.5)	1 (1.3)
D	6 (7.5)	0 (0)
Single-leg hop test IKDC grade		
A	0 (0)	62 (77.5)
B	0 (0)	15 (18.8)
C	0 (0)	3 (3.8)
Anterior Drawers test		
Grade 1	0 (0)	37 (46.3)
Grade 2	34 (42.5)	39 (48.8)
Grade 3	46 (57.5)	4 (5)
Lachman test		
Grade 1	0 (0)	36 (45)
Grade 2	30 (37.5)	42 (52.5)
Grade 3	50 (62.5)	2 (2.5)
KL score		
Grade 1	22 (27.5)	22 (27.5)
Grade 2	6 (7.5)	6 (7.5)
Normal	52 (65)	52 (65)
IKDC (subjective)		
Mean	49.499	91.067
Minimum	6.9	66.7
Maximum	71.3	98.9
Std Deviation	13.856	6.099
Lysholm score		
Mean	38.35	94.05
Minimum	2	80
Maximum	66	100
Standard deviation	11.584	4.846

Abbreviations: IKDC - International Knee Documentation Committee.

The current study was unique in a way that we analyzed the influence of as many as nine tunnel-related parameters, which include both femoral and tibial tunnel positions, tunnel angles, and GIA, on clinical and radiological outcome in the long term, which makes ours distinguishable from other studies.

Conclusion

In our study, patients with ideal coronal tunnel parameters showed significantly better rotational stability and clinical outcome compared with those with non-ideal coronal tunnel parameters at long-term follow-up after ACLR. Sagittal

Table 3 Statistical association between various tunnel parameters and clinical outcome (objective) expressed as *p*-values

Ideal vs nonideal	SINGLE-LEG HOP TEST	IKDC (OBJ)	PIVOT	ADT	LT
CTTA	0.458	0.672	**0.038***	0.363	0.766
STTA	0.527	0.302	0.514	0.666	0.514
CTTP	0.365	**0.017***	0.378	0.730	0.801
STTP	0.062	0.062	0.127	0.080	0.095
CFTA	0.975	0.147	**0.024***	0.332	0.737
SFTA	0.858	0.113	0.503	0.191	0.096
CFTP	0.556	0.737	0.294	0.331	0.294
SFTP	0.365	0.672	0.378	0.109	0.378

*- denotes *p*-value < 0.05.
Abbreviations: CFTA - coronal femoral tunnel angle; SFTA - sagital femoral tunnel angle; CTTA - coronal tibial tunnel angle; STTA - sagital tibial tunnel angle; CFTP - coronal femoral tunnel; position; SFTP - sagital femoral tunnel position; CTTP - coronal tibial tunnel position; STTP - sagital tibial tunnel position; GIA - graft inclination angle; ADT - Anterior Drawer Test; LT- Lachman test; IKDC - International Knee; Documentation Committee.

Table 4 Association between graft inclination angle and outcome

Ideal vs nonideal	SINGLE LEG HOP TEST	KL SCORE	IKDC	PIVOT	ADT	LT
GIA (*p*-value)	0.325	0.672	0.574	0.196	0.066	0.068

Abbreviations: GIA- Graft inclination angle; KL SCORE - Kellgren and Lawrence Score; IKDC - International Knee; Documentation Committee; ADT - Anterior Drawer Test; LT- Lachman test.

Table 5 Association between tunnel parameters and radiological outcome

Ideal vs nonideal	CTTA	STTA	CTTP	STTP	CFTA	SFTA	CFTP	SFTP
KL SCORE (*p*-value)	0.905	0.078	0.285	0.093	0.341	0.796	0.058	0.905

Abbreviations: KL SCORE - Kellgren and Lawrence Score; CFTA - coronal femoral tunnel angle; SFTA - sagital femoral tunnel angle; CTTA - coronal tibial tunnel angle; STTA - sagital tibial tunnel angle; CFTP - coronal femoral tunnel position; SFTP - sagital femoral tunnel position; CTTP - coronal tibial tunnel position; STTP - sagital tibial tunnel position.

Table 6 Ideal coronal tunnel parameters showing statistaclly significant superior clinical outcome over non-ideal coronal tunnel parameters

Tunnel parameters		Clinical outcome (Pivot shift test)		Chi-square (*p*-value)
		Gr-0	Gr-1, 2, 3	
CTTA	Ideal	31	29	0.038
	Nonideal	5	15	
CFTA	Ideal	29	25	0.024
	Nonideal	7	19	
		Clinical outcome (IKDC Objective)		
		GR-A & B	**GR-C & D**	
CTTP	Ideal	68	0	0.017
	Nonideal	11	1	

Abbreviations: CFTA - coronal femoral tunnel angle; CTTA - coronal tibial tunnel angle; CTTP - coronal tibial tunnel position; gr - grade.

tunnel parameters and GIA did not have any significant influence on the radiological or clinical outcome after ACLR. None of the tunnel parameters or GIA had influence on OA changes in the long term. Future prospective studies comparing clinical and radiological long-term outcome following ACLR using three-dimensional computed tomography (3D CT) scan or magnetic resonance imaging in a larger population would be recommended.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Epidemiology of Knee Injuries in Baseball Players from the State of São Paulo

Epidemiologia das lesões do joelho em atletas de beisebol do estado de São Paulo

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Abstract

Objective This study aimed to identify the main knee complaints and injuries associated with baseball and their prevalence in the state of São Paulo, Brazil.

Methods This epidemiological study analyzed data from an online questionnaire sent to baseball athletes from the state of São Paulo, Brazil, from 2019 to 2022.

Results Ninety-eight athletes participated in the study. Their average age was 24.3 years, and 85.72% of the subjects were men. The most prevalent ethnicities were yellow (50%) and white (42.86%). Most athletes had incomplete or complete higher education (75.5%). Most (88.77%) have been training for over 1 year, and 40.82% played in more than 1 position. More than half also practiced another sport. Most (66.32%) athletes present knee complaints or symptoms, and 37.75% had suffered a knee injury playing baseball, with several mechanisms (contact with the ground, contact with another player, or no contact). More than half (59.45%) of the athletes required time away from baseball due to complaints, symptoms, or injuries.

Conclusion Among the athletes interviewed, 66.32% had a knee complaint, and 37.75% had already had a knee injury, especially meniscal and ligament injuries. The injury rate was highest in the first year of practice.

Keywords
- baseball
- knee
- knee injuries
- tibial meniscus injuries
- tendinopathy

Work developed at the Knee Group, Department of Orthopedics and Traumatology, Faculdade de Ciências Médicas Santa Casa de Misericórdia de São Paulo (FCMSCSP), São Paulo, SP, Brazil.

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Resumo

Objetivo Identificar as principais queixas e lesões de joelho associadas ao beisebol, e sua prevalência em atletas de beisebol no estado de São Paulo.

Métodos Estudo epidemiológico desenvolvido por meio da análise de dados obtidos por um questionário *online*, entre os anos de 2019 e 2022, distribuído entre atletas de beisebol do estado de São Paulo.

Resultados Noventa e oito atletas participaram do estudo, com média de 24,3 anos de idade, sendo que 85,72% eram homens. Os grupos raciais mais prevalentes foram os amarelos (50%) e brancos (42,86%), e a maioria dos atletas possuía ensino superior incompleto ou completo (75,5%). Um total de 88,77% treinava há mais de um ano e 40,82% atuavam em mais de uma posição. Mais da metade praticava simultaneamente outro esporte. Um total de 66,32% dos atletas apresentava queixas ou sintomas no joelho e 37,75% já haviam sofrido alguma lesão no joelho associada à prática do beisebol através de diversos mecanismos (contato com solo, contato com outro jogador, sem contato). Um total de 59,45% dos atletas precisou ser afastado da prática devido às queixas, sintomas ou lesões apresentadas.

Conclusão Dos atletas entrevistados, 66,32% apresentaram alguma queixa no joelho e 37,75% já tiveram alguma lesão diagnosticada nessa articulação, sendo as mais prevalentes as lesões meniscais e as ligamentares. A taxa de lesões foi maior no primeiro ano de prática.

Palavras-chave

- beisebol
- joelho
- traumatismos do joelho
- lesões do menisco tibial
- tendinopatia

Introduction

Musculoskeletal injuries are common in sports, accounting for approximately 80% of sports injuries.[1] Joint injuries, especially in the knee, have increased significantly due to the growth in the number of people who practice physical activity both professionally and recreationally. Furthermore, these practices start at an increasingly younger age group, with a demand for training and increasingly higher levels of competitiveness,[2,3] sometimes lacking proper technical supervision.

Studies on baseball injuries focus on the upper limbs, which correspond to approximately 45% of injuries occurring during training and games. Eighty percent of articles published based on Major League Baseball are related to the upper limbs, while 6.6% refer to the lower limbs.[4] However, lower limb injuries are also present in this sport, corresponding to around 33% of the total injuries in this modality.[5–7] Despite this, the literature on this topic is limited.

Given the scarcity of literature on knee injuries in baseball and the absence of precise national epidemiological data that would allow us to understand their panorama, this work aimed to identify the main complaints and injuries associated with baseball and their prevalence in our environment, starting a discussion about the need to implement preventative measures for safe practice.

Methods

From May 2019 to May 2022, after approval by the Ethics and Research Committee (CAAE: 17721819.0.0000.5479), researchers from the Knee Group of the Department of Orthopedics and Traumatology of the same hospital asked several baseball clubs in the state of São Paulo and university teams to distribute an online questionnaire among their athletes. The Google Forms questionnaire included a digital version of the informed consent form and specific questions for demographic, epidemiological identification, and knee injuries. The questionnaire was developed and evaluated internally by group members over three rounds of review. The final version was sent directly to athletes to collect data related to baseball practice.

Amateur athletes from Liga Esportiva das Atléticas de Medicina do Estado de São Paulo (LEAMESP) and the Anhanguera, Atibaia, Gecebs, Nippon Blue Jays, São Paulo Gigante, Los Tomateros, Underdogs, and UniSant'Anna clubs received an invitation to voluntarily self-complete the questionnaire (►**Supplementary Material, Annex 1**). The questionnaire was sent by WhatsApp to the representative of each institution, reaching a total of 195 athletes.

The inclusion criteria were amateur baseball athletes from the state of São Paulo, regardless of age, gender, or ethnicity, who practice the sport at least once a week at different levels of performance, and affiliated with the clubs above, and who answered the questionnaire and consent form completely and correctly. The previously defined exclusion criteria were athletes with musculoskeletal injuries resulting from another sport, those who did not answer the questionnaire as requested, and para-athletes, that is, those with physical, visual, or intellectual impairment.

Questionnaire Description

The questionnaire prepared by the authors consisted of 23 questions: 4 on demographic data, 6 on sports practice, and

13 on specific symptoms, diagnoses, and treatments for knee injuries. This questionnaire aimed to identify epidemiological issues involving this population.

The demographic data section requested information on gender, age, ethnicity, and education. The section on baseball sports practice collected data on time spent practicing the sport (more than or less than a year), time dedicated to training in weekly hours, and the playing position—pitcher, catcher, infielder (first base, second base, third base, and shortstop) and outfielder (left fielder, center fielder, and right fielder). Data collection also included information on the practice of other sports, training time in hours per week, and practice time, either more or less than a year.

The questionnaire also asked about specific knee symptoms, diagnoses, and treatments, such as knee-related clinical complaints (including pain and topography, episodes of instability, edema, locking, and crepitus), specific injury diagnoses throughout baseball practice, a description of these diagnoses if more than one, injury mechanisms (non-contact, contact with the ball, ground, object, another player, and others), time away from baseball due to clinical complaint or injury, length of absence in months, performance of conservative treatments and their nature, and surgical treatments and their descriptions.

Data Analysis

As for demographic data, age was shown as mean and standard deviation. Gender, ethnicity, education, sports practice, specific knee symptoms, diagnoses, and treatments were displayed in absolute and relative numbers.

The remaining data were tabulated and displayed as previously explained. We analyzed age, time of baseball practice in years, weekly training hours, playing position, and practice of another sport to highlight potential associations between complaints or injuries and some study variables.

For this secondary analysis, we stratified participants into different subgroups and observed the distribution of complaints and injuries in each one. These subgroups referred to median age and baseball practice time for less than a year or equal or more than a year. This division was based on studies showing differences in injury rates in athletes stratified this way.[8,9] Weekly training hours comprised five categories. We also analyzed the participation in one or more baseball positions. Regarding other sports, participants were subdivided into groups only playing baseball and practicing additional modalities.

Results

Ninety-eight of 195 athletes completed the questionnaire voluntarily, corresponding to a response rate of 50.25%. The mean age of participants was 24.3 ± 7.1 years. The sample included 84 (85.72%) men and 14 (14.28%) women. No athlete was excluded after completing the questionnaire. There were 4 distinct ethnicities, that is, 49 (50%) yellow, 42 (42.86%) white, 6 (6.12%) brown, and 1 (1.02%) black. Among the athletes, 75.5% declared that they had incomplete or complete higher education (►**Table 1**).

Regarding the specific practice of baseball, 87 (88.77%) athletes trained for more than a year, and 24 (24.48%) trained more than 10 hours a week. Forty (40.82%) subjects played in at least two positions; most athletes played as infielders or outfielders (51.02% and 47.95%, respectively), and 50 (51.02%) athletes practiced other sports (►**Table 2**).

Sixty-five athletes (66.32%) complained of knee symptoms. Thirty-seven (37.75%) had already been diagnosed with a baseball-associated knee injury, including 14 (37.83%) with ligament injuries, 14 (37.83%) with several meniscal injuries, and 10 (27.02%) with tendinopathies. It is worth mentioning that 16 (43.24%) athletes already diagnosed declared the occurrence of more than one injury. Regarding trauma mechanisms, 10 (45.45%) athletes suffered an injury due to contact with the ground, 8 (36.36%) reported no contact, and 4 (18.18%) had contact with another player. Twenty-two (59.45%) reported the need to take time off from sports due to clinical complaints or injuries, of which 5 (22.72%) underwent surgical treatment (►**Table 3**).

For the secondary analysis, we initially subdivided the athletes into 2 groups based on their median age, 23 years old (►**Table 1**). Among athletes older than 23, 71.11% had clinical complaints regarding their knees, and 35.55% had already been diagnosed with a knee injury.

We noted that 72.72% (eight out of 11) of athletes who have played baseball for less than a year had clinical knee

Table 1 Demographic data in mean, standard deviation and median or absolute and relative numbers of participants

Age	Mean (SD)	Median			
	24.33 (±7.1)	23			
Gender	Male	Female			
	84 (85.72%)	14 (14.28%)			
Ethnicities	Yellow	White	Brown	Black	
	49 (50%)	42 (42.86%)	6 (6.12%)	1 (1.02%)	
Education	Incomplete elementary education	Incomplete high school education	Complete high school education	Incomplete college education	Complete college education
	5 (5.1%)	4 (4.08%)	15 (15.4%)	52 (53.06%)	22 (22.44%)

Abbreviations: SD, Standard deviation; %, relative number in percentage.

Table 2 Data regarding baseball practice in absolute and relative numbers

Practicing time (N = 98)	**Less than a year**	**Over a year**			
	11 (11.23%)	87 (88.77%)			
Training time (hours per week) (N = 98)	Up to 5 hours	5–10 hours	10–15 hours	15–20 hours	Over 20 hours
	36 (36.73%)	38 (38.77%)	17 (17.34%)	6 (6.12%)	1 (1.02%)
Positions*	Pitcher	Catcher	Infielder	Outfielder	
	30 (30.61%)	18 (18.36%)	50 (51.02%)	47 (47.95%)	
Field positioning (N = 98)	Single	Multiple			
	58 (59.18%)	40 (40.82%)			
Other sports (N = 98)	Yes	No			
	50 (51.02%)	48 (48.97%)			
Training time (hours per week) in other sport (N = 50)	Up to 5 hours	5–10 hours	10–15 hours	15–20 hours	Over 20 hours
	21 (42%)	18 (36%)	7 (14%)	3 (6%)	1 (2%)
Practicing time in other sport (N = 50)	Less than a year	Over a year			
	4 (8%)	46 (92%)			

Abbreviations: SD, Standard deviation; %, relative number in percentage. *participants may play in more than one position.

complaints, and 45.45% (five out of 11) had already been diagnosed with a knee injury. Among athletes practicing for more than a year, 65.51% reported complaints (57 of 87), and 36.78% had injuries (32 of 87) (►**Table 4**).

Understanding the limitation of the subject distribution by subgroups with complaints and injuries per weekly training hours, we highlight that 66.66% of the 36 athletes who trained up to 5 hours per week had complaints, including 54.16% with diagnosed injuries (►**Table 5**). Furthermore, of the 40 athletes training in more than one position, 72.5%, and 42.5% reported experiencing knee symptoms or injuries, respectively; of the 50 who played other sports, 66% had complaints, and 34% reported injuries. Among the 48 subjects who only played baseball, 66.66% had symptoms, and 39.58% presented diagnosed injuries.

Discussion

This study aimed to show epidemiological data on knee symptoms and musculoskeletal injuries in amateur baseball athletes in the state of São Paulo, Brazil, to assist their health care and contribute with information for creating preventive measures and regulations for baseball practice. As far as we know, this is the first study to evaluate the epidemiology of knee injuries in baseball athletes in a Brazilian context.

According to Law 9,615 of 1998 of the Brazilian Federal Government providing general rules for sports practice, professional athletes are those receiving remuneration defined in a formal employment contract. Therefore, all athletes in this study qualify as non-professionals (amateurs).

In the main baseball leagues from the United States leagues (Major League Baseball and Minor League Baseball), shoulder and knee injuries account for 14.7% and 6.5% of all lesions.[6] These athletes, despite predominantly using their upper limbs for the throwing movement, also perform intense effort on the lower limbs for straight-line running, sudden direction changes when running, jumping, and, depending on the playing position, remaining crouched for long periods, maintaining or performing knee flexion movements repeatedly.[10] Even throwing effectiveness closely relates to the energy transfer from the lower limbs to the trunk.[11] Thus, the knee is susceptible to injuries in baseball. However, these injuries remain underdiagnosed as there is little research on the topic.

A Japanese study[12] analyzed young baseball athletes reporting pain in the shoulder, elbow, or both. The authors observed that 51.9% of them also complained of knee pain. In our study, 66.32% of all athletes had knee complaints, regardless of whether they reported upper limb symptoms, and 37.5% of participants had a diagnosed injury. A study performed on the database of injuries diagnosed in baseball professional players from North American leagues reported a knee injury rate of only 6.5%,[6] showing the heterogeneity in injury rates in different contexts.

The literature reports that most knee injuries in baseball athletes are contusions (30.5%),[6] ligament injuries (17.5%),[6] tendinopathies (16.9%),[6] and meniscal injuries (9.2–33%).[1,6] The incidence of these conditions varies depending on the study location. Patellofemoral dislocation and subluxation (1.4%)[6] have a lower prevalence. In our study, the main injuries included ligament (37.83%) and meniscal (37.83%) injuries, in addition to tendinopathies (27.02%).

We believe that the amateur nature of baseball practice at the regional level may account for the higher incidence of knee complaints and injuries in our study compared with the international literature, which mainly evaluates professional athletes.[4,6] This discrepancy makes us question the need for more studies focusing on knee injuries in amateur baseball athletes.

Regarding practice time, we found that athletes who trained for less than a year have a higher rate of diagnosed knee injuries. This phenomenon also occurs in other sports, such as road running, in which studies performed since the 1980s concluded that less experienced athletes tend to suffer

Table 3 Data regarding specific knee symptoms, diagnoses, and treatments in absolute and relative numbers

Symptoms	**None**	**Anterior pain**	**Posterior pain**	**Lateral pain**	**Edema**	**Instability**	**Locking**	**Crepitation**
	42 (33.9%)	49 (39.5%)	11 (8.9%)	36 (29%)	9 (7.3%)	15 (12,10%)	3 (2.4%)	44 (35.5%)
Diagnosed injury	Yes	No						
	37 (37.75%)	61 (62.24%)						
Injuries (N = 37)	Tendinopathy	ACL rupture	PCL rupture	LCL rupture	MCL rupture	Multiligamentous lesions	Meniscus	Osteochondritis dissecans
	10 (27.02%)	10 (27.02%)	3 (8.1%)	2 (5.4%)	1 (2.7%)	2 (5.4%)	14 (37.83%)	0 (0%)
	ITBS	Patellar chondropathy	Patellar dislocation	Osgood Schlatter	Baker cyst			
	0 (0%)	10 (27.02%)	7 (18.91%)	3 (8.1%)	1 (2.7%)			
Mechanisms of knee injury (N = 22)	Contact with the ball	Contact with the ground	Contact with an object	Contact with another player	No contact			
	0 (0%)	10 (45.45%)	0 (0%)	4 (18.18%)	8 (36.36%)			
Time away from baseball resulting from knee injury (N = 37)	Yes	No						
	22 (59.45%)	15 (40.54%)						
Time away from baseball (N = 22)	Up to 1 month	1–3 months	3–6 months	Over 6 months				
	7 (31.81%)	8 (36.36%)	4 (18.18%)	3 (13.63%)				
Non-surgical treatment due to knee injury (N = 37)	Yes	No						
	21 (56.75%)	16 (43.25%)						
Surgical treatment due to knee injury (N = 37)	Yes	No						
	5 (13.51%)	32 (86.49%)						

Abbreviations: ACL, anterior cruciate ligament; LCL, lateral collateral ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament; N, number of participants in the group; %, relative number in percentage; ITBS, iliotibial band syndrome.

Table 4 Presence of symptoms and diagnosed injuries concerning practice time

	All (N = 98)	Over a year (N = 87)	Less than a year (N = 11)
Symptoms	65 (66.32%)	57 (65.51%)	8 (72.72%)
Diagnosed injuries	37 (37.75%)	32 (36.78%)	5 (45.45%)

Abbreviations: SD, standard deviation; %, relative number in percentage.

Table 5 Relationship between baseball training time (in hours per week) and the presence of symptoms and diagnosed injuries in absolute and relative numbers

Hours per week	Symptoms	Injuries
Up to 5 hours (N = 36)	24 (66.66%)	13 (54.16%)
5–10 hours (N = 38)	25 (65.78%)	12 (31.57%)
10–15 hours (N = 17)	12 (70.58%)	6 (35.29%)
15–20 hours (N = 6)	3 (50%)	3 (50%)
Over 20 hours (N = 1)	1 (100%)	1 (100%)

Abbreviations: SD, Standard deviation; %, relative number in percentage.

a higher number of lower limb injuries.[13,14] More recent studies showed that this incidence can be up to twice as high in beginner athletes, that is, during the first year of practice.[8,9] Despite the sample heterogeneity, we can infer that athletes with less practice time have a higher injury rate, even though there are discrepancies in injury characterization, classification in terms of performance level, and difficulty in evaluating the moment of occurrence. Therefore, further studies are required in this area to promote differentiated care for athletes with less practice time.

Regarding the trauma mechanism of the diagnosed injuries, Dahm et al.[6] pointed out that the most significant ones were non-contact (43.9%) and contact with the ground (18.8%). Our study reported 36.36% and 45.45% of mechanisms with no contact and contact with the ground, respectively. Dick et al.[5] stated that 42% of baseball injuries occurred with no contact, and 45% occurred with contact. The main injuries diagnosed in our study were knee ligament and meniscal injuries, often associated with torsional trauma, corresponding to the non-contact trauma mechanism, and corroborating the described scenario.

One injury described in baseball athletes is called catcher's knee.[15] It is little known and, therefore, may be underdiagnosed. The catcher's knee is an osteochondritis dissecans of the posterior region of the femoral condyle resulting from persistent, repetitive joint hyperflexion, a typical movement mechanism for athletes in this position. This study specifically asked about this diagnosis in the knee symptoms and injuries section. The catchers did not present a specific pattern of diagnosis of injuries or complaints, and we did not have any cases of catcher's knee in our sample.

The participants in this study presented high rates of symptoms, injuries, or both diagnosed in the knees, consistent with other studies evaluating the upper limbs of high-performance athletes.[4–6] Today, as far as the authors know, Brazil has no guidelines referring to baseball or the use of equipment to prevent knee injuries. This lack may contribute to the difference in data observed in amateur and professional athletes or to the lack of studies focused on the epidemiology of these injuries.

Our study had some limitations, such as the small and heterogeneous sample despite the wide distribution of the questionnaire across leagues and the difficulty in interpreting and associating the presence of complaints and injuries with variables such as playing position, since the same participant may act in different positions. Although this study provided insights about knee injuries and amateur baseball in Brazil, we believe further studies are required with sample calculation and probably a larger sample size to obtain more precise relationships and analyses.

Conclusion

Among the athletes interviewed, 66.32% reported knee complaints, and 37.75% had a previous knee injury diagnosed. The most prevalent conditions were meniscal and ligament injuries. The injury rate was higher in the first year of baseball practice.

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Conflict of Interests
The authors declare no conflict of interests.

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Treatment of Tibial Plateau Fractures with a Circular External Fixator: A Comparative Analysis of Two Assembly Methods

Tratamento de fraturas do planalto tibial com fixador externo circular: Uma análise comparativa de duas formas de montagem

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Abstract

Objective To compare the functional outcomes of two circular external fixation techniques to treat complex fractures of the proximal end of the tibia.

Materials and Methods The present is a retrospective cohort study with 51 patients who underwent surgical treatment for complex fractures of the tibial plateau with a circular external fixator. There were two groups of patients: 12 subjects underwent treatment with the classic assembly technique, and 39 subjects underwent treatment with the simplified technique. The variables analyzed included age, sex, injury mechanism, trauma energy, associated injuries, fixator type, time of fixator use, and clinical-radiographic outcomes. The classic technique mainly uses transfixing Kirschner wires, while the simplified one replaces the Kirschner wires with Schanz pins in the distal block of the circular external fixator.

Result There were no statistically significant differences ($p > 0.05$) between the two groups concerning the clinical-radiographic outcomes, including fracture consolidation, quality of joint fracture reduction, range of motion, lower limbs residual discrepancy, and postoperative pain.

Conclusion We suggest that the simplified technique, using Schanz pins instead of Kirschner wires, can be a viable and effective alternative to treat complex fractures of the proximal end of the tibia with a circular external fixator. This simplified approach

Keywords
- tibial plateau fractures
- external fixators
- Ilizarov technique
- Kirschner wires

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can offer benefits, such as a lower infection rate and greater patient comfort, without compromising clinical and radiographic outcomes, thus justifying its use.

Resumo

Objetivo Comparar os resultados funcionais entre duas técnicas de fixação externa circular utilizadas no tratamento de fraturas complexas da extremidade proximal da tíbia.

Materiais e Métodos Trata-se de um estudo de coorte retrospectivo, com 51 pacientes submetidos ao tratamento cirúrgico de fraturas complexas do planalto tibial com fixador externo circular. Os pacientes foram divididos em dois grupos: 12 pacientes tratados com a técnica clássica e 39 pacientes tratados com a técnica simplificada. As variáveis analisadas incluíram idade, sexo, mecanismo da lesão, energia do trauma, lesões associadas, tipo de fixador, tempo de uso do fixador e resultados clínico-radiográficos. A técnica clássica lança mão principalmente de fios de Kirschner transfixantes, e a simplificada substitui os fios de Kirschner por pinos de Schanz no bloco distal do fixador externo circular.

Resultados A partir da comparação das montagens, não encontramos diferenças estatisticamente significativas ($p > 00{,}5$) entre os dois grupos em relação aos resultados clínico-radiográficos, incluindo a consolidação da fratura, a qualidade da redução da fratura articular, a amplitude de movimento, a discrepância residual na medida dos membros inferiores e a dor do paciente no pós-operatório.

Conclusão Sugerimos que a técnica simplificada, utilizando pinos de Schanz no lugar dos fios de Kirschner, pode ser uma alternativa viável e eficaz no tratamento de fraturas complexas da extremidade proximal da tíbia com fixador externo circular. Essa abordagem simplificada pode oferecer benefícios, como menor taxa de infecção e maior conforto para o paciente, sem comprometer os resultados clínicos e radiográficos, o que justifica, o seu uso.

Palavras-chave
- fraturas do planalto tibial
- fixadores externos
- técnica de Ilizarov
- fios de Kirchner

Introduction

Fracture of the proximal end of the tibia historically represents a spectrum of injuries with complex treatment. In bicondylar injuries and those with metaphyseal-diaphyseal dissociation, complications inherent to traditional treatment methods are invariably significant. Therefore, research focuses on alternative forms with less invasive approaches to preserve the biological and anatomical structures of the affected region to reduce the chances of complications. Currently, with the advent of minimally-invasive techniques, it is believed that the reestablishment of axial alignment of the lower limb is more important than the absolute restoration of joint congruity in the therapeutic outcome of tibial plateau fractures.[1–3]

Ilizarov developed the circular external fixation technique to treat difficult-to-manage orthopedic issues. The method is based on the biological principles of bone consolidation and a circular external fixator with rings and transfixing tensioned Kirschner wires for bone fixation.[4]

Efforts have been made to simplify device application and configuration to improve patient comfort while maintaining the appropriate combination of system stability and dynamics. Reducing the number of wires in the assembly reduces the infection rate, improves patient comfort during treatment, and, at the same time, reduces device stability. Introducing Schanz pins to Ilizarov circular external fixator assemblies enables a more simplified configuration of a sufficiently-rigid apparatus and reduces wire-related soft tissue complications.[5]

Cardoso et al.[6] performed a biomechanical comparison of two circular external fixator assemblies in composite bone models to treat these fractures: the classic assembly (mainly using Kirschner wires) and a proposed simplified assembly which mainly uses Schanz pins. These authors observed that both assemblies had similar biomechanical behaviors.

Therefore, the present study aimed to compare the functional outcomes in a series of cases using the classic assembly or the proposed assembly with more Schanz pins to evaluate the feasibility of a simplified circular external fixator to treat tibial proximal end fractures.

We hypothesized that the simplified assembly would not alter the clinical-radiographic outcomes compared with the classic assembly. As such, justifying the use of the simplified assembly to treat complex fractures of the tibial plateau.

Materials and Methods

The present retrospective, quantitative, and comparative study used medical records from patients diagnosed with tibial plateau fractures classified as Schatzker V and VI[7] who

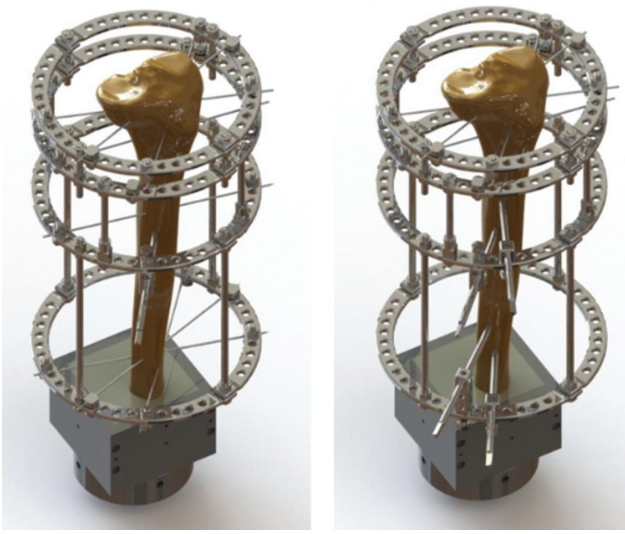


Fig. 1 Illustration of the classic (left) and simplified (right) assemblies demonstrating the positioning of the Kirschner wires and Schanz pins.

underwent surgical treatment with a circular external fixator.

The institutional Ethics in Research Committee approved the study under number CAAE: 52077521.7.0000.5360.

Cohort and Sample

The sample consisted of all patients (51) with fractures of the tibial plateau classified as Schatzker V and VI[7] from March 2012 to June 2021 who underwent surgical treatment with a circular external fixator. The patient's medical records supplied the extracted data.

The outcomes of patients treated with the classic Ilizarov circular external fixator, which mainly uses transfixing Kirschner wires (n = 12), were compared with those of patients treated using a simplified assembly, which replaces the Kirschner wires of the distal block by Schanz pins (n = 39). ►**Fig. 1** illustrates both assemblies.

The descriptive variables evaluated were age, sex, injury mechanism, trauma energy, associated injuries, fixator type, time of fixator use, and postoperative follow-up time.

The inferential analyses included the following: external fixator usage time in months, consolidation and presence of infection, quality of joint fracture reduction, range of motion, residual limb discrepancy and postoperative pain at the end of the follow-up.

Patients who lost to follow-up or treated with a transarticular circular external fixator were excluded. Patients still using circular external at the time of data collection fixator, regardless of the assembly, were also excluded.

A group of three orthopedic surgeons, two of whom members of the Association for the Study and Application of the Method of Ilizarov (ASAMI) and the Brazilian Society of Orthopedics and Traumatology (SBOT, for its acronym in Portuguese [*Sociedade Brasileira de Ortopedia e Traumatologia*]), and one SBOT member, performed the radiological analysis of joint deviation. The radiological results were divided into good alignment, misalignment up to 2 mm, misalignment ranging from 2 mm to 4 mm, and misalignment higher than 4 mm.

Statistical Analysis

After defining the variables and collecting data, results were pooled in a Microsoft Office Excel spreadsheet (Microsoft Corp., Redmond, WA, United States), version 12.0 and analyzed using the Jamovi software (open source), version 1.2. First, descriptive analyses determined means and confidence intervals for numerical variables and absolute and relative frequency measures for categorical variables. Next, we proceeded to the inferential analyses.

The Mann-Whitney U test verified differences between fixator use time and the postoperative follow-up time in both groups given the non-normality of the dependent variable and the sample size. The remaining analyses used the Chi-squared association test because the variables were categorical. The Fisher exact test analyzed selected associations with cells with absolute values lower than 5, and the continuity correction (Yates) test determined associations in cells with an absolute value of 0. For all hypothesis tests, the significance level was of 5%.

Results

We analyzed the medical records of a total of 82 patients. The exclusion criteria were transarticular assembly (n = 6) and loss at follow-up (n = 25); therefore, 51 patients remained in the sample.

Regarding fixators, 12 patients (23.5%) underwent the classic assembly (►**Fig. 2**), and 39 (76.5%), the simplified assembly (►**Fig. 3**). The analysis compared the outcomes of these two groups of patients.

The mean age of the patients treated with the classic and simplified assemblies was of 46.3 and 45.8 years respectively, with no statistically significant difference between the groups. Both groups had a predominance of male subjects, with no statistically significant difference in sex distribution.

In both groups, there was a predominance of high-energy trauma, mostly traffic accidents, with no statistically significant difference between them. Of the total number of associated injuries, most proximal tibial fractures were isolated (52.3%), followed by associated fractures of the femur (proximal, diaphyseal, or neck fractures) in 8.4% of the patients.

The average time of fixator use, regardless of the assembly, was of 7.25 months. The type of fixator assembly, whether classic or simplified, did not determine a statistically significant difference in the time of use ($p = 0.171$) per the temporal distribution shown in ►**Fig. 4**.

The average postoperative follow-up was of 48.5 months in the classic group, and of 42.7 months in the simplified group, with no statistically significant difference ($p = 0.629$).

Two variables determined the quality of the treatment outcome: union without infection, and non-union and/or infection. Consolidation with no infection occurred in 83.3% of the patients in the classic group, and in 94.9% of the subjects in the simplified group. ►**Table 1** shows the lack of

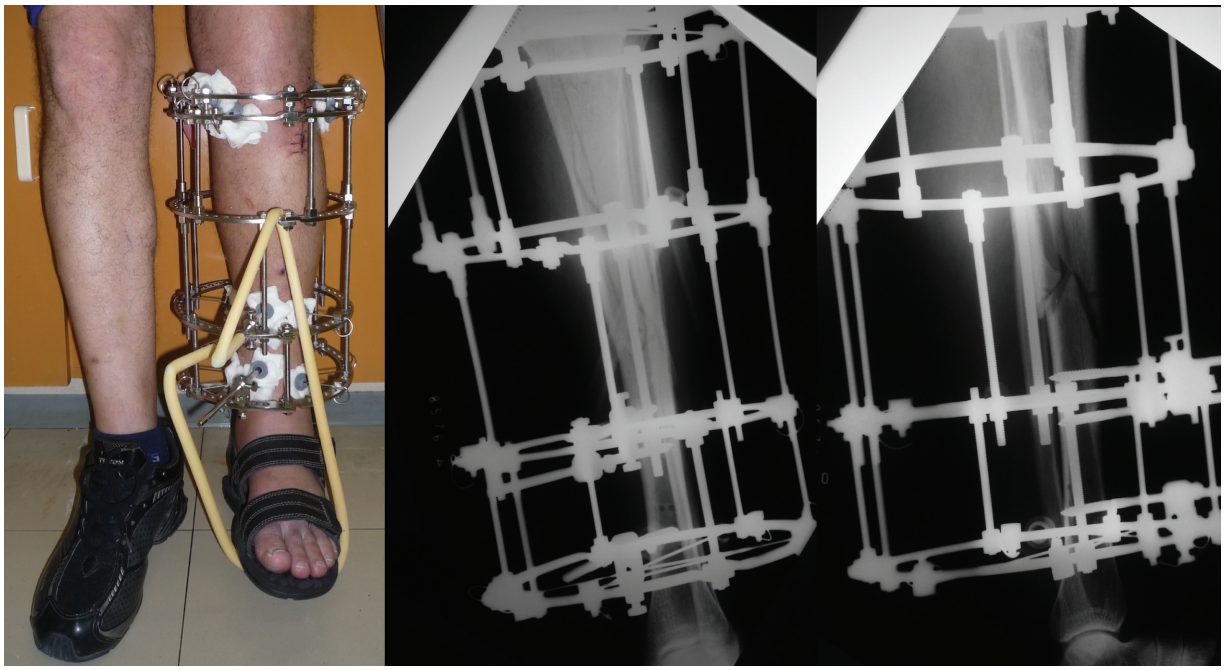


Fig. 2 Clinical and radiographic images demonstrating the classic assembly in a patient included in the study.

statistically significant difference ($p = 0.232$) regarding the Fisher exact test between both groups.

In the classic group, 66.7% of the patients had good radiographic outcomes (that is, proper alignment or misalignment of up to 2 mm), while 71.8% of those in the simplified group presented good radiographic outcomes, with no statistically significant difference ($p = 0.65$).

Neither did the range of motion of the knee joint after fixator removal show statistical differences between the different assemblies ($p = 0.826$), as shown in ►**Table 2**, considering that the range of motion was higher than 80° among 83.3% of the classic group and in 87.8% of those in the simplified group.

Regarding the residual discrepancy between limbs, there was no statistical significance ($p = 0.51$ in the Fisher exact test associated with the Yates continuity correction test), as 83.3% of the patients in the classic group and 92.3% of the simplified group had no dysmetria between the limbs.

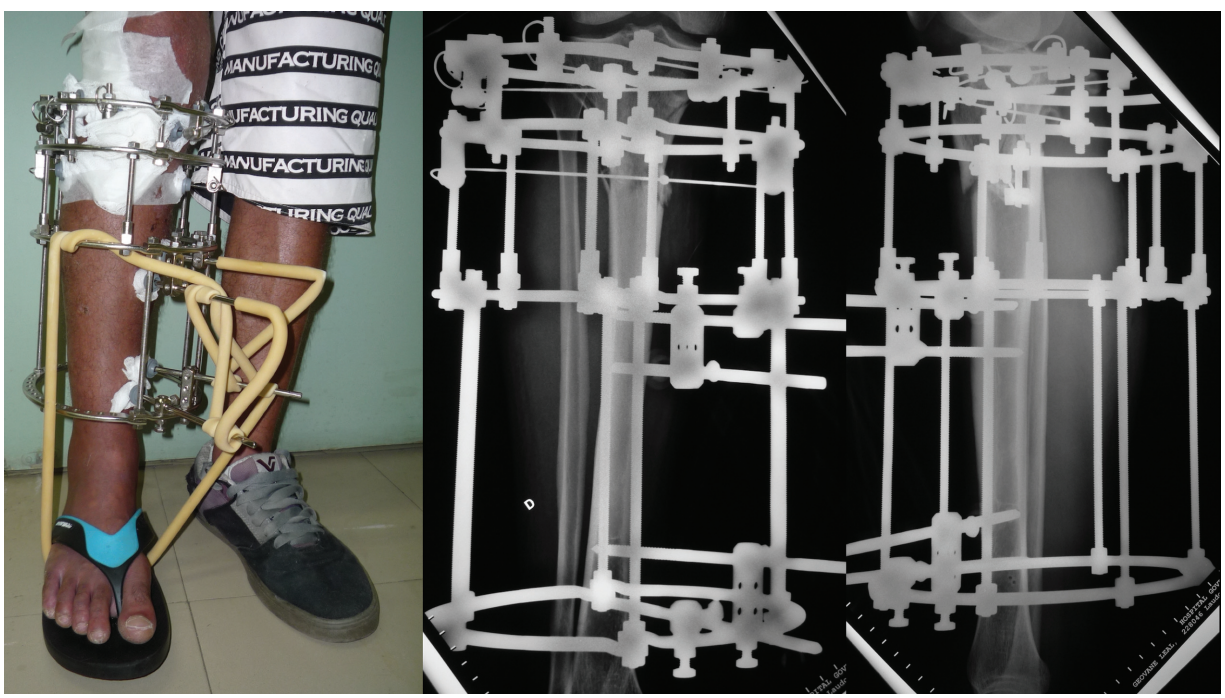


Fig. 3 Clinical and radiographic images demonstrating the simplified assembly in a patient included in the study.

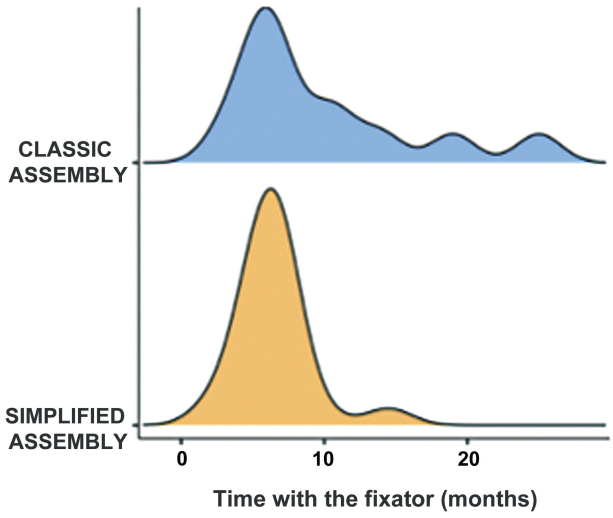


Fig. 4 Graph showing the temporal distribution of the use of the external fixator in the classic and simplified assembly groups.

When evaluating residual pain after external fixator removal, there was no statistically significant difference ($p = 0.893$) between the groups, as shown in ►**Table 3**, considering that 25% of the classic group and 30.6% of the simplified group complained of moderate or severe postoperative pain.

Discussion

Based on clinical experience and biomechanical studies, for severe tibial plateau fractures, the best stabilization of each bone fragment using circular external fixation occurs with two-level fixation and four wires inserted at right angles. However, in most clinical situations, it is not possible to position the wires at right angles due to anatomical limitations. Reducing the number of wires or the angle between them affects the stability of the bone fragment fixation, which ultimately can hinder the success of the orthopedic treatment.[8]

The literature is not consensual regarding the type of external fixation to treat these fractures. There are descriptions of the use of circular fixators and exclusively Kirschner wires, circular fixators and various associations of Kirschner wires and Schanz pins, and fixators that use bars and rings with Kirschner wires in the metaphysis and exclusively Schanz pins in the diaphysis.[9]

Reducing the number of wires in the assembly reduces the infection rate and improves patient comfort during treatment, simultaneously reducing device stability. The introduction of Schanz pins to Ilizarov circular external fixator assemblies enables the configuration of a more rigid device and a reduction in wire-associated soft tissue complications.[5] As such, this simplified assembly was proposed to replace the Kirschner wires from the distal block with two Schanz pins for each ring, as shown in ►**Fig. 1**.

Table 1 Fisher exact test comparing the therapeutic outcome in patients submitted to the classic and simplified assemblies

	Outcome		
Fixator type	Non-union or infection	Consolidation with no infection	Total
Classic	2	10	12
	16.7%	83.3%	100%
Simplified	2	37	39
	5.1%	94.9%	100%
Total	4	47	51
	7.8%	92.2%	100%

Note: Fisher exact test ($p = 0.232$).

Table 2 Fisher exact test comparing the range of motion of the knee joint after external fixator removal in patients treated with the classic and simplified assemblies

	Knee range of motion				
Fixator type	< 80°	80°–109°	110°–130°	> 130°	Total
Classic	2	5	3	2	12
	16.7%	41.7%	25%	16.7%	100%
Simplified	5	19	11	4	39
	12.8%	48.7%	28.2%	10.3%	100%
Total	7	24	14	6	51
	13.7%	47.1%	27.5%	11.8%	100%

Note: Fisher exact test ($p = 0.826$).

Table 3 Fisher exact test comparing pain after external fixator removal in patients treated with the classic and simplified assemblies

	Pain				
Fixator type	Absent	Mild	Moderate	Severe	Total
Classic	8	1	3	0	12
	66.7%	8.3%	25%	0%	100%
Simplified	20	7	10	2	39
	51.3%	17.9%	25.6%	5.1%	100%
Total	28	8	13	2	51
	54.9%	15.7%	25.5%	3.9%	100%

Note: Fisher exact test ($p = 0.893$).

In the present study, the average age of the patients in the classic and simplified groups was of 46.3 and 45.8 years respectively, and most subjects were male. The average time of fixator use was of 7.25 months. Ghimire et al.[10] found similar data in their study, with a predominance of male patients and an average age of 39.98 years, but with an estimated time until fixator removal of 15.09 weeks. In both studies, traffic accidents were the main cause of fractures.

Ali et al.[9] studied a standardized assembly for complex tibial plateau fractures and observed an average time of fixator use of 18 weeks. In our study, 23.5% of the patients used the classic fixator, and 76.5% used the simplified device, with no difference in postoperative range of motion between the groups. The range of motion at the end of the treatment with both assemblies was higher than 80° in more than 80% of the cases. Ali et al.[9] reported an average range of motion at the end of treatment of 112°.

In the present study, most proximal tibial fractures were isolated (52.3%), followed by associated (proximal, diaphyseal, or neck) femoral fractures. The radiological analysis of fracture consolidation, the quality of joint surface reduction, and the residual discrepancy between limbs presented no statistically significant differences between the groups.

We compared our findings with those of a 2006 multicenter, prospective, randomized study from the Canadian Orthopaedic Trauma Society.[11] Both studies evaluated different treatment approaches for fractures. We focused on comparing two types of external fixator assembly for proximal tibial fractures, while the Canadian Orthopaedic Trauma Society compared treatment with a circular fixator versus open reduction and internal fixation in patients with several fractures. These studies suggest that different external fixator assemblies and a circular fixator compared to open reduction and internal fixation can be viable options to treat fractures. However, it is necessary to consider patient characteristics, the nature of the fracture, and individual clinical features when deciding the most appropriate treatment approach. Therefore, analyzing the two studies, the simplified circular external fixator appears to be a good alternative to treat proximal tibial fractures, resulting in outcomes consistent with those of other studies[11] concerning the quality of the treatment outcome and associated complications.

The main complications related to high-energy tibial plateau fractures are compartment syndrome, neurovascular injury, and skin necrosis. The postoperative infection rate with open reduction can range from 5% to 20%.[12,13] The percutaneous assembly reduces the risk of periosteal injury and preserves local biology. Both groups presented similar complications concerning loss of joint mobility, postoperative residual pain, and limb length asymmetry. Regarding the therapeutic outcome, there was no significant difference between the two types of assembly and the literature in terms of non-union, infection, or both.[11,14]

The present study shows that an assembly using Schanz pins results in a high consolidation rate and low risk for deep infection, which is consistent with the literature.[15,16]

Due to its retrospective nature, the present study has critical limitations, including the disparity between the cohorts studied, with a predominance of simplified assemblies, and the limited number of patients and high rate of loss to follow-up. Therefore, further studies are required to minimize selection bias.

Conclusion

Since there is no current consensus to define the ideal type of assembly of the circular external fixator to treat severe tibial plateau fractures and the increased focus on finding less invasive and biologically-aggressive treatments, the simplified device is a viable and promising option.

Given that there were no statistical differences between the compared groups, we suggest the simplified technique for the cases herein described. In addition, new studies may provide more robust evidence for this technique.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Cross-cultural Validation of the Health Mindset Scale for Brazil

Validação transcultural da Escala de Mindset Direcionado à Saúde no Brasil

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Abstract

Objective To cross-culturally validate the Health Mindset Scale for Brazil, as well as adapt the terms and questionnaires for adequate understanding of Brazilians, using factor analysis as an instrument to validate its reliability.

Methods Cross-cultural validation of the Health Mindset Scale into Brazilian Portuguese using the Beaton method, Cronbach's alpha calculation and factor analysis

Results The sample consisted of 215 patients aged between 18 and 87 years ($M = 41.98$; $SD = 15.72$), with a mean age between 31 and 50 years (42.0%), and female (52 .6%), a marginally significant difference ($p < 0.10$) between men and women was observed for item 3. In this item, men's mean ($M = 5.48$; $SD = 0.99$) was higher than the average for women ($M = 5.10$; $SD = 1.22$), with a small effect size for the difference ($d = 0.26$). Pearson's r correlation coefficient was examined between the mean score and age ($r = -0.21$; $p = 0.002$), the result of which indicated a weak, negative and significant linear relationship. The older the age, the lower the average score on the Health Mindset Scale.

Conclusion The version of the health-focused mindset scale for Brazilian Portuguese was introduced and cross-culturally validated, demonstrating good reliability with a Cronbach's alpha of 0.786. Consequently, it constitutes a new instrument for clinical practice and can be correlated with established scales in the literature.

Keywords
- quality of life
- surveys and questionnaires
- reproducibility of the tests
- health

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Resumo

Objetivo Validar transculturalmente a escala de *mindset* da saúde para o Brasil, bem como adaptar os termos e questionários para a adequada compreensão do brasileiro, utilizando a análise fatorial como instrumento para validar a sua confiabilidade.

Métodos Validação transcultural da *Health Mindset Scale* para o português brasileiro através do método do Beaton, cálculo do alfa de *Cronbach* e análise fatorial

Resultados Amostra foi composta por 215 pacientes com idades entre 18 e 87 anos (M = 41,98; DP = 15,72), sendo a média de idade entre 31 e 50 anos (42,0%), e do sexo feminino (52,6%), uma diferença marginalmente significativa ($p < 0,10$) entre homens e mulheres foi observada para o item 3. Nesse item a média dos homens (M = 5,48; DP = 0,99) foi maior do que a média das mulheres (M = 5,10; DP = 1,22), com tamanho de efeito para diferença pequeno (d = 0,26). O coeficiente de correlação r de Pearson foi examinado entre o escore médio e a idade ($r = -0,21$; $p = 0,002$), cujo resultado indicou relação linear fraca, negativa e significativa. Quanto maior a idade, menor o escore médio na *Health Mindset Scale.*

Conclusão A versão da escala de *mindset* direcionada à saúde para o português brasileiro foi apresentada e validade transculturalmente, apresentando bom coeficiente de confiabilidade – alfa de *Cronbach* 0,786. Sendo assim, configura novo instrumento para a prática clínica e pode ser correlacionado escalas já consagradas na literatura.

Palavras-chave

- qualidade de vida
- inquéritos e questionários
- reprodutibilidade dos testes
- saúde

Introduction

Mindset theory proposes the ways in which individuals see and evaluate their own capabilities, especially with regard to the malleability of different attributes, such as intelligence and personality.[1,2]

The mindset is divided into two approaches: fixed and growth. The growth mindset concerns the individual who believes that their capabilities are subject to change, according to their level of commitment, training and dedication. This type of belief is associated with the individual who is always willing to learn and, therefore, is prone to expanding their knowledge and skills.[1,2]

On the other hand, those dominated by the fixed mindset, show themselves as individuals who believe that their ability is innate, hereditary, and not subject to improvement. These are those individuals most associated with the fear of failure, who limit themselves to the type of activity they know they already master, refusing new challenges.[1,2]

Mindset theory began to be discussed in the 1970s. Carol S. Dweck highlighted the theory by analyzing the different ways in which children reacted when challenged to perform tasks of different levels of difficulty. And in 2007, an instrument was developed to evaluate individuals regarding their perception of their own intelligence.[1,2]

With the advancement of studies and the dissemination of his ideas regarding mindset,[3] several adaptations emerged from the initial scale, making it possible to apply it not only to intelligence, but also to other areas of social and behavioral sciences, and, recently, being applied to the medical field.[3,4]

The scale developed by Claudia Mueller et al.[4] provides a tool that can be validated in the national territory. It is an adaptation of the original scale by Dweck et al.,[1,2] which consists of three items, with responses ranging from 1 (strongly disagree) to 6 (strongly agree) on the Likert scale[5] (►**Table 1**). In its initial publication, the scale was named the Health Belief Scale[6] and was later referred to as the Health Mindset Scale.[7]

In this way, expanding part of the concepts presented, the health-oriented mindset addresses how the individual perceives their own health, whether in a fixed, immutable, or growing way, having direct implications for the follow-up and treatment of this patient. Since the individual with a fixed mindset, in theory, believes that their health is innate,

Table 1 Mindset Health Scale

1. Your body has a certain amount of health, and you really can't do much to change it					
1	2	3	4	5	6
Strongly agree			Strongly disagree		
2. Your health is something about you that you can't change very much					
1	2	3	4	5	6
Strongly agree			Strongly disagree		
3. You can try to make yourself feel better, but you can't really change your basic health					
1	2	3	4	5	6
Strongly agree			Strongly disagree		

immutable, having little receptivity to health education and prevention policies, given that their health is not subject to change.[4,6,7]

On the other hand, it is expected that the individual with a growth mindset will perceive their health as capable of improvement, being more open to health education, accepting new goals and challenges during therapeutic decisions, and, ultimately, being able to present greater quality of life.[4,6,7]

Materials e Methods

Study design and ethical statements

The present questionnaire study for cross-cultural validation of the health-oriented mindset scale was developed between October 2021 and August 2022. The authors obtained formal authorization from the research group that developed the original questionnaire for application and validation of the scale in Brazilian territory. (Annex 1)

The study was approved by the Ethics and Research Committee on February 11, 2022. All caregivers of the study participants were duly informed and guided, receiving the Free and Informed Consent Form (FICF) for signature, with the appropriate specifications about the study, information about the researchers and role of the participant.

The study was carried out with patients from the Department of Orthopedics and Traumatology of our hospital. The sample consisted of 215 patients aged between 18 and 87 years (M = 41.98; SD = 15.72), the average age between 31 and 50 years (42.0%), and female (52 .6%), as detailed in ►**Table 2**.

For cross-cultural adaptation of the scale, guidelines were used according to the method of Beaton et al.[8].

Initially, the scale was translated from English (original language) to Brazilian Portuguese – the language of interest – independently by two native Brazilian individuals, not appearing as authors or co-authors of the work, one of them without medical training or knowledge, called " Translator 1" and "Translator 2". Both were native Brazilians and fluent in English.

Table 2 Sample Characteristics

Variable	f	%
Sex		
Female	113	52,6
Male	102	47,4
Age range		
18 to 24 years old	22	10,2
25 to 30 years	43	20,0
31 to 40 years old	45	21,0
41 to 50 years old	45	21,0
51 to 60 years old	28	13,0
Over 60 years old	32	14,8

Table 3 Pre-test scale

1. Seu corpo tem uma certa quantidade de saúde e não há muito que você possa fazer para mudá-la
2. Sua saúde é algo sobre você que não se pode mudar muito
3. Você pode tentar se sentir melhor, mas você realmente não pode mudar sua saúde básica

Table 4 Reverse translation

1. Your body has a certain amount of health and there isn't much you can do to change it
2. Your health is something that can't be changed very much
3. You can try to make yourself feel better, but your basic health can't be changed

Then, the two versions obtained were synthesized and reviewed by a third assessor, also fluent in both languages. For the purposes of resolving conflicts and standardizing the scale, a third scale was obtained, based on discussions between authors and translators, called "pre-test" (►**Table 3**).

In this way, the "pre-test" scale was submitted to two bilingual translators, whose mother tongue was English, being fluent in the Brazilian Portuguese language, also without medical training or knowledge, highlighting that they did not know the topic, as well as not had knowledge about the original scale, carried out the reverse translation, that is, the "pre-test" scale was translated into English (►**Table 4**).

An expert committee was formed, consisting of the translators, two orthopedic spine surgeons, and three general practitioners. This committee was responsible for reviewing the obtained translations. Through this analysis, it was possible to resolve issues of semantics, redundancy, and comprehension, resulting in the "pre-final" version of the health mindset scale in Brazilian Portuguese.

The "pre-final" scale was administered to 20 Brazilian patients under follow-up at the Spine Outpatient Clinic of the Department of Orthopedics and Traumatology at our hospital by the three authors of this study. During this stage, the interviewees were asked to select the best response that represented their understanding of the content. They were also encouraged to identify any questions or concerns regarding the clarity and comprehensibility of the presented questions, as well as any ambiguities.

Once again, the committee of experts was convened so that it could analyze the responses, in order to resolve conflicts, correct ambiguities and resolve and standardize the questions, as demonstrated in ►**Table 5**.

In this way, the final version of the health mindset scale was obtained (►**Table 6**).

Health Mindset Scale

The scale is made up of 03 questions, which seek to demonstrate how the individual perceives their own health, both

Table 5 Understanding and translation process of the Health Mindset Scale

Question	Summary version		Final version	
	Discussion	Consensus	Discussion	Consensus
1	The expression "certain amount of health"	Grau de saúde	–	–
2	The expression "Your health is something about you"	Nossa saúde	The expression "change very much"	Mudar em quase nada
3	The expression "basic health"	Sua saúde	The expression "You can try to make yourself feel better"	Você tentar ter hábitos de vida mais saudáveis
Answer	Summary version		Final version	
	Discussion	Consensus	Discussion	Consensus
Strongly agree	Concordo fortemente	–	–	Concordo totalmente
Strongly disagree	Discordo fortemente	–	–	Discordo totalmente

Table 6 Final Scale

1. O nível de saúde do nosso corpo já vem pronto, e isso a gente não pode mudar
2. Nossa saúde é algo que não podemos em quase nada
3. Você pode tentar ter hábitos de vida mais saudáveis, mas sua saúde não vai mudar muito

due to innate health conditions and the possibility of improving or developing healthier lifestyle habits.

Responses are expressed through values on the Likert et al. scale,[5] ranging from 1 (totally disagree) to 6 (totally agree), according to ►**Table 1**

The individual is considered to have a growth mindset the closer their answers are to number 6 (I completely disagree), the opposite is also true: the closer the individual gets to number 1 in their answers, they will be considered to have a fixed mindset.

Internal consistency was assessed using Cronbach's alpha coefficient,[9] the purpose of which is to evaluate the homogeneity of differentiating factors between items that make up the same questionnaire or subgroups thereof. Therefore, a low coefficient indicates a lower correlation between items.

However, a high coefficient reflects redundancy between one or more items in the questionnaire. For this type of study, the recommended value for the coefficient should be between 0.70 and 0.95, in accordance with those observed by Terwee et al.[10]

The internal consistency of the three items was satisfactory ($\alpha = 0.786$). ►**Table 7** presents descriptive statistics for each item and the α if the item is excluded.

Complementarily, ►**Table 8** presents bivariate inter-item correlations.

Table 7 Descriptive statistics and α if the item is excluded from the Mindset Health Scale items

Item	M	SD	α if the item is deleted
1. O nível de saúde do nosso corpo já vem pronto, e isso a gente não pode mudar.	5,02	1,45	0,72
2. Nossa saúde é algo que não podemos mudar em quase nada.	5,32	1,29	0,70
3. Você pode tentar ter hábitos de vida mais saudáveis, mas sua saúde não vai mudar muito.	5,31	1,28	0,70

Note: M = average; SD = standard deviation.

Table 8 Inter-item, item-total and alpha correlations if the pain item excluded from the Mindset Health Scale

Item	1.	2.	3	Item-Total Correlation	α if the item is deleted
1. O nível de saúde do nosso corpo já vem pronto, e isso a gente não pode mudar.	1			0,62	0,72
2. Nossa saúde é algo que não podemos mudar em quase nada.	0,55	1		0,63	0,70
3. Você pode tentar ter hábitos de vida mais saudáveis, mas sua saúde não vai mudar muito.	0,54	0,56	1	0,63	0,70

High bivariate correlations were observed between items ($r > 0.50$). Item-total correlations ranged between 0.62 and 0.63. As shown in ►**Table 7**, no item harms the total alpha value, given the estimate of α if the item is excluded.

Results

Sample Characteristics

The sample consisted of 215 patients aged between 18 and 87 years ($M = 41.98$; $SD = 15.72$), with a prevalence between 31 and 50 years (42.0%), and female (52.6%), as demonstrated in ►**Table 2**.

Cronbach's alpha coefficient was 0.75 for male patients and 0.80 for female patients. The results did not indicate a statistically significant difference for items 1 and 2. However, a marginally significant difference ($p < 0.10$) was observed between men and women for item 3. In this item, the average for men ($M = 5\ .48$; $SD = 0.99$) was greater than the average for women ($M = 5.10$; $SD = 1.22$), with a small effect size for difference ($d = 0.26$) (►**Table 9**).

Additionally, the Pearson correlation between items and item-total correlation were presented. Correlations of magnitude were considered: weak - greater than 0.10; moderate - greater than 0.30; and strong - greater than 0.50.[11]

Pearson's correlation coefficient "r" was examined between the mean score and age ($r = -0.21$; $p = 0.002$), the result of which indicated a weak, negative and significant linear relationship. The older the age, the lower the average score on the Health Mindset Scale.

Data analysis were carried out using the IBM SPSS 24.0 program.[12] The value of $p < 0.05$ was used because it was considered statistically significant and $p < 0.10$ was considered marginally significant.

Differences by sex

Cronbach's alpha coefficient was 0.75 for male patients and 0.80 for female patients. ►**Table 9** also presents the means for each item and the total mean by gender.

Aiming to compare item scores by sex, mean comparison statistics were performed using the T test for independent samples. The effect size of the difference between the sexes was investigated by calculating Cohen's D,[13] considering effect sizes: small ($d > 0.20$); moderate ($d > 0.50$); and strong ($d > 0.80$).

The overall results did not indicate a statistically significant difference. However, for item 3 there was a marginally significant difference ($p < 0.10$) between men and women. In this item, the mean for men ($M = 5.48$; $SD = 0.99$) was higher than the mean for women ($M = 5.10$; $SD = 1.22$), with a small effect size for the difference ($d = 0.26$).

Descriptive statistics and floor and ceiling effect

►**Table 10** presents descriptive statistics (means and standard deviations) of the items, as well as the floor and ceiling effect.

According to the criteria established by McHorney[14] of 20% to indicate a floor and ceiling effect, it can be seen in ►**Table 5** that the scale items show a considerable ceiling effect. There is a tendency for participants to select answer 6 on the scale. 57.2% of participants in item 1, 68.8% of participants in item 2, and 65.1% of participants in item 3 selected the highest point on the scale.

Discussion

The questionnaire proposed by Dweck is based on two constructs: the growth mindset and the fixed mindset. Initially, the scale consisted of 8 questions, but a recurring complaint from interviewees was regarding the number of questions addressing the same topic, causing content redundancy, which was then reduced to 3, with good acceptance from participants.[4,6,7]

It is important to initially highlight the scarcity of national work regarding the health-oriented mindset. The term mindset is widely discussed, derived from psychometric analysis as Carol S. Dweck described,[1,2] or as a synonym for

Table 9 Descriptive statistics and comparison by sex

	Male		Female		Difference		Effect Size
	M	SD	M	SD	t	p	Cohen's D
Item 1	5,12	1,39	4,92	1,51	1,04	0,297	0,13
Item 2	5,41	1,20	5,23	1,36	1,03	0,300	0,14
Item 3	5,48	1,05	5,15	1,44	1,90	0,054	0,26
Average total score	5,34	0,99	5,10	1,22	1,57	0,118	0,21

Table 10 Descriptive statistics and floor and ceiling effects of Mindset Health Scale items

Item	M	SD	Floor - Ceiling
1. O nível de saúde do nosso corpo já vem pronto, e isso a gente não pode mudar.	5,02	1,45	6,5% - 57,2%
2. Nossa saúde é algo que não podemos mudar em quase nada.	5,32	1,29	4,2% - 68,8%
3. Você pode tentar ter hábitos de vida mais saudáveis, mas sua saúde não vai mudar muito.	5,31	1,28	5,1% - 65,1%

Note: M = average; SD = standard deviation.

behavioral programming, whether for entrepreneurship or to achieve a certain goal.

On the other hand, there are several works validating foreign scales using the Beaton method,[8] such as the cross-cultural validation of the Early-Onset Scoliosis 24 Item Questionnaire (EOSQ-24©) carried out by Mendonça.[15]

The analysis of the health mindset opens up a range of possibilities for understanding the health-disease process in each patient, both through their vision of health and their adherence and engagement with therapeutic proposals and lifestyle changes.[16]

In the case of healthy individuals, a constructive mindset is associated with better eating and physical activity habits, both in obese and eutrophic individuals.[16]

In a study with 132 adolescents with type 1 diabetes, it was noted that patients with a growth mindset were more related to lower levels of glycosylated hemoglobin (HbA1c) and a greater frequency of self-tests throughout the day, both for younger patients.[17]

Despite being a relatively new concept, the health mindset theory is very promising. Another study with 210 Native Americans suggested that patients with a growth mindset were more likely to adopt behaviors that could help reduce the transmission of COVID19 in community settings, adopting measures such as greater frequency of hand hygiene, use of alcohol gel and hygiene of personal items such as cell phones.[18]

In addition to being an objective and quick-to-apply instrument, it can be easily analyzed in conjunction with other scales. It was correlated with the Scoliosis Research Society Health-Related Quality of Life (SRS-30) in a population of 110 adolescents, in which individuals with a growth mindset reported higher quality of life rates compared to patients with a fixed mindset.[19]

Analyzing the mindset of parents and children seems to have a strong relationship with treatment results. It was noticed that parents with a growth mindset had more schooling, less emotional stress and fewer complaints of pain during follow-up and use of braces for adolescent idiopathic scoliosis, which led to less administration of analgesics. In this way, parents and patients with a growth mindset showed greater satisfaction with the treatment.[20]

In chronic diseases, they present better glycemic control in diabetes[17] and better quality of life in the case of kidney transplant recipients.[21]

In dialogue with the original authors of the scale, it was determined that it would not be possible to establish a specific cutoff point to categorize individuals as having either a fixed or growth mindset. The proximity to the extremes of the scale will determine where the patient falls on the spectrum.

Therefore, by identifying and intervening in patients or parents of patients with a fixed mindset, medical professionals and their teams have the potential to improve the quality of life for the patient through targeted approaches and more personalized treatments. When it comes to mindset, it relates to an individual's behavior, and interventions aimed at promoting a growth mindset can impact treatment adherence and potentially change the patient's outcome.

It was observed that the interviewees had a good understanding of the terms used, as the scale is quick and objective. Individuals under the age of 60 demonstrated a greater capacity for transitioning from a fixed mindset to a growth mindset. In other words, the younger the individual, the greater their potential for change. A properly directed treatment plan could potentially alter the patient's mindset, likely due to their life conditions resembling a growth mindset more closely.

Conclusion

The Brazilian Portuguese version of the health mindset scale was presented and cross-culturally validated, showing a good reliability coefficient – Cronbach's alpha 0.786. Therefore, it truly constitutes a new tool for clinical practice, both globally and nationally. It is relevant both due to the wide range of possibilities for analyzing patient behavior, as well as the ease and speed of its application, as well as the possibility of correlating it with other scales.

Validation brought greater adaptation to Brazilian culture, in which no publications had yet been found, seeking greater efficiency when measuring the Mindset of individuals, aiming to achieve the objective for which the instrument proposes. And, above all, providing the assistant team with more tools for clinical practice and individualizing interventions and treatments to obtain better outcomes during medical practice.

To correlate with other instruments, it is suggested to continue the study, initially in an exploratory manner, leading to a confirmatory study with a larger sample, making the results more generalizable.

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Conflict of Interests
The authors declare no conflict of interest.

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Translation, Transcultural Adaptation, and Validation of the Brazilian Portuguese Version of the Body Image Disturbance Questionnaire for Scoliosis (BR-BIDQ-S)

Tradução, adaptação transcultural e validação da versão para o português brasileiro do Body Image Disturbance Questionnaire para escoliose (BR-BIDQ-S)

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Abstract

Objective The Body Image Disturbance Questionnaire for Scoliosis (BIDQ-S) for scoliosis derives from the Body Image Disturbance Questionnaire (BIDQ) with specific adaptation for scoliosis patients. Despite its significance and applicability, this instrument has never been translated into Brazilian Portuguese. The current study aimed to translate, transculturally adapt, and validate the BIDQ-S into Brazilian Portuguese.

Methods BIDQ-S was translated and culturally adapted into Brazilian Portuguese using the American Association of Orthopedic Surgeons (AAOS) criteria. The questionnaire validation relied on internal consistency and comparison with the Cobb angle, Pediatric Quality of Life Inventory (PedsQL), and Scoliosis Research Society (SRS-22). The Brazilian version (BR-)BIDQ-S validation occurred in a sample of 35 adolescents with scoliosis waiting for specialized treatment.

Results Internal consistency of the BR-BIDQ-S was 0.899 according to the Cronbach's index (i.e., virtually perfect). Although BR-BIDQ-S did not correlate with the Cobb angle, it presented correlations with the Physical, Emotional, and Social domains from the PedsQL and the Function/Activity domain from the SRS-22.

Keywords
- scoliosis
- evaluation
- diagnosis
- quality of life

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Conclusion BR-BIDQ-S was reliable in evaluating the body image of adolescents with scoliosis, presenting an internal consistency of 0,899 (virtually perfect). Moreover, similar to the original instrument, it correlated with PedsQL and SRS-22.

Resumo

Objetivo O questionário BIDQ-S para escoliose se originou a partir do Body Image Disturbance Questionnaire (BIDQ) e representa a versão adaptada e validada especificamente em pacientes com escoliose. Este instrumento, a despeito da sua aplicabilidade e importância, ainda não tem versão para uso no Brasil. O presente estudo teve como objetivo traduzir, adaptar transcuturalmente e validar o BIDQ-S para o português brasileiro.

Método Foi realizado estudo de tradução adaptação transcultural e validação do instrumento Body Image Disturbance Questionnaire-Scoliosis version (BIDQ-S) para o português brasileiro, utilizando os critérios recomendados pela American Association of Orthopedic Surgeon (AAOS). A validação do instrumento foi realizada por meio de consistência interna e confrontando-se com ângulo de Cobb, Pediatric Quality of Life Inventory (PedsQL) e Scoliosis Research Society (SRS-22). O BR-BIDQ-S (versão brasileira) foi validado em um grupo de 35 adolescentes portadores de escoliose idiopática do adolescente que se encontravam na fila de espera para tratamento.

Resultados A consistência interna do Br-BIDQ-S foi de 0,899 medido pelo coeficiente Alfa de Cronbach (considerada quase perfeita). Não houve correlação com o ângulo de Cobb, contudo o Br-BIDQ-S teve correlação com os domínios Dimensão Física, Dimensão Emocional e Dimensão Social do PedsQL e também com a Dimensão Função/Atividade do SRS-22.

Conclusão O Br-BIDQ-S mostrou-se confiável para avaliar a imagem corporal de adolescentes com escoliose, com validade interna de 0,899 (considerada quase perfeita), similar àquela do instrumento original, havendo correlação com o PedsQL e com o SRS-22.

Palavras-chave
- escoliose
- avaliação
- diagnóstico
- qualidade de vida

Introduction

Scoliosis is a lateral curvature of the spine greater than 10° associated with a rotational component, while spinal asymmetry refers to deviations lower than 10°.[1] Scoliosis classification relies on etiology, curvature location, age of onset, or curvature.[1] Secondary scoliosis or scoliosis of known etiology represents around 20% of all causes, while idiopathic scoliosis is the most common clinical type.[2,3] Idiopathic scoliosis classification may also rely on age as infantile (0–3 years old), juvenile (4–9 years old), and adolescent (over 10 years old).[2]

It is worth highlighting that scoliosis does not change the appearance of the back alone but may extend to the anterior region of the trunk, scapulae (shoulder imbalance or elevation), and pelvic and hip tilt.[3] Tones et al.[4] concluded that adolescents with scoliosis can suffer a significant psychosocial impact, especially when presenting prior associated emotional factors. Among psychosocial disorders, concern about body image has become a growing problem impacting the lives and mental health of adolescents.[4] Schwieger et al.[5] analyzed patients from The Bracing in Adolescent Idiopathic Scoliosis Trial (BrAIST) and reported that those with a Cobb angle $\geq$ 40° had worse scores on the Spinal Appearance Questionnaire (SAQ) and the Pediatric Quality of Life Inventory (PedsQOL) 4.0 Generic Scales even after 2 years of treatment follow-up. These scores reflect a significant loss of self-esteem and quality of life.

The BIDQ-S questionnaire originated from the Body Image Disturbance Questionnaire (BIDQ) proposed by Cash et al.[6] BIDQ-S is an adapted and validated BIQS version by Auerbach et al.[7] to assess body image disorders, especially in scoliosis patients. The version validated by Auerbach et al.[7] is in English, with translations into Korean, German, Turkish, and simplified Chinese. However, there is no validated version in Brazilian Portuguese. Therefore, considering the applicability and significance of this questionnaire, this study aimed to translate the BIDQ-S into Brazilian Portuguese, culturally adapt it, and validate it in this language.

Casuistry and Methods

This study transcultural adapted and validated BIDQ-S into Brazilian Portuguese using the translation and transcultural adaptation criteria proposed by Beaton et al.[8] (2007and recommended by the American Association of Orthopedic Surgeons (AAOS).[7] After translation, the instrument was validated using a generic questionnaire, a quality of life-specific questionnaire, and the relationship with the Cobb angle.[1–3]

The study occurred from September 2021 to June 2022 and is part of a larger project approved by the institutional Research Ethics Committee under number CAAE 27816320.0000.5520. All subjects agreeing to participate in the study and their guardians signed the Free and Informed Consent (ICF) and Assent forms.

We performed all stages of translation and cross-cultural validation proposed by AAOS.[8] In the first stage, three bilingual Portuguese-English authors experienced in medicine freely translated (BIDQ-S),[7] from English to Brazilian Portuguese. The second stage consisted of translation harmonization and synthesis. The third stage was an adaptation based on the opinion of three experts in spine who were fluent in English and evaluated the harmonized version. The final version was the result of the second harmonization based on experts' suggestions.

The final version of the BIDQ-S for Brazilian Portuguese underwent a pre-test for cross-cultural adaptation with ten adolescents reporting a complete and sufficient understanding of the instrument. Next, the validation of this version employed 35 patients with adolescent idiopathic scoliosis who were on the waiting list for treatment, using data obtained directly from managers of the Unified Health System (SUS, for its acronym in Portuguese). All patients' contact occurred by letters, telephone calls, electronic means, through patient associations, or in person by the study team.

The research subjects were from the Hospital's Orthopedics Service. The study included all subjects identified as having adolescent idiopathic scoliosis aged from 10 to 18 years old who were awaiting treatment at a service with potential access. Patients with non-idiopathic scoliosis (congenital or neuromuscular), scoliosis lower than 10 degrees, or waiting for a second spinal procedure were excluded.

Sociodemographic Questionnaire and Radiological Information

The applied sociodemographic and clinical questionnaire asked about age, gender, self-declared ethnicity/race, weight, height, body mass index (BMI), education, and origin. Next, we collected information regarding illness duration, associated conditions, development of secondary sexual characteristics, etc. We also analyzed panoramic radiographs of the patient's spine to determine the Cobb angle of the main curvature and, as a result, the degree of scoliosis (ranging from 1 to 3).

The instrument: The Body Image Disturbance Questionnaire-Scoliosis (BIDQ-S)[6]

The questionnaire had seven items. Items 1, 2, 5, 6, and 7 were subdivided into A and B. Items 1A, 2A, 3, 4, 5A, 6A, and 7A were questions with objective answers about image disturbances. Each question had five answer options, ranging from "not worried" to "extremely worried." Each answer received a score from 1 ("not worried") to 5 ("extremely worried"). The final BIDQ-S score was the average of the points obtained on these questions. The higher the score, the greater the body image concern/disturbance level. As mentioned, items 1, 2, 5, 6, and 7 had subdivisions into A and B, with B being subjective characterizations (open responses) of the objective response from subdivision A. In this way, the BIDQ-S instrument presented a quantitative and qualitative analysis of the image disturbances in the patient with scoliosis.[7]

Pediatric Quality of Life Inventory (PedsQL) version for adolescent report (13–18 years old)[9,10]

PedsQL has several versions, subdivided by age (5–7, 8–12, and 13–18, 18–25 years old) and by patient or parent report (for patients up to 18 years old). The questionnaire consists of four scales: physical dimension, emotional dimension, social dimension, and educational dimension, and the final scores are divided into these dimensions. The answers range from never (0) to virtually always (4), and the scores undergo a reversible transformation in percentages, i.e., $0 = 100$, $1 = 75$, $2 = 50$, $3 = 25$, and $4 = 0$. Therefore, when calculating the result, the higher the percentage, the better the quality of life. The dimension cannot be computed if more than 50% of items are incomplete. The result from each domain is the average of the items answered, while the final result is the average of the four separate domains.[9,10]

Scoliosis Research Society (SRS-22r)[11,12]

The revised version of the SRS-22 consists of 22 questions divided into five domains, i.e., function/activity, pain, personal image/appearance, mental health, and treatment satisfaction. Answers are objective and range from 1 (worst answer) to 5 (best answer). This questionnaire is validated in Brazilian Portuguese. Data analysis evaluates subtotal and mean values from each domain. The percentage of the result is calculated, considering 100% the best possible answer.[11,12]

Data Analysis

We used the Statistical Package for the Social Sciences (SPSS) software version 25.0 for Windows for data tabulation and analysis. Quantitative variables were expressed as mean $\pm$ standard deviation or median and interquartile range (IQR). Qualitative variables were shown as simple and relative frequencies. Statistical analysis consisted of independent samples t-tests, Pearson correlation, ANOVA, and Cronbach's alpha. The significance level was $p < 0.05$.

Results

Most subjects were female, around 14 years old, mixed race, attending elementary level II, from the state capital, and with an average Cobb angle above 50 degrees (►**Table 1**).

The BIDQ-S had the worst scores related to questions 1 ,2 ,3, and 7, in that order, demonstrating concern about appearance, difficulty stopping thinking about appearance, sadness associated with scoliosis, and the need to avoid situations because of scoliosis. There was no difference in the responses of girls compared with boys (►**Table 2**). The internal consistency of the BIDQ-S in the Brazilian Portuguese version was 0.899 per Cronbach's alpha coefficient. This internal

Table 1 Sociodemographic of the sample

Characteristics ($n = 35$)	N (%) or mean (±standard deviation)
Gender	
Female	27 (77.1%)
Male	8 (22.9%)
Age	14.14 (±1.7)
Weight	51.3 (±11.31)
Height	1.62 (±0.10)
Body mass index	19.76 (±3.81)
Race	
Black	9 (25.7%)
Mixed	22 (62.9%)
White	4 (11.4%)
Education	
Fundamental II	24 (68.6%)
High school	11 (31.4%)
Origin	
State capital	18 (51.4%)
Countryside	17 (48.6%)
Cobb angle from the main curvature	55.50 (±21.16)
Cobb angle lower than 20°	2 (6.7%)
Cobb angle ranging from 20° to 49°	6 (20%)
Cobb angle equal or higher than 50°	22 (73.3%)

consistency is virtually perfect according to the Lands and Koch criteria.[13]

There was no significant correlation between BIDQ-S and the Cobb angle ($r = 0.312$ with $p = 0.094$) using Pearson's correlation. Regarding health-related quality of life, measured by PedsQL, the lowest scores were in the Emotional Dimension domain. The PedsQL did not correlate with the Cobb angle ($r = -0.259$ with p 0.168); there was a correlation between the BIDQ-S and the Physical Dimension, Emotional Dimension, and Social Dimension domains of the PedsQL (►**Table 3**).

There was a significant correlation between the BIDQ-S and the SRS-22 in the function/activity dimension. The SRS-22 was also related to the Cobb angle in the function/activity and pain dimensions through Pearson correlation (►**Table 4**).

Discussion

The Brazilian Portuguese version of the BIDQ-S had an internal consistency of 0.899 according to Cronbach's alpha coefficient, considered virtually perfect.[13] The worst scores were in the domains concerned with appearance, difficulty stopping thinking about appearance, sadness associated with scoliosis, and the need to avoid situations due to scoliosis. Despite not correlating with the Cobb angle, the BIDQ-S questionnaire significantly correlated with the participants' health-related quality of life in the Physical Dimension, Emotional Dimension, and Social Dimension domains of the PedsQL. The BIDQ-S correlated only with the Function/Activity Dimension of the SRS-22.

Our internal consistency is similar to that obtained in equivalent studies described previously and to the original BIDQ and BIDQ-s versions, confirming the validity of the Brazilian Portuguese version of the BIDQ-S. The original BIDQ questionnaire, a generic instrument originating a version for scoliosis created by Cash et al.,[6] in 2004, presented a Cronbach's alpha coefficient of 0.89.[13] The Australian version of the BIDQ presented a Cronbach's alpha of 0.92.[14] The adapted version and validated for scoliosis (BIDQ-S), presented by Auerbach et al.,[7] 2014, had a coefficient of 0.82.[7] The validation of the BIDQ-S questionnaire in its Korean, Turkish, German, and Simplified Chinese had Cronbach's alpha of 0.88,[15] 0.88,[16], 0.87,[17], and 0.877[17], respectively.

Our study did not find a significant correlation between the Brazilian Portuguese version of the BIDQ-S and the Cobb angle, even when analyzing patients with and without surgical indication as subgroups. The BIDQ-S validation study from Auerbach et al.[6] ($N = 49$) also found no correlation between the Cobb angle of the main curvature and the BIDQ-S questionnaire scores. The validation study of the BIDQ-S in its Simplified Chinese version, by Bao et al. apud Wetterkamp et al.[17]

Table 2 Body Image Disturbance Questionnaire for Scoliosis (BIDQ-S) scores per questions and participants' genders

BIDQ-S	Total	Female	Male	*p*
BIDQ-S – Question 1	2.66 (±1.21)	2.70 (±1.17)	2.50 (±1.41)	0.718
BIDQ-S – Question 2	2.40 (±1.14)	2.33 (±1.11)	2.63 (±1.30)	0.578
BIDQ-S – Question 3	2.43 (±1.17)	2.48 (±1.15)	2.25 (±1.28)	0.656
BIDQ-S – Question 4	1.51 (±0.74)	1.48 (±0.70)	1.63 (±0.92)	0.691
BIDQ-S – Question 5	1.54 (±1.09)	1.63 (±1.18)	1.25 (±0.71)	0.275
BIDQ-S – Question 6	1.63 (±1.06)	1.67 (±1.07)	1.50 (±1.07)	0.706
BIDQ-S – Question 7	2.20 (±1.39)	2.30 (±1.43)	1.88 (±1.25)	0.433
BIDQ-S – Total	2.05 (±0.84)	2.08 (±0.85)	1.95 (±0.85)	0.695

Table 3 Pediatric Quality of Life Inventory (PedsQL) score and its correlation with the Body Image Disturbance Questionnaire for Scoliosis (BIDQ-S) and Cobb angle

PedsQL domains	PedsQL ($n = 35$)	BIDQ-S versus PedsQL ($n = 35$)	BIDQ-S versus Cobb ($n = 35$)
Physical dimension	70,09 (±22,67)	−0,666 ($p < 0,001$)	−0,300 ($p = 0,107$)
Emotional dimension	64,71 (±24,37)	−0,672 ($p < 0,001$)	−0,060 ($p = 0,752$)
Social dimension	82,43 (±25,30)	−0,741 ($p < 0,001$)	−0,261 ($p = 0,163$)
Educational dimension	69,42 (±12,41)	−0,245 ($p = 0,156$)	−0,053 ($p = 0,779$)
Total PedsQL score	71,67 (±16,68)	−0,798 ($p < 0,001$)	−0,259 ($p = 0,168$)

Questionnaire comparison used the Pearson correlation.

Table 4 Scoliosis Research Society (SRS-22) score and its correlation with the Body Image Disturbance Questionnaire for Scoliosis (BIDQ-S) and Cobb angle

SRS-22 domains	SRS-22 ($n = 27$)	BIDQ-S ($n = 35$)	Cobb ($n = 30$)
Function/activity dimension	3.57 (±0.78)	−0.484 ($p = 0.011$)	−0.434 ($p = 0.039$)
Pain dimension	3.63 (±0.96)	−0.234 ($p = 0.240$)	−0.431 ($p = 0.040$)
Personal image/appearance dimension	3.27 (±0.68)	−0.022 ($p = 0.914$)	−0.305 ($p = 0.156$)
Mental health dimension	3.53 (±0.80)	−0.303 ($p = 0.125$)	−0.118 ($p = 0.593$)
Treatment satisfaction dimension	3.76 (±1.08)	−0.067 ($p = 0.738$)	−0.094 ($p = 0.670$)
SRS-22 in percentage	70.37 (±11.35)	-0.342 ($p = 0.081$)	−0.467 ($p = 0.025$)

Questionnaire comparison used the Pearson correlation.

($N = 100$) also did not observe a significant correlation between the BIDQ-S questionnaire and the Cobb angle.[17] The same study, in a subanalysis, grouped patients with Cobb $\geq 40°$ and $< 40°$, observing that those with a Cobb angle $\geq 40°$ had a higher (worse) C-BIDQ-S result than subjects with a Cobb $<40°$.[17] The Korean validation study by Bae et al.[15] ($N = 113$) indicated that patients with larger Cobb angles tend to present worse body image.[15] The German validation study from Wetterkamp et al.[17] ncluding 259 patients was the single one with a significant correlation between the Cobb angle and G-BIDQ-S.[17] Wetterkamp et al.[17] hypothesized that the study by Auerbach et al.[7] did not find a significant correlation between the Cobb angle and the BIDQ-S due to a smaller sample size.[17] This can be extrapolated to our study, raising the possibility of a lack of correlation due to the small sample size.

The mean BIDQ-S score in our study was 2.05 (± 0.84), and it was calculated by the average points from questions 1 to 7, ranging from 1 (best possible scenario) to 5 (worst possible scenario). Compared with other studies, the German version had a mean score of 2.04 (± 0.76), including 2.26 ± 0.84 in the surgical subgroup and 1.83 ± 0.60 in the non-surgical subgroup.[17] For the Korean version, the mean score was 2.4 ± 0.8, with the score from the brace user subgroup being significantly higher in comparison with the observation subgroup; moreover, the subgroup requiring surgery had a significantly higher score than the brace subgroup.[15] The mean score of the original validation study from Auerbach et al.[7] was 1.50 ± 0.49, with significant differences between the surgical (1.57), non-surgical (1.45), and control (1.06) subgroups. Our study found the highest BIDQ-S scores in questions 1, 2, and 3, respectively, consistent with the Turkish validation study, with an overall mean value of 2.03 and the highest scores in questions 1 (2.93 ± 1.267), 2 (2.40 ± 1.07), and 3 (2.11 ± 1.12).[16]

Our study showed a significant negative correlation between BIDQ-S and SRS-22 in the function/activity dimension. When correlating BIDQ-S with SRS-22, the German validation study found a moderate negative correlation, specifically in the personal image/appearance domain from SRS-22 (−0.74).[17] The Korean version of the BIDQ-S found a significant correlation only for the appearance domain of SRS-22 ($p < 0.001$, $r = -651$).[15] Auerbach et al.[7] also found a significant correlation between BIDQ-S and SRS-22 since BIDQ-S correlated with the total SRS-22 (−0.72), the activity (−0.53), pain (−0.53), image (−0.60), and mental (−0.50) domains scores, all with $p < 0.001$. We believe cultural differences may explain the inconsistency in the correlation between BIDQ-S and SRS-22 in our study and the remaining literature.

Our study found a significant negative correlation between BIDQ-S and PedsQL in the physical, emotional, and social dimensions. Bauer et al.[18] found a strong relationship between BIDQ-S, SRS-22, and PedsQL questionnaires. Their study also highlighted that the mental health domain of SRS-22r correlated well with the emotional domain of PedsQL, suggesting that mental health issues interfere more with personal image than the level of deformity alone.[18] Therefore, these authors emphasize that they chose to apply the BIDQ-S as a body image questionnaire in patients with idiopathic scoliosis as it has a good correlation with other existing questionnaires and fewer questions, consequently requiring a lower application time.[18]

Our study has some limitations. The number of patients in our sample, although similar to the one in the original version, may have been relatively small to provide power to all analyses.

Our patients were recruited from a clinical-surgical outpatient clinic; therefore, most underwent surgery as the most recommended treatment and usually presented larger Cobb angles. As it occurred in a specialized center for scoliosis treatment, our results may not reflect the same characteristics of the scoliosis population, reducing the external validity of the study. Most of our sample consisted of girls and, although there were no significant differences between genders, this may have given some bias to the work. Despite these limitations, we could validate BIDQ-S in its Brazilian Portuguese version and carry out fundamental secondary analyses confirmed in similar studies.

Conclusion

Our study demonstrated that the Brazilian Portuguese version of the BIDQ-S (BR-BIDQ-S) is a reliable instrument for assessing adolescent body image, with an internal validity of 0.899 (virtually perfect), which is similar to the internal consistency of the original instrument. Furthermore, BR-BIDQ-S correlated with the quality of life of adolescents measured by PedsQL and with the Function/Activity Domain of SRS-22, reinforcing its validity.

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Conflicts of Interests
The authors declare no conflicts of interest.

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Appendix 1 Original and Brazilian Portuguese versions Body Image Disturbance Questionnaire for Scoliosis (BIDQ-S)

English	Brazilian Portuguese
1A. Are you worried about the appearance of your back shape? 1. Not at all worried 2. Somewhat worried 3. Moderately worried 4. Very worried 5. Extremely worried	1A. 1A Você está preocupado com a aparência da forma de suas costas? 1. Não 2. Um pouco 3. Moderadamente 4. Muito 5. Extremamente
1B. What are these concerns? 1. My shoulders are uneven (one is higher or lower than the other) 2. My shoulder blade sticks out 3. My chest is asymmetric from the front (one side looks higher or lower than the other side) 4. My hips are asymmetric (one hip is higher or lower than the other) 5. My rib bump	1B. Quais são essas preocupações? 1. Meus ombros são desalinhados (um é mais alto ou mais baixo que o outro) 2. Minha escápula fica aparente 3. Meu tórax é assimétrico olhando de frente (um lado é mais alto ou mais baixo que o outro) 4. Meus quadris são assimétricos (um lado é mais alto ou baixo que o outro) 5. A deformidade das minhas costelas
2A. If you are at least somewhat concerned or worried, do these concerns/worries preoccupy you? That is, you think about them a lot and they're hard to stop thinking about? (Circle the best answer) 1. Not at all preoccupied (I do not think about them) 2. Somewhat preoccupied (I think about them from time to time) 3. Moderately preoccupied (I think about them a moderate amount) 4. Very preoccupied (I think about them a lot) 5. Extremely preoccupied (I think about them constantly)	2A. Se você está ao menos um pouco preocupado, você pensa muito sobre o assunto e é difícil parar de pensar sobre isso? 1. Não (não penso sobre) 2. Um pouco (penso de vez em quando) 3. Moderadamente (penso em uma quantidade moderada) 4. Muito (penso muito) 5. Extremamente (penso constantemente)
2B. How do your concerns about the way your back looks affect your life? For example, some kids say that they avoid swimming because they are embarrassed to show their back.	2B. Como as preocupações sabre a aparência de suas costas afetam sua vida? Por exemplo, algumas crianças falam que evitam nadar porque têm vergonha de mostrar suas costas.
3. Has the way your back looks caused you to feel upset? How much? 1. Not upset at all 2. Mild (a little bit upset) 3. Moderate (Somewhat upset) 4. Severe, and very disturbing (very upset) 5. Extreme, and disabling (extremely upset)	3. A forma de suas costas já fez você se sentir triste? Quanto? 1. Não 2. Um pouco triste 3. Moderadamente triste 4. Muito triste, muito perturbador 5. Extremamente triste, incapacitante
4. Have your worries about how your back looks caused you any problems at school, at your job, or with your friends and family? How much? 1. No problems 2. A few problems, but overall I can do what I need to do, and my performance is not affected 3. Several problems, but I can cope with them; problems are still manageable 4. A lot of problems that limit what I can do; problems cause a lot of limitations 5. Extreme problems that keep me from doing almost everything I want or need to do	4. As suas preocupações sobre a forma de suas costas causaram algum problema na escola, trabalho ou com seus amigos e família? Quanto? 1. Não 2. Alguns problemas, mas no geral eu posso fazer o que preciso fazer, e minha performance não é afetada 3. Muitos problemas, mas posso lidar com isso, problemas que consigo manejar 4. Vários problemas que limitam o que posso fazer, problemas que causam muitas limitações 5. Problemas extremos que me impedem de fazer quase tudo que quero ou preciso fazer
5A. Has your back shape caused problems with your friends, family members, or dating? How much? 1. Never 2. Occasionally 3. Sometimes 4. A lot 5. All the time	5A. A forma de suas costas causou problemas com seus amigos, membros da família ou relacionamentos? Quanto? 1. Nunca 2. Ocasionalmente 3. Às vezes 4. Muito 5. O tempo todo

Appendix 1 (*Continued*)

English	Brazilian Portuguese
5B. If so, how?	5B. Se sim, como?
6A. Has your back shape caused problems with your schoolwork, your job, or your ability to do other things that are important to you (e.g., play sports, be social with your friends)? How much? 1. Never 2. Occasionally 3. Sometimes 4. A lot 5. All the time	6A A forma de suas costas já causou problemas com trabalhos de escola, trabalho ou sua habilidade de fazer outras coisas que são importantes para você? (ex: esportes, sair com os amigos)? Quanto? 1. Nunca 2. Ocasionalmente 3. Às vezes 4. Muito 5. O tempo todo
6B. If so, how?	6B. Se sim, como?
7A. Do you ever avoid things because of your back shape? How often? (Circle the best answer) 1. Never 2. Occasionally 3. Sometimes 4. A lot 5. All the time	7A. Você já evitou situações por causa da forma de suas costas? Quão frequentemente? 1. Nunca 2. Ocasionalmente 3. Às vezes 4. Muito 5. O tempo todo
7B. If so, how?	7B. Se sim, como?

Treatment with Raloxifene Induces the Expression of Kisspeptin, Insulin, and Androgen Receptors in Bones of Castrated Adult Female Rats

Tratamento com raloxifeno induz à expressão dos receptores de kisspeptina, insulina e androgênio em ossos de ratas adultas castradas

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Abstract

Objective To evaluate the effects of estrogen, raloxifene and genistein on the expression of *KISS1* (kisspeptin), *KISS1R* (kisspeptin receptor), *AR* (androgen receptor) and *INSR* (insulin receptor) in the bones of ovariectomized rats.

Methods Forty-eight adult rats were randomly divided into 6 groups, containing 8 animals each: G1–nonovariectomized control; G2–ovariectomized and treated with conjugated equine estrogens (50 µg/Kg/day); G3–ovariectomized and treated with raloxifene (0.75 mg/kg/day); G4–ovariectomized animal that received soy extract with genistein (300 mg/kg/day); G5–ovariectomized animal that received estrogen and genistein; and G6–ovariectomized animal that received estrogen and raloxifene. Three months after surgery, the castrated animals received the drugs orally daily for 120 days. All animals were sacrificed after this period, by deepening the anesthesia. The left tibia

Keywords
- raloxifene hydrochloride
- estrogens
- genistein
- kisspeptins
- osteoporosis

Work developed at the Laboratory of Structural and Molecular Gynecology (LIM 58), Discipline of Gynecology, Department of Obstetrics and Gynecology, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (HCFMUSP), São Paulo, SP, Brazil.

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was removed for total RNA extraction and analysis of gene expression of *KISS1*, *KISS1R*, *AR* and *INSR*, by quantitative real-time polymerase chain reaction (qRT-PCR).
Results *KISS1* was not detected in any of the treated groups. *KISS1R*, *INSR* and *AR* showed higher expression in the G3 group ($p < 0.001$), while lower levels of transcripts for these genes were observed in G4 and G5. G2 animals showed hypoexpression of the evaluated genes.
Conclusion The results indicate that raloxifene, alone or combined with estrogen, was able to induce the expression of genes associated with the recovery of bone tissue homeostasis in ovariectomized rats.

Resumo

Objetivo Avaliar os efeitos do estrogênio, raloxifeno e genisteína na expressão de *KISS1* (kisspeptina), *KISS1R* (receptor da kisspeptina), *AR* (receptor de androgênio) e *INSR* (receptor de insulina) nos ossos de ratas ovariectomizadas.
Métodos Quarenta e oito ratas adultas foram divididas aleatoriamente em 6 grupos, contendo 8 animais cada: G1–controle não ovariectomizado; G2–ovariectomizado e tratado com estrogênios conjugados equinos (50 µg/Kg/dia); G3–ovariectomizado e tratado com raloxifeno (0,75 mg/kg/dia); G4–ovariectomizado que recebeu extrato de soja com genisteína (300 mg/kg/dia); G5–ovariectomizado que recebeu estrogênio e genisteína; e G6–ovariectomizado que recebeu estrogênio e raloxifeno. Após 3 meses da cirurgia, os animais castrados receberam os fármacos diariamente por via oral, durante 120 dias. Todos os animais foram sacrificados após esse período, por aprofundamento da anestesia. A tíbia esquerda foi removida para extração de RNA total e análise da expressão gênica de *KISS1, KISS1R, AR* e *INSR,* por reação de cadeia de polimerase quantitativa em tempo real (*quantitative real-time polymerase chain reaction*, qRT-PCR, em inglês).
Resultados *KISS1* não foi detectado em nenhum dos grupos tratados. *KISS1R*, *INSR* e *AR* mostraram maior expressão no grupo G3 ($p < 0,001$), enquanto menores níveis de transcritos para esses genes foram observados em G4 e G5. Os animais de G2 apresentaram hipoexpressão dos genes avaliados.
Conclusão Os resultados indicam que o raloxifeno, isolado ou combinado com estrogênio, foi capaz de induzir a expressão de genes associados à recuperação da homeostase do tecido ósseo em ratas ovariectomizadas.

Palavras-chave
- cloridrato de raloxifeno
- estrogênio
- genisteína
- kisspeptinas
- osteoporose

Introduction

Osteoporosis presents itself as a global and growing challenge. One in two women, especially postmenopausal women, has this condition.[1] Although age and osteoporosis may be independent factors, 34% of all fractures observed in women are related to aging and a decrease in sex hormone levels. It is known that this reduction leads to an imbalance between bone formation and resorption, with a progressive decrease in mineralization and tissue structure, and consequently an increase in the risk of fractures.[2]

Characterized by the loss of bone mass and deterioration of its microarchitecture,[1,2] osteoporosis causes disability, reduced quality of life, and increased mortality due to the high risk of serious fractures.[3] The increasing incidence of osteoporosis, as well as healthcare costs in an aging society, accentuate the need to better understand the physiology and pathogenesis of bone loss.[2,3] In this sense, recent studies highlight the importance of reproductive axis molecules in bone physiology, including kisspeptin, during the remodeling of this tissue.

Kisspeptin is a neuropeptide produced in the hypothalamus and acts in the synthesis of important hormones, such as luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Both kisspeptin and its receptor are essential for reproduction in men and women.[4] It was recently demonstrated in rodents that its administration promotes the *in vitro* differentiation of osteoblasts through the expression of its receptor (KISS1R or GPR54).[4,5] Thus, kisspeptin may have direct beneficial effects on skeletal homeostasis, independently of its role in the release of sex steroids.[5] However, there are few data on its expression and function, as well as its receptor, in bone, especially in osteoporosis related to hypoestrogenism.

Bone tissue samples from affected patients are difficult to obtain, making the use of experimental models an excellent option to help better understand this disease. Thus, the development of an experimental model of ovariectomy has contributed to the investigation of the etiology and pathophysiology of osteoporosis, as well as the establishment of preventive measures and new therapies.[6] Castration of female rats induces a pathological process similar to that of diseases that affect the bone structure, with consequent weight gain and decreased absorption of intestinal calcium.[6,7] The experimental model that best mimics osteoporosis in postmenopausal women is obtained by performing ovariectomy in rats $>$ 6 months old.[7,8]

Aware of the relevance of estrogen in physiology and the complications of classical hormonal therapy and selective estrogen receptor modulators (SERMs), phytoestrogens have aroused great clinical interest as a therapeutic alternative. These molecules show high structural and chemical similarity to estrogens. For instance, genistein shares a structure similar to that of 17 β-estradiol, enabling it to bind to estrogen receptors (ERs) and functionally possess estrogenic and antiestrogenic activities.[6,7]

Raloxifene (benzothiophene analogue) acts as a selective modulator of estrogen receptors, being used in the treatment and prevention of osteoporosis. Studies show that raloxifene increases bone density and reduces the risk of vertebrae fractures by up to 50% in women with early menopause.[9]

In the present study, we conducted a comparative assessment of the effects of treatments involving estrogen, raloxifene, and genistein-rich soy extract, either individually or in combination, on the gene expression patterns of kisspeptin (KISS1) and its receptor (KISS1R) in the bones of ovariectomized rats. Additionally, we examined the expression levels of androgen receptors (ARs) and insulin receptors (INSRs).

Methods

Animal treatment and euthanasia

A total of 48 newborn rats (*Rattus norvegicus albinus*) of the Wistar lineage were obtained from the central vivarium of our university. The animals were kept in plastic cages measuring 45 × 35 × 15cm, with a metal mesh lid, with food and water ad libitum, at an ambient temperature of 22°C and artificial lighting. A 12-hour light photoperiod was maintained interspersed with a 12-hour dark period, considering the light period from 7:00 am to 7:00 pm. This protocol was evaluated and approved by the Animal Research Ethics Committee under number 0421/07.

Nine days after birth, the rats received testosterone propionate (0.1 mg/g), subcutaneously, in order to induce an increase in final bone mass.[6,7] After 6 months of life, the weight range observed was 278 g to 312 g. At that time, 40 rats underwent ovariectomy (►**Fig. 1**). The others, not castrated, constituted the control group (G1). After 21 days, a colpocytological examination was carried out to prove the effect of castration.[6,7]

Three months after ovariectomy, the 40 rats were randomly divided into 5 equal groups, containing 8 rats each, namely: G2–ovariectomized rats that received conjugated equine estrogens, dose of 50 µg/Kg/day; G3–ovariectomized rats that received raloxifene, 0.75 mg/kg/day; G4–ovariectomized rats that received soy extract enriched with genistein, 300 mg/kg/day; G5–ovariectomized rats that received soy extract enriched with genistein and combined estrogens; and G6–ovariectomized rats that received raloxifene and combined estrogens. These substances were administered for 120 consecutive days, with the aid of a metal probe, as previously described.[6,7]

After the treatment period, the animals were euthanized in a CO2 chamber in accordance with the institutional

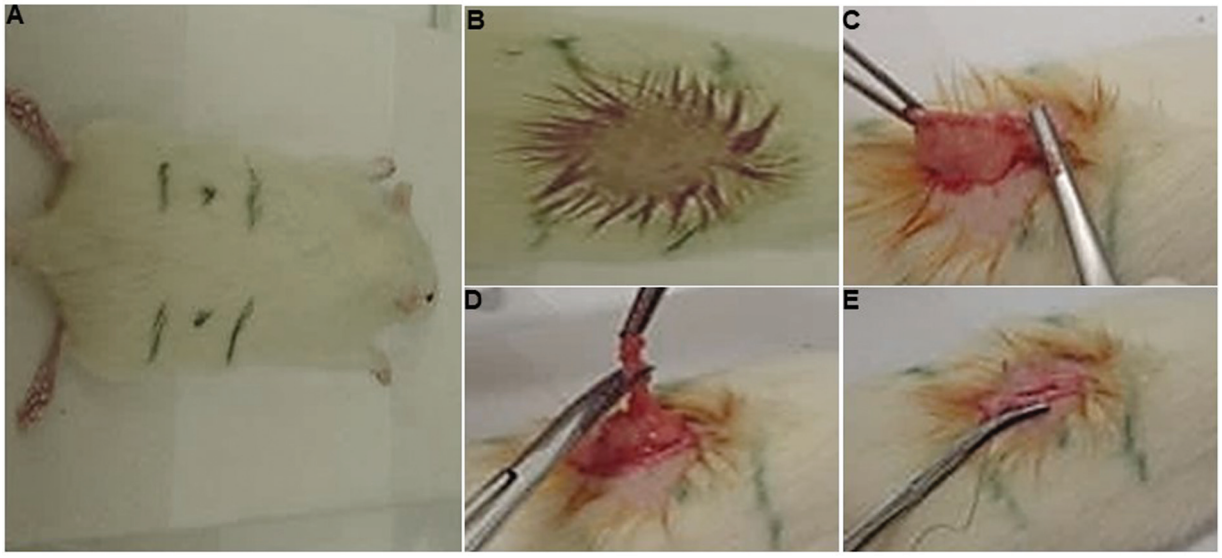


Fig. 1 Ovariectomy of adult rats (6 months old). Photographs of the stages of the ovariectomy technique performed in the present study. (**A**) Delimitation of the area where the ovary is located; (**B**) shaving the back and performing aseptic preparation with Povidine (aqueous solution); (**C**) exposure of the left horn of the uterus; (**D**) surgical removal of the left ovary; and (**E**) closure of the incisions layer by layer.

guideline for animal management of the School of Medicine of Universidade de São Paulo, São Paulo, Brazil. Next, the tibias were collected for histological, immunohistochemical and molecular processing, according to the specific protocol to be described for each analysis.

Tissue collection and gene expression analysis by real-time quantitative polymerase chain reaction (qRT-PCR)

The right tibia was quickly dissected on a cooled surface (4°C), frozen in liquid nitrogen and stored in a -80°C freezer. To extract total RNA, the tibiae were pulverized in liquid nitrogen using a mortar and steel pestle (Thermo Fisher Scientific Inc., Waltham, MA, United States) previously cooled in dry ice. Trizol reagent (Invitrogen, Thermo Fisher Scientific) was added to the bone powder. This mixture was homogenized with the aid of the Polytron PT10-35 device (Kinematica AG, Malters, Switzerland.

The RNA obtained was treated with DNAse I (Fermentas, Hanover, MD, United States), as recommended by the manufacturer, to eliminate possible contamination with genomic DNA. The concentration and purity of the RNAs were determined by spectrophotometry in a Nano Drop device (Thermo Fisher Scientific) and by electrophoresis in 1% agarose gels. Complementary DNA (cDNA) was synthesized from 1µg of extracted total RNA, using the HiCapacity cDNA synthesis kit (Thermo Fisher Scientific), according to the protocol determined by the manufacturer, on the Veriti device (Thermo-Fisher Scientific) and standard cycling of the device. The primer oligonucleotides for amplification were designed using Primer Express (Applied Biosystems, Foster City, CA, United States) software, version 1.0. For real-time polymerase chain reaction (RT-PCR), inventoried assays (set of primers and fluorescent probes) were used to amplify the genes *ACTB* (beta-actin, 4352340E), *KISS1* (kisspeptin, Rn00710914_m1), *KISS1R* (receptor kisspeptin, Rn00576940_m1), *INSR* (insulin receptor, Rn00690703_m1) and *AR* (androgen receptor, Rn00560747_m1). The reactions were carried out in triplicate (3 replicates for each gene and samples tested in the analyses), in 96-well plates and using the ABI Prism 7500 apparatus (Applied Biosystems, Foster City, CA, United States).

The values related to the amplification of the genes of interest in the treated groups, in relation to the animals in the control group and normalized by the *ACTB* gene, were obtained using the 2(-delta delta C(T)) (ddCT) method.[10]

Statistical analysis

The data were analyzed in a Microsoft Excel (Microsoft Corporation, Redmond, WA, United States) spreadsheet and the means and standard deviations (SDs) of the mean were calculated for each evaluated group. Initially, the sample distribution was evaluated. For comparison between groups, when the distribution was homogeneous, the analysis of variance (ANOVA) test ($p < 0.05$) was used, followed by the Tukey post-test. Otherwise, the Kruskal-Wallis test was used, followed by the Dunn test.

To compare two groups, the Student t-test or the Mann-Whitney test were used, depending on the sample distribution. It was considered significant when $p < 5\%$. All analyzes were performed using SPSS Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, United States).

Results

No statistically significant variation in weight was observed between animals in different groups ($p < 0.05$), as described in a previous work by our group.[7] These results showed that, after the 4th month of treatment, the highest weight was observed for animals in the group treated with estrogen and genistein (G5 = 336.7 g) and the lowest in those treated with raloxifene alone (G3 = 307.6 g).[7] In ►**Fig. 2**, representative photomicrographs of the bone tissue profile (tibia) of non-castrated rats can be seen, compared with the bone tissue of an ovariectomized rat. The figure allows us to observe the difference in the histoarchitecture of bone trabeculae induced by the procedure, demonstrating the effectiveness of the model used in our studies.[7]

Our group had already demonstrated[6,7] the effectiveness of these treatments in remodeling bone architecture. Therefore, in the present work, we evaluate the influence of these treatments on the expression of genes relevant to reproduction and whose loss has been associated with bone demineralization. The qRT-PCRs showed that greater induction of KISS1R, INSR and AR expression were observed in the group

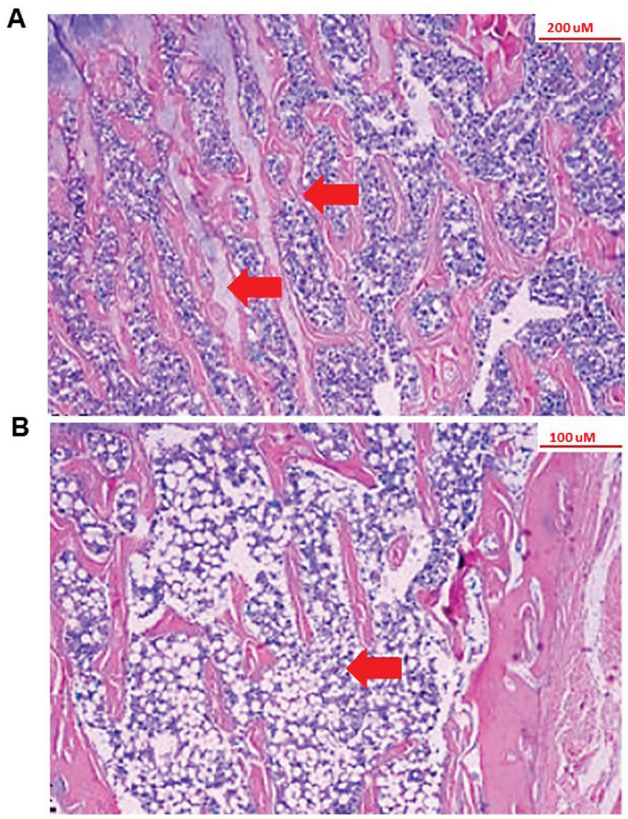


Fig. 2 Effect of castration on bone microarchitecture. Bone photomicrograph of nonovariectomized (**A**) and ovariectomized (**B**) female rats, showing the difference in architecture and tissue organization after castration. Arrows indicate the location of bone trabeculae. The images demonstrate the efficiency of castration in bone tissue.

treated with raloxifene (G3), with statistically significant values ($p < 0.001$). Lower levels of transcripts for these same genes were observed in the G4 and G5 groups (genistein and genistein combined with estrogen, respectively), but without significant differences. ►**Fig. 3** presents the expression values obtained for each group tested.

Animals treated with estrogen alone (G2) showed hypoexpression of all evaluated genes, but without a statistically significant difference in relation to the other groups. The G6 group (treated with raloxifene and estrogen) showed greater expression of the genes evaluated than the groups that received estradiol alone or in combination with genistein, but a significant difference was only observed for AR (►**Fig. 3**).

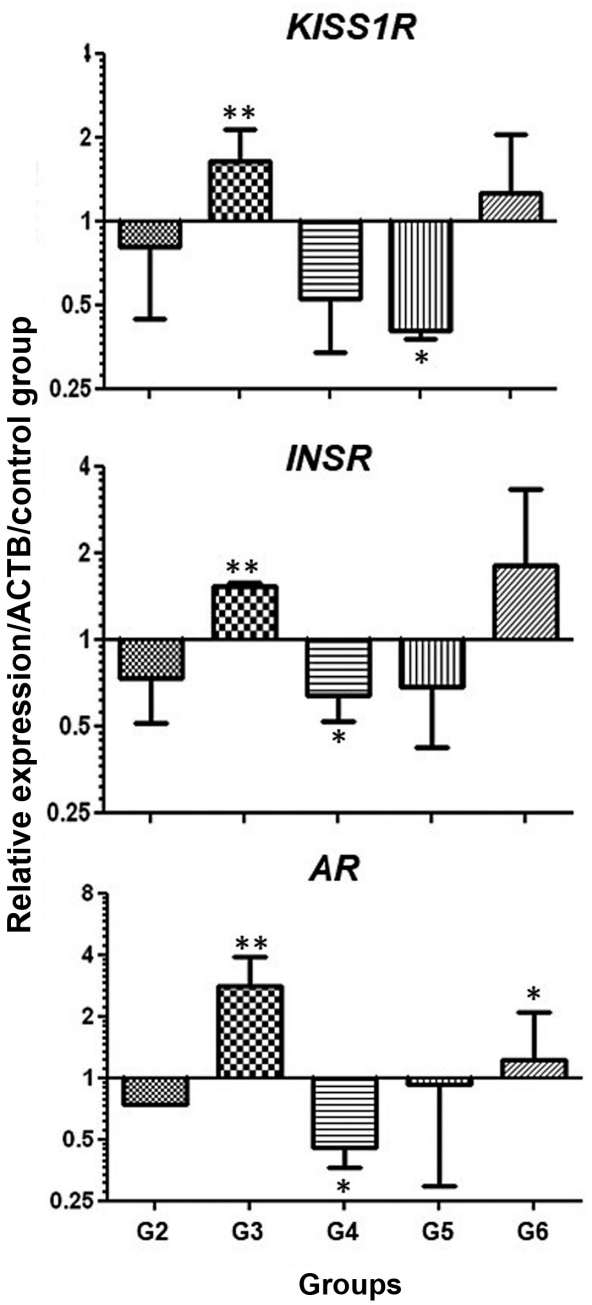


Fig. 3 Detection of gene expression by real-time polymerase chain reaction (RT-PCR). Relative expression of KISS1R, INSR and bone AR in rats from the different evaluated groups. Gene expression values were obtained by the ddCT method, using as a reference the amplification values of the nonovariectomized control group, after normalizing the amplification values of each sample (for all target genes) by the values obtained for the constitutive gene (*ACTB*, beta-actin). Asterisks indicate *p*-values ($^{*}p < 0.05$ and $^{**}p < 0.001$).

Discussion

It is known that, in hypoestrogenism, osteocytes die, with clear recruitment and greater activity of osteoclasts. These, in turn, lead to the degradation of bone tissue and phagocytosis of osteocytes.[11–13] Studies have shown osteocytes, osteoblasts and/or bone lining cells, in the process of apoptosis, being phagocytosed by osteoclasts.[12,13] Perhaps this is the main mechanism of action of estrogen on bone.

Estrogen inhibits bone resorption, acting on osteoclasts through several pathways. In hypoestrogenism, there is an increase in the formation and action of osteoclasts, as well as their survival time, inducing a greater number and resorptive activity of these cells. In parallel, the synthesis of bone matrix by osteoblasts is reduced, with greater reabsorption occurring in relation to formation,[14] as well as the disarray in bone microarchitecture seen in our experiment, when comparing ovariectomized animals with the physiological control group.[12,14]

Evidence shows that estrogen, raloxifene and genistein-enriched soy extract can attenuate bone changes caused by hypoestrogenism.[6,7,9] Our study showed a positive effect of the association of estrogen and raloxifene on the expression of genes of interest in the bones of castrated rats. However, greater efficacy was observed for raloxifene alone. As for soy extract rich in genistein, isolated or associated with estrogen, no significant beneficial action was observed on bone tissue. Some studies have shown that genistein is not effective in maintaining bone mass after ovariectomy, both in animals and in postmenopausal women.[15]

Lower levels of gene expression were observed in the bones of rats treated with estrogen alone. In this sense, the mechanisms of action of this hormone on bones are not completely elucidated, although some of its routes of action are well characterized. It is known that estradiol 17β-benzoate inhibits the formation and activity of osteoclasts, leading to a reduction in the number of these cells.[16,17] This characteristic of estrogen action could justify the loss of gene expression in the groups treated with estradiol in the present study. Faloni et al.[18] observed that the alveolar bones of rats treated with estrogen showed a decrease in the number of osteoclasts due to the induction of apoptosis. Although this data is positive for bone density, the loss in cellularity could compromise the detection of transcripts.

Raloxifene can act as an agonist or antagonist in a tissue-specific manner, as it has an affinity for the ER similar to 17β-estradiol.[19] Some studies suggest that raloxifene is capable of stimulating estrogenic pathways exclusively through ER_{β}, justifying its tissue selectivity.[9,20,21] Our results showed that its isolated action was beneficial to the bone; however, as already described, the association with estrogen did not

present an adjuvant effect. This result can be explained by competition for the receptor, or by inhibition of the estrogen receptor with this hormonal combination.[21,22] A previous study demonstrated that raloxifene is more effective in bone tissues with greater estrogen receptor availability.[23]

Previous results from our group showed that treatment with genistein and raloxifene increases the expression of type I collagen and its messenger RNA. However, the combined use of conjugated equine estrogens and raloxifene or genistein does not appear to improve or reduce bone quality after ovariectomy.[6,7]

Kisspeptin is a peptide encoded by the *KISS1* gene and is important in modulating the hypothalamic-pituitary-gonadal (HHG) axis. It is produced in the hypothalamus, specifically in its anteroventral periventricular area and in the arcuate nucleus, and is the ligand for G protein-linked receptor 54 (GPR54 = KISS1R). In humans, mutations in the gene that encodes KISS1R lead to deficiency in the production of gonadotropin-releasing hormone (GnRH), which culminates in hypogonadotropic hypogonadism.[24,25]

The interaction of kisspeptin with its receptor is associated with the GnRH/LH peaks that precede the ovulation hormonal cascade in sheep[26] and rats.[27] In models of androgenized rats with dihydrotestosterone (DHT), a decrease in the expression of the *KISS1* gene and also of its protein was demonstrated,[28] which corroborates our findings. The *KISS1R* gene showed increased expression in groups treated with raloxifene, alone or combined with estradiol, which appears to be a compensatory mechanism for the decreased expression of *KISS1*. In a study carried out by Gore et al.,[29] treatment with estradiol from 19 days of fetal life until 7 days of age caused a reduction in the expression of *KISS1* and an increase in *KISS1R*.

The bidirectional influence between bone and energy metabolism was demonstrated by the discovery that the product of osteocalcin (osteoblasts) increases, among other findings, insulin secretion and sensitivity. On the other hand, the anabolic action of insulin is crucial for the function of osteoblasts. This relationship is clear in diabetic patients with severe osteopenia due to insulin deficiency.[30]

The present work showed that the treatment of ovariectomized adult rats with raloxifene, alone or combined with estrogen, induced an increase in the expression of *KISS1R*, *INSR* and *AR*. Although studies that define the best conditions for using these drugs, including women with hypoestrogenic osteoporosis, are necessary, our data show that this treatment can be an important alternative in the recovery of bone tissue homeostasis in these patients.

Conclusion

The results obtained indicate that the use of raloxifene was able to induce the hyperexpression of the *KISS1R*, *INSR*, and *AR* genes in castrated adult female rats.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Can We Forgo the Use of Tourniquets in Total Knee Arthroplasty?

Podemos dispensar o uso do torniquete nas artroplastias totais do joelho?

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Abstract

Objective To analyze whether there is more bleeding in patients undergoing total knee arthroplasty (TKA) without using a tourniquet. The secondary objectives were to analyze the operative time, the length of hospital stay, the need for transfusion, and the complication rate.

Methods The present is a retrospective study through the analysis of medical records. The patients were divided into two groups: TKA with and without the use of a tourniquet. Reductions in the levels of hemoglobin and packed cell volume 24 h and 48 h after surgery, the operative time, the length of hospital stay, the need for transfusion, and the rate of complications up to 6 months postoperatively were compared between the groups.

Results During the period analyzed, 104 patients underwent TKA, and 94 were included in the study. There were no differences between the groups regarding the mean values of hemoglobin and packed cell volume before surgery ($p = 0.675$ and $p = 0.265$), 24 h ($p = 0.099$ and $p = 0.563$), and 48 h ($p = 0.569$ and $p = 0.810$) after the procedure. Neither were there differences between the groups in terms of the operative time and the length of hospital stay ($p = 0.484$ and $p > 0.05$). Moreover, there were no differences regarding the need for transfusion and the complication rate.

Conclusion It is possible to forgo the use a tourniquet in TKA without a significant change in hemoglobin and packed cell volume levels 24 h and 48 h after surgery when compared with the group using a tourniquet. There were no significant differences in the total operative time, length of stay, need for transfusion, and complication rate.

Keywords
- arthroplasty
- knee
- hemorrhage
- tourniquet

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Resumo

Objetivo Analisar se há mais sangramento em pacientes submetidos a artroplastia total do joelho (ATJ) sem a utilização do torniquete. Os objetivos secundários foram analisar os tempos cirúrgico e de internação, a necessidade de transfusão e a taxa de complicações.

Materiais e Métodos Estudo retrospectivo por meio da análise de prontuários. Os pacientes foram divididos em dois grupos: ATJ com e sem a utilização de torniquete. Foram comparados os valores das quedas da hemoglobina e do hematócrito 24 h e 48 h após a cirurgia, os tempos cirúrgico e de internação, a necessidade de transfusão e a taxa de complicações até 6 meses de pós-operatório.

Resultados No período, foram operados 104 pacientes, sendo 94 incluídos no estudo. Não houve diferença entre as médias dos valores da hemoglobina e do hematócrito entre os grupos no pré-operatório ($p = 0{,}675$ e $p = 0{,}265$, respectivamente), 24 h ($p = 0{,}099$ e $p = 0{,}563$, respectivamente) e 48 h ($p = 0{,}569$ e $p = 0{,}810$, respectivamente) após a cirurgia. O tempo cirúrgico e o tempo de internação também não foram diferentes entre os grupos ($p = 0{,}484$ e $p > 0{,}05$, respectivamente). Não houve diferença com relação à necessidade de transfusões, nem com relação à taxa de complicações analisadas.

Conclusão Podemos dispensar o uso do torniquete nas cirurgias de ATJ sem alteração significativa no valor dos níveis de hemoglobina e de hematócrito 24 h e 48 h após a cirurgia quando comparado ao grupo com uso de torniquete. Não houve diferenças significativas no tempo total das cirurgias, no tempo de internação, na necessidade de transfusões e nas taxas de complicações analisadas.

Palavras-chave

- artroplastia
- joelho
- hemorragia
- torniquete

Introduction

The use of a tourniquet in total knee arthroplasty (TKA) is common, as it reportedly improves the visualization of the operative field, reduces intraoperative blood loss, and increases cementation quality.[1,2] Research carried out in 2009 at the American Association of Hip and Knee Surgeons annual meeting to analyze the medical management in TKA showed that a tourniquet was used in up to 58% of the cases.[3]

However, many studies point to numerous disadvantages in adopting the tourniquet, including short-term postoperative deficits in knee flexion or extension,[1,4,5] pain and prolonged limb edema,[6] increased wound-related complications, and peripheral nerve injuries, depending on the duration of tourniquet use.[7] The tourniquet may also be associated with increased cerebral and cardiac microembolic events.[8] Some authors mention that using a tourniquet may also increase the risk of deep-vein thrombosis (DVT)[4] and skin irritation due to contact with the device.[9] The purpose of the tourniquet, supposedly to reduce perioperative blood loss, has been contested.[10] In addition, the tourniquet increases occult blood loss in certain cases.

Recent meta-analyses have demonstrated that tourniquet use is related to a greater risk of severe adverse events, postoperative pain, longer length of stay,[1,11] and increased occult bleeding.[1] The only finding potentially favoring tourniquet use would be reduced surgical time.[1,11]

The primary objective of the present study was to analyze whether the postoperative reductions on the serum levels of hemoglobin (Hb) and packed cell volume (PCV) are higher in patients undergoing TKA with no tourniquet. The secondary objectives were to determine the presence of differences concerning operative time, length of stay, need for transfusion, new surgeries to drain postoperative hematoma, arthrofibrosis, wound dehiscence, superficial and deep infections, DVT, pulmonary thromboembolism (PTE), acute myocardial infarction (AMI), and deaths up to the sixth postoperative month.

We hypothesized that there would be no increase in bleeding or operative time, and that there could be a reduction in complication rates when TKA was performed without a tourniquet.

Materials and Methods

The present study was conducted after approval form the institutional Research Ethics Committee (under number CAAE 61606122.0.0000.5696). The study followed resolution no. 466/2012 of the Brazilian National Health Council and the Declaration of Helsinki.

The present retrospective observational study analyzed medical records of patients undergoing TKA between 2017 and 2022 in the same hospital and by the same team. The patients were divided into two groups: TKA with and without a tourniquet. The levels of Hb PCV before and 24 h and 48 h after surgery, the operative time, the length of stay, the number of transfusions, new surgeries to drain hematoma in the postoperative period, arthrofibrosis, wound dehiscence,

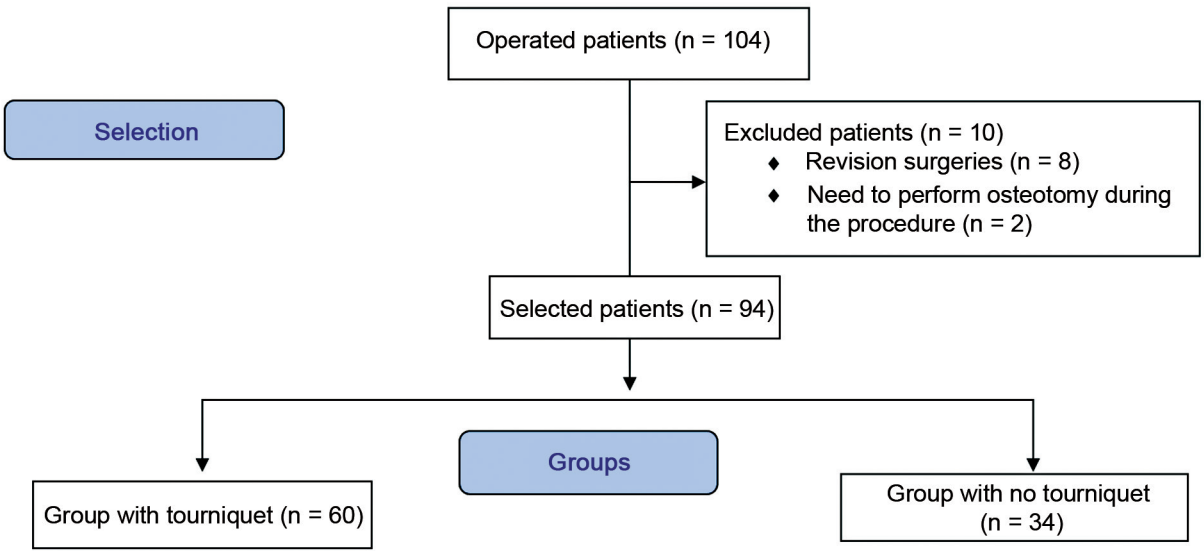


Fig. 1 Flowchart.

superficial and deep infections, DVT and PTE incidence rates, AMI, and deaths up to the sixth postoperative month were compared between groups.

The study included all patients over 18 years old who underwent TKA in the same hospital by the same surgical team. Patients undergoing revision TKA, those requiring associated corrective osteotomy, those with previous coagulation disorders, or those who had used an anticoagulant up to seven days before surgery were excluded.

All patients had a blood sample collected through peripheral puncture before, 24 h, and 48 h after surgery. In addition, the surgical time of each procedure was evaluated using notes from the nursing and anesthesia team. All patients underwent spinal anesthesia and surgery via the medial parapatellar approach, maintaining ischemia from the beginning of the skin incision until the final dressing in cases of tourniquet use. The implants used were cemented, subsequently stabilized, with no patellar replacement, and using the same instrumentation for implantation (Meta Bio Industrial Ltd., Rio Claro, SP, Brazil). No suction drain was used in any case. Patients operated on with a tourniquet received 1 g of tranexamic acid intra-articularly at the end of joint capsule closure. Patients not using a tourniquet received 1 g of intravenous tranexamic acid during anesthetic induction and 500 mg intra-articularly at the end of joint capsule closure. All patients received drug thromboembolic prophylaxis with 40 mg of low-molecular-weight heparin subcutaneously 6 hours after the procedure and every 24 hours during hospitalization. After hospital discharge, the patients were prescribed 10 mg of oral rivaroxaban daily for 10 days. The criterion for transfusion indication was an Hb level >7 g/dL associated with clinical symptoms such as hemodynamic instability, oliguria, reduced level of consciousness, or regular and/or poor general condition. The criteria to indicate hospital discharge were hemodynamic stability, walking with the aid of a walker, and controlled pain.

For the statistical analysis, we considered a retrospective cohort with Hb and PCV as dependent outcomes, while age, sex, surgical time, length of stay, and complication rate were independent variables. The statistical analysis used a linear model for repeated measures with the Sidak post-hoc test. The quantitative data underwent a *t*-test, whereas the categorical variables underwent a Chi-squared test. The analysis employed the IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States) software, version 23.0.

Results

During the selected period, 104 patients underwent surgery, and 94 were included in the study. ►**Fig. 1** shows the study flowchart. Tourniquets were used in 60 patients, and 34 patients were operated on without a tourniquet. ►**Table 1** illustrates the lack of statistical difference regarding age, sex, and initial Hb and PCV levels.

►**Table 2** shows that although the mean surgical time in the group not using a tourniquet was higher, this difference was not statistically significant ($p = 0.484$). The length of stay in days was not different between the groups ($p > 0.05$).

►**Table 3** presents the complication rates. There was no difference between groups in any of the variables analyzed. Moreover, there were no reports of PTE or surgery for hematoma drainage.

►**Fig. 2** shows the mean Hb values in both groups before surgery (95% confidence interval [95%CI]: -0.711–0.492; $p = 0.675$) and 24 h (95%CI: -0.091–1.039; $p = 0.099$) and 48 h (95%CI: -0.391–0.706; $p = 0.569$) after the procedure. ►**Fig. 3** shows the mean PCV levels in both groups before surgery (95%CI: -2.814–0.783; $p = 0.265$) and 24 h (95%CI: -1.238–2.260; $p = 0.563$) and 48 h (95%CI: -1.944–1.522; $p = 0.810$) after the procedure.

Table 1 Preoperative demographics

Variable	With tourniquet ($n = 60$)	Without tourniquet ($n = 34$)	*p*-value*
Age (years)	68.3 ± 9.13	68.2 ± 7.43	0.189
Male (%)	17 (28.3)	13 (38.2)	0.322
Hb (g/dL)	12.85 ± 1.57	13.05 ± 1.31	0.675
PCV (%)	38.21 ± 4.74	39.49 ± 4.19	0.265

Abbreviations: Hb, hemoglobin; PCV, packed cell volume.
Note: Quantitative data are represented as mean ± standard deviation values.

Table 2 Comparison between groups regarding surgical time and length of stay

Variable	With tourniquet ($n = 60$)	With no tourniquet ($n = 34$)	*p*-value*
Surgical time (minutes)	107.16 ± 2.94	111.79 ± 26.17	0.484
Length of stay (days)	2.07 ± 0.25	2.15 ± 0.36	> 0.05

Note: Data are represented as mean ± standard deviation values.

Table 3 Postoperative complications in each group

Variable	With tourniquet ($n = 60$)	Without tourniquet ($n = 34$)	*p*-value*
Need for transfusion	1	0	> 0.05
Superficial infection	4	1	> 0.05
Deep infection	1	1	> 0.05
Arthrofibrosis management	1	1	> 0.05
Deep-vein thrombosis	1	1	> 0.05
Acute myocardial infarction	2	0	> 0.05
Death	2	0	> 0.05
TOTAL	12	4	> 0.05

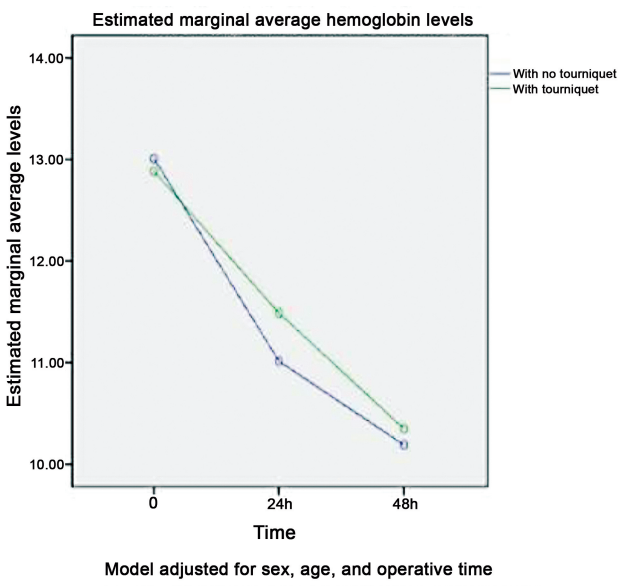


Fig. 2 Variation in hemoglobin levels in patients undergoing total knee arthroplasty.

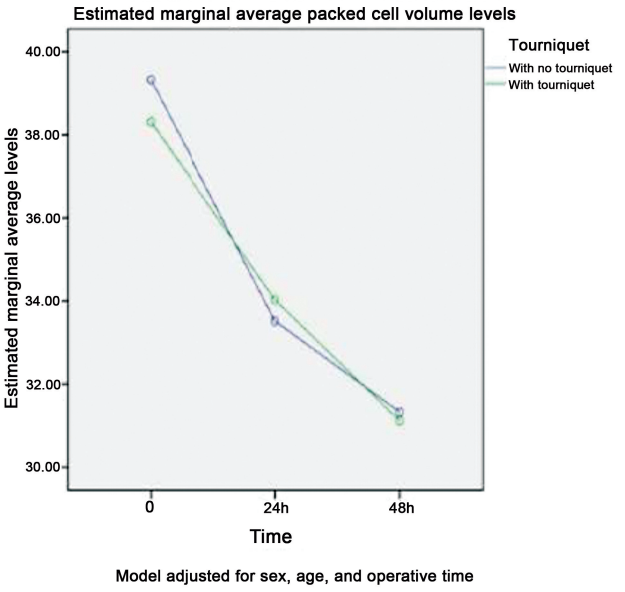


Fig. 3 Variation in packed cell volume levels in patients undergoing total knee arthroplasty.

Discussion

The present study showed no significant difference in terms of the postoperative reductions on the levels of Hb and PCV, a finding similar to those of meta-analyses published in 2014[4] and 2021,[11] but contrary to those of meta-analyses published in 2019[10] and 2022.[1] The difference in Hb loss in the first 24 h between groups was the most significant result, but it was not significant ($p = 0.099$). In addition, after the first 48 h, the Hb levels were similar between the groups ($p = 0.569$). We suppose this initial trend of a higher drop in Hb levels in the group not using a tourniquet may have occurred due to earlier bleeding. This drop would be detectable in tests performed within the first 24 h, which may not occur in the group using the tourniquet, which would theoretically have a later, hidden bleeding. This detail may justify the divergence in the literature on this subject.[4,10,11] Sun et al.[1] showed less intraoperative bleeding and more occult bleeding in the tourniquet group. This paper[1] only included studies using tranexamic acid, which was also a routine in our patients and has proven effective in bleeding reduction.[12]

The operative time was not significantly different between the groups. The mean surgical time was of 107.16 ± 22.94 and 111.79 ± 26.17 minutes in the groups using or not using tourniquets respectively ($p = 0.484$). This finding differs from those of the latest meta-analyses indicating that the tourniquet would contribute to reducing the operative time.[1,11] We believe including more patients in the study could show some difference concerning this variable. Alternatively, the experience of our group in operating without a tourniquet may have approximated the surgical times in both modalities.

The potential postoperative complications reported in the literature,[5,11,13] such as increased length of stay and need for transfusion, new surgeries for hematoma drainage in the postoperative period and for arthrofibrosis, wound dehiscence, superficial and deep infections, DVT, PTE, AMI, and deaths. The rates of these complications were not different between the two groups.

In a prospective study with more than 150 patients published in 2021, Zak et al.[14] reported that the length of stay was equal between the groups. Yi et al.,[5] in 2021, demonstrated, in a prospective study with 50 patients in each group, a lower length of stay in the group not using a tourniquet. In the present study, the length of stay was not different between the groups using a tourniquet or not (2.07 ± 0.25 and 2.15 ± 0.36 respectively; $p > 0.05$). Both studies[5,14] cited for comparison used tranexamic acid during surgery and did not mention their criteria for hospital discharge, which in the study included hemodynamic stability, the ability to walk with the aid of a walker, and pain control.

A single patient from the tourniquet group required a blood transfusion. However, this subject had preoperative chronic anemia, and the drop in Hb and PCV levels was within the standard observed in other patients. In a prospective study published in 2019, Alexandersson et al.[13] reported 1 transfusion in the group not using a tourniquet (consisting of 43 patients) and 4 transfusions in the group with a tourniquet (38 patients). The same study[13] reported two cases of infections in the group using a tourniquet (one superficial infection and one deep infection) and no infection in the group without a tourniquet. These data are consistent with those of the present study, since we observed higher numbers of infections in the group with a tourniquet despite the lack of statistical difference between them (four cases of superficial infections and one deep infection in the group with a tourniquet, and one case of superficial infection and one deep infection in the group without a tourniquet).

We did not observe cases of clinical DVT in the present study, but we did not actively search for thrombi with imaging tests. A previous prospective study[15] with groups of 60 patients receiving tranexamic acid during the procedure did not find any case of clinical DVT; however, the tourniquet group presented more cases of asymptomatic thrombi at an ultrasound examination of the lower limbs. Large retrospective studies[16,17] demonstrated a low rate of clinical DVT after TKA with and without a tourniquet. In one of them, using the Danish registry[16] with 19,804 patients, the clinical DVT rate was low in both groups, with no difference between them (0.77% in the tourniquet group and 1.10% in the group not using a tourniquet).

The present study has limitations. Firstly, it is a retrospective study. A prospective randomized study could lead to different results. Secondly, the use of data from a single center limits the number of patients studied despite reducing the bias of comparing different surgeons with different practices. Thirdly, the number of patients was low for a retrospective study. And fourthly, we do not have data on functional and pain assessments to compare the groups.

Our results were not in line with those of the current literature showing that, with the use of tranexamic acid and tourniquets in an optimized and customized way[1,2,18] during TKA, the advantages of the tourniquet are obtained without increasing the complication rates.

Conclusion

It is possible not to use a tourniquet in TKA without significant changes in Hb and PCV levels 24 h and 48 h after surgery compared with the group using a tourniquet. Likewise, there was no significant difference in operative time, length of stay, need for transfusion, new surgeries for postoperative hematoma drainage and arthrofibrosis, wound dehiscence, superficial and deep infections, DVT, PTE, AMI, and deaths between the two groups.

Authors' Contributions

Each author contributed individually and significantly to the development of the present paper. JPFG wrote and reviewed the paper, analyzed the results, developed the statistical analysis, participated in the intellectual conception of the study, and coordinated the entire project; CWJ, BZ, and PMC collected data, wrote, and reviewed the paper; PRB analyzed the results and developed the statistical analysis; MVD reviewed the paper and participated in the intellectual conception of the study.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Periarticular Infiltration Compared to Single Femoral Nerve Block in Total Knee Arthroplasty: A Prospective Randomized Study

Infiltração periarticular comparada ao bloqueio do nervo femoral único na artroplastia total de joelho: Um estudo prospectivo randomizado

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Abstract

Objective To compare patients undergoing total knee arthroplasty (TKA) under spinal anesthesia and single femoral nerve block (FNB) with subjects undergoing TKA under spinal anesthesia and periarticular infiltration (PAI).

Materials and Methods A total of 100 patients undergoing primary TKA were randomized into two groups. Group 1 included patients undergoing surgery under FNB associated with spinal anesthesia, while group 2 included patients undergoing TKA under IPA and spinal anesthesia. The assessment of these subjects in the early postoperative period included pain, active flexion, active extension, elevation of the extended limb, and morphine use.

Results There was no significant difference in the types of analgesia concerning pain, the elevation of the extended limb, and morphine use. Active flexion and extension were better in the PAI group ($p = 0.04$ and $p = 0.02$ respectively).

Conclusion We conclude that the techniques are similar regarding pain control, limb elevation, and morphine use. The use of IPA provided better active flexion and extension during the hospital stay compared to single FNB in patients undergoing TKA.

Keywords
- analgesia
- anesthetics, local
- arthroplasty, replacement, knee
- nerve block
- infiltration
- femoral nerve

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Resumo

Objetivo Avaliar pacientes submetidos a artroplastia total do joelho (ATJ) sob raquianestesia e bloqueio do nervo femoral (BNF) único e comparar com pacientes que submetidos a ATJ sob raquianestesia e infiltração periarticular (IPA).

Materiais e Métodos Um total de 100 pacientes submetidos a ATJ foram randomizados em dois grupos. O grupo 1 incluiu pacientes submetidos a ATJ sob BNF associado à raquianestesia, ao passo que o grupo 2 incluiu pacientes submetidos a ATJ sob IPA associada à raquianestesia. Os indivíduos foram avaliados no pós-operatório precoce quanto à dor, à flexão e extensão ativas, à elevação do membro estendido e ao uso de morfina.

Resultados Não se observou diferença significativa associada ao tipo de analgesia em relação à dor, à elevação do membro em extensão e ao consumo de morfina. Houve melhor flexão e extensão ativas no grupo que recebeu IPA ($p = 0,04$ e $p = 0,02$, respectivamente).

Conclusão Concluímos que as técnicas utilizadas são semelhantes quanto ao controle da dor, à elevação de membro e ao uso de morfina. O uso de IPA proporcionou uma melhor flexão e extensão ativas durante o período de internação hospitalar comparado ao uso de BNF único em pacientes submetidos a ATJ.

Palavras-chave

- analgesia
- anestesia local
- artroplastia do joelho
- bloqueio nervoso
- infiltração
- nervo femoral

Introduction

More than 80% of patients who undergo surgical procedures experience acute postoperative pain, and approximately 75% of them classify this pain as moderate or severe. Evidence suggests that postoperative pain treatment is often inadequate, with direct effects on quality of life, recovery, and the risk of postoperative complications, such as chronic pain.[1–4]

Among the methods to control pain after total knee arthroplasty (TKA), femoral nerve block (FNB) using a catheter and intermittent anesthetic infusion provides good postoperative analgesia. However, its potential disadvantages include a decrease in quadriceps activation, resulting in lower muscle control during gait and increased risk of falls. Recent studies[5–12] have demonstrated that intraoperative periarticular infiltration (PAI), using a cocktail of medications, produces an analgesic effect similar to that of FNB, with the advantage of not compromising muscle function.

The present study aimed to evaluate and compare patients undergoing TKA under spinal anesthesia and single FNB to patients undergoing the same procedure but under spinal anesthesia and PAI. The assessment of these subjects in the early postoperative period included pain, knee range of motion (ROM), ability to lift the limb, morphine requirement, and complications. We hypothesize that PAI produces the same analgesic effect in the early postoperative period of TKA compared to FNB, but with a lesser impact on muscle function in the initial rehabilitation phase.

Materials and Methods

In total, 100 patients with an indication for TKA were initially selected and randomized into two groups. Group 1 included 50 patients who underwent TKA under spinal anesthesia and simple (single) FNB, and group 2 consisted of 50 patients who underwent the same surgical procedure but under spinal anesthesia and PAI.

The inclusion criteria were patients of both sexes, aged 18 or older, and undergoing primary TKA for advanced osteoarthrosis. The exclusion criteria were patients with allergies to any of the medications included in the research protocol, contraindication to or failure of spinal anesthesia, known abusers of alcohol or drugs, with rheumatoid arthritis or other inflammatory diseases, those submitted to previous surgeries (except for meniscal and ligament injury treatment), those with psychiatric illnesses diagnosed or under treatment, paralysis, paresis, or paresthesia in the contralateral limb, and patients who did not agree to participate in the study.

The participants were initially randomized into 2 groups of interest using a sequence of random numbers ordered from 1 to 100 per their entry date into the study. A responsible person kept the randomization list confidential and informed the surgeon and anesthetist to which group the patient belonged before anesthetic induction. This same person did not participate in any other phase of the study, having no contact with patients or evaluators. A team member, a doctor duly trained and blinded to the randomization, performed data collection.

Group 1 underwent spinal anesthesia with 15 mg of bupivacaine and 100 mcg of morphine; immediately after, the anesthetist performed a single FNB with 150 mg of ropivacaine and 150 mcg of clonidine aided by a peripheral nerve stimulator (Stimuplex B. Braun Medical Inc., Melsungen, Hesse, Germany). Group 2 received the same spinal anesthesia as group 1 and PAI with an analgesic solution consisting of 150 mcg of clonidine, 30 mg of ketorolac, 375 mg of ropivacaine, and 1 mg of epinephrine diluted in 50 mL of saline solution. The surgeon performed PAI during

the procedure, administering 20 mL in the posteromedial capsular region, 15 mL in the posterolateral region, and distributing the remaining volume throughout the femoral and tibial subperiosteal regions (lateral, medial, and anterior).

The postoperative assessment followed a logical order, starting with pain, active and passive ROM, the active elevation of the limb, and the amount of morphine used. Patient evaluation occurred during hospitalization at 24 (first postoperative day [1PO]), 48 (2PO), and 72 (3PO) hours postoperatively. In the postoperative period, all patients underwent the same physical therapy protocol and received the same analgesia protocol, which included continuous use of 30 mg of codeine every 6 hours, 750 mg of paracetamol every 8 hours, 1 g of dipyrone every 6 hours, and 30 mg of ketorolac every 8 hours for 48 hours. The prescription of morphine at a dose of 0.05 mg/kg every 3 hours was left to the patient's discretion as needed.

Pain was assessed through the Visual Analogue Scale (VAS) as rated by the patient from 0 to 10, with 0 indicating no pain and 10, the most intense pain. The passive and active ROM were determined in degrees using a universal goniometer, with the patient in the supine position. Elevation of the extended limb is the active elevation distance in centimeters of the limb measured from the calcaneus to the physical examination table. Morphine use was quantified in mg/day and subsequently evaluated in the medical record analysis.

The study occurred from September 2019 to February 2021, and all patients underwent treatment and surgery using the same surgical technique and implants. The same anesthesia team performed the anesthetic procedure. The Teaching and Research Committee of Universidade de Passo Fundo approved the study in August 2019 (under opinion 3.537.0920), and all patients included signed the informed consent form (ICF).

Statistical Analysis

The sample size calculation was made using the Windows Programs for Epidemiologists (Winpepi, freeware) software, version 11.65 and based on a study by Zhang et al.[7] This calculation reached a minimum total of 44 patients per group considering a 5% significance level, 80% power, and an effect size of at least 0.6 standard deviation (SD) between groups regarding the pain score.

The quantitative and ordinal variables were expressed as mean ± SD values, and the categorical variables were expressed as absolute and relative frequencies. The Shapiro-Wilk test determined data normality. Group comparison over time used the generalized estimating equations (GEE) model complemented by the least significant difference (LSD) test. The linear model was applied to variables with normal distribution, while the gamma model was used for variables with asymmetric or ordinal distribution.

The significance level adopted was of 5% ($p < 0.05$), and the analyses employed the IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States) software, version 28.0.

Results

The study included and analyzed 100 patients. ►**Table 1** characterizes the patient sample, and the groups were similar regarding age, gender, and operated side. The average hospital stay was of four days for both groups.

There was no statistically significant difference in pain between the groups, neither were there differences in the interaction effect between group and time regarding pain levels. Both groups presented a significantly lower pain level on 3PO compared to 1PO and 2PO, which do not differ significantly from each other. Even after adjustment per daily morphine intake, the outcomes remained similar between the groups (►**Table 2**).

Table 1 Sample characterization

Variables	Total sample (n = 100)	FNB group (n = 50)	PAI group (n = 50)	*p*
Age (years): mean ± SD	67.9 ± 7.7	68.1 ± 7.5	67.7 ± 7.9	0.400*
Sex: n (%)				1.000**
Male	23 (23.0)	11 (22.0)	12 (24.0)	
Female	77 (77.0)	39 (78.0)	38 (76.0)	
Location: n (%)				1.000**
Headquarters	69 (69.0)	35 (70.0)	34 (68.0)	
Branch	31 (31.0)	15 (30.0)	16 (32.0)	
Side: n (%)				0.316**
Right	54 (54.0)	30 (60.0)	24 (48.0)	
Left	46 (46.0)	20 (40.0)	26 (52.0)	
Hospitalization time (days): mean ± SD	4.28 ± 0.52	4.39 ± 0.53	4.18 ± 0.48	0.208*

Abbreviations: FNB, femoral nerve block; PAI, periarticular infiltration; SD, standard deviation.
Notes: *Student's *t*-test; **Pearson Chi-squared test.

Table 2 Group comparison of the variables analyzed 1, 2, and 3 days after surgery

Variables	FNB group (n = 50)	PAI group (n = 50)	$p^{\#}$
Pain (VAS): mean ± SD			
1st day PO	4.94 ± 2.25^{b}	4.94 ± 2.40^{b}	1.000
2nd day PO	4.86 ± 2.22^{b}	4.32 ± 1.98^{b}	0.195
3rd day PO	2.84 ± 1.80^{a}	2.88 ± 1.99^{a}	0.915
Difference between the 1st and 3rd days PO (95%CI)	−2.10 (−2.68 to −1.52)	−2.06 (−2.69 to −1.43)	0.199**
Active ROM in flexion: mean ± SD			
1st day PO	42.7 ± 22.4^{a}	47.9 ± 22.9^{a}	0.248
2nd day PO	56.2 ± 18.8^{b}	63.4 ± 17.4^{b}	**0.046**
3rd day PO	77.8 ± 15.1^{c}	83.0 ± 11.2^{c}	**0.047**
Difference between the 1st and 3rd days PO (95%CI)	35.1 (29.5 to 40.6)	35.1 (29.8 to 40.4)	0.571**
Active ROM in extension: mean ± SD			
1st day PO	1.30 ± 2.44^{b}	1.22 ± 2.17^{b}	0.869
2nd day PO	1.10 ± 2.32^{ab}	0.50 ± 1.52^{a}	0.122
3rd day PO	0.80 ± 1.85^{a}	0.80 ± 1.85^{ab}	1.000
Difference between the 1st and 2nd days PO (95%CI)	−0.20 (−0.47 to 0.07)	−0.72 (−1.21 to −0.24)	**0.025****
Difference between the 2nd and 3rd days PO (95%CI)	−0.30 (−0.73 to 0.13)	0.30 (−0.13 to 0.73)	
Difference between the 1st and 3rd days PO (95%CI)	−0.50 (−1.00 to −0.00)	−0.42 (−1.10 to 0.25)	
Elevation (cm): mean ± SD			
1st day PO	16.9 ± 21.8^{a}	22.7 ± 25.4^{a}	0.222
2nd day PO	26.6 ± 24.2^{b}	35.2 ± 25.0^{b}	0.078
3rd day PO	39.4 ± 23.6^{c}	43.3 ± 23.7^{c}	0.401
Difference between the 1st and 3rd days PO (95%CI)	22.5 (18.1 to 26.9)	20.7 (15.4 to 26.0)	0.160**
Morphine use (mg)			
1st day PO	3.62 ± 3.95^{b}	4.20 ± 4.51^{b}	0.489
2nd day PO	2.71 ± 3.71^{b}	2.95 ± 3.08^{b}	0.722
3rd day PO	0.59 ± 1.39^{a}	1.16 ± 2.87^{a}	0.201
Difference between the 1st and 3rd days PO (95%CI)	−3.03 (−4.02 to −2.04)	−3.04 (−4.48 to −1.60)	0.880**

Abbreviations: 95%CI, 95% confidence interval; FNB, femoral nerve block; PAI, periarticular infiltration; PO, postoperatively; ROM, range of motion; SD, standard deviation; VAS, Visual Analog Scale.
Notes: *+ = 1/++ = 2/+++ = 3/++++ = 4; **group versus time interaction effect; [a,b,c]Intragroup comparison: equal letters denote lack of difference per the least significant difference (LSD) test at 5% significance; #comparison between the groups using the LSD test and the generalized estimating equations (GEE) model.

The ROM presented a statistically significant difference between the groups: the PAI group presented significantly higher mean active flexion on 2PO ($p = 0.046$) and 3PO ($p = 0.047$) when compared to the FNB group (►**Fig. 1**). Active extension was significantly different over time between the groups (significant interaction effect; $p = 0.025$): the PAI group presented a significant reduction on 2PO (with an average value of 0.72), and the FNB group presented a significant decrease only on 3PO (►**Fig. 2**). However, despite the statistical difference between the groups, we believe it may not be clinically relevant in the medium and long terms.

Active flexion, hip contraction, and elevation parameters increased significantly from 2PO onwards in both groups. Morphine use only decreased significantly on 3PO in both groups.

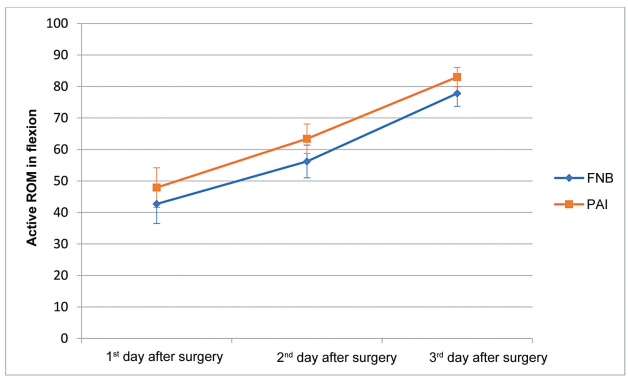


Fig. 1 Assessment of the active range of motion (ROM) in flexion per time and study group. FNB, femoral nerve block; PAI, periarticular infiltration.

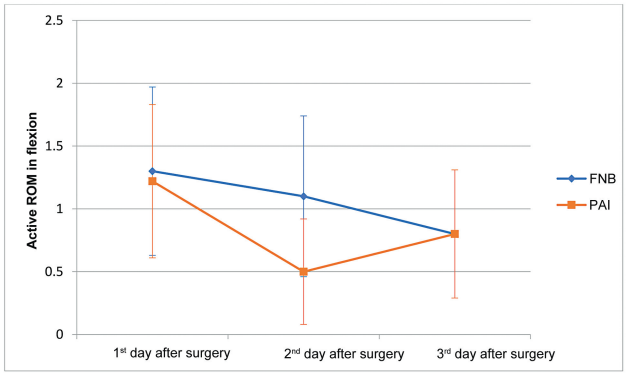


Fig. 2 Assessment of the active ROM in extension per time and study group. FNB, femoral nerve block; PAI, periarticular infiltration.

Two patients (one from each group) had allergic reactions: itching and rash; and one patient (from the FNB group) fell to the ground from their own height on 2PO, with no other consequences.

Discussion

Several studies have demonstrated that FNB and PAI are reliable techniques to control pain in the early TKA postoperative period.[5,10] Inadequate pain control in the TKA postoperative period increases the risk of chronic pain, resulting in lower quality of life, prolonged hospital stay, and increased treatment costs.[13–15]

The present study aimed to compare a single FNB with PAI in the early TKA postoperative period. We confirmed the hypothesis of adequate pain control associated with better muscle contraction capacity during the early postoperative phase in the PAI group. The single FNB group presented a deleterious effect on muscle function evidenced by active flexion and extension during the initial rehabilitation phase, consistent with the suggestion by some authors.[5,7,16]

The primary sensory innervation of the knee comes from the femoral nerve anteriorly and the posterior cutaneous nerve of the thigh posteriorly. Single FNB or continuous analgesia with a catheter are postoperative analgesia methods that provide better pain control and reduce opioid consumption and its adverse effects.[12] However, it is worth highlighting that regional anesthetic techniques require a specialist in anesthesia, present a failure rate of 0% to 67%, and the risk of falls due to motor inhibition has been reported by some authors,[16–22] mainly with the use of blocks with a continuous anesthetic release via a catheter. In the present study, a patient from the FNB group fell on 2PO. Although the patient did not present any major motor limitations during the evaluation, we cannot exclude the FNB as a causal factor.

In the clinical practice, PAI gained prominence due to the fact that several studies have shown outcomes comparable to those of FNB in controlling pain and opioid use.[7–9,11,12] In a systematic review of 14 randomized clinical trials, Albrecht et al.[5] demonstrated pain relief and similar postoperative functional outcomes between the FNB and PAI techniques. Wall et al.[10] randomized 230 patients with an indication for TKA and found no statistical difference between groups undergoing PAI and FNB. In this study,[10] it is worth highlighting that the anesthetic techniques were performed by 59 anesthetists and 33 surgeons, representing high variability in execution but preserving the reproducibility of the outcomes.

Regarding morphine use during hospital stay, some prospective studies[7,8,12] did not find significant differences. In contrast, Parvataneni et al.[11] observed divergent data, showing a greater morphine intake on 1PO in patients undergoing PAI. In the present study, subjects from both groups showed a gradual decrease in morphine use throughout the days, and there was no difference between the groups.

Regarding knee mobility, we found a significant active mobility gain in subjects from the PAI group. Berninger et al.[9] and Wall et al.[10] observed a greater flexion capacity in patients undergoing PAI, more evident on 1PO and 2PO, respectively.

Despite the difference in active mobility, in the present study we did not find significant differences between the groups regarding lower limb elevation. We believe that the lack of difference may be associated with the performance of a single FNB, that is, with no continuous anesthetic infusion. This result is not consistent with those of Parvataneni et al.,[11] who found a better ability to lift the extended limb on 1PO in the PAI group and similar pain scores during the postoperative hospitalization, suggesting that PAI provides pain control equivalent to that of FNB while maintaining the motor strength of the quadriceps.

Recently, some studies evaluated the adductor canal block (ACB) and compared it with FNB and the association of ACB and PAI. The ACB resulted in outcomes similar to those of FNB in terms of analgesia control, but with less motor involvement than the FNB.[23–25] Regarding the association of ACB and PAI, Goytizolo et al.[26] reported no difference in the addition of ACB to PAI alone. However, further studies are required to elucidate this issue.

We believe that the present study has certain critical points. All patients were operated on by the same surgical and anesthetic teams, receiving the same protocol of PAI, FNB, and analgesic medication. To keep the procedure more reproducible in locations with no ultrasound-assisted FNB available, we opted for the single FNB technique, since the continuous infusion technique requires specific training and appropriate equipment. We did not use medium and long-term functional scores or quality of life and mental health assessment scores. We must highlight that the lack of specific studies with the same group of patients in the literature limits the precision of sample size calculation. As such, the sample size calculation may be undersized, as the only reference variable was pain. Thus, even though our results are consistent with those of the literature, we highlight the need for future studies for better procedural standardization, to investigate the effect of combining procedures, and to assess the clinical relevance of the findings.

Conclusion

We concluded that pain control, limb elevation, and morphine use were similar between analgesia techniques. The PAI technique provided greater capacity for active knee extension and flexion during the first three postoperative days.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Distal Radial Fractures with Scaphoid Fractures

Fraturas do rádio distal associadas à fratura do escafoide

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Abstract

Objective This study evaluated the epidemiological data and functional outcomes from patients with concomitant distal radial and scaphoid fractures treated in a single center specialized in hand surgery. Functional outcomes analysis used validated instruments.

Methods Patients diagnosed with distal radial and scaphoid fractures treated from January 2011 to December 2021 underwent assessments using the Disabilities of the Arm, Shoulder and Hand (DASH), Patient-Rated Wrist Evaluation (PRWE), Visual Analog Scale (VAS) for pain, goniometry, radiographic consolidation, and complications six months after surgery.

Results The study included 23 patients, 73.9% men and 26.1% women. Most (56.5%) fractures occurred on the right side, and 43.5% happened on the left side. Treatment of most (56%) distal radial fractures used a locked volar plate. Functional assessment by PRWE resulted in a mean score of 35.9 points (range, 14 to 71 points), while DASH showed a mean score of 37.8 points (range, 12 to 78 points). The mean VAS was 2.33 during activities (range, 0.6 to 6.2).

Conclusion Distal radial fractures associated with scaphoid fractures resulted from high-energy trauma, and most patients were males. There was a low rate of complications with surgical treatment, and the patients had satisfactory functional evolution with a low level of pain.

Keywords
- general surgery
- functional status
- radius fractures
- wrist fractures
- scaphoid bone
- therapeutics

Resumo

Objetivo Avaliar os resultados epidemiológicos e funcionais dos pacientes que apresentaram fraturas concomitantes do rádio distal e do escafoide e foram tratados em um único centro especializado em cirurgia da mão, através de instrumentos validados para analisar os desfechos funcionais desses pacientes.

Métodos Foram avaliados os pacientes com diagnóstico de fratura do rádio distal e escafoide tratados de janeiro de 2011 até dezembro de 2021, através dos questionários *Disabilities of the Arm, Shoulder and Hand* (DASH), *Patient Rated Wrist Evaluation* (PRWE) e Escala Visual Analógica da dor (EVA); goniometria; consolidação radiográfica; complicações em seis meses de pós-operatório.

Palavras-chave
- cirurgia geral
- estado funcional
- fraturas do rádio
- fraturas do punho
- osso escafoide
- terapêutica

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Resultados Vinte e três pacientes foram incluídos no estudo, sendo 73,9% homens e 26,1% mulheres; 56,5% das fraturas ocorreram à direita e 43,5% à esquerda. A maioria das fraturas do rádio distal foi tratada com placa volar bloqueada, totalizando 56%. Na avaliação funcional pelo PRWE, obteve-se média de 35,9 pontos (variação de 14 a 71 pontos) e pelo DASH média de 37,8 pontos (variação de 12 a 78 pontos). A EVA apresentou uma média de 2,33 durante a atividade (variação de 0,6 a 6,2).
Conclusão Verificou-se que as fraturas do rádio distal associadas a fraturas do escafoide foram causadas por traumas de alta energia, com o sexo masculino mais acometido. Houve baixo índice de complicações com tratamento cirúrgico e os pacientes tiveram evolução funcional satisfatória, com baixo índice de dor.

Introduction

Isolated distal radial fractures are common, and their incidence in the population is high.[1] Meanwhile, scaphoid fractures are the most frequent among carpal bones. However, the simultaneous occurrence of distal radial and scaphoid fractures is rare[2], and it often results from high-energy trauma. The literature reports its incidence in 0.5 to 5% of distal radial fractures.[3]

Concomitant radial and scaphoid fractures represent a treatment challenge. At surgery, scaphoid fractures require anatomical reduction and compression fixation. On the other hand, distal radial fractures require traction for proper reduction and fixation.[4,5] This implies careful operative planning adapted to each fracture type. Postoperative management also involves conflicting principles: scaphoid fractures require a longer immobilization period for consolidation, but distal radial fractures require a shorter immobilization period followed by early rehabilitation to avoid wrist joint stiffness.[6]

In 2022, in a systematic review of 20 case series about concomitant distal radial da scaphoid fractures, Blackburn et al.[3] noted that the main limitation of these studies was the lack of functional and quality of life assessments using validated instruments, such as the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the Patient-Rated Wrist Evaluation (PRWE) questionnaire.

The primary objective of this study was to evaluate the functional outcomes of patients with concomitant distal radial and scaphoid fractures. The secondary objective was to analyze the epidemiological aspects of patients treated in a single center specialized in hand surgery, using validated instruments to determine their functional outcomes.

Methods

We collected medical records from January 2011 to December 2021 of all patients diagnosed with an acute distal radial fracture (up to 15 days) registered in the surgical schedule of the only medical center specialized in hand surgery. Of the patients initially selected (N = 957), only those diagnosed with a concomitant distal radial and ipsilateral scaphoid fracture (N = 38) who underwent surgical treatment were included.

Patients with fractures in other carpal bones, complete injuries of the scapholunate ligament (visualized on stress radiographs with an opening greater than 5 mm), fractures with neurotendinous injuries, fractures with loss of skin coverage, and patients with sequelae of previous traumatic, degenerative, or both injuries with functional deficits in the affected hand or contralateral wrist were excluded from this study.

The same surgeon specialized in hand surgery and microsurgery operated on all selected patients and followed the same fracture fixation steps, first performing scaphoid fixation using a percutaneous method and then a radial fracture fixation. The surgeon followed these steps regardless of the method chosen.

After identifying the patients, we recruited those selected by telephone, telegram, or both for an in-person clinical assessment of the outcomes analyzed in this study.

The clinical outcomes evaluated, i.e., PRWE and DASH questionnaires, were the primary outcomes for functional assessment. Secondary outcomes included active and passive wrist range of motion measurements (flexion, extension, radial deviation, ulnar deviation, pronation, supination), grip strength measured with a Jamar dynamometer, pain measurement using the Visual Analog Scale (VAS), and radiographic evaluation. All patients were assessed for a minimum follow-up period of 6 months.

The DASH questionnaire is a tool to assess the impact of the disease on the function of the affected upper limb. It has 37 questions about upper limb function, and its score ranges from 0 (no complaints) to 100 (highly limiting conditions for the limb).[7]

The PRWE questionnaire consists of 15 questions specifically about wrist function. It has five questions about pain, six about function in specific activities, and four about daily activities. The final score ranges from 0 (no complaints) to 10 (highly limiting conditions for the limb).[8]

The radiographic analysis included the evaluation of orthogonal radiographs of the wrist and measured the radiographic values of radial height, ulnar variance, radial angulation, and volar inclination. Fracture consolidation and the occurrence of osteoarthritis were also determined according to the Knirk and Jupiter classification,[9] in which grade 0 represents the absence of osteoarthritis signs, grade I indicates decreased joint space, grade II implies a

higher decrease in joint space with osteophyte formation, and grade III denotes direct bone contact with the osteophyte and subchondral cyst formation. The researcher in charge of data analysis conducted the radiographic evaluation.

Complications include any complications during the intervention or clinical follow-up of patients requiring surgical treatment and not foreseen in the initial surgery. The definition of pseudarthrosis was the absence of signs of clinical and radiographic consolidation of the distal radial or scaphoid fracture after 6 months of osteosynthesis[10] at radiographs in orthogonal planes.

The Ethics Committee approved this project under CAAE number 60074522.2.0000.5505.

For statistical analysis, the data were stored in an Excel® for Mac spreadsheet and subsequently imported into the SPSS® 23 for Mac Software. Descriptive statistics of categorical data used absolute frequency of occurrence and its respective proportion. Continuous data were analyzed for distribution subjectively using a histogram and objectively using the Shapiro-Wilk test. Due to the non-symmetric nature of continuous data, the description employed median and the 25th and 75th percentile values.

The non-parametric Spearman correlation test determined correlations between variables. For statistical inference, p-values <0.05 were considered for type I error. The Cohen index[11] assessed the magnitude of the correlations using the following classification: values >0.8 indicate great magnitude, values ranging from 0.5 to 0.8 indicate medium magnitude, and values ranging from 0.2 to 0.3 show small magnitude.

Results

We analyzed 957 medical records of patients undergoing surgical treatment from January 2011 to December 2021 due to a distal radial fracture. Of these patients, 38 also presented an ipsilateral scaphoid fracture, resulting in a 3.7% prevalence. We excluded two records because their fractures were at the great arch, and the final sample had 36 patients. After telephone and telegram attempts, we could not locate 11 patients, and two had died from unrelated causes. In the end, 23 patients were evaluated (►**Fig. 1**).

Concerning demographic characteristics, there were 73.9% men and 26.1% women, with 82.6% right-handed and 7.4% left-handed subjects. Regarding the lesion side, the distribution was similar, with 56.5% fractures on the right side and 43.5% on the left side. Treatment of most distal radial fractures used a volar locked plate (56%), followed by a dorsal locked plate (21.7%), while the remaining patients received other fixation methods. Scaphoid fracture fixation mostly employed compressive screws, and only two patients underwent fixation with Kirschner wires (►**Table 1**).

Regarding the results of the questionnaires, the mean PRWE score was 35.9 points (range, 14 to 71), the mean DASH score was 37.8 points (range, 12 to 78), and the mean VAS was 2.33 during activities (range, 0.6 to 6.2).

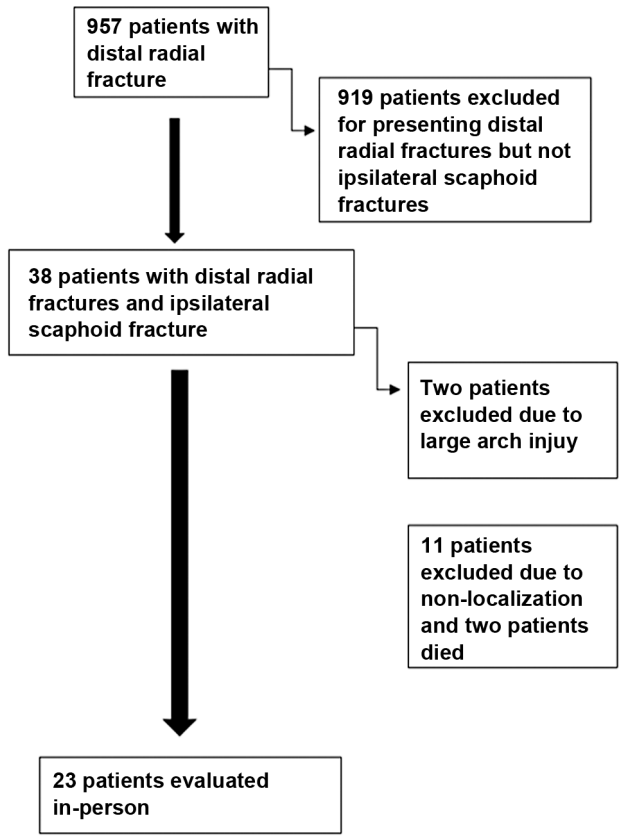


Fig. 1 Organizational chart of patient acquisition.

Analysis of radiographic aspects revealed an average of 0.65 mm (−2 mm to 3 mm) for ulnar variance, 11.43 mm (14 mm to 8 mm) for radial height, 20.57 degrees (24 degrees to 18 degrees) for radial tilt, and 15.30 degrees (24 degrees to −6 degrees) for volar tilt. The AO/ASIF system for distal radial fractures classified two fractures as A3, 11 as C2, and ten as C3. Per the IDEAL classification system,[12] 20 patients were potentially unstable, and three were complex. When evaluating the presence of arthrosis in the participants' wrists using the Knirk-Jupiter classification, twelve subjects were grade 0, nine were grade 1, and only two were grade 2 (►**Fig. 2** and ►**Table 2**).

Of the 23 participants, only three had complications. The first was a surgical wound infection one week post-operatively, treated with antibiotics and evolving to complete resolution. Two patients required removal of the radius synthesis due to tenosynovitis of the flexor tendons associated with the blocked volar plate.

The mean immobilization time was 8 weeks (range, 6 to 12 weeks), while the average return to work took 18.81 weeks (range, 8 weeks to 1 year). One patient required 2 years and 3 months before returning to work due to a complex regional pain syndrome requiring treatment in conjunction with the specialized pain team (►**Table 3**).

According to the Spearman correlation index, there was a pattern of great magnitude in the measured range of motion values (active flexion, active extension, active radial deviation, active ulnar deviation) (►**Table 4**). The correlation index

Table 1 General characteristics and treatment from 23 patients with distal radial and scaphoid fractures

	n	%
Gender		
Female	6	26.1
Male	17	73.9
Total	23	100.0
Dominance		
Right	19	82.6
Left	4	17.4
Total	23	100.0
Lesion side		
Right	13	56.5
Left	10	43.5
Total	23	100.0
Radius fixation method		
External fixation	2	8.7
Kirschner wire	1	4.34
Hebert	2	8.7
Dorsal plate	5	21.7
Volar plate	13	56.5
Total	23	100.0
Scaphoid fixation method		
Kirschner wire	2	8.7
Anterograde screw	10	43.5
Retrograde screw	11	47.8
Total	23	100.0

between PRWE and DASH questionnaires was 0.773, considered as medium magnitude. The same occurred between PRWE and VAS during activities. The other correlations exhibited effects of small magnitude effects (►**Table 5**).

Discussion

Among distal radial fractures, the concomitant association with ipsilateral scaphoid fractures is rare, with an incidence ranging from 0.5% to 5% according to the literature. All patients in this series suffered high-energy trauma mechanisms. Most subjects were males (73.4%), in the fourth decade of life (average age, 38.4 years old), consistent with the literature.[2,4,7,9,13–19] The fractures presented a comminuted pattern, strengthening the hypothesis of high-energy trauma, corresponding to subgroup C per the AO/ASIF Classification (21 patients). Most (86%) scaphoid fractures presented a simple line at waist level without displacement, and the remaining 14% of fractures occurred at the proximal pole of the scaphoid.

In the present study, including 10 years (2011-2021) of records, we evaluated 957 patients with surgical distal radial

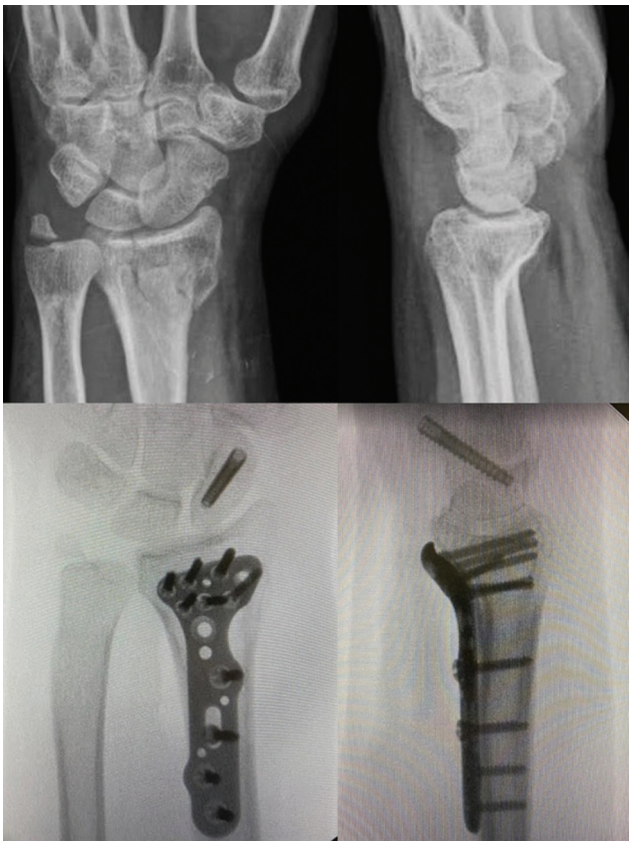


Fig. 2 45-year-old male patient with a history of high-energy trauma. Treatment consisted of osteosynthesis of the distal radius with a volar plate and osteosynthesis of the scaphoid with a compressive screw.

fracture, including 36 subjects presenting a concomitant, ipsilateral scaphoid fracture, resulting in an incidence of 3.7%. Among these, we included 23 patients in this study to analyze their outcomes. This represents a significant sample given the low prevalence of this injury and the researched literature, which reportedly has only five publications with considerable sample sizes.[2–4,13,19] The largest series identified was published by Vukov et al. (1988)[13] and had 26 patients. However, all subjects received conservative treatment, which resulted in a high rate of complications (57%).

In this study, a single surgeon performed the surgical treatment of the injuries; therefore, the surgical tactic for lesion treatment always started with the distal radial fracture followed by scaphoid fixation using a percutaneous, antegrade, or retrograde technique chosen for each case. We adopted this strategy since most scaphoid fractures were non-displaced, not requiring reduction maneuvers for fixation.

Our results demonstrated that all patients presented consolidation of both radius and scaphoid fractures. Only one patient faced difficulties in returning to his original work activity due to complex regional pain syndrome. Similarly, Fowler et al. (2018),[4] in a series of 23 patients treated surgically, obtained a scaphoid consolidation rate of 93%. A single subject had a displaced scaphoid fracture and, at the postoperative evaluation, only one case did not present

Table 2 Functional assessment, classification, and pain in 23 patients with distal radial and scaphoid fractures

	Mean	Standard deviation	Median	1st interquartile range	3rd interquartile range
Immobilization time (weeks)	8.00	2.54	8.00	6.00	8.00
Time to resume work (weeks)	18.81	20.52	12.00	12.00	16.00
Active flexion (degrees)	50.09	10.37	52.00	42.00	58.00
Passive flexion (degrees)	54.78	9.89	56.00	48.00	63.00
Active extension (degrees)	54.70	11.59	54.00	49.00	62.00
Passive extension (degrees)	59.65	11.87	58.00	53.00	69.00
Active radial deviation (degrees)	9.96	2.93	10.00	8.00	10.00
Passive radial deviation (degrees)	12.52	2.91	12.00	12.00	14.00
Active ulnar deviation (degrees)	19.04	5.08	18.00	16.00	20.00
Passive ulnar deviation (degrees)	22.70	5.10	22.00	20.00	24.00
VAS in rest (centimeters)	0.82	1.02	0.30	0.05	1.25
VAS during activity (centimeters)	2.33	1.71	1.40	1.20	3.20
PRWE	35.96	14.03	34.00	27.00	41.50
DASH	37.83	14.77	34.00	30.00	40.00
Ulnar variance (millimeters)	0.65	1.56	1.00	−1.00	2.00
Radial height (millimeters)	11.43	1.80	12.00	10.00	12.50
Radial tilt(degrees)	20.57	1.97	20.00	19.50	22.00
Volar tilt (degrees)	15.30	6.89	16.00	14.50	19.00
Jamar on the operated side (N/Kg)	27.32	7.29	30.34	22.67	32.67
Jamar on the non-operated side (N/Kg)	31.46	9.92	33.33	24.67	36.67

VAS, Visual analog scale; DASH, Disabilities of the Arm, Shoulder and Hand; PRWE, Patient-Rated Wrist Evaluation.

Table 3 Arthrosis presence per the Knirk-Jupiter classification

Knirk-Jupiter classification		
G0	9	39.1%
G1	9	39.1%
G2	5	21.7%
G3	0	0.0%

consolidation (corresponding to a patient with an ipsilateral brachial plexus injury).

The complication rate presented in this study was 13%, reinforcing the effectiveness of surgical treatment for patients' functional outcomes. Blackburn et al. (2022)[3] in a systematic review of the literature, identified 20 case series involving concomitant ipsilateral fractures of the scaphoid and distal radius. This review noted the association with high-energy mechanisms and supported the need for a

Table 4 Correlations with motion arc measurements

		Passive flexion	Passive extension	Passive radial deviation	Ulnar radial deviation
Active flexion	Correlation coefficient	0.990*	–	–	–
	p-value	<0.01			
Active extension	Correlation coefficient	–	0.978*	–	–
	p-value		<0.01		
Active radial deviation	Correlation coefficient	–	–	0.845*	–
	p-value			<0.01	
Ulnar active deviation	Correlation coefficient	–	–	–	0.826*
	p-value				<0.01

*Valores acima de 0.8 são considerados valores de grande magnitude.

Table 5 Correlações dos resultados dos questionários PRWE, DASH e EVA

		PRWE	DASH	EVA Repouso	Eva Esforço
PRWE	Correlation coefficient	–	0.773*	0.462	0.739*
	p-value		<0.01	0.026	<0.01
DASH	Correlation coefficient	–	–	0.210**	0.418**
	p-value			0.336	0.047
VAS in rest	Correlation coefficient	–	–	–	0.642*
	p-value				<0.01
VAS during activity	Correlation coefficient	0.739*	0.418**	0.642*	–
	p-value	<0.01	0.047	<0.01	

VAS, Visual analog scale; DASH, Disabilities of the Arm, Shoulder and Hand; PRWE, Patient-Rated Wrist Evaluation.
*Medium magnitude values.
**Small magnitude values.
The correlation had a great magnitude in the measured range of motion values (active flexion, active extension, active radial deviation, active ulnar deviation). The correlation index of PRWE and DASH questionnaires had a medium magnitude, of 0.773, just like the correlation between PRWE and VAS under activity. The other correlations showed small effect magnitudes. ►**Table 4** and ►**Table 5** show these correlations.

surgical approach for this injury. However, the authors also realized the scarcity of studies presenting adequate parameters for comparison with postoperative assessment, identifying a single paper using questionnaires such as PRWE.

Given the low prevalence of this injury, prospective randomized multicenter studies are needed to provide more robust evidence. Although our study was retrospective, we contributed to the analysis of outcomes by employing validated functional assessment tools and demonstrating that both DASH and PWRE were consistent in their evaluations, an association previously not identified in the literature review previously mentioned. These instruments allowed us to statistically identify a correlation index of 0.773, indicating that both instruments should be considered when evaluating these patients in future studies.

Conclusion

We found that distal radial fractures associated with scaphoid fractures were more prevalent in young male patients and resulted from high-energy trauma. Surgical treatment proved effective according to the evaluation of clinical, radiographic, and functional outcomes and had a low rate of complications.

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Conflict of Interests
The authors declare no conflict of interests.

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Glenosphere Size Does Not Matter in Reverse Total Shoulder Arthroplasty

O tamanho da glenosfera não importa na artroplastia total reversa de ombro

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Abstract

Objective There are few studies to date reporting on outcomes following reverse total shoulder arthroplasty with cohorts stratified by glenosphere size. The purpose of this study is to investigate the role that glenosphere size has on postoperative outcomes.

Methods Patients who underwent reverse TSA between 1987 with minimum of 2.0 years of follow-up were included. Patients were stratified into two cohorts based on glenosphere size of 36mm or 40mm. Patients' range of motion, patient-reported outcomes, and radiographic variables (glenoid preoperative morphology, scapular notching, humeral loosening) were evaluated.

Results All measurements of range of motion measurements with the exception of internal rotation saw significant preoperative to postoperative improvements within each cohort. There were no significant differences in postoperative range of motion, ASES, or VAS pain scores across the two cohorts. Overall, forward elevation improved to $134^\circ \pm 16^\circ$ in the 36mm cohort and $133^\circ \pm 14^\circ$ in the 40mm cohort ($p = 0.47$). External rotation improved to $37^\circ \pm 13^\circ$ for 36mm patients and $35^\circ \pm 19^\circ$ for 40mm patients ($p = 0.58$). In the 36mm group, internal rotation increased by 1.3 vertebral levels and 2.3 vertebral levels in the 40mm cohort. At final follow-up, the 36mm cohort had a VAS score of 2 ± 2, ASES score of 66 ± 19, and SST score of 6 ± 3. Similarly, the 40mm cohort had a VAS score of 2 ± 3, ASES score of 77 ± 28, and SST score of 9 ± 3.

Conclusions Reverse TSA provides sustained improvements in range of motion and shoulder function irrespective of glenosphere size.

Level of Evidence III.

Keywords
- arthroplasty
- shoulder
- scapula
- shoulder joint
- range of motion articular

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Resumo

Objetivo Até agora, poucos estudos relataram os desfechos da artroplastia total reversa (ATR) de ombro com coortes estratificadas pelo tamanho da glenosfera. O objetivo deste estudo é investigar o papel do tamanho da glenosfera nos desfechos pós-operatórios.

Métodos O estudo incluiu pacientes submetidos à ATR de ombro desde 1987 com acompanhamento mínimo de 2,0 anos. Os pacientes foram estratificados em duas coortes com base no tamanho da glenosfera (36 mm ou 40 mm). A amplitude de movimento, os desfechos relatados pelo paciente e as variáveis radiográficas (morfologia pré-operatória da glenoide, incisura escapular e instabilidade do úmero) foram avaliados.

Resultados Todas as medidas de amplitude de movimento, à exceção da rotação interna, melhoraram de forma significativa entre o período pré-operatório e pós-operatório nas duas coortes. Não houve diferenças significativas na amplitude de movimento pós-operatória, pontuação da *American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form* (ASES) ou escala visual analógica (EVA) de dor entre as duas coortes. De modo geral, a elevação anterior melhorou para $134^\circ \pm 16^\circ$ na coorte de 36 mm e $133^\circ \pm 14^\circ$ na coorte de 40 mm ($p = 0{,}47$). A rotação externa melhorou para $37^\circ \pm 13^\circ$ em pacientes da coorte de 36 mm e $35^\circ \pm 19^\circ$ em pacientes da coorte de 40 mm ($p = 0{,}58$). A rotação interna aumentou 1,3 níveis vertebrais na coorte de 36 mm e 2,3 níveis vertebrais na coorte de 40 mm. No último acompanhamento, a coorte de 36 mm apresentou EVA de 2 ± 2, ASES de 66 ± 19 e pontuação do *Simple Shoulder Test* (SST) de 6 ± 3. Da mesma forma, a coorte de 40 mm teve EVA de 2 ± 3, ASES de 77 ± 28 e SST de 9 ± 3.

Conclusões A ATR de ombro causa melhoras sustentadas da amplitude de movimento e função articular independentemente do tamanho da glenosfera.

Nível de Evidência III.

Palavras-chave

- artroplastia
- ombro
- escápula
- articulação do ombro
- amplitude de movimento articular

Introduction

Reverse total shoulder arthroplasty (reverse TSA) is an effective treatment for several shoulder arthropathies and has been shown to provide substantial improvements in pain and shoulder function.[1–3] In the past decade, there has been over a 3-fold increase in the number of reverse TSA procedures performed annually in the United States as the number of approved indications rapidly expanded.[4–13] While reverse TSA overall is clinically effective, questions remain on how different implant types and sizes affect outcomes. Specifically, the choice of glenosphere size is one of the few variables controllable by the operating surgeon.

There are conflicting reports about the impact that glenosphere size has on functional outcomes following reverse TSA. Mollon et al.[14] and others suggest that larger glenospheres may correlate with better functional outcomes and improved radiographic results.[15–17] On the other hand, Schoch et al. and others found insufficient evidence to support the claim that glenosphere size significantly affects functional outcomes.[18,19] Sabesan et al.[20] also report that any difference in functional outcomes is hard to attribute to any one variable as it is difficult to control for demographic and anatomic variations in the patient population, specifically with regards to consistent placement of the glenosphere. Additionally, while the choice of glenosphere size is one of the few variables controllable by the operating surgeon, there are no established guidelines for determining the optimal size for each patient. It is commonly known that glenosphere size usually comes down to surgeon preference as a smaller glenosphere lends itself to easier insertion but a larger glenosphere may reduce the risk of future dislocation.

The purpose of this study is to contribute to the existing literature and evaluate the impact that glenosphere size has on functional outcomes following reverse TSA at mid- to long-term follow-up. We hypothesized that there would be no significant difference between glenosphere sizes with regards to shoulder function and pain.

Methods

Patient Population

The institutional review board approved this study. The institutional shoulder arthroplasty registry was queried using CPT code 23472 to identify the patients who had

undergone a reverse total shoulder arthroplasty. Each chart was screened, and patients were included if they had a minimum follow-up of 2.0 years. Patients were excluded if they had an anatomic TSA, hemiarthroplasty, or follow-up time less than 2.0 years. Demographic information such as age at surgery, sex, revision status, and BMI were recorded. Implant survival was defined as shoulders that did not go onto revision following index reverse TSA. Implant size was determined intra-operatively based on anatomic evaluation. Preoperative planning software was not utilized to determine the size before surgery.

Clinical Evaluation

The clinical endpoints measured in this study were range of motion scores and patient reported outcomes. Range of motion scores include forward elevation, external rotation, and internal rotation values of the shoulder as evaluated by the operating surgeon at both preoperative and latest postoperative visits. Patient reported outcomes include self assessment scores comprising Visual Analog Scale (VAS), ASES, the Simple Shoulder Test (SST) scores, and conversion metrics. Internal rotation was categorized as defined by Amroodi et al.[21] Implant survival time in subjects, defining failure as either implant revision or removal, was conducted using Kaplan-Meier survival analysis. Any differences in survival distributions were determined using a log rank test.

Radiographic Assessment

Radiographic analysis was conducted by two fellowship trained orthopedic surgeons (B.O.P and P.J.C). A fellow (S.M.) was available to review any discrepancies between the two reviewers. The preoperative glenoid morphology was analyzed using the Walch classification system.[22] Humeral lucency and glenoid loosening were defined using the system outlined in Sanchez et al.[23]; radiolucent lines >2mm were recorded by zone. Scapular notching was also assessed.

Statistical Analysis

Categorical variables were analyzed using either $\chi 2$ or Fisher's Exact test. Normality of continuous variables was determined by a Kolmogorov-Smirnov test from which a Mann Whitney U or student's *t*-test was run. Outcomes were expressed as mean ± standard deviation. Preoperative, postoperative, and change in pre- to post-operative range of motion (ROM), patient reported outcomes (PROs), and radiographic measures were compared using a one-way analysis of variance (ANOVA) test. A Pearson's coefficient was used to compare the association between overall BMI and patient's age at surgery, ROM, and PRO scores. A p-value < 0.05 was considered significant.

Results

Overall

50 shoulders met inclusion criteria and were included in this study. The glenosphere distribution was 36mm ($n = 38$) and 40mm ($n = 12$). 34/38 of the 36mm glenosphere patients were female, while only 2/12 of the 40mm cohort was female ($p < 0.01$). There were 14 males and 36 females included in the study. There were 40 index rTSA cases and 10 revision rTSAs.

36mm Glenosphere Cohort

The average age at surgery was 72.1 ± 7.4 years with an average follow-up time of 6.7 ± 3.3 years. 34/38 patients were female (89%) and 4/38 were female (11%). Patients presented for surgery with an average BMI of 28.4 ± 5.9 with an average ASA score of 2.3 ± 0.6. The three most common indications for surgery were arthropathy ($n = 16$), failed hemiarthroplasty for fracture ($n = 10$), and chronic fracture dislocation with rotator cuff tear ($N = 3$). Reverse TSA with latissimus dorsi tendon transfer was performed in 13 shoulders.

40mm Glenosphere Cohort

The average age at surgery was 74.1 ± 7.2 years with an average follow-up time of 4.8 ± 3.1 years. 10/12 patients were male. Patients presented for surgery with an average BMI of 27.3 ± 4.5 with an average ASA score of 2.5 ± 0.5. The three most common indications for surgery were arthropathy ($n = 6$), failed hemiarthroplasty for fracture ($n = 4$), and chronic fracture dislocation with rotator cuff tear ($N = 2$). Reverse TSA with latissimus dorsi tendon transfer was performed in 2 shoulders.

Outcomes: 36mm Cohort

All measurements of range of motion saw significant preoperative to postoperative improvements. Overall, forward elevation improved from 81° ± 46° preoperatively to 134° ± 16° postoperatively ($p < 0.01$). External rotation improved from 26° ± 31° preoperatively to 37° ± 13° ($p < 0.01$) while internal rotation improved from 1.3 vertebral levels ($p = 0.35$). Significant improvements were also seen for each patient reported outcome index. ASES scores improved from 33 ± 16 preoperatively to 66 ± 19 postoperatively ($p < 0.01$). SST scores improved from 2 ± 2 preoperatively to 6 ± 3 ($p < 0.01$). VAS pain index scores went from a mean preoperative score of 6 ± 3 to a mean postoperative score of 2 ± 2 ($p < 0.01$) (►**Table 1**).

Table 1 Comparison of postoperative outcomes

Measure	36mm	40mm	p-value
Forward Elevation (°)	134 ± 16	133 ± 14	0.47
External Rotation (°)	37 ± 13	35 ± 19	0.58
Internal Rotation	1.3	2.3	0.84
ASES	66 ± 19	77 ± 28	0.05
SST	6 ± 3	9 ± 3	<0.01
VAS	2 ± 2	2 ± 3	0.68

Outcomes: 40mm Cohort

All measurements of range of motion saw significant preoperative to postoperative improvements. Overall, forward elevation improved from $74° \pm 7°$ preoperatively to $133° \pm 29°$ postoperatively ($p = 0.02$). External rotation improved from $11° \pm 28°$ preoperatively to $35° \pm 19°$ ($p = 0.04$) while internal rotation improved on average by 2.3 vertebral levels (p-value = 0.28). Significant improvements were also seen for each patient reported outcome index. ASES scores improved from 30 ± 19 preoperatively to 77 ± 28 postoperatively ($p < 0.01$). SST scores improved from 3 ± 4 preoperatively to 9 ± 3 ($p < 0.01$). VAS pain index scores went from a mean preoperative score of 7 ± 3 to a mean postoperative score of 2 ± 3 ($p < 0.01$) (►**Table 1**).

Comparison of Cohort Outcomes

There was no significant difference in range of motion across the two cohorts. For patient-reported outcomes, the 40mm cohort had a significantly higher SST score, but there was no difference in ASES or VAS scores. The 36mm cohort had four surgically revised complications while the 40mm cohort had none. For a complete comparison of postoperative outcomes, please see ►**Table 1**.

Radiography

Preoperative radiography was available for 30 shoulders. Walch glenoid classification was able to be done in eighteen 36mm shoulders: A1 ($n = 12$), A2 ($n = 3$), B2 ($n = 1$), B3 ($n = 1$), and D ($n = 1$) and twelve 40mm shoulders: A1 ($n = 4$), A2 ($n = 3$), B2 ($n = 3$), B3 ($n = 1$), and D ($n = 1$). The pre-RTSA morphology could not be assessed in three shoulders due to anterior glenoid fracture ($n = 2$) and previous anatomic TSA ($n = 1$). Postoperative radiography was available for all patients. Postoperative scapular notching was seen in 8/38 of the 36mm patients and 2/12 of the 40mm cohort at final follow-up (p-value = 0.46). Glenoid loosening was seen in three 36mm cohort shoulders. Humeral loosening was seen in six 36mm and three 40mm shoulders. Tuberosity resorption was seen in six 36mm glenosphere shoulders.

Complications and Revisions

There were four complications that were surgically revised in the 36mm cohort. One index rTSA patient was revised two months following surgery for a disassembled glenosphere. One index rTSA patient experienced baseplate loosening 5.8 years following surgery, which was revised. One index rTSA patient was revised 8.9 years after surgery due to an infection. One revision rTSA patient had the prosthesis explanted due to an infection 3.8 years after reverse TSA. The 40mm cohort had no complications or revisions.

Discussion

There have been several studies to date that investigate the role of glenosphere size on outcomes following reverse total shoulder arthroplasty.[14,16,17,24] While there is some literature to suggest that larger glenosphere sizes are associated with improved outcomes, other studies suggest there are no advantages to such an approach. In this study, we found that there was no significant difference in range of motion or patient-reported outcomes for patients who received a 36mm or 40mm glenosphere.

Earlier studies have suggested that a larger glenosphere size is associated with increased postoperative external rotation.[14–16] Haidamous et al found that patients with a larger glenosphere were significantly more likely to have an external rotation greater than 30°[16] Similarly, Mueller et al demonstrated that at 5 years follow-up, patients with a 44mm glenosphere had an average of 12° more external rotation than their 36mm counterparts.[14] A biomechanical cadaveric study by Langohr et al.[19] also demonstrated that increasing glenosphere size did not lead to an increased external rotation. Thus, there are conflicting findings surrounding the relationship between glenosphere size and external rotation. In our study, we found there was no significant difference in postoperative external rotation between the 36mm and 40mm glenospheres (36mm: 37°; 40mm: 35°; p-value = 0.58). However, our findings may be due to a much smaller sample size of 40mm glenospheres. We hypothesize that if there was an increased number of 40mm patients, that they would have a significantly higher external rotation. In a future study, it would be valuable to control for confounding variables such as patient age, activity level, and indication for surgery when assessing for the relationship between glenosphere size and external rotation.

Patient reported outcome scores are valuable in assessing self-reported shoulder function after reverse TSA. In a study investigating 370 38mm and 219 42mm glenospheres, Schoch et al found no significant difference in ASES and Constant scores at a mean follow-up of 2.6 years.[18] Similarly, Sabesan et al.[20] also demonstrated that a larger glenosphere size does not confer an advantage in regards to patient-reported outcomes. In our study, we found there were no significant differences in ASES or SST scores between the 36mm and 40mm cohorts at an average of 5–7 years following surgery. However, there was a significant difference in SST scores (36mm: 6 ± 3; 40mm; 9 ± 3; p-value < 0.01). Most notably, both cohorts reported an identical mean VAS score of 2, which suggests that all sizes of glenospheres are effective at reducing pain in reverse TSA candidates. These findings are promising - regardless of glenosphere size, patients can achieve excellent outcomes following reverse TSA.

There have been multiple studies to date investigating the role of glenosphere size on scapular notching in reverse TSA.[14,17,24] While there are some studies suggesting that a larger glenosphere reduces the risk of scapular notching, other studies suggest no such advantage exists.[14,15,17,24] In a mid-term follow-up study, Mueller et al found no significant differences in the incidence of scapular notching in patients who received a 36mm or 44mm glenosphere.[14] Similarly, Mollon et al.[17] found 10% of 38mm cohort and 9.5% of 42mm cohort had scapular notching at final follow-up. In a randomized controlled trial, Torrens et al observed that 49% of

38mm glenosphere patients had scapular notching while only 12% of 42mm patients had it.[24] Consistent with the previous retrospective studies, we found there was no significant difference in scapular notching based on glenosphere size. 21% of the 38mm and 17% of the 40mm cohort had scapular notching at final follow-up ($p = 0.49$). However, further prospective research need to be conducted before definitive conclusions can be drawn regarding the role of glenosphere size in scapular notching. The studies suggesting no difference exists have been larger in size, but also retrospective in comparison to the smaller, but prospective randomized trial which found that a smaller glenosphere increases the risk of scapular notching.

There are limitations to consider with this study. The small number of 40mm patients made it difficult to draw definitive conclusions between the two cohorts. The lack of preoperative imaging for some patients reduces the ability to understand preoperative characteristics of patients in this study. The retrospective nature of this study creates an inherent bias in the results. Some patients who had undergone reverse TSA at our institution were deceased or lost to follow-up, which may have led to changes in the results.

Conclusion

This study contributes to the literature investigating the relationship between glenosphere size and clinical outcomes. We found there were no significant differences in range of motion, patient-reported outcomes, or scapular notching between the 36mm and 40mm cohorts. Both glenosphere sizes provided long-term pain relief to patients. Importantly, there were no complications or revisions when a larger 40mm glenosphere was used.

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The Lack of High-quality Educational Resources about Adhesive Capsulitis on YouTube

Ausência de recursos didáticos de alta qualidade sobre a capsulite adesiva no YouTube

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Abstract

Objective The advent of the Internet has provided new, easily accessible resources for patients seeking additional health information. Many doctors and healthcare organizations post informative videos on this platform, and nearly all patients are looking for videos online for a second opinion.

Methods The phrases "frozen shoulder," "frozen shoulder treatment," "adhesive" capsulitis, and "adhesive capsulitis treatment" were entered into YouTube's search bar for a normal inquiry. The informativeness and overall quality of the adhesive capsulitis videos were rated using three separate scales.

Results The mean and standard deviation values of the scoring systems were JAMA 1.25 ± 0.51, DISCERN 39.4 ± 13.4, GQS 2.83 ± 0.96 and ACSS 7.43 ± 4.86, respectively. Number of views, rate of views, and likes all had a positive correlation with Global Quality Score (GQS), as did DISCERN and ACSS. There was no statistically significant difference between the median JAMA, GQS score and Discern Criteria values according to the video source/uploader ($p > 0.05$).

Conclusion YouTube videos on adhesive capsulitis, thus, need to be of higher quality, reliability, and instructive quality. There is a need for reliable videos about adhesive capsulitis, with instructional and high-quality cited.

Keywords
- adhesive capsulitis
- bursitis
- video recording
- mídias sociais
- internet

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Resumo

Objetivo O advento da Internet proporcionou recursos novos e de fácil acesso para pacientes que procuram mais informações sobre saúde. Muitos médicos e organizações de saúde publicam vídeos informativos nesta plataforma e quase todos os pacientes procuram tais vídeos online para uma segunda opinião.

Métodos As frases "*frozen shoulder* (ombro congelado)", "*frozen shoulder treatment* (tratamento de ombro congelado)", "*adhesive capsulitis* (capsulite adesiva)" e "*adhesive capsulitis treatment* (tratamento de capsulite adesiva)" foram inseridas na barra de pesquisa do YouTube para uma consulta normal. A informatividade e a qualidade geral dos vídeos sobre capsulite adesiva foram avaliadas usando três escalas distintas.

Resultados Os valores de média e desvio padrão dos sistemas de pontuação do *Journal of the American Medical Association* (JAMA) foram $1,25 \pm 0,51$, DISCERN, $39,4 \pm 13,4$, *Global Quality Score* (GQS, Índice de Qualidade Global em português) $2,83 \pm 0,96$ e *Adhesive Capsulitis Specific Score* (ACSS, Escore Específico de Capsulite Adesiva em português), $7,43 \pm 4,86$, respectivamente. O número de visualizações, a taxa de visualizações e as curtidas tiveram uma correlação positiva com GQS, DISCERN e ACSS. Não houve diferença estatisticamente significativa entre os valores medianos de JAMA, GQS e DISCERN de acordo com a fonte/carregador do vídeo ($p > 0,05$).

Conclusão Os vídeos do YouTube sobre capsulite adesiva precisam ter maior qualidade, confiabilidade e qualidade instrutiva. Há necessidade de vídeos confiáveis sobre capsulite adesiva, com citações instrutivas e de alta qualidade.

Palavras-chave

- capsulite adesiva
- bursite
- gravação em video
- redes sociais
- internet

Introduction

The advent of the Internet has provided new, easily accessible resources for patients seeking additional health information.[1] When it comes to broad Internet searches, YouTube is just second to Google in popularity. Patients, however, are becoming more inclined to it as a means of learning about available healthcare options.[2] Many doctors and healthcare organizations post informative videos on this platform, and nearly all patients are looking for videos online for a second opinion. YouTube is not a peer-reviewed platform, thus this development raises questions about the reliability of the information presented in its medical-related videos.[3] Adhesive capsulitis, also known as frozen shoulder, is a common shoulder problem that manifests with progressive loss of glenohumeral motion with pain.[4] This disease is one of the most common musculoskeletal problems seen in orthopaedics. This condition is quite prevalent in the orthopaedic population. Despite the prevalence of this problem and the advancements in shoulder surgery, many questions remain about the optimal course of therapy.[5] With these unknowns, patients with adhesive capsulitis will likely use YouTube to explore treatment options.

Several studies have shown evidence that the educational quality of YouTube videos dealing with orthopaedic diseases is inadequate.[1–3,6–8] Only one study in the literature examines youtube videos related to adhesive capsulitis.[9] The results of this study were consistent with those of other research. However, only videos that were relevant to a search keyword were used in their study.[9] Our goal with this study was to examine the informativeness and overall quality of these videos by expanding the search phrases adhesive capsulitis patients might use to find them on YouTube. As with other studies in the literature, we assumed that these videos' quality and instructional quality needed to be improved.

Materials and Methods

On February 18, 2022, using Google Chrome (version 92.0.4515.159-64 bit) with the cache and cookies emptied, a search was performed on YouTube's database. Subjects included "frozen shoulder," "frozen shoulder treatment," "adhesive capsulitis," and "adhesive capsulitis treatment." The top 50 videos for each search keyword, as chosen by YouTube's algorithm based on "relevance," were included; this yielded a total of 200 videos for analysis.[10] Videos were considered for inclusion if they met the following criteria: they were in English, their principal subject was about frozen shoulder, and the audio and visual quality were satisfactory. Videos were excluded if they were repetitive, had no dialogue, were in a language other than English, were not about adhesive capsulitis, or were categorized as news, drama, or satire. There was no maximum duration for videos, and compilations of numerous episodes were counted as a single work. A YouTube® account was set up for the research, and once duplicates were eliminated, a complete list of video URLs was compiled. Only 173 videos were included for the study due to the exclusion of 26 that were considered to be repetitive and one that were in a language other than English.

For each included YouTube video, the following attributes were recorded: (1) title, (2) video duration, (3) views, (4)

video source/uploader, (5) content type, (6) days since upload, (7) view rate (views/day), and (8) likes. The authors and uploaders of the videos were classified into seven groups: (1) academic (related to authors or uploaders affiliated with research groups, universities, or colleges), (2) physician (related to independent physicians or groups of physicians without research or academic affiliation), (3) non-physicians (healthcare workers other than licensed medical doctors), (4) trainer, (5) medical source (content or animations from health websites), (6) patient, and (7) commercial. The content types were categorized as: (1) exercise education, (2) disease-specific information, (3) patient experience, (4) surgical technique or approach, (5) non-surgical management, and (6) advertising.

The criteria published in the Journal of the American Medical Association (JAMA) were used to evaluate the accuracy and reliability of the videos (►**Fig. 1**).[11] Four factors, each weighted at 1, provide a generic evaluation of the credibility of the cited material. Accuracy and reliability are best represented by a score of 4, whereas a score of 0 shows the opposite. These criteria have been used extensively in the literature to assess the reliability of online resources, despite the fact that they have not been validated.[10,12]

Three different scales were used to rate the educational value and quality of the adhesive capsulitis videos. Five factors are used to calculate the Global Quality Score (GQS) for educational content (►**Fig. 2**).[10,13] Quality education is represented by a maximum possible score of 5. The "Adhesive Capsulitis Specific Score" (ACSS) was developed for data pertaining to adhesive capsulitis, with its foundations on the recommendations made public by the American Academy of Orthopaedic Surgeons (►**Fig. 3**). The ACSS is a 21-item questionnaire that assesses information about patient presentation and symptoms, adhesive capsulitis in general, diagnostic and assessment procedures, and available treatment choices. Higher quality is represented by a higher score

JAMA Scoring System

Authorship	Authors and contributors, their affiliations, and relevant credentials should be provided.
Attribution	References and sources for all content should be listed clearly, and all relevant copyright information should be noted.
Disclosure	Web-site ‘‘ownership’’ should be prominently and fully disclosed, as should any sponsorship, advertising, underwriting, commercial funding arrangements or support, or potential conflicts of interest.
Currency	Dates when content was posted and updated should be indicated.

Fig. 1 JAMA criteria.

Global Quality Scoring System

Score	*Description of quality*
1	Poor quality and unlikely to be of use for patient education
2	Poor quality and of limited use to patients because some information is present
3	Suboptimal quality and flow; somewhat useful to patients; important topics are missing; some information is present
4	Good quality and flow; useful to patients because most important topics are covered
5	Excellent quality and flow; highly useful to patients

Fig. 2 Global Quality Score.

Adhesive Capsulitis Spesific Score (ACSS)	
Information about patient	
1 Point	Explain the symptoms of frozen shoulder.
1 Point	Describes activities associated with symptoms.
1 Point	Provides information about the patient profile.
Information about frozen shoulder	
1 Point	Explains the frozen shoulder.
1 Point	It gives information about shoulder joint anatomy.
1 Point	It talks about the frozen shoulder mechanism and its phases.
1 Point	It talks about risk factors.
Diagnosis and evaluation	
1 Point	It talks about physical examination and findings.
1 Point	It mentions X-ray and it can be used to evaluate bone structures.
1 Point	It mentions MRI and that it may be needed to detect soft tissue abnormalities.
Treatment	
1 Point	It explains that most of them can be cured with relatively simple treatments.
1 Point	It talks about physical therapy exercises.
1 Point	It mentions steroid injections.
1 Point	It mentions hydrodilation therapy
1 Point	It mentions NSAID use.
1 Point	It mentions that surgical treatment can be performed when conservative treatments are insufficient.
1 Point	It describes manipulation under anesthesia.
1 Point	It mentions arthroscopic surgery.
1 Point	Physical therapy is required for the continuation of the surgically obtained movement after the surgery.
1 Point	It mentions that full range of motion may not be regained after surgery and that some degree of stiffness may remain.
1 Point	It mentions that, in rare cases, frozen shoulder may recur, especially if acontributing factor such as diabetes is still present.

Fig. 3 Adhesive Capsulitis Specific Score.

up to a maximum of 21. Very good (21 points), good (16 points), moderate (12 points), poor (8 points), and very poor (4 points) were the range of possible ACSS ratings.[10,13] The DISCERN score was created in Oxford, United Kingdom to evaluate the quality of health-related written materials. It consists of 16 questions, each of which is given a score between 1 and 5, giving a possible total of 6 to 80 (►**Fig. 4**).[14] Poor (16–28 points), poor (29–41 points), fair (42–54 points), good (55–67 points), and excellent (68–80 points) are the quality categories.

The videos included in the study were determined by the non-observer author and presented to the observers in a table format. The videos were examined and scored blindly by two observers who had been trained in pre-evaluation

DISCERN Scoring System

Section 1: Is the publication reliable?
1 Are the aims clear?
2 Does it achieve its aims?
3 Is it relevant?
4 Is it clear what sources of information were used to compile the publication (other than the author or producer)?
5 Is it clear when the information used or reported in the publication was produced?
6 Is it balanced and unbiased?
7 Does it provide details of additional sources of support and information?
8 Does it refer to areas of uncertainty?
Section 2: How good is the quality of information on treatment choices?
9 Does it describe how each treatment works?
10 Does it describe the benefits of each treatment?
11 Does it describe the risks of each treatment?
12 Does it describe what would happen if no treatment is used?
13 Does it describe how the treatment choices affect overall quality of life?
14 Is it clear that there may be more than one possible treatment choice?
15 Does it provide support for shared decision-making?
Section 3: Overall rating of the publication
16 Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about treatment choices.

Fig. 4 DISCERN score.

scoring using DISCERN, GQS, JAMA, and ACSS. The Interclass Correlation Coefficient (ICC) was used to determine the level of agreement across observers, with values below 0.5 indicating low reliability, between 0.5-0.75 suggesting moderate reliability, between 0.75 and 0.9 indicating good reliability, and above 0.9 indicating excellent reliability.

IBM SPSS Statistics version 20 was used for the data analysis. Continuous data were summarized as means and standard deviations while categorical data were summarized as percentages and relative frequencies. The numbers were rounded to one decimal place.Video reliability as well as quality were compared among video sources and content using either one-way analysis of variance (ANOVA) or Kruskal-Wallis tests, depending on the data distribution. Differences between groups were examined using the Mann-Whitney U test for statistical significance. The level of agreement between the reviewers was determined using the Interclass Correlation Coefficient (ICC). Spearman's rank correlation coefficient was used to examine correlations between evaluations of videos' usefulness and their technical characteristics. Statistical significance was assumed when the p-value was less than 0.05.

Results

The averages of the features of the videos included in the study were: video duration 16.73 ± 123.09 minutes, number of views 264431.7 ± 617136.8, number of days after uploading 1537.95 ± 1159.3 days, view rate 269.75 ± 867.91 and number of likes 3826.78 ± 11595.45. Video source/uploader distribution 12 (6.9%) academic, 72 (41.6%) doctors, 71 (41%) non-physicians, 1 (0.6%) trainer, 13 (7.5%) medical sources, 2 (1.2%) were patients, and 2 (1.2%) were commercial. Looking at the contents of the videos, 44 (25.4%) were exercise training, 112 (64.7%) disease-specific information, 3 (1.7%) patient experience, 11 (6.4%) surgical technique/approach, and 3 (1.7%) included non-surgical management.

According to the JAMA criteria, 95.9% of the videos were rated 2 points or less. According to GQS, 27.7% of videos were rated 2 points or less. According to DISCERN criteria, 38 (21.9%) of the videos were very poor, 47 (27.2%) were poor, 62 (35.9%) were fair, 22 (12.7%) were good, and 4 (2.3%) were very good was evaluated. According to ACSS, 3 (1.7%) of the videos were very good, 31 (17.9%) good, 37 (21.4%) fair, 40 (23.1%) bad, and 62 (35.9%) vide rated very bad. The mean and standard deviation values of the scoring systems were JAMA 1.25 ± 0.51, DISCERN 39.4 ± 13.4, GQS 2.83 ± 0.96 and ACSS 7.43 ± 4.86, respectively. There were positive correlations between the number of views and GQS, between view rate and GQS, and between likes and GQS, DISCERN and ACSS (r:0.364, $p < 0.001$; r:0.414, $p < 0.001$; r:0.458, $p < 0.001$; r:0.265, $p < 0.001$; r:0.168, $p < 0.027$; respectively). There was no statistically significant difference between the median JAMA, GQS score and Discern Criteria values according to

Table 1 Mean and standard deviation values of scores by video source/Uploader

	Academic	Physician	Non-physician	Medical source
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
JAMA	1.95 ± 1.15	1.19 ± 0.38	1.19 ± 0.41	1.26 ± 0.33
GQS	3.66 ± 0.65	2.45 ± 1	3.14 ± 0.75	2.96 ± 0.87
DISCERN Criteria	57 ± 14.37	36.74 ± 13.82	40.02 ± 10.37	40.88 ± 11.73
ACSS	13.45 ± 4.55	7.28 ± 5.13	9.53 ± 4.7	3.5 ± 3.53

the video source/uploader ($p > 0.05$). The values of the scoring systems according to the video source/uploader are summarized in ►**Table 1**.

A statistically significant difference was found between the median ACSS values according to the video source/uploader ($p = 0.013$). Here, the difference was seen between the ACSS median values of those whose video upload source was an instructor and those who were a medical source. The median ACSS value of the video upload source was 5, while the median PPIS value was 9 for the medical source (►**Table 2**). No statistically significant difference was found between the median values of JAMA, GQS score, Discern Criteria, and ACSSS values according to content type (►**Table 3**).

Discussion

This study's essential findings are according to the JAMA criteria, 95.9% of the videos were rated 2 points or less. According to GQS, 27.7% of videos were rated 2 points or less. According to DISCERN criteria, 49.1% of the videos were evaluated as very poor or poor. According to the ACSS, 59% of the videos were rated as bad or very bad. These findings are similar to those of Tang et al.,[9] which evaluated the educational and quality of adhesive capsulitis videos. This study has the feature of evaluating video reliability with JAMA scoring and evaluating more search terms and adhesive capsulitis videos that patients can search on YouTube. Another feature of this study is that there is no restriction on the duration of the video. Because as the duration of the videos increases, their information and educational content increase.[8] Failure to evaluate long videos may affect the research results by excluding highly educational videos. As a result of the comprehensive evaluation, this study concluded that the reliability, quality, and educational level of YouTube videos related to adhesive capsulitis needed to be improved.

Videos uploaded to YouTube do not go through an evaluation process.[3] For this reason, the number of likes and views of the videos can create a quality video perception in patients and cause misinformation.[15] As a result, the number of views of videos that are thought to be beneficial for patients may be less.[16,17] In this study, between the number of likes and the scoring; and there was a positive correlation between the number of views and GQS. These findings show that patients tend to watch better quality videos of adhesive capsulitis and like the ones that are highly educational. Our findings can be interpreted as adhesive capsulitis patients prefer videos that are educational and of high quality, but the number of these videos is insufficient.

The instruction for YouTube videos may vary depending on the video uploader and source.[18] Koller et al.,[18] in their study evaluating videos about hip arthritis, found academic and doctor- sourced videos to be more educational. However, in this study, doctors or academic sources did not provide more educational information than other uploaders. Videos prepared for commercial purposes with commercial concerns may have negative consequences on the treatment of patients.[19] The major cause for poor videos might be related to commercial concerns. Given that most films are made in accordance with the provider's practice and there is no doctor-patient liability obligation, most providers may feel free to advise viewers about only particular parts of the condition and treatment methods.[3] This may cause patients with adhesive capsulitis to claim that the only treatment method offered is the right option and to request the wrong treatment. The solution to this situation may be to prepare patient information platforms without commercial concerns and to direct patients to these platforms.

Young patients use many social media platforms other than youtube to learn about their disease.[20] Artificially intelligent conversational agents (or "chatbots") have showed promise as direct patient engagement and tools for education, and Chat GPT is one such example.[21] These days' AI algorithms that deal with natural language are made to take in data that isn't neatly organized or standardized, and then provide results that sound human. These algorithms draw on a big corpus of previously written material by humans to create answers that have a high probability of matching the user's query. Chatbots have the potential to enhance medical care by supplying instantaneous answers to patient concerns, but because they are trained on language patterns rather than objective databases, they run the risk of giving patients erroneous but appearing reliable answers.[22] In order to learn more about the capacity and educational value of the information that patients access about frozen shoulder on the internet, more information can be obtained through studies examining frozen shoulder data on different social media platforms. In addition, there is a need to evaluate the information that chatbots provide to patients about frozen shoulder. Considering these data, artificial intelligence models can be trained by doctors. In this way, slideshows and videos that provide accurate and reliable

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Table 2 Comparison of scores by video source/Uploader

				Video source/Uploader				
	Academic	Physician	Non-physician	Trainer	Medical source	Patient	Commercial	P-value*
	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	
JAMA	1.5 (1-4)	2 (1-3)	1,5 (1-4)	1 (1-3)	2 (1-3)	1 (1-1)	1 (1-4)	0.081
GQS	2 (1-4)	2.8 (1-5)	2.5 (1-5)	2.5 (1-4)	3 (1-5)	1.8 (1-2.5)	2.5 (1-4)	0.715
DİSCERN Criteria	24 (16-47.5)	36 (14.5-56)	34 (15.5-55)	38 (16-63.5)	42 (23.5-54)	22 (14-30)	34 (20-46)	0.065
ACSS	5 (2-10)[ab]	6,3 (1.5-17.5)[ab]	6 (1-18)[ab]	5 (1-13.5)[a]	9 (5-14.5)[b]	3 (2-4)[ab]	9 (4-16)[ab]	0.013

*Kruskal Wallis test [a-b]: There is no difference between groups with the same letter.

Table 3 Comparison of scores by content type

	Content type					
Exercise education	Disease-specific information	Patient experience	Surgical technique or approach	Non-surgical management	Advertising	P-value*
Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	Mean(min-max)	
JAMA 1.5 (1-3)	2 (1-4)	1 (1-1)	1.5 (1-4)	1.5 (1-3.5)	1 (1-4)	0.191
GQS 3 (1-4)	2.5 (1-4.5)	2.5 (2.5-2.5)	3 (1-5)	2.5 (1-5)	3 (1-4)	0.934
DISCERN Criteria 37.8 (25-63.5)	36.5 (15-55)	30 (30-30)	33 (14.5-56)	35 (14-54.5)	35 (20-46)	0.483
ACSS 5 (1-9)	7 (1.5-18)	4 (4-4)	6 (2.5-12.5)	5.5 (1-14.5)	9.5 (4-16)	0.051

*Kruskal Wallis Testi.

information to patients can be prepared with artificial intelligence support. It can be made available to patients.

This study has some limitations. Videos are continuously being added to YouTube, making it a dynamic platform. It also offers personalized videos using artificial intelligence. Therefore, the videos watched in searches may only partially reflect the videos presented to patients. We used internet provider software with cleared cookies and history to minimize personalized video presentation. However, previous studies have also used this method.[12,23] Again, using only English videos and searching only from one location may change the properties of the evaluated videos. Artificial intelligence can offer different videos according to countries and locations. Different non-English search terms and videos may have different informational content. Only the first 50 videos were evaluated for each search term. The evaluated videos represent a small fraction of the videos associated with adhesive capsulitis. Findings may change as the numberof videos evaluated increases. However, this method has been used before.[10,12] At the same time, although we evaluated the adhesive capsulitis videos by expanding the search terms in this study, we assume that we obtained similar data to the findings of Tang et al.[9]

The internet has made it easier than ever to access information on any topic imaginable. However, this also means a lot of misinformation and disinformation is available online. This can be a problem, as people may not be able to tell the difference between reliable and unreliable information. One way to address this problem is to filter information on the internet. This can be done by using software that identifies and blocks harmful or misleading content. However, it is important to note that no filtering system is perfect, and some false or misleading information may still slip through the cracks. Another way to address the problem is to educate people on critically evaluating information. This includes teaching people how to identify reliable sources of information, spot bias, and assess the quality of evidence. It is also important to be aware of the limitations of the internet. The internet is a vast and ever-changing resource, and it can be difficult to keep up with all the new information being published. This means that it is important to be skeptical of information that you find online, and to always do your own research before drawing any conclusions. Here are some tips for evaluating information on the internet: Consider the source of the information. Is it a credible website or organization? Look for evidence to support the claims being made. Are there any studies or statistics cited? Be aware of bias. Is the information coming from a biased source, such as a political party or a special interest group? Use your common sense. If something sounds too good to be true, it probably is. By following these tips, you can help ensure that you get accurate and reliable information from the internet.

Considering these findings, there is a need for educational and high-quality educational videos to inform patients. There should be clear and high-quality videos that deal with frozen shoulder as a whole, prepared by shoulder surgeons and their associations. These videos should be uploaded to public sites and patients should be directed to these videos. While preparing these videos, they can benefit from the information in https://www.mayoclinic.org/diseases-conditions/frozen-shoulder/symptoms-causes/syc-20372684, https://www.healthline.com/health/frozen-shoulder and https://orthoinfo.aaos.org/en/diseases-conditions/frozen-shoulder/. In addition, by training artificial intelligence software on this disease, many videos with high quality content on frozen shoulder can be prepared quickly and effectively. It can be made available to patients.

Conclusion

YouTube videos on adhesive capsulitis, thus, need to be of higher quality, reliability, and instructive quality. There is a need for reliable videos about adhesive capsulitis, with instructional and high-quality cited. In this way, patients can be directed to video sources with this quality video content.

Author's Contribution:
Each author contributed individually and significantly to the development of this article: AY and VG designed the protocol, reviewed the literature, analyzed the data, and critically reviewed and wrote the manuscript. MY and AM analyzed the data, reviewed the literature, and critically reviewed and wrote the manuscript. All authors read and approved the final manuscript.

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The authors have no conflict of interests to declare.

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Reports of Maltreatment in a Children's Hospital: Evaluation of the Epidemiological Profile and Its Relationship with the Outcome in Fractures

Notificações de maus-tratos em um hospital infantil: Avaliação do perfil epidemiológico e sua relação com o desfecho em fraturas

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Abstract

Objective To describe suspected/confirmed cases of child maltreatment related to fractures in a pediatric hospital in southern Brazil.

Method Study of the Information System of Notifiable Diseases notifications and the victims' medical records between January/2016 and December/2020. Variables related to the victim, the perpetrator, the type of abuse, the presence of fractures, and their anatomical location and death were evaluated. Logistic regression was performed to identify fracture-related variables, adjusted for sex and age. The results were expressed in odds ratios and their respective 95% confidence intervals. It was considered significant $p < 0.05$.

Results There were 276 cases, 73 infants (26.4%), male predominance (151, 54.7%), with authorship of the mistreatment by relatives (245, 96,0%), 85 (31,5%), they presented fractures, with five deaths (1.9%). Factors related to the presence of fracture: age of the victim (less than two years old; $n = 82$; or 2.48; 95% CI: 1.45 - 4.25), having more than two aggressors involved ($n = 144$; or 2.09; 95% CI: 1.16-3.75), the medium being traffic/automobile accident, ($n = 52$; or 2.65; 95% CI: 1.04–6.75), consult an orthopedist ($n = 91$; or 6.77 / 95% CI: 3.66–12.51), and the need for surgical intervention ($n = 15$; OR 36.72; 95% CI: 8.22–164.03).

Conclusions The importance of suspicion, early identification of aggression, and the correct completion of notifications for activating the system of guaranteeing rights and removal of the aggressor was emphasized.

Keywords
- child abuse
- bone fractures
- violence
- negligence

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Resumo

Objetivo Descrever os casos suspeitos/confirmados de maus-tratos infantis relacionados a fraturas, atendidos em um hospital pediátrico no Sul do Brasil.

Método Estudo das notificações do Sistema de Informação de Agravos de Notificação e dos prontuários das vítimas, entre janeiro/2016 e dezembro/2020. Avaliadas variáveis relacionadas à vítima, ao autor, à tipologia de maus-tratos, à presença de fraturas e sua localização anatômica e óbito. Regressão logística foi realizada para identificar as variáveis relacionadas à fratura, ajustada para sexo e idade, expressa em razão de chance e seus respectivos intervalos de confiança de 95%. Foi considerado significativo $p < 0.05$.

Resultados Houve 276 casos, 73 lactentes (26,4%), predomínio do sexo masculino (151, 54,7%), com autoria dos maus-tratos por parentes (245, 96,0%), 85 (31,5%), apresentaram fraturas, sendo cinco óbitos (1,9%). Fatores relacionados à presença de fratura: idade da vítima (menor de dois anos; $n = 82$; RC 2,48; IC 95%: 1,45 - 4,25), ter mais de dois agressores envolvidos ($n = 144$; RC 2,09; IC 95%: 1,16 - 3,75), o meio ser trânsito/acidente automobilístico, ($n = 52$; RC 2,65; IC 95%: 1,04–6,75), consultar com ortopedista ($n = 91$; RC 6,77 / IC 95%: 3,66–12,51), e necessidade de intervenção cirúrgica ($n = 15$; RC 36,72; IC 95%: 8,22–164,03).

Conclusões Ressaltada a importância da suspeição e identificação precoce da agressão, o preenchimento correto das notificações, para o acionamento do sistema de garantia de direitos e afastamento do agressor.

Palavras-chave

- maus-tratos infantis
- fraturas ósseas
- violência
- negligência

Introduction

Violence against children has been present in humanity since primitive times and is often linked to the educational process at home, characterized by any acts, omissions, or negligence in the care provided to the child and which can result in death, emotional or physical harm, abuse or sexual exploitation.[1,2]

In the United States, of 680 thousand cases of violence against children, 75.0% were related to neglect, 18.0% to physical violence, and 8.0% to sexual violence[3–6] - for every 1000 children, 9.1 suffer aggression,[4,5] only 8 out of 100 cases of physical violence in the U.S. are reported.[7] There is recidivism in up to 50.0% and, in these, the risk of death reaches 10.0%.[7]

In Brazil, physical aggression in minors varies between 20.0%[8] and 35.1%.[1] In 2019, there were 159,063 complaints of mistreatment by Disque Direitos Humanos (Disque 100 [Call Human Rights]), an increase of 15.0% compared to 2018.[9] Of these 86,837 (55.0%) referred to domestic violence against children and adolescents: neglect (38.0%), psychological violence (23.0%), physical violence (21.0%), sexual violence (11.0%), exploitation of child labor (3.0%) and others (3.0%).[9]

Many of these acts of violence do not leave physical marks. When present, they are associated with soft tissue injuries (more prevalent), with those affecting the head and abdomen regions being the main causes of death in this group.[6,10] Bone fractures are the second most common finding in victims of violence.[1,3,6,7] Up to about 50.0% of fracture occurrences occur in the first year of life - and a third of these types of injuries occur in those under 3 years of age.[3,6,11] They are the result of child violence. Suspicion should be advanced with caution when the lesions do not correspond to the mechanism of trauma or the declared history.[2,3,6,7,12,13]

Thermal damage, unexplained soft tissue or skull injuries, rib and/or multiple fractures, delay in seeking medical attention, or any injury to a child who is not yet walking should draw the attention of the healthcare professional.[2–4,7] Spinal injuries are rare in children, but they can happen in victims of violence.[3,14] Children with disabilities require increased attention, as they are a risk group for violence,[6,7,10,15] are at greater risk of osteopenia than those without disabilities, which may predispose to pathological fractures,[4] differential diagnoses of maltreatment.[6,7]

Orthogonal radiographs of the skull, spine, long bones, hands, and feet are relevant in cases of suspected violence.[3,6,7,12,16–18] However, they do not replace the anamnesis since it is necessary to confirm the compatibility of the report of the trauma mechanism with that evidenced in the image.[2,3,6,7,13,14]

Age is one of the most important characteristics in distinguishing between accidental trauma and violence. An example is tibia fractures, which are highly suspected in children who are of preambulatory age and may be accidental in young children who are already walking.[3,6,7,19]

The diagnosis of violence in the health sector[1,2,6,7,19] and notification to the responsible bodies avoids worse outcomes, such as emotional and physical sequelae and even death, especially in cases in which the victim suffers several aggressions over time in a chronic form.[1,6,7,10,11,19–23] Whereas neglect is the most frequent type of child abuse,[2,3,7,11,23,24] it is observed that the incidence of injuries

in these cases can be reduced through a preventive approach with parents, guiding them to avoid accident-prone scenarios, including those typical of each age.[2,6,7,19]

To monitor, identify, and even prevent cases of mistreatment of children and adolescents, since 2001, Brazil has compulsorily adopted the notification of suspected or confirmed cases that have been attended to in the establishments of the Unified Health System ([Sistema Único de Saúde] SUS). This notification should be forwarded to municipal epidemiological surveillance and a protection agency.[25] From these records, health authorities and managers can assemble the profile of those involved and their impact,[21,25] to develop relevant public policies to prevent and manage this sad aggravation.

This study, therefore, aims to describe the profile of children with maltreatment notification who present fractures and their related factors in a pediatric orthopedic reference center in Southern Brazil.

Methods

This is a cross-sectional study, with data analysis of children's medical records (ages 0 to 15 incomplete) notified by mistreatment in the emergency room of a pediatric hospital in Santa Catarina from January 2016 to June 2020.

The notifications were selected according to the International Classification of Diseases (ICD-10), with the possibility of outcome in fractures and/or deformities of orthopedic management[7,11,26]; availability of information in the medical records; and standardizing terms: "motorcycle accident," "collision," and "car/automobile accident" to "automobile accident." The records that contained more than one item selected for the "type of violence" field were divided into two or more, allowing a more faithful analysis.

Variables related to the victim are categorized into age (age groups), sex (male or female), race (white and non-white), presence or absence of disability/disorder, and the municipality of residence (capital or other). Those related to the perpetrator: number of involved, gender (male or female), suspicion of alcohol use, bond/degree of kinship with the victim (father, mother, stepfather, stepmother, boyfriend, ex-boyfriend, brother, friends, caregiver, friend, unknown, person in an institutional relationship or others, specifying them) were grouped, generating the variable "known" and "unknown."

Concerning violence, a typology was found (neglect, physical, psychological, suicide attempt, and others), being categorized into "neglect," "physical," and "others" (together with the others previously listed), and death as a result of aggression. Automobile accidents with a record in the victim's medical record of the non-use of legally provided safety devices were considered negligence.

In addition to manually verifying the notification forms, an analysis of the records in the patients' medical records was performed, aiming to investigate the outcome: "presence of fractures." They were categorized in terms of presence (yes or no) based on the orthopedist's clinical and radiological diagnosis, topography (whether in the upper limbs, lower limbs, axial skeleton, or two or more body segments), and the need for surgical intervention.

The data were analyzed using the *Statistical Package for the Social Sciences*, version 22.0, by descriptive statistics in simple frequency and proportion. Binary logistic regression was employed, using the chi-square or Fisher's exact tests in the crude model (variables with $p < 0{,}20$). The selection method was used *backward* for the adjusted analysis, with results expressed in odds ratio (or) and respective confidence intervals (CI) of 95%. $p < 0.05$ was considered significant.

In April 2020, a systematized search of the PubMed database (*US National Library of Medicine National Institutes of Health*) on child maltreatment yielded 182 articles (►**Table 1** and ►**Fig. 1**).

The study was approved by the Institutional Research Ethics Committee (Consolidated Opinion 4.203.338/2020).

Results

From January 2016 to December 2020, 276 notifications of suspected or confirmed cases of interpersonal or self-inflicted violence were made, corresponding to a total of 253 children and adolescents. No records confirming or excluding the diagnosis of fractures were found in 6 of the 276 cases, leaving 270 notifications for analysis.

Regarding the characteristics of children and adolescents reported as victims of maltreatment described in ►**Table 1**, there was a predominance of males (54.7%), over 10 years of age (30.1%), of white ethnicity (89.4%), without disabilities (94.0%) and who inhabited cities that were not Florianópolis (65.2%). The age of the victim showed a significant difference

Table 1 Data and search keys from the April 2020 literature review

PubMed	Child abuse x child X fractures x notification
	("child abuse" [Mesh] OR "child abuse" OR "abused children" OR "abused child" OR "childhood abuse" OR "childhood violence" OR "violence against children" OR "violence toward children" OR "Nonaccidental Trauma in Children" OR "infant Apparent Life-Threatening Event" [Mesh] OR "Infantile Apparent Life-Threatening Event") AND ("fractures, bone"[MeSH Terms] OR "fractures" OR "fracture") AND ("2015/01/01"[PDAT]: "2020/12/31"[PDAT]) AND "last 5 years"[PDat] AND Humans[Mesh] AND (English [lang] OR French[lang] OR Portuguese[lang] OR Spanish[lang]) AND ((infant[MeSH] OR child[MeSH] OR adolescent[MeSH]) OR infant[MeSH:noexp] OR child, preschool[MeSH] OR infant, newborn[MeSH] OR infant [MeSH] OR adolescent[MeSH] OR child[MeSH:noexp])

Source: Prepared by the author, 2020.

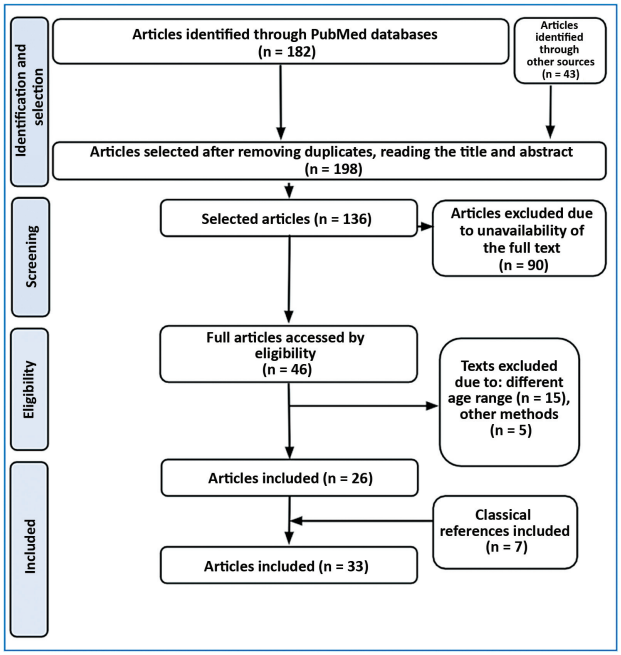


Fig. 1 Search Strategy on Child Maltreatment With Bone Fractures, Pubmed: 2015-2020. Source: www.prisma.statement.gov [Data from the author].

according to sex. Most of the victims were boys aged 10-15 years ($p < 0.05$).

The sex distribution of the perpetrators of the aggression concerning the sex of the victim was statistically significant ($p < 0,05$). In 57.4% of the notifications, the authorship of these violences was linked to at least two suspects who acted jointly, mostly parents (50.2%), without suspicion of alcohol use in 91.3% of the notifications. Acquaintances predominated (96.0%) (►**Table 2**).

Neglect was the most described typology (53.9%), the beating was the most common means (33.9%), resulting in fractures in 31.5% of cases, and the axial axis was the most affected anatomical segment (40.0%). Regarding the fracture site and sex of the victim, fractures only in the axial skeleton were frequent in males, and fractures in two or more segments predominated in females ($p < 0,05$). 15 of them (17.6%) required surgical intervention. There were five deaths: two due to gunshot wounds, one due to beatings, one due to automobile accidents, and one due to falls (►**Table 3**).

In the analysis adjusted for sex and age, age of the victim (less than two years) (or 2.48; 95% CI: 1.45 - 4.25), involvement of two or more aggressors (or 2.09; 95% CI: 1.16 - 3.75), the means being traffic/automobile accident, (or 2.65; 95%

Table 1 Characterization of victims of physical/self-inflicted violence (according to age, ethnicity, presence of disabilities, and the municipality of residence), according to sex, SINAN-HIJG, 2016–2020 (*n= 276*)

Variables	Total	Female		Male		*p*-value
	n (%)	n (%)	CI95%	n (%)	CI95%	
n	276 (100)	125 (45.3)	–	151 (54.7)	–	
Age† (*n = 276*)						**0.031**[b]
0-29 days	9 (3.2)	6 (4.8)	2.1–10.3	3 (2.0)	0.6–6.1	
30d – 1 year	73 (26.4)	38 (30.4)	22.9–39.1	35 (23.2)	17.1–30.7	
2 |–6 years	62 (22.5)	34 (27.2)	20.0–35.8	28 (18.5)	13.1–25.6	
6 |–10 years	49 (17.8)	19 (15.2)	9.8–22.7	30 (19.9)	14.2–27.1	
10 |–15 years	83 (30.1)	28 (22.4)	15.9–30.7	55 (36.4)	29.1–44.5	
Ethnicity* (*n = 274*)						0.994[a]
White	245 (89.4)	110 (89.4)	82.5–93.8	135 (89.4)	83.3–93.4	
Not White	29 (10.6)	13 (10.5)	6.2–17.5	16 (10.6)	6.6–16.7	
Disability* (*n = 275*)						0.232[b]
No	187 (94.0)	86 (96.6)	89.9–98.9	101 (91.8)	89.9–95.7	
Yes	12 (6.0)	3 (3.4)	1.1–10.1	9 (8.2)	4.2–15.1	
Municipality of residence* (*n = 273*)						0.189[a]
Florianópolis	95 (34.8)	38 (30.7)	23.1–39.4	57 (38.3)	30.7–46.4	
Other‡	178 (65.2)	86 (69.4)	60.6–76.9	92 (61.7)	53.6–69.3	

Abbreviations: CI95%: 95% Confidence Interval; HIJG: Hospital Infantil Joana de Gusmão; SINAN: Sistema de Informação de Agravos de Notificação.
[a]Chi-square test.
[b]Fisher's exact test.
*Data without information from all records.
†Stratification according to Marcondes[29]
‡Grouping of all Brazilian municipalities cited as the victim's residence.

Table 2 Characterization of perpetrators of ill-treatment (according to the gender of the perpetrator, relationship with the victim, dichotomized relationship, number of perpetrators, and use of alcohol by the perpetrator), according to the sex of the victims, SINAN-HIJG, 2016–2020 (*n*= *276*)

Variables	Total	Female		Male		*p*-value[a]
	n (%)	n (%)	CI95%	n (%)	CI95%	
Sex* (*n* = *248)*						**0.001**[a]
Male	55 (22.2)	18 (15.5)	9.9–23.4	37 (28.0)	21.0–36.4	
Female	55 (22.2)	37 (31.9)	24.0–41.0	18 (13.6)	8.7–20.7	
Perpetrators of both sexes involved in the assault	138 (55.7)	61 (52.6)	43.3–61.6	77 (58.3)	49.6–66.5	
Bond with the victim*(*n* = *251*)						0.865[b]
Mother	39 (15.5)	22 (18.5)	12.4–26.6	17 (12.8)	8.1–19.8	
Father	25 (10.0)	12 (10.1)	5.7–17.0	13 (9.9)	5.8–16.3	
Both†	126 (50.2)	56 (47.1)	38.2–56.2	70 (53.0)	44.3–61.5	
Mother + others‡	13 (5.18)	7 (5.8)	2.8–11.9	6 (4.6)	2.0–9.8	
Father + others‡	1 (0.40)	0 (0)	0 -0	1 (0.8)	0.1–5.3	
Own person	14 (5.58)	8 (6.7)	3.4–13.0	6 (4.6)	2.0–9.8	
Unknown	10 (3.98)	4 (3.4)	1.2–8.7	6 (4.6)	2.0–9.8	
Acquaintance or Relative	22 (8.76)	10 (8.4)	4.5–15.0	12 (9.1)	5.2–15.4	
Father + Mother + Others	1 (0.40)	0 (0)	0 -0	1 (0.8)	0.1–5.3	
Bond with the victim dichotomized* (*n* = *251*)						0.752[b]
Known	241 (96.0)	115 (96.4)	91.3–98.8	126 (95.5)	90.2–98.0	
Unknown	10 (4.0)	4 (3.4)	1.2–8.7	6 (4.6)	2.0–9.8	
Number of perpetrator* (*n* = *251*)						0.403[a]
1	107 (42.6)	54 (45.4)	36.6–54.5	53 (40.2)	32.0–48.8	
2 or more	144 (57.4)	65 (54.6)	45.5–63.4	79 (59.8)	51.2–68.0	
Alcohol use* (*n* = *161*)						0.263[b]
No	147 (91.3)	67 (88.2)	78.5–93.8	80 (94.1)	86.4–97.6	
Yes	14 (8.7)	9 (11.8)	6.1–21.5	5 (5.9)	2.4–13.6	

Abbreviations: CI95%, 95% Confidence Interval; HIJG, Hospital Infantil Joana de Gusmão; SINAN, Sistema de Informação de Agraos de Notificação.
[a]Chi-square test.
[b]Fisher's exact test.
*Data without information from all records.
†Grouping of father and mother bonds.
‡Grouping of all ties other than "Father" or "mother" but associated with one of them.

CI: 1.04–6.75), presence of consultation with orthopedist (or 6.77; 95% CI: 3.66–12.51), and the need for surgical intervention (or 36.72; 95% CI: 8.22–164.03) were statistically significantly associated with increased risk of fractures (►**Table 4**).

Discussion

Male victims, as noted in the literature,[12] were the most affected (54.7%), with a 1.2-fold risk of presenting associated fractures, when compared to females.

The extremes of age (< 2 years and > 10 years) were the groups most likely to suffer aggression. Infants (< 2 years) presented a 2.4 times higher risk of fractures when compared to those older than two years, regardless of sex, corroborating the international literature[6,7,19] and differing from that computed by Disque 100 (Dial 100), where school victims were the most listed.[9] It should be noted that the smaller the child, the more dependent on care the child is, including reaching a health service, with underreporting due to omission of care.[2]

In the southern region of the country, white ethnicity predominates,[8,26] explaining the disparity between reports of violence in people of this ethnicity (89.4%) in relation to the others, different from the data of the Disque 100, which indicates the brown population as the most affected by mistreatment, followed by white and black.[9] In this study, having white skin color was associated with a 1.5 times higher risk for fractures related to abuse when compared to other skin colors.

The presence of victims with disabilities was not significant (6.0%), diverging from the literature,[1,2,7,9,15,19] leading

Table 3 Typology of cases of maltreatment, its consequences, and outcome "bone fractures" according to the sex of the victims (according to the type of violence, the environment, the presence of fractures, the type of fracture, whether there was consultation with an orthopedist and whether there was a need for surgery or deaths), SINAN-HIJG, 2016–2020 (*n*= *276*)

Variables	Total	Female		Male		*p*-value
	n (%)	n (%)	CI95%	n (%)	CI95%	
Type (*n* = *271*)						0.352[a]
Negligence	146 (53.9)	61 (50.0)	41.1–58.9	85 (57.0)	48.9–64.8	
Physics	106 (39.1)	50 (41.0)	32.5–50.0	56 (37.6)	30.1–45.7	
Other**	19 (7.0)	11 (9.0)	5.0–15.7	8 (5.4)	2.7–10.4	
Means/Instrument* (*n* = *248*)						0.297[b]
Spanking	84 (33.9)	39 (34.8)	26.5–44.2	45 (33.1)	25.6–41.5	
Traffic Accident	52 (21.0)	21 (18.8)	12.5–27.2	31 (22.8)	16.4–30.7	
Electric Shock	33 (13.3)	14 (12.5)	7.5–20.1	19 (14.0)	9.0–21.0	
Falls	32 (12.9)	20 (17.9)	11.7–26.2	12 (8.8)	5.0–15.0	
Firearm	17 (6.9)	5 (4.5)	1.8–10.4	12 (8.8)	5.0–15.0	
Other***	30 (12.1)	13 (11.6)	6.8–19.1	17 (12.5)	7.9–19.3	
Presence of Fractures* (*n* = *270*)						0.537[a]
No	185 (68.5)	88 (70.4)	61.7–77.8	97 (66.9)	58.7–74.1	
Yes	85 (31.5)	37 (29.6)	22.2–38.3	48 (33.1)	25.8–41.2	
Type of fracture* (*n* = *85*)						**0.017[a]**
Upper Member(s) Only	15 (17.7)	8 (21.6)	10.8–38.5	7 (14.6)	6.9–28.2	
Lower Member(s) Only	16 (18.8)	7 (18.9)	8.9–35.6	9 (18.8)	9.8–32.9	
Axial Skeleton Only	34 (40.0)	8 (21.6)	10.8–38.5	26 (54.17)	39.6–68.0	
In 2 or more segments	20 (23.5)	14 (37.8)	23.3–54.99	6 (12.5)	5.5–25.8	
Orthopedic consultation *(n = 276)*						**0.024[a]**
No	185 (67.0)	75 (60.0)	51.1–68.3	110 (72.9)	65.1–79.4	
Yes	91 (33.0)	50 (40.0)	31.7–48.9	41 (27.2)	21.0–34.9	
Surgery*(*n* = *276*)						0.912[a]
No	261 (94.6)	118 (94.4)	88.6–97.3	143 (94.7)	89.7–97.3	
Yes	15 (5.4)	7 (5.6)	2.7–11.4	8 (5.3)	2.7–10.3	
Death*(*n* = *270*)						0.380[b]
No	265 (98.1)	122 (99.2)	94.3–99.9	143 (97.3)	92.9–99.0	
Yes	5 (1.9)	1 (0.8)	0.1–6.0	4 (2.7)	1.0–7.1	

CI95% = 95% Confidence Interval%;
[a]Chi-square test.
[b]Fisher's exact test.
*Data without information from all records; NA: not applicable.
**Moral violation, ill-treatment, suicide attempt.
***Suicide attempt, blunt object, sharp object, threat, hanging, exogenous intoxication, evasion, "shaken baby," burning hot object.
HIJG: Hospital Infantil Joana De Gusmão; LM or LMS: lower member / lower members; UM or UMS: upper member / upper members; NDIS: Notifiable Diseases Information System.

to infer that the failure to seek emergency care for these patients could be related to possible notification errors, the lack of diagnosis of aggression and/or notification and the inability to verbalize victims with disabilities.[2,26] In this group, there was no association with fracture risk.

The greater number of notifications from other municipalities (65.2%) than the capital can be justified because the hospital is large and a reference in orthopedics in the State.

Regarding the authorship of the maltreatment, most had at least two aggressors, mainly the father and mother, simultaneously, corroborating with the literature, which maintains the pattern of parents as the main suspects of child maltreatment.[1–7,9,15,17,19] In 91.0% of the cases, the authors of the aggressions were not under suspicion of alcohol use, in line with the literature,[2,9,15] there was no relationship between the use of alcohol by the aggressors and the outcome fractures.

Table 4 Factors associated with the outcome "bone fractures" in victims of maltreatment, SINAN-HIJG, 2016–2020 (*n= 270*).

	Not adjusted		Adjusted for age and gender	
Variables	**CR (CI95%)**	***p*-value**	**CR (CI95%)**	***p*-value**
Sex of the victim *(n = 270)*				
Female (125)	1	0.537	1	
Male (145)	1.18 (0.70–1.97)		1.34 (0.79–2.29)	0.283
Age of victim *(n = 270)*				
≥ 2 years (82)	1		1	
< 2 years (188)	2.37 (1.39–4.03)	**0.001**	2.48 (1.45–4.25)	**0.001**
Ethnicity *(n = 270)*				
Not white (41)	1		1	
White (239)	1.52 (0.62–3.71)	0.356	1.33 (0.53–3.31)	0.542
Disability *(n = 195)*				
No (186)	1		1	
Sim (9)	0.66 (0.13–3.29)	0.616	0.74 (0.14–3.81)	0.718
Municipality (*n = 267*)				
Florianópolis (94)	1		1	
Other** (173)	0.33 (0.44–1.32)	0.325	0.78 (0.44–1.38)	0.395
Gender of the perpetrator(s)* *(n = 242)*				
Female (120)	1		1	
Male (122)	1.17 (0.67–2.03)	0.589	1.20 (0.66–2.17)	0.554
Gender of the perpetrator(s)* *(n = 242)*				
Female (53)	1		1	
Both (135)	1.64 (0.80–3.37)	0.176	1.68 (0.80–3.52)	0.169
Male (54)	0.79 (0.32–1.96)	0.607	0.87 (0.34–2.25)	0,775
Number of perpetrator *(n = 251)*				
1 aggressor (107)	1		1	
2 more aggressors (144)	2.14 (1.19–3.83)	**0.011**	2.09 (1.16–3.75)	**0.014**
Use of alcohol by the perpetrator (*n= 161*)				
No (147)	1		1	
Yes (14)	0.99 (0.29–3.33)	0.988	1.26 (0.36–4.40)	0.714
Bond with the victim *(n = 246)*				
Unknown (10)	1		1	
Known (236)	1.72 (0.36–8.31)	0.499	1.61 (0.33–7.83)	0.554
Typology *(n = 265)*				
Other (18)	1		1	
Negligence (145)	3.26 (0.72–14.81)	0.126	2.60 (0.56–12.02)	0.221
Physics (102)	4.95 (1.08–22.72)	**0.040**	3.67 (0.78–17.16)	0.099
Means (*n = 248*)				
***Other (53)	1		1	
Beating (79)	2.07 (0.87–4.92)	0.099	1.90 (0.78–4.60)	0.157
Traffic (51)	2.51 (0.99–6.30)	0.051	2.65 (1.04–6.75)	0.042
Shock (33)	0.13 (0.16–1.10)	0.061	0.13 (0.15–1.07)	0.057
Fall (32)	2.21 (0.79–6.19)	0.131	2.28 (0.78–6.57)	0.129

(*Continued*)

Table 4 (*Continued*)

	Not adjusted		Adjusted for age and gender	
Variables	**CR (CI95%)**	***p*-value**	**CR (CI95%)**	***p*-value**
Orthopedic Consultation *(n = 270)*				
No (179)	1		1	
Yes (91)	5.02 (2.88–8.73)	<**0.001**	6.77 (3.66–12.51)	<**0.001**
Surgical Intervention *(n = 270)*				
No (255)	1		1	
Yes (15)	16.52 (3.63–75.05)	<**0.001**	36.72 (8.22–164.03)	<**0.001**
Development: Death (*n= 266*)				
No (261)	1		1	
Sim (5)	1.46 (0.24–8.88)	0.684	1.09 (0.17–6.95)	0.928

Abbreviations: CI95% = 95% Confidence Interval; CR, Chance of Ratio; SC: Santa Catarina; SINAN: Sistema de Informação de Agravos de Notificação.
*Data without information from all records.
**Municipalities that are not Florianópolis.
***Suicide attempt, blunt object, sharp object, threat, hanging, exogenous intoxication, evasion, "shaken baby," burning hot object.

Corroborating national and international research,[2–6,12] neglect (53.9%) and physical aggression (39.1%) were the most prevalent typologies, with similar distribution between genders. The high prevalence of the latter may be related to the use of physical force as a form of "education" or disciplinary practice,[1,2,12] where parents who were raised through punishment and physical punishment perpetrate this culturally accepted habit,[1,2] regardless of the existence of public policies, such as Law No. 13,010–"Lei do Menino Bernardo" (Bernardo Boy Law)[27] or the Statute of the Child and Adolescent.[28]

The increased risk of these two forms of maltreatment in the occurrence of fractures was 3.3 and 5.0 times higher, respectively, when compared to all the others studied. Understanding the importance of vigilance of parents to their children and especially continuing education about accidents and unintentional injuries.[2,3,7]

When the means of aggression were evaluated, "traffic accidents" and" beating" responded to more than half of the notifications (54.9%), followed less expressively by electric shock (13.3%), falls (12.9%), and "others," similar to the literature,[2,6,7,9,19] signaling for the practice of physical force as an educational disciplinary measure[1,2,12] and the absence of observance of safe transportation.[2,29] "Beating" and "traffic accidents" were related to a 2.1-and 2.5-fold risk of causing fractures.

The outcome "fractures" was 2.2 times more frequently observed in the "falls," paying attention to the need for surveillance and supervision, especially of minors who are starting to walk.[2,3,7] Its prevalence (31.5%) was 4.5 times higher than in another national study.[15]

Regarding the anatomical location of the fractures, 40.0% were present only in the axial skeleton, including the skull, a region related to a more severe outcome.[2–7,12,15,18,19] 23.5% of the victims presented injuries in more than one segment, being a risk factor for mistreatment[2–7,11,18,19], that is, a child with multiple fractures, especially in more than one anatomical site, should be evaluated more closely for this diagnostic suspicion.

Of the patients studied, regardless of gender, children under two years of age had a 2.5 times higher risk of suffering fractures than other age groups, in addition to a 1.7 times higher risk for the same outcome if the violence was perpetrated by acquaintances when compared to those who were assaulted by strangers. Other factors associated with a higher risk of fractures were aggression being committed by two perpetrators or more, victims of automobile accidents, and care provided by an orthopedist—risks respectively 2.1, 2.7, and 6.8 times higher. Considering that automobile accidents are sometimes related to negligence, a great challenge emerges: Safe transportation for children must be established in the safety rules for the transport of children in vehicles.[29]

Fifteen patients (17.7%) underwent orthopedic surgery as part of the treatment, and the presence of bone fracture was related to 16.5 times more need for surgical intervention and 1.5 times the risk of death when compared to the absence of it in the study.

These data reinforce the importance of prevention,[2,29] of attention to the signs that may raise suspicions of mistreatment, and the appropriate investigation by the "front line" professional and referral to the specialist when appropriate.[6,7,19]

The secondary source of the data is cited as a probable limitation, which was resolved by manually checking the notification forms one by one and checking the victim's hospital records.

Conclusions

Due to the dependence and vulnerability inherent to the life cycle, children are a risk group for various violence, whether accidental or intentional, requiring both family education for prevention and the attention of the assistance professional in the identification and correct notification of this

aggravation, with adequate management of cases, avoiding serious outcomes.

Authors' Contribution

Each author contributed individually and significantly to developing this article: JRA, VBP: Study design. JRA: Data collection. JRA, VBP, MH: Data analysis, manuscript writing, manuscript review, and supervision.

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Conflict of Interest

The authors declare no conflict of interest.

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Stability of Proximal Femoral Osteotomies in Pediatric Bone Models Fixed with Flexible Intramedullary Nails and Evaluated by the Finite Element Method

Estabilidade de osteotomias proximais em modelos do fêmur pediátrico fixadas por hastes intramedulares flexíveis e avaliadas pelo método dos elementos finitos

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Abstract

Objective To evaluate the stability of osteotomies created in the subtrochanteric and trochanteric regions in a pediatric femur model fixed by flexible intramedullary rods.

Method Tomographic sections were obtained from a pediatric femur model with two elastic titanium rods and converted to a three-dimensional model. This model created a mesh with tetrahedral elements according to the finite element method. Three virtual models were obtained, and osteotomies were performed in different regions: medi-odiaphyseal, subtrochanteric, and trochanteric. A vertical load of 85N was applied to the top of the femoral head, obtaining the displacements, the maximum and minimum main stress, and the equivalent Von Mises stress on the implant.

Results With the applied load, displacements were observed at the osteotomy site of 0.04 mm in the diaphyseal group, 0.5 mm in the subtrochanteric group, and 0.06 mm in the trochanteric group. The maximum stress in the diaphyseal, subtrochanteric, and trochanteric groups was 10.4 Pa, 7.52 Pa, and 26.4 Pa, respectively. That is around 40% higher in the trochanteric group in regards to the diaphyseal (control). The minimum stress of the bone

Keywords
- femoral fractures
- finite element analysis
- fracture fixation, intramedullary

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was located in the inner cortical of the femur. The equivalent Von Mises stress on the implants occurred at osteotomy, with a maximum value of 27.6 Pa in the trochanteric group.
Conclusion In both trochanteric and subtrochanteric osteotomies, fixation stability was often lower than in the diaphyseal model, suggesting that flexible intramedullary nails are not suitable implants for proximal femoral fixations.

Resumo

Objetivo Avaliar a estabilidade de osteotomias criadas nas regiões subtrocantérica e trocantérica em modelo de fêmur pediátrico, fixadas por hastes intramedulares flexíveis.
Método A partir de um modelo de fêmur pediátrico com duas hastes elásticas de titânio, foram obtidos cortes tomográficos que foram convertidos para um modelo tridimensional. Neste modelo foi criado uma malha com elementos tetraédricos, de acordo com o método dos elementos finitos. Foram obtidos três modelos virtuais, e realizadas osteotomias em regiões diferentes: mediodiafisária, subtrocantérica e trocantérica. Foi aplicado um carregamento vertical de 85N no topo da cabeça do fêmur, obtidos os deslocamentos, a tensão máxima e mínima principal e tensão equivalente de Von Mises no implante.
Resultados Com o carregamento aplicado foram observados deslocamentos no local da osteotomia de 0,04mm no grupo diafisário, 0,5mm no subtrocantérico e 0,06mm no trocantérico. A tensão máxima principal foi 10,4Pa, 7,52Pa e 26,4Pa nos grupos diafisário, subtrocantérico e trocantérico, respectivamente. Ou seja, a tensão máxima foi em torno de 40% maior no grupo trocantérico, em relação ao diafisário (controle). A face de tensão mínima do osso localizou-se na cortical interna do fêmur. A tensão equivalente de Von Mises nos implantes ocorreu na osteotomia, com valor máximo de 27,6Pa no grupo trocantérico.
Conclusão Tanto nas osteotomias no nível trocantérico, quanto subtrocantérico, a estabilidade da fixação foi muitas vezes menor que no modelo diafisário, sugerindo que as hastes intramedulares flexíveis não são implantes adequados para as fixações proximais do fêmur.

Palavras-chave
- fraturas do fêmur
- análise de elementos finitos
- fixação intramedular de fraturas

Introduction

Intramedullary elastic fixation is a reliable and effective option for treating fractures in the pediatric femur's diaphysis.[1,2] However, when a fracture occurs in the trochanteric or subtrochanteric regions, the use of flexible rods is questioned due to possible insufficiency of mechanical stability to maintain the reduction and provide consolidation.[3–6] Under these conditions, it is interesting to simulate the mechanical behavior of an implant in order to anticipate whether it depends on clinical conditions.

There are usually two methods of evaluating the mechanical behavior of bone and implants: direct experimental techniques (or mechanical methods) and mathematical models. However, direct experimental techniques have disadvantages, being prone to errors and inaccuracies.[7]

The Finite Element Method (FEM) is a powerful tool initially developed in the 1950s and widely accepted after investments in technology by the National Aeronautics and Space Administration (NASA).[8] In the field of Engineering, this method is used to solve conditions such as stress analysis, fluid flow, electromagnetism, and heat transfer using computer models.[8]

In the Medical field, especially in Orthopedics and Biomechanics, the first records of the application of the FEM date back to the 1970s, when estimates of the ability of different types of tests to predict the mechanical behavior of bones were carried out.[7,9] Through the FEM, it is possible to accurately represent complex geometries and incorporate the different properties of materials, allowing the application of loads at specific points in the structure. This way, obtaining information about the maximum and minimum stress and deformations is possible.[7] Therefore, FEM is used to accurately predict the response of an implant when subjected to a variety of loads, in addition to incorporating the effect of the interfaces between the implant and the bone.[7,10,11]

The objective of this study was to evaluate the stability provided by two flexible intramedullary rods in simulations of fractures located in the subtrochanteric, trochanteric, and diaphyseal regions created in a pediatric femur model using the finite element method.

Material and Methods

This is a laboratory study using artificial bone models, and therefore, the Institutional Research Committee's approval of the project is waived.

An infant femur model with dimensions corresponding to a 9-year-old child (Sawbone Inc., Pacific Research Laboratories Inc., WA, United States). This synthetic bone has mechanical properties similar to human bone.[12,13]

The preparation of the specimen was described earlier.[6] In summary, two flexible titanium rods (*Titanium Elastic Nail* - TEN®, TiGa 114v, DePuy Synthes®, Oberdorf, Switzerland) with a diameter of 3.5 mm were inserted retrograde into the spinal canal. Radiography were performed to confirm proper positioning, followed by computed tomography of the entire bone model, archived in the DICOM communication protocol (*Digital Imaging and Communications in Medicine*). Computed tomography was completed using a Siemens ® 16-channel Tomograph, Emotion model (Erlangen, Germany), with a resolution of 512×512 and a cutting distance of 1.0 mm. DICOM was imported into the InVesalius® program (free software of the Renato Archer Information Technology Center, Campinas, São Paulo, Brazil), which enabled the generation of segmented models of the imported anatomical system for the three-dimensional (3D) construction of the anatomical structure. Once the volumetric object reconstructed in three dimensions was obtained, the software allowed the export of the file in the Standard Triangle Language (STL) format.

The Rhinoceros® 6 program (Robert McNeel & Associates, Seattle, WA, United States), version 6, generated virtual 3D models of each bone-stem set. To obtain a more accurate and faithful contour, we carried out reshuffles on the resulting intersection lines. These lines were drawn considering the region under study and may contain variations in the number of points according to the need for details of the area in question. Then, these lines were intersected and cut off, forming a set of three or four lines. This set allowed the generation of a three-dimensional surface.

The analysis by the FEM was conducted by the SimLab® program (HyperWorks, Troy, MI, USA), using the Optistruct solver.

To simulate the fractures, osteotomies were performed in the virtual models at three levels: cut at the level of the lesser trochanter (trochanteric group), cut located 3.5 cm distally to the lesser trochanter (subtrochanteric group), and cut in the central region of the diaphysis (mediodiaphyseal group, or control). Tetrahedral elements were used for knitting, and the number of knots was defined. In the virtual environment, a load of 85.0 N was applied to the top of the femoral head in the vertical direction, and the corresponding deformations and stresses were obtained.

For the simulations, it was necessary to know and define the material properties of each of the digital models' parts, namely cortical bone, spongy bone, and titanium alloy (TiGa114v). The properties of the materials used for the simulations are presented in ►**Chart 1**.

Chart 1 Properties of materials used in simulations

Material	Properties	
	Modulus of Elasticity (MPa)	Poisson's Ratio (v)
Cortical bone	137	0.3
Cancellous bone	13.7	0.3
Titanium rod	114	0.33

Results

With a loading of 85.0 N, the following displacements were obtained at the osteotomy simulation site: 0.04 mm in the control group, 0.5 mm in the subtrochanteric group, and 0.06 mm in the trochanteric group.

The greatest areas of stress were identified in the lateral cortical of the femur and the upper region of the neck. The main maximum stress reached 10.4 Pa, 7.52 Pa, and 26.4 Pa in the control, subtrochanteric, and trochanteric groups, respectively (►**Fig. 1**).

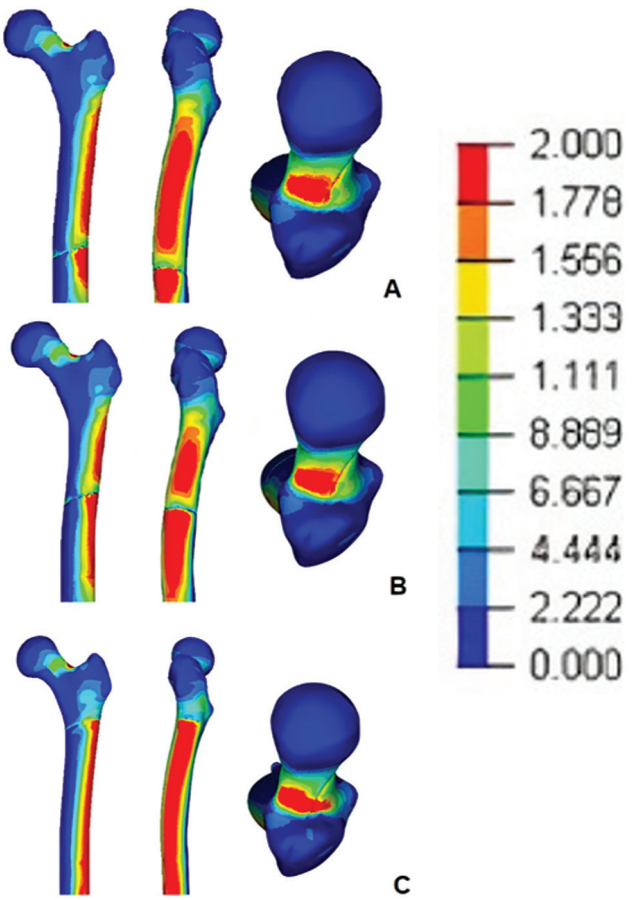


Fig. 1 Distribution of the areas of maximum stress in the proximal regions of the femur in the simulations of the three types of osteotomies. A - Diaphyseal Osteotomy, B - Subtrochanteric Osteotomy, C- Trochanteric Osteotomy. The red colors represent the areas of greatest stress.

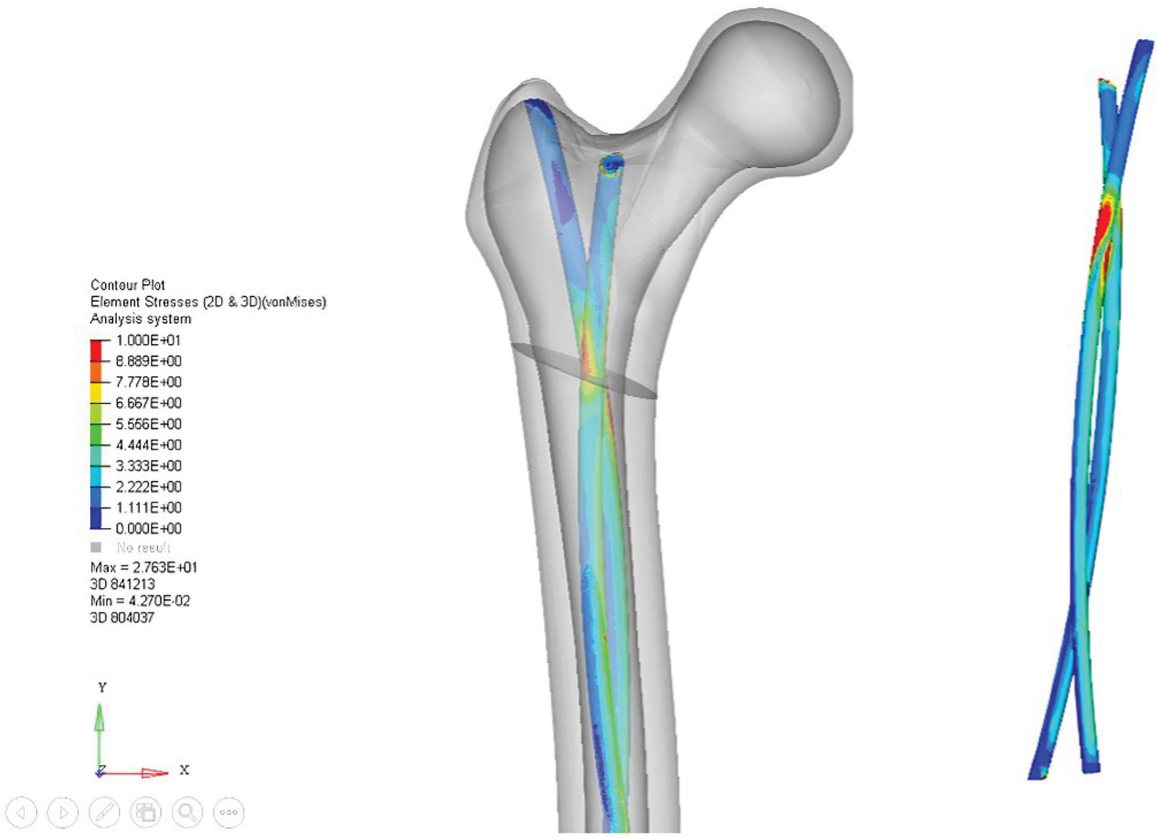


Fig. 2 The figure represents the reconstruction of the proximal region of the femur, the osteotomy section, and the flexible rods. The rods without the bone contour are presented in detail on the side, illustrating the concentration of Von Mises equivalent stress higher in the osteotomy region (areas in red; critical region). If there is implant failure, it will occur at this level, leading to loss of reduction.

The main minimum stress face in the bone was identified in the medial cortical of the femur, presenting values of −11.6 Pa in the control group, -9.95 Pa in the subtrochanteric group, and −25.9 Pa in the trochanteric osteotomy. The equivalent Von Mises stress on the implants was observed in the osteotomy region, reaching a maximum value of 27.6 Pa in the trochanteric group (►**Fig. 2**).

Discussion

Fractures in the subtrochanteric region of the femur have a strong tendency to deflect the proximal fragment in bending, varus, and external rotation, which is associated with shortening.[14–16] This results in increased stress between the fragments, which become more dependent on the stabilizing effect of the implant.

Therefore, the fixation must counteract the mechanical moments generated by local forces, providing adequate stability to maintain the reduction and allow consolidation. Thus, elastic rods may not meet these criteria, as already shown by clinical reports[3] and mechanical tests,[6] not being indicated for fractures in the most proximal regions.

To study the stability of the bone-implant model set, we used the FEM, used to simulate and verify the distribution of stress and displacements from the solution of equilibrium equations under loads.[17] To use the methodology, it was necessary to use a model of a fracture represented by an oblique osteotomy. The FEM provides the theoretical and mathematical substrates. However, in the case of fractures, it is applied to an idealized model. Therefore, it has the inconvenience of not taking into account many characteristics of the fracture, such as irregularities and different inclinations of the stroke, in addition to the possibility of presenting more than one fragment. In addition, it does not consider the action of soft parts in stabilizing/destabilizing the fracture. This limitation is inherent to the method; however, even with all the simplification, it is very useful in preclinical evaluations of implant development, for example, which is useful from the point of view of cost, time, and ethical research with human beings. Simplifications and restrictions also occur in studies in Engineering and other Exact Sciences.

There are several studies involving FEM in Orthopedics in the literature, and the topics involving fracture fixation and treatment of bone tumor lesions are the most addressed.[11,18–22] The FEM, because it is non-invasive, provides important biomechanical information, as well as assists in the development of orthopedic devices and has been more widely used in models of anatomical structures of adults, including for simulations of fixation of unstable subtrochanteric fractures.[20,23,24] Wang et al.[20] evaluated the biomechanical performance of three

implants to treat unstable subtrochanteric fractures in adults using the FEM and observed that the proximal femoral stem was more stable than the blocked stem and the LISS system (*Less Invasive Reverse System*).

Our results showed that the most proximal osteotomy (trochanteric) presented the highest maximum stress and the highest Von Mises equivalent stress, which indicates that the implant's mechanical demand is higher in this site than in the other two groups. In addition, since the greatest Von Mises equivalent stress occurs at the sites of osteotomies, it is noticed that the implants serve as "tutors" and protect the fracture. This was also observed in the study by Soni et al.[25], who performed a two-dimensional simulation of femoral fractures in children with the FEM to evaluate the effectiveness of using flexible rods constructed of steel or titanium.

In this study, when loading was applied, the regions of greatest stress were in the lateral cortical of the femur and the upper region of the neck. These results show that, with the load, the trochanteric cut presented a 153% higher stress request than the control (mediodiaphyseal cut).

However, the fragments' displacement at the osteotomy site was very small in all groups, which can be attributed to the low loading (85.0 N) applied to the systems. This value was selected after considering the mass of the unloaded lower limb of a 10-year-old child ($\sim$8.5 kg)[26]; therefore, intentional loading is not recommended clinically in the early postoperative phase. Additionally, this loading restricted the deformation to the elastic phase of the implants; that is, no irreversible deformation occurred in the clinic. If this limit is exceeded, there will be permanent deformation of the implant and loss of fracture reduction.

Conclusions

For osteotomies in the trochanteric and subtrochanteric regions, there is greater mechanical demand for the implant, which may exceed the stabilization limits of the flexible intramedullary nails. Thus, clinically, this type of implant should be indicated in the classic situations for which it was designed, that is, in fractures of the diaphyseal region of the femur.

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Conflict of Interest
The authors declare no conflict of interest.

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Pericapsular Hip Block Guided by Ultrasonography in Elderly People with Hip Fracture in the Emergency Sector: Clinical Trial

Bloqueio pericapsular do quadril guiado por ultrassonografia em idosos com fratura do quadril no setor de emergência: Ensaio clínico

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Abstract

Objectives This study evaluated pain intensity in elderly subjects with hip fractures admitted to the emergency sector and undergoing preoperative pericapsular nerve group (PENG) block. Additionally, the degree of tolerable hip flexion was assessed.

Methods A prospective, randomized, and controlled clinical trial with parallel groups. The control group consisted of elderly subjects with hip fractures undergoing standardized intravenous systemic analgesia. The intervention group consisted of elderly patients with hip fractures undergoing PENG block and standardized systemic analgesia. The groups were evaluated at rest and during movement using the Pain Assessment in Advanced Dementia (PAINAD) scale. We determined pain intensity and reduction, in addition to the degree of tolerable flexion of the fractured hip. All patient assessments occurred before the medication or block administration and at 45 minutes, 12, 24, and 36 hours postmedication or block.

Keywords
- analgesia
- anesthesia, conduction
- nerve block
- pain
- hip fractures
- ultrasonography

Work developed at the Department of Orthopedics and Traumatology, Hospital Municipal Dr. Alípio Corrêa Netto, and the Department of Pain Therapy, Faculdade de Ciências Médicas da Santa Casa de São Paulo, São Paulo, SP, Brazil.

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Results Preoperatively and 24 hours after PENG block, elderly subjects with hip fracture showed a significant reduction in pain at rest or movement compared to control patients ($p < 0.05$), with 60% of patients assessed at rest demonstrating desirable pain reduction ($\geq$50%) and only 13.3% of the control group achieving the desired pain reduction. During movement, after undergoing PENG block, 40% of subjects demonstrated the desired pain reduction and no patient from the control group. The intervention group also showed a significant improvement in the tolerable hip flexion group ($p < 0.05$).

Conclusion Preoperative PENG block in elderly subjects with hip fractures admitted to the emergency sector provided a significant reduction in pain compared with the control group.

Resumo

Objetivos Este estudo avaliou a intensidade da dor em idosos acometidos por fratura do quadril internados no setor de emergência e submetidos ao *Pericapsular Nerve Group* (PENG) *block* no pré-operatório. Ademais, o grau de flexão tolerável do quadril foi avaliado.

Métodos Ensaio clínico, prospectivo, aleatorizado e controlado em grupos paralelos. O grupo controle consiste em idosos com fratura do quadril, submetidos à analgesia sistêmica endovenosa padronizada. O grupo intervenção consiste em idosos com fratura do quadril submetidos ao PENG *block* e analgesia sistêmica padronizada. Os grupos foram avaliados em repouso e durante o movimento pela escala de dor *Pain Assessment in Advance Dementia* (PAINAD). Aferiram-se intensidade da dor e redução álgica, assim como o grau de flexão tolerável do quadril fraturado. Todos os pacientes foram avaliados previamente à administração de medicação ou bloqueio e aos 45 minutos, 12, 24 e 36 horas pós-medicação ou bloqueio.

Resultados No pré-operatório e 24 horas após o PENG *block*, idosos com fratura do quadril apresentaram redução significativa da dor em repouso ou movimento em comparação com o controle ($p < 0,05$), com 60% dos pacientes avaliados em repouso, demonstrando a redução álgica desejável de $\geq$ 50% e apenas 13,3% do grupo controle com redução álgica desejável. Durante o movimento, após o PENG *block*, 40% demonstraram redução álgica desejada e nenhum paciente do grupo controle apresentou a redução desejada. Verificou-se, também, no grupo intervenção a melhora significativa da flexão tolerável do quadril ($p < 0,05$).

Conclusão O PENG *block* no pré-operatório de idosos com fratura do quadril, internados no setor de emergência, proporcionou redução significativa da dor em comparação ao grupo controle.

Palavras-chave
- analgesia
- anestesia por condução
- bloqueio nervoso
- dor
- fraturas do quadril
- ultrassonografia

Introduction

Proximal femoral fractures are common in the elderly population.[1] Their prevalence is increasing given the growing longevity of the population,[2] with an estimated global incidence of 6.3 million elderly subjects by the year 2050.[3]

These fractures are an orthopedic emergency with significant mortality and morbidity and require surgical treatment and adequate analgesia.[3,4] Surgery is recommended, preferably within the first 24 to 48 hours, as it demonstrates pain relief and reduces the incidence of postoperative complications and mortality.[5,6]

Unfortunately, in public emergency services, it is not uncommon to find elderly patients with hip fractures in bed waiting for definitive surgical treatment and experiencing severe pain. In this preoperative period, the administration of opioids for pain relief is the usual therapy, even though it is associated with several side effects, such as nausea, vomiting, constipation, hypotension, drowsiness, and mental changes. Less commonly, but even more worrying, is that some patients can develop delirium and life-threatening respiratory depression.[4,7] In contrast, the fear of these complications by the medical and nursing team can increase the risk of oligoanalgesia. The use of opioids in elderly patients requires a balance based on their harmful potential and inefficiency when administered parenterally alone.[8] Inadequate pain control or excessive opioid use are directly linked to an acute confusional state,[8] which, in turn, when associated with hip fractures, can virtually double the mortality rate in one year in this population.[9]

Therefore, pain treatment, in addition to being a humanitarian issue, impacts the good outcomes of these patients. Pain is associated with increased neurohormonal stress response, myocardial ischemia, and delayed recovery and mobilization in these patients.[7] The literature review emphasizes that analgesia in the elderly population should focus on minimizing risk factors for delirium, including pain, constipation, and delirium-like side effects.[10]

Within this context, regional anesthesia for the management of acute pain is increasingly present in emergency sectors or departments,[8] demonstrating better efficacy compared with the traditional analgesia available to patients with hip fractures.[4] Hip regional blocks performed in the emergency sector demonstrated benefits in reducing pain and opioid use, being recommended by a systematic review.[11] However, the association with ultrasound (US) contributes to the efficiency of this technique.[4,12]

Understanding the anatomical aspect of the joint capsule is critical for effective hip analgesia. The anterior region of the capsule receives innervation from the femoral nerve (FN), obturator nerve (ON), and accessory obturator nerve (AON) branches, which are the major contributors to the sensory innervation of the hip joint. This innervation pattern suggests that these branches must be the main block targets.[13–15] (►**Fig. 1** and **2**)

Girón-Arango et al.,[14] based on this anatomical information and considering that the main FN and AON branches consistently lie between the anterior inferior iliac spine and the iliopubic eminence, described an US-guided technique for blocking these capsular branches of the hip, known as pericapsular nerve group (PENG) block.[14–16] (►**Fig. 3** and **4**)

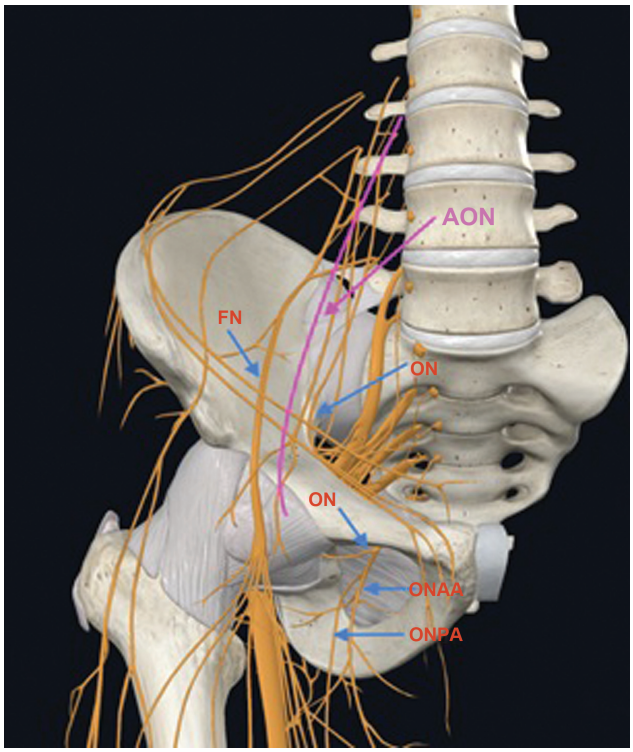


Fig. 1 Innervation of the anterior region of the hip joint capsule. **Abbreviations:** FN, Femoral nerve; ON, obturator nerve; AON, accessory obturator nerve; ONAA, obturator nerve, anterior branch; ONPA, obturator nerve, posterior branch.[15]

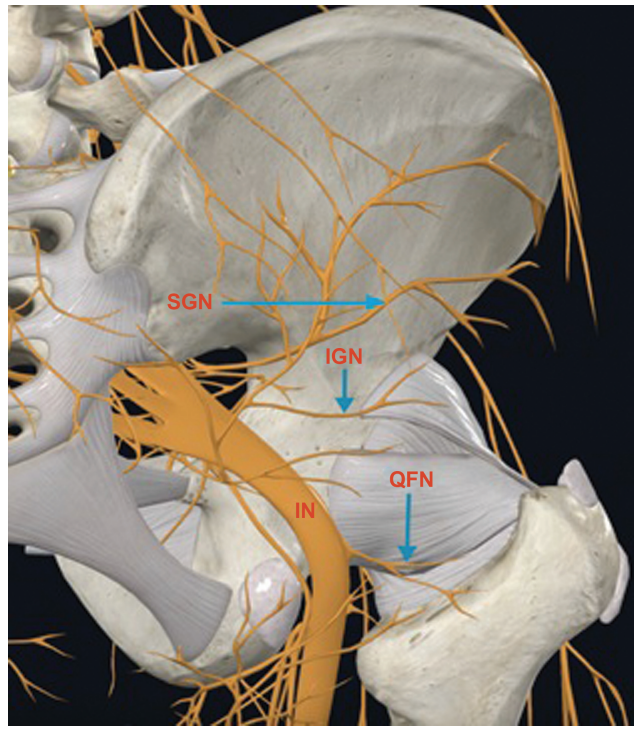


Fig. 2 Innervation of the posterior region of the hip joint capsule. **Abbreviations:** IGN, Inferior gluteal nerve; SGN, superior gluteal nerve; IN, ischial nerve; QFN, quadratus femoral nerve.[15]

Preoperative PENG block reports in elderly subjects with hip fractures, performed in the public service emergency sector, are scarce. In this scenario, the present study considers that this block could help reduce pain and increase the mobility of these patients compared with standardized systemic analgesia.

The primary objective of this study was to evaluate pain intensity in elderly patients with hip fractures admitted to the emergency sector and undergoing preoperative PENG block. Our secondary goal was to assess the tolerable degree of flexion of the affected hip.

Material and Methods

This prospective, randomized, controlled clinical trial with two parallel arms was registered on Plataforma Brasil and approved by the Research Ethics Committee (protocol number 38115120.4.0000.5479). All patients or legal guardians signed an Informed Consent Form. The study was registered under number RBR-2zdn8pb in the Brazilian Clinical Trials Registry (REBEC).

Patient selection among elderly subjects admitted to the emergency sector of a public hospital with a radiographic diagnosis of hip fracture was sequential, using stratified probabilistic sampling. Type I error was set at 0.05, with $p1 = 0.05$ (proportion of subjects from the control group with at least 50% reduction in pain during movement) and $p2 = 0.5$ (proportion of subjects in the intervention group with at least 50% reduction in pain during movement), and the test

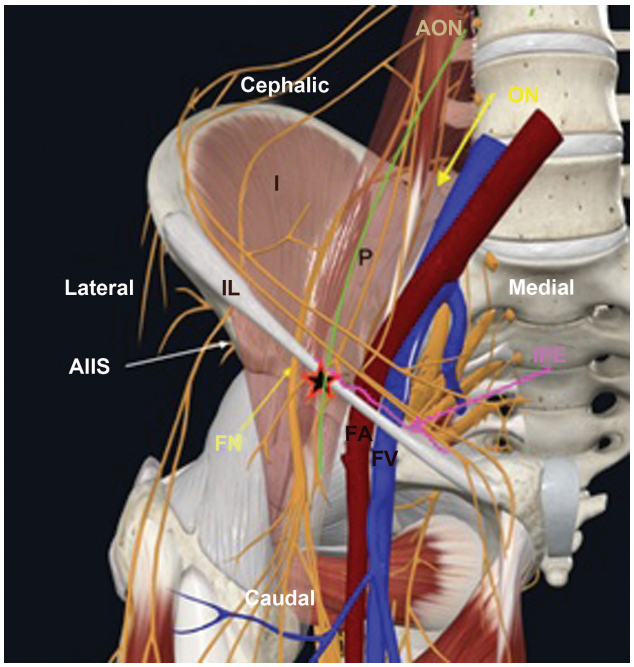


Fig. 3 Anatomical location of the PENG block in a three-dimensional representation of the right hemipelvis and hip. **Abbreviations:** FA, Femoral artery; AIIS, anterior inferior iliac spine; IPE, iliopubic eminence; I, iliacus muscle; IL, inguinal ligament; FN, femoral nerve; ON, obturator nerve; AON, accessory obturator nerve; P, psoas major muscle; FV, femoral vein; ★ anesthetic infusion point; PENG, pericapsular nerve group.[15]

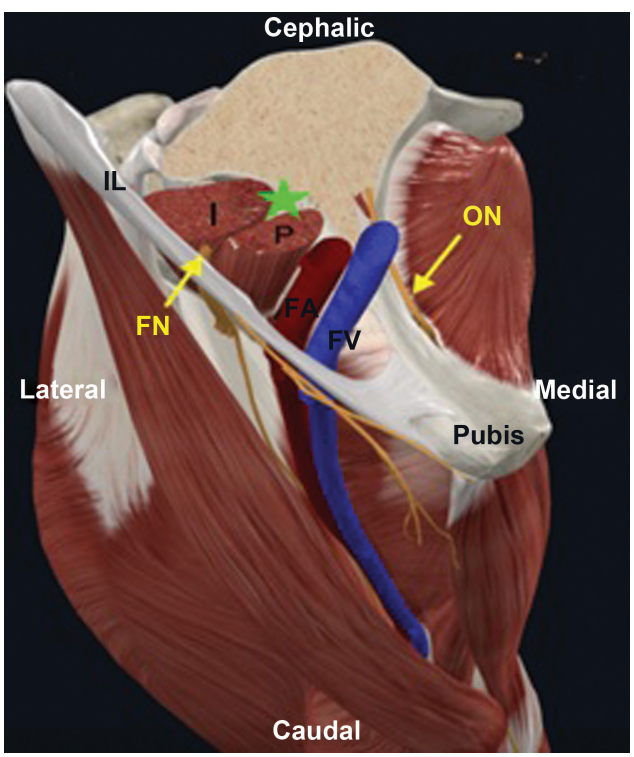


Fig. 4 Anatomical location of the PENG block in a three-dimensional representation of the right hip (transverse section). **Abbreviations:** FA, Femoral artery; I, iliacus muscle; IL, inguinal ligament; FN, femoral nerve; ON, obturator nerve; P, psoas major muscle; FV, femoral vein; ★ anesthetic infusion point; PENG, pericapsular nerve group.[15]

Table 1 Sample size for $p1 = 0.05$ and $p2 = 0.50$

Type I (α) error	Statistical power (1-β)	$p_1 = 0{,}05$ and $p_2 = 0{,}50$			
		n	n per group	+5%	
				n	n per group
	0.80	30	15	32	16

power was 0.80. The total sample consisted of 30 patients.[17] However, considering a 5% dropout rate, the optimal final sample for the study was of 32 patients (►**Table 1**).

We approached 59 patients with hip fractures for potential inclusion in the study from March 2020 to February 2022.

Inclusion Criteria

Patients aged 65 years or older, regardless of gender or level of cognition, radiographically diagnosed with acute type III or IV femoral neck fracture based on the Garden classification,[18] or with type III to V transtrochanteric fracture per the Tronzo classification,[19] and with American Society of Anesthesiology (ASA) classification II and III, were included.[20]

Exclusion Criteria

Patients with chronic, pathological fractures, other fractures, previous hip flexion limitation, history of allergies or reported reactions to the anesthetic used for the block, or skin lesions close to the puncture site were excluded. We also excluded patients with advanced renal or hepatic failure, those using anticoagulants (therapeutic dose) or presenting a coagulation disorder before the fracture, as well as patients unaccompanied by their legal guardians.

There were 27 patients excluded, and 32 were randomized into four blocks using a computer-generated random numerical sequence[21] placed in a sealed envelope. After opening the envelope, a researcher not linked to the study performed the draw at the time of hospitalization. Since this study was open, patients and investigators knew the allocation group after the draw. Only the principal investigator performed the PENG block, while previously trained investigators and residents collected the data.

The control and intervention groups had 16 patients each. At the end, 15 subjects from each group were assessed, totaling 30 patients (►**Fig. 5**).

Analyzed Variables

- Sociodemographic data and fracture types.
- Pain Assessment in Advanced Dementia (PAINAD) scale's score at rest and movement.
- Tolerable degree of flexion of the fractured hip.

We applied the same form to all patients, which included the following information:

a) Sociodemographic and clinical data: including age, gender, vital signs, preexisting diseases, ongoing medications, previous treatment, personal history, habits

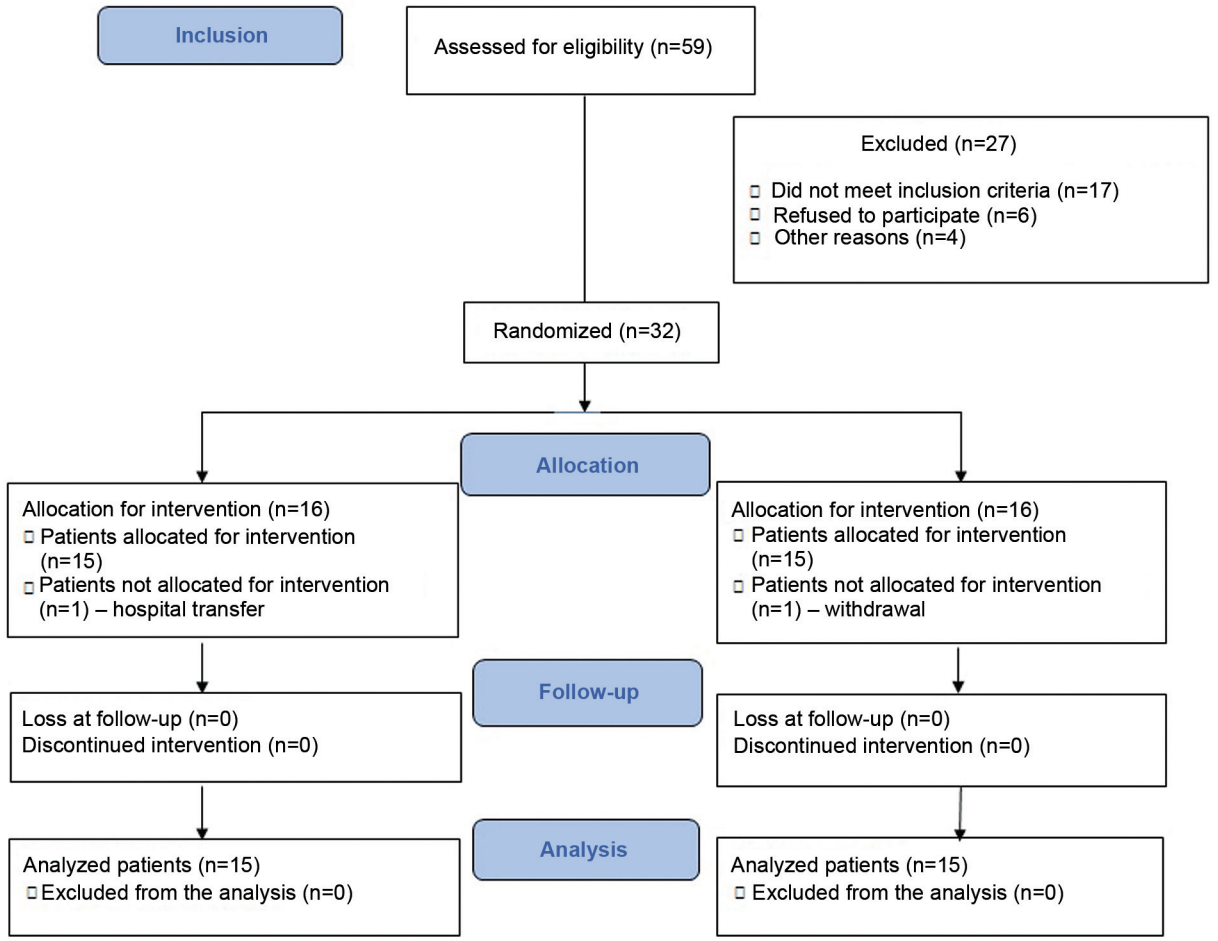


Fig. 5 A CONSORT 2010 flowchart.

and addictions, drug allergy, fracture type, signs of systemic toxicity, adverse effects, or complications.

b) Pain assessment per the translated and validated PAINAD,[22] an observational scale consisting of five items: breathing, negative vocalization, social expressions, body language, and comfortability. The score for each item ranges from 0 to 2, with a total score from 0 to 10 points.[23]

c) Tolerable hip flexion according to a goniometer measurement on the fractured hip during passive and assisted flexion with neutral rotation and interrupted by signs of pain, resistance to movement, or whichever occurs first. The measurements were stratified as 0 to 15, 16 to 45, 46 to 60, and $>60°$ flexion (►**Fig. 6**).

Control Group

We assessed subjects at rest and during movement before administering any medication using the research questionnaire and recorded pain intensity and tolerable hip flexion.

Subsequently, these patients received systemic intravenous analgesia (tramadol, 100 mg, and sodium dipyrone, 1 g, every 8 and 6 hours, respectively). Reassessment occurred at rest and movement after 45 minutes, 12, 24, and 36 hours.

Intervention Group

The intervention group was assessed before the PENG block following the same protocol used for the controls. Next, these patients went to the emergency sector's procedure room to



Fig. 6 Measurement of tolerable hip flexion using a goniometer.

perform the US-guided PENG block. After asepsis and antisepsis of the fractured hip, the investigator, wearing a mask and sterile gloves, placed a sterile field and sterile protection for the ultrasound low-frequency curvilinear transducer model HS30, identification code US591, (Samsung Ltd., Suwon, South Korea) under regular maintenance. With the patient in the supine position, ultrasound visualization identified the anterior superior iliac spine (ASIS), anterior inferior iliac spine (AIIS), iliopectineal eminence (IPE), femoral artery and vein, and psoas tendon. After confirming the anatomical references, the investigator performed an anesthetic button by introducing a 100 mm, 22G needle from lateral to medial, immediately lateral, and inferior to the psoas, until the IPE was reached. After negative aspiration to rule out intravascular introduction, 25 mL of a 0.25% levobupivacaine anesthetic solution were administered (►**Fig. 7**).

After the PENG block, at 45 minutes, 12, 24, and 36 hours, the research questionnaire was administered again at rest and during movement, recording pain intensity and tolerable degree of hip flexion for each period. This group also received the same systemic analgesia as the control.

Primary and Secondary Outcome

Outcomes included a reduction in pain intensity by $\geq$ 50% using the PAINAD scale in the preoperative period of elderly subjects with hip fractures undergoing the PENG block and improvement in tolerable hip flexion $\geq$ 45° per goniometer assessment.

Statistical Analysis

Patient characteristics were presented as absolute and relative frequencies (for qualitative variables), and mean, median, standard deviation (SD), minimum, maximum, as well as first- and third-quartile values.

The Mann-Whitney test compared quantitative variables from independent groups. The Pearson chi-square or Fisher

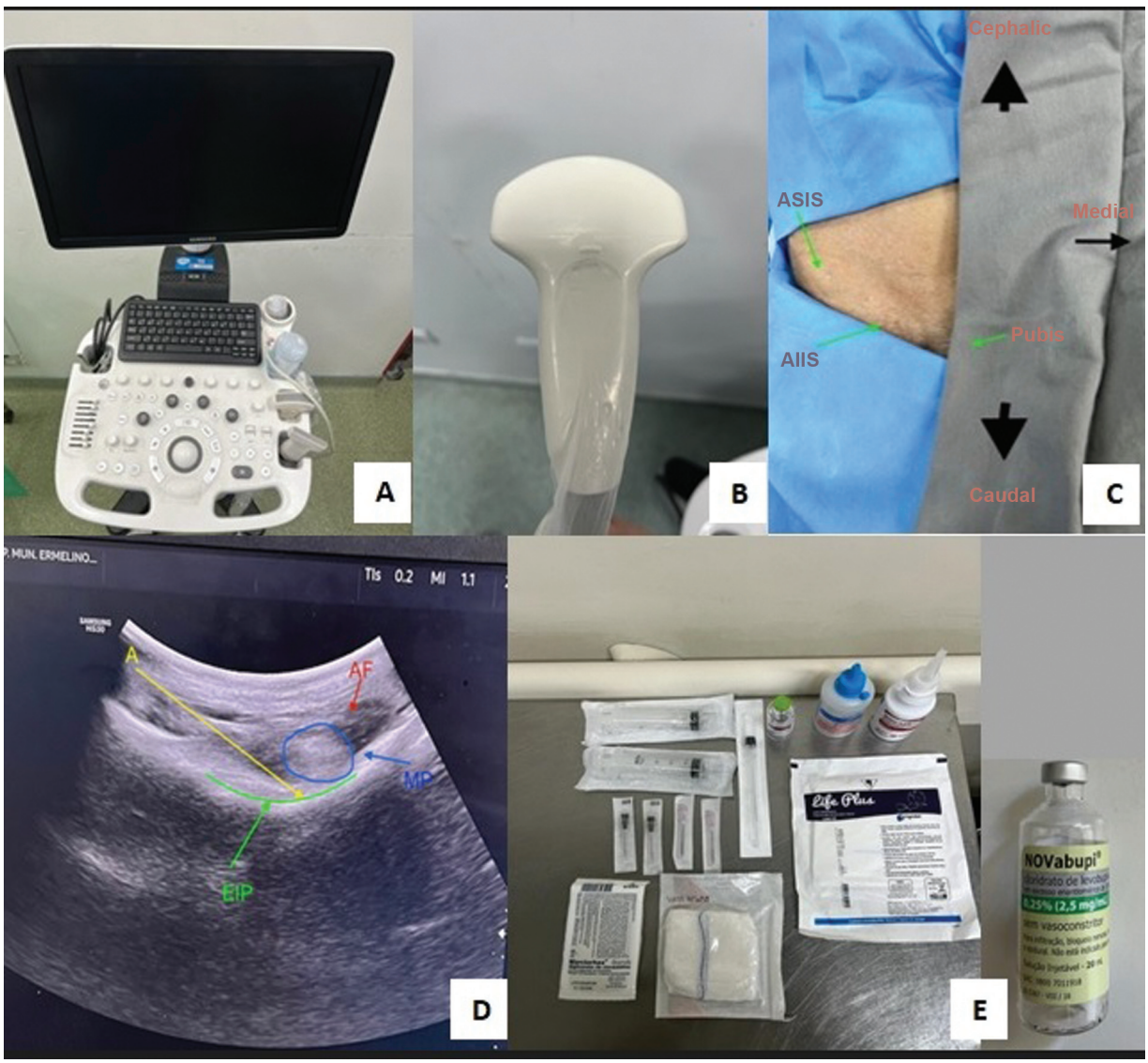


Fig. 7 Ultrasound and patient preparation for the PENG block. (**A**). Ultrasound device used in the study. (**B**). Curvilinear transducer used in the study. (**C**). Hemipelvis with sterile fields to receive the PENG block. (**D**). Ultrasound image during PENG block. (**E**). Material used for the PENG block. **Abbreviations:** A, Site of local anesthetic application; FA, femoral artery; AIIS, anterior inferior iliac spine; ASIS, anterior superior iliac spine; IPE, iliopubic eminence; P, psoas major muscle; PENG, pericapsular nerve group.

Table 2 Characteristics of study patients per treatment group

Characteristic	Control	Intervention	Total	*p*-value
	n = 15	n = 15	n = 30	
	n (%)	n (%)	n (%)	
Gender				0.999[a]
Female	12 (80.0)	12 (80.0)	24 (80.0)	
Male	3 (20.0)	3 (20.0)	6 (20.0)	
Age (years)				0.618[c]
Mean (SD)	79.5 (11.3)	80.9 (9.7)	80.2 (10.4)	
Median (min-max)	77 (65–98)	82 (65–98)	79.5 (65–98)	
Fracture classification				0.705[b]
Transtrochanteric (extracapsular) fractures	9 (60.0)	10 (66.7)	19 (63.3)	
Femoral neck (intracapsular) fractures	6 (40.0)	5 (33.3)	11 (36.7)	

Abbreviations: SD: standard deviation; max: maximum value; min: minimum value. **Notes:** [a]Fisher exact test. [b]Pearson chi-square test. [c]Mann-Whitney test.

exact test assessed the association between qualitative variables.

The McNemar test evaluated the degree of flexion frequencies before and after the intervention.

We adopted a 5% significance level for all hypothesis tests and performed the analyses using the statistical software Statistical Package Social Sciences (SPSS, IBM Corp. Armonk, NY, USA) for Windows, v.25. Result presentation followed the study objectives:

- Comparison of the PAINAD between groups and times.
- Comparison of PAINAD variation between times per group.
- Comparison of pain reduction by $\geq 50\%$ between groups and time.
- Assessment of the degree of flexion between groups and times.
- Comparison of PAINAD variation and fracture types.
- Description of the sociodemographic and clinical characteristics of the study participants according to the assigned treatment.
- Graphical representation of results.

Results

There were no statistically significant differences regarding sociodemographic and clinical characteristics (►**Table 2**).

Pain evaluation using the PAINAD scale for each treatment group and period showed no significant difference between the groups during hospitalization (a period with no medication or block). In contrast, after drug administration or PENG block, there was a significant difference between groups ($p < 0.05$) for all periods evaluated (45 min, 12, 24, and 36 h) both at rest and during movement ($p \leq 0.05$) (►**Table 3**).

Comparison of PAINAD variation during hospitalization with the postmedication or block times showed a statistical difference between groups at rest ($p \leq 0.05$), except for the 36-hour timepoint. The movement assessment presented a statistical difference between groups at all times compared to hospitalization ($p < 0.001$) (►**Table 4**).

We noted a reduction in pain by 50% or more between groups and assessment times. The control group evaluated at rest demonstrated the desired pain reduction ($\geq$ 50%) in 13.3, 20, 13.3, and 20% of patients, respectively, at each evaluation time (45 min, 12, 24, and 36 h). The intervention group presented, in these respective periods, 46.7, 66.7, 60, and 33.3% of patients with desired pain improvement ($\geq$ 50%), with a significant difference for the 12 and 24-hour timepoints ($p < 0.05$).

During movement, no patient from the control group presented pain reduction $\geq 50\%$. In contrast, the intervention group demonstrated pain reduction in 40, 60, 40, and 20% of patients at 45 minutes, 12, 24, and 36 hours after the PENG block, respectively ($p \leq 0.05$, except for the 36-hour timepoint) (►**Table 5**, ►**Fig. 8**).

Tolerable hip flexion had a statistical difference between groups and assessment times ($p < 0.05$) (►**Table 6**, ►**Fig. 9**).

Pain and fracture type showed no difference between groups (►**Fig. 10**).

Discussion

This study demonstrated that the preoperative PENG block performed in the emergency sector provided significant analgesia in elderly subjects with hip fractures both at rest and in movement, in addition to favoring a tolerable degree of flexion of the fractured hip.

Hip analgesic block techniques only had a moderate effect, not adequately covering the obturator nerve.[24] International guidelines question whether these blocks are relevant when compared to systemic analgesia.[25]

Girón-Arango et al.,[14] in 2018, demonstrated with their innovative technique that the PENG block for hip fractures provided a significant pain reduction.[14] Subsequently, clinical trials corroborated with similar outcomes.[26,27] This technique presented low complexity and risks, confirming it is safe and

Table 3 The PAINAD scale of study participants per treatment group and evaluation time during rest or movement

Characteristic		Control	Intervention	*p*-value[a]
		n = 15	n = 15	
		n (%)	n (%)	
Rest				
Hospitalization	Mean (SD)	2.0 (1.3)	1.7 (1.6)	0.464
	Median (Q_1-Q_3)	2 (1–3)	1 (1–3)	
45 minutes	Mean (SD)	1.7 (1.2)	0.5 (0.8)	0.001
	Median (Q_1-Q_3)	1 (1–2)	0 (0–1)	
12 hours	Mean (SD)	1.9 (1.4)	0.3 (0.8)	<0.001
	Median (Q_1-Q_3)	2 (1–3)	0 (0–0)	
24 hours	Mean (SD)	2.0 (1.5)	0.3 (0.8)	0.001
	Median (Q_1-Q_3)	2 (1–3)	0 (0–0)	
36 hours	Mean (SD)	2.0 (1.5)	0.9 (1.2)	0.046
	Median (Q_1-Q_3)	2 (1–3)	1 (0–1)	
Movement				
Hospitalization	Mean (SD)	6.2 (1.5)	7.3 (1.5)	0.051
	Median (Q_1-Q_3)	6 (5–8)	8 (6–8)	
45 minutes	Mean (SD)	6.1 (1.2)	3.6 (2.1)	0.001
	Median (Q_1-Q_3)	6 (5–7)	3 (2–5)	
12 hours	Mean (SD)	6.5 (1.2)	3.1 (2.0)	<0.001
	Median (Q_1-Q_3)	6 (5–7)	3 (2–4)	
24 hours	Mean (SD)	6.5 (1.2)	3.8 (1.6)	<0.001
	Median (Q_1-Q_3)	6 (6–7)	4 (2–5)	
36 hours	Mean (SD)	6.3 (1.3)	4.3 (1.1)	0.001
	Median (Q_1-Q_3)	6 (5–7)	4 (4–5)	

Abbreviations: PAINAD, pain assessment in advanced dementia; SD, standard deviation; Q1, first quartile; Q3, third quartile. **Note:** [a]Mann-Whitney test.

Table 4 The PAINAD scale comparison between hospitalization and times per treatment group and evaluation time during rest or movement

Comparison				Control	Intervention	*p*-value[a]
Rest	**Hospitalization**	**45 minutes**	**Mean (SD)**	**-0.27 (0.80)**	**-1.20 (1.32)**	**0.044**
			Median (Q_1-Q_3)	0 (-1; 0)	-1 (-2; 0)	
		12 hours	Mean (SD)	-0.07 (1.16)	-1.47 (1.36)	0.008
			Median (Q_1-Q_3)	0 (-1; 1)	-1 (-2; 0)	
		24 hours	Mean (SD)	0 (1.00)	-1.40 (1.35)	0.004
			Median (Q_1-Q_3)	0 (-1; 1)	-1 (-2; 0)	
		36 hours	Mean (SD)	0 (1.60)	-0.80 (1.37)	0.117
			Median (Q_1-Q_3)	0 (-1; 1)	0 (0; 1)	
Movement	**Hospitalization**	45 minutes	Mean (SD)	-0.13 (0.74)	-3.73 (1.79)	<0.001
			Median (Q_1-Q_3)	0 (0; 0)	-4 (-4; -2)	
		12 hours	Mean (SD)	0.27 (0.96)	-4.27 (2.19)	<0.001
			Median (Q_1-Q_3)	0 (0; 1)	-4 (-5; -3)	
		24 hours	Mean (SD)	0.33 (1.23)	-3.53 (1.85)	<0.001
			Median (Q_1-Q_3)	1 (0; 1)	-4 (-4; -2)	
		36 hours	Mean (SD)	0.07 (1.53)	-3.00 (1.41)	<0.001
			Median (Q_1-Q_3)	0 (-1; 1)	-3 (-4; -2)	

Abbreviations: PAINAD, pain assessment in advanced dementia; SD, standard deviation; Q1, first quartile; Q3, third quartile. **Note:** [a]Mann-Whitney test.

Table 5 Pain reduction ≥ 50% and < 50%, per the PAINAD scale at rest or movement per treatment group and evaluation time

	Hospitalization	PAINAD	Control	Intervention	*p*-value[a]
Rest	45 min	<50%	13 (86.7)	8 (53.3)	0.109
		≥50%	2 (13.3)	7 (46.7)	
	12 h	<50%	12 (80.0)	5 (33.3)	0.025
		≥50%	3 (20.0)	10 (66.7)	
	24 h	<50%	13 (86.7)	6 (40.0)	0.021
		≥50%	2 (13.3)	9 (60.0)	
	36 h	<50%	12 (80.0)	10 (66.7)	0.682
		≥50%	3 (20.0)	5 (33.3)	
Movement	45 min	<50%	15 (100)	9 (60.0)	0.017
		≥50%	0	6 (40.0)	
	12 h	<50%	15 (100)	6 (40.0)	0.001
		≥50%	0	9 (60.0)	
	24 h	<50%	15 (100)	9 (60.0)	0.017
		≥50%	0	6 (40.0)	
	36 h	<50%	15 (100)	12 (80.0)	0.224
		≥50%	0	3 (20.0)	

Abbreviation: NA, not available; PAINAD, pain assessment in advanced dementia. **Note:** [a]Fisher exact test.

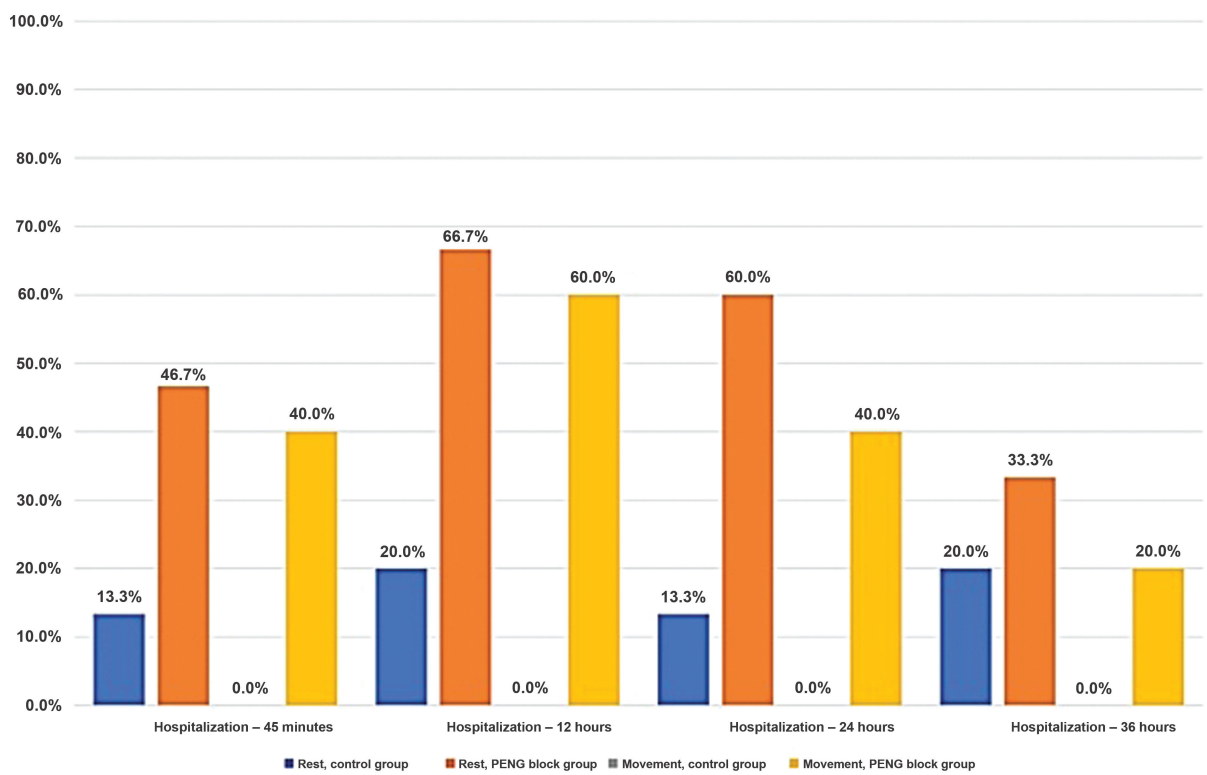


Fig. 8 Graphical representation of the percentage of patients with pain improvement ≥50% at rest and movement per treatment group and evaluation period. **Abbreviation:** PENG, pericapsular nerve group.

Table 6 Tolerable degree of hip flexion and strata range (0–15, 16–45, 46–60, and > 60°) per treatment group and evaluation time

Characteristic		Control	Intervention	*p*-value
		n = 15	n = 15	
		n (%)	n (%)	
Hospitalization				
Tolerable hip flexion measured in degrees	Mean (SD) Median (Q_1-Q_3)	20.7 (8.8) 20 (15-20)	13.9 (10.5) 10 (8–15)	0.022[a]
Flexion degree	0–15	5 (33.3)	12 (80.0)	0.010[c]
	16–45	10 (66.7)	3 (20.0)	
45 minutes				
Tolerable hip flexion measured in degrees	Mean (SD)	20.3 (8.5)	47.0 (14.6)	<0.001[a]
	Median (Q_1-Q_3)	20 (15–25)	45 (40–60)	
Flexion degree	0–15	5 (33.3)	0	0.002[b]
	16–45	10 (66.7)	8 (53.3)	
	46–60	0	6 (40.0)	
	>60	0	1 (6.7)	
12 hours				
Tolerable hip flexion measured in degrees	Mean (SD)	19.0 (10.2)	49.7 (10.1)	<0.001[a]
	Median (Q_1-Q_3)	20 (10–30)	50 (45–60)	
Flexion degree	0–15	7 (46.7)	0	<0.001[b]
	16–45	8 (53.3)	5 (33.3)	
	46–60	0	10 (66.7)	
24 hours				
Tolerable hip flexion measured in degrees	Mean (SD)	18.7 (9.3)	42.7 (10.5)	<0.001[a]
	Median (Q_1-Q_3)	20 (10–25)	45 (40–50)	
Flexion degree	0–15	7 (46.7)	0	0.002[b]
	16–45	8 (53.3)	11 (73.3)	
	46–60	0	4 (26.7)	
36 hours				
Tolerable hip flexion measured in degrees	Mean (SD)	19.2 (8.2)	43.3 (11.3)	<0.001[a]
	Median (Q_1-Q_3)	15 (15–25)	45 (40–50)	
Flexion degree	0–15	8 (53.3)	1 (6.7)	0.011[b]
	16–45	7 (46.7)	10 (66.7)	
	46–60	0	3 (20.0)	
	>60	0	1 (6.7)	

Abbreviations: SD, standard deviation; NA, not available; Q1, first quartile; Q3, third quartile. **Notes:** [a]Mann-Whitney test. [b]Fisher exact test. [c]Pearson chi-square test.

effective, and providing less motor blockade.[28] Even so, we must be attentive to the arguments regarding the need for more clinical trials to assure its safety.[29]

Our study selected the PENG block considering its anatomical basis and development aiming analgesia in hip fractures with excellent preliminary outcomes. The PENG block is technically simple and can occur in the emergency sector. Reports of its preoperative performance in the emergency sector for elderly subjects remain scarce, and our study corroborates its practice.

Elderly subjects experience pain in a complex, multidimensional way requiring multidisciplinary management.[30] In a study on pain treatment, it is recommended to use a single measurement scale. We must consider what clinically significant reduction is ideal for treating pain and calculate it using percentage, not absolute reduction. Therefore, a pain reduction ranging from 30 to 33% is clinically significant.[31–35]

Even using a more rigorous method, considering a clinically significant pain reduction of 50% or more, our study demonstrated that, at rest, over 12 hours, more than 65% of patients undergoing PENG block reached that goal, in contrast with 20% of subjects from the control group. During movement, in the same period, 60% of patients from the intervention group

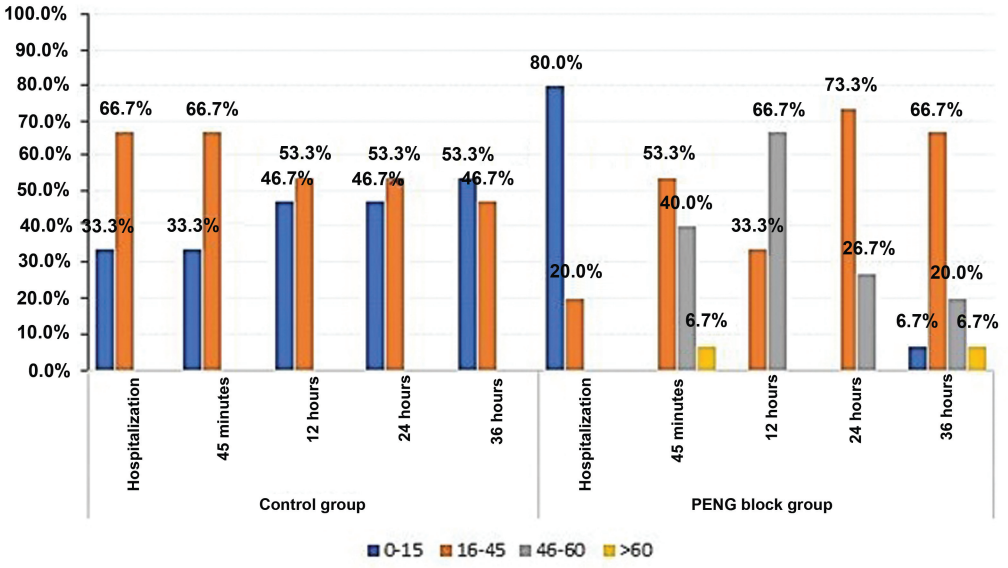


Fig. 9 Graphical representation of the frequency of tolerable degree of hip flexion (0–15, 16–45, 46–60, and >60°) per treatment group and evaluation period. **Abbreviation:** PENG, pericapsular nerve group.

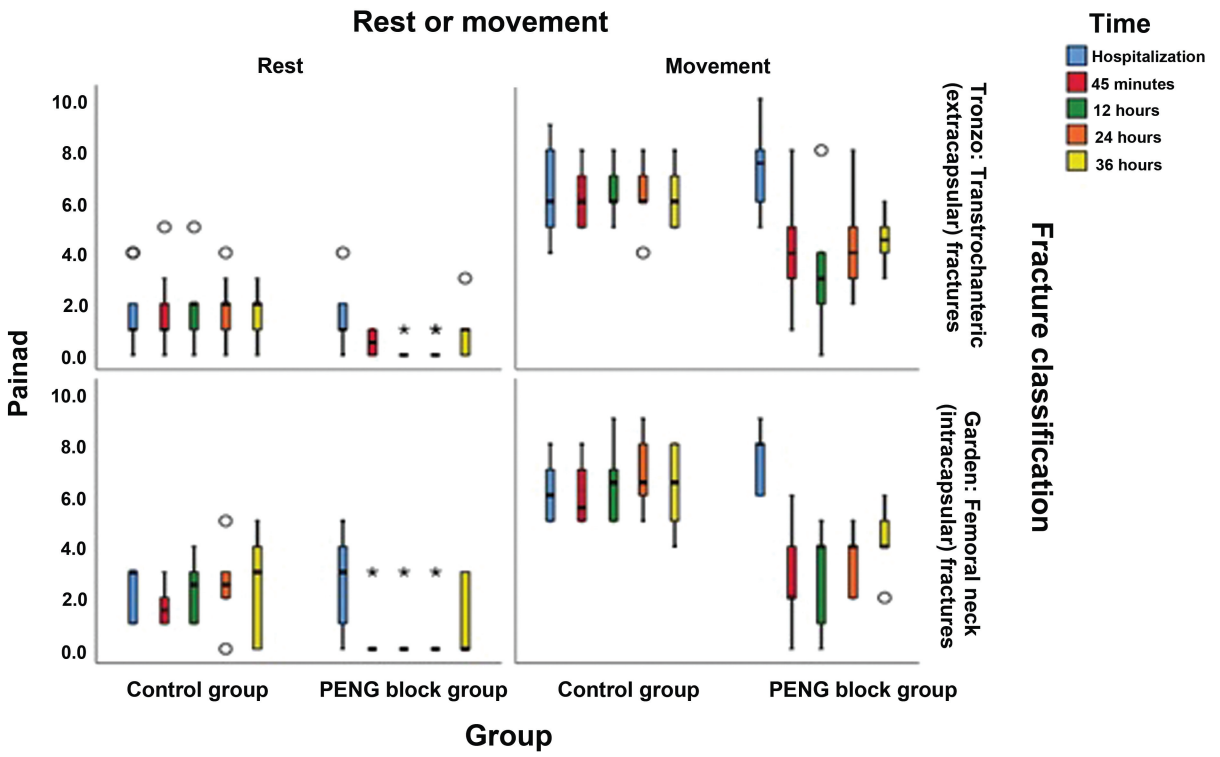


Fig. 10 Graphical representation of the PAINAD scale per fracture type, treatment group, and evaluation period. **Abbreviations:** PAINAD, pain assessment in advanced dementia; PENG, pericapsular nerve group.

reported pain reduction by 50% or more, but none from the control group stated the same.

The study also aimed to improve the tolerable degree of hip flexion (≥45°), favoring greater mobility and comfort and, as a result, facilitating assistance with basic care, such as hygiene and nutrition. We noted an excellent, especially at 12-hour postblock, with more than 66% of patients from the intervention group demonstrating hip flexions of 46 to 60°, in contrast to no control patient.

Conclusion

Elderly subjects with hip fractures undergoing the PENG block as preoperative additional analgesia experienced reduced pain and a better degree of tolerable hip flexion compared to those who received only standardized intravenous systemic analgesia. This method should be considered in the preoperative analgesia of elderly subjects with hip fractures awaiting definitive surgical treatment.

Authors' Contribution

The authors contributed individually and significantly in preparing this article: GMF: conception and design, collection, analysis and interpretation of data, article writing. MVP: conception and interpretation of data. EHM: conception and design. AISN: data acquisition. TRG: design and intellectual content review. LHSR: data interpretation. All authors read and approved the final version.

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Conflict of Interests

The authors have no conflict of interests to declare.

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Implementation of the Fast-track Protocol for Total Hip Arthroplasty in a Public Hospital in the State of São Paulo – Brazil

Implantação do protocolo de recuperação rápida para artroplastia total do quadril em hospital público do estado de São Paulo – Brasil

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Abstract

Objective Evaluate the results of the implementation of the Fast Track Protocol (FTP), a medical practice based on scientific evidence, for elective total hip arthroplasty surgery, mainly comparing the National Average Hospital Admission Rate of 7.1 days.

Methods 98 patients who underwent elective total hip arthroplasty surgery via the direct anterior approach, anterolateral approach and posterior approach were included in the FTP from December 2018 to March 2020, being followed up preoperatively, intraoperatively and immediately postoperatively.

Results The average length of hospital stay was 2.8 days, being 2.1 days for the direct anterior approach, 3.0 days for the anterolateral access approach and 4.1 days for the posterior access approach. The average surgery time was 90 minutes, 19 (19.39%) of the patients were referred to the ICU in the postoperative period, however, none of them underwent surgery using the direct anterior approach. We had no cases of deep vein thrombosis (DVT), pulmonary embolism (PTE) or neurological injury, 19 (19.39%) patients had postoperative bleeding requiring dressing change, 4 (4.08%) needed

Keywords
- arthroplasty, replacement, hip
- arthroplasty, replacement, knee
- clinical protocols

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blood transfusion, 2 (2.04%) patients had implant instability, 1 (1.02%) patient had a fracture during surgery and 1 (1.02%) patient died of cardiac complications.
Conclusion FTP may be a viable alternative to reduce the length of stay and immediate postoperative complications for elective total hip arthroplasty surgery decreasing the length of stay of patients by 2 to 3 times when compared to the national average of 7.1 days.

Resumo

Objetivo Avaliar os resultados da implantação do Protocolo de Recuperação Rápida (PRR), prática médica baseada em evidências científicas, para cirurgia eletiva de artroplastia total do quadril principalmente comparando à Taxa Média de Internação Hospitalar nacional de 7.1 dias.
Métodos 98 pacientes submetidos a cirurgia eletiva de artroplastia total do quadril pela via direta anterior, via anterolateral e via posterior foram incluídos no PRR no período de dezembro de 2018 a março de 2020 sendo acompanhados no pré-operatório, intraoperatório e pós-operatório imediato.
Resultados a Taxa Média de Permanência Hospitalar foi de 2,8 dias, sendo 2,1 dias para a Via de Acesso Anterior, 3,0 dias para via de acesso anterolateral e 4,1 dias para via de acesso posterior. O tempo médio de cirurgia foi de 90 minutos, 19 (19,39%) dos pacientes foram encaminhados à UTI no pós-operatório, no entanto nenhum deles operado pela via direta anterior. Não tivemos casos de trombose venosa profunda (TVP), embolia pulmonar (TEP) ou lesão neurológica, 19 (19,39%) pacientes tiveram sangramento pós-operatório com necessidade de troca de curativo, 4 (4,08%) necessidade de transfusão sanguínea, 2 (2,04%) pacientes apresentaram instabilidade do implante, 1(1,02%) paciente teve fratura durante a cirurgia e 1(1,02%) paciente faleceu por complicações cardíacas.
Conclusão O PRR pode ser uma alternativa viável para diminuir o tempo de internação e as complicações pós-operatórias imediatas para a cirurgia eletiva de artroplastia total do quadril diminuindo 2 a 3 vezes o tempo de internação dos pacientes quando comparado com a média nacional de 7,1 dias.

Palavras-chave
- artroplastia do quadril
- artroplastia do joelho
- protocolos clínicos

Introduction

In Brazil, there is a projection that in 2030, people over 60 years old who have a higher incidence of hip and knee osteoarthritis will be 19% of the Brazilian population or 42,122,847 people.[1]

The growth of the elderly population also has consequences for the number of hip and knee arthroplasty surgeries performed in the SUS (Public Health System), in which there is an average annual increase of 3.3% and 8.7% respectively,[2] with 15,042 hospitalizations for hip arthroplasty in 2019, pre-pandemic due to COVID 19 according to the DataSus website.

Rapid Recovery Protocols originally come from Enhanced Recovery After Surgery (ERAS) or Fast Track Protocol (FTP) which was developed in the late 1990's by Dr. Henrik Kehlet as a strategy to reduce the length of hospital stay after major surgeries, but only from 2005 allowed a better recovery not only in quantitative terms, but also in qualitative terms.[3,4] According to the ERAS Society, the organization that initiated studies on FTP's for abdominal surgeries, there are about 20 precautions that influence the response to surgical stress and increase the patient's recovery speed after the procedure. Thus, an FTP team must include professionals who are engaged and experienced in surgery, anesthesia, nursing, physiotherapy, and nutrition. The team has primary responsibility for reviewing the available literature and formulating and delivering the appropriate protocol for their institution.[5] The implementation of the FTP in any hospital depends on the interaction and coordinated work of the multidisciplinary teams that are the pillars for the success of this journey of implementation and maintenance of the active protocol.

Taking into account that the Brazilian socioeconomic reality is that of a developing country and that the health system in Brazil is mostly represented by the SUS, which faces great financial difficulties and scarce resources, we adapted a FTP model to the reality of Brazilian public hospitals for elective total hip arthroplasty surgery performed in a public hospital in São Paulo - Brazil.

Methodology

This work is a clinical research protocol that was conducted in compliance with all stipulations of this protocol, current

national regulations, and guidelines established by the Document of the Americas and the ICH Guide to Good Clinical Practice. And it was approved by the Research Ethics Committee, under number CAAE: 30064919.6.0000.0068.

A prospective study carried out on 98 patients selected to electively undergo total hip arthroplasty surgery by anterolateral approach (AA), posterior approach (PA) and direct anterior approach (DAA), from December 2018 to March 2020.

Patients included with a diagnosis of hip osteoarthritis and/or necrosis of the femoral head (Ficat III or IV) and who agreed to sign the Informed Consent Form were eligible. Exclusion criteria: Crowe's dysplasia type 3 or 4; previous hip surgery; clinical inability or reluctance to participate in the study.

Implementation Program

After performing the preoperative exams, the patients were referred for a preoperative consultation with the anesthesiologist for clinical evaluation and ASA classification.[6] If complementary exams or evaluations from other specialties were necessary, the patient was referred to the specialist, returning with the anesthesiologist for a final evaluation.

Once eligible for the surgery, the nursing team advised the hospitalization, explained details of the surgery and delivered an informative booklet with illustrations of the surgical procedure with the steps to be followed in the preoperative, intraoperative and postoperative periods. It was also explained to the patient that they would be discharged from the hospital as soon as their clinical condition was stable and safe according to established clinical parameters.

At that moment, the nutritionist guided the patient regarding pre-surgical caloric and nutritional intake, so that they could be hospitalized on the day of surgery in a favorable metabolic state, explaining the need to fast for 8 hours preoperatively and the supplemented abbreviated fasting methodology with maltodextrin 3 hours before surgery.

The patient was assessed by the physiotherapy team, with preoperative functional assessment scores. They guided the patient about strengthening exercises to be performed before surgery, so that the patient could maintain or even gain muscle mass in the hip and knee extensors, facilitating postoperative physical rehabilitation.

The criterion for choosing the surgical approach was based on the surgeon's experience. Each physician standardized the use of only one access route to the hip to be performed in all of their patients and the randomization occurred due to the random criterion for scheduling presurgical outpatient consultations with the surgeons.

Preferential anesthesia was spinal anesthesia without the use of morphine supplemented with pericapsular and periacetabular infiltration performed at the end of the procedure by the surgeon with 1ml per kilogram of the following solution: 70ml of Saline Sodium Chloride 0.9%, 30 ml of Ropivacaine 7.5mg/ml, 1 ml of Adrenaline 1mg/ml and 1 ml of Clonidine 150mcg/ml. If the patient had contraindication for spinal anesthesia, general anesthesia was performed.

The use of infusion of blood products was carefully evaluated, taking into account the surgeon's perception of blood loss during the surgical procedure, the calculation of the loss of aspirated fluids and the clinical conditions that were monitored by the anesthesiologist.

Postoperative referral to the ICU was restricted only to patients who presented hemodynamic instability, need for infusion of blood products or changes in cardiological monitoring during surgery.

The perception of pain during post-anesthetic recovery was assessed by the anesthetic team. Simple analgesics or anti-inflammatory drugs were prescribed and opioids were left only as a rescue option.

The patient was received from Post-Anesthetic Recovery, evaluated by the nursing team and the nutritionist prescribed the diet, avoiding prolonged fasting.

The physiotherapy team evaluated the patient and advised them on the need for early walking to avoid postoperative comorbidities such as DVT.

DVT prophylaxis was established with Enoxaparin Sodium 40mg subcutaneously once a day during the hospitalization period in the ward.

The surgeons held medical consultations together with the physiotherapist to provide support and initial gait guidelines on the same day or the day after the surgery. The criteria for starting gait were the patient's ability to sit up in bed, be able to transfer alone with the aid of the walker to the chair, stand up with the support of the walker without pain.

If a postoperative drain was used, it was preferably removed within 24 hours.

Hospital discharge guidelines were provided by the multidisciplinary team, emphasizing the following aspects: Encouraging the patient, family member and/or caregiver to talk about their concerns with home care, continuing rehabilitation at home with an emphasis on post-surgical restrictions such as not bending the hip more than 90 degrees, not crossing the operated leg over the other, not internally rotating the foot on the operated side.

Patients were released for hospital discharge if they met the following criteria: being pain-free, walking alone with or without the use of a walker, being able to sit up in bed alone, having spontaneously defecated and urinated, the dressing of the surgical incision had to be dry and clean, normal blood pressure, heart rate and temperature parameters.

Simple analgesics were prescribed for home, such as Dipyrone 1g every 6h if pain and Paracetamol 750mg every 6h if pain and if there was moderate or severe pain, Tramadol 50mg every 6h if pain was moderate or severe. DVT prophylaxis with Acetyl Salicylic Acid (ASA) 100mg orally for 30 days was also prescribed.

Evaluations regarding postoperative complications covered the immediate postoperative period up to 3 months of outpatient follow-up.

Weekly meetings between members of the multidisciplinary team were held with the intention of standardizing information and distributing tasks to be carried out in order to adapt FTP concepts to the Brazilian reality.

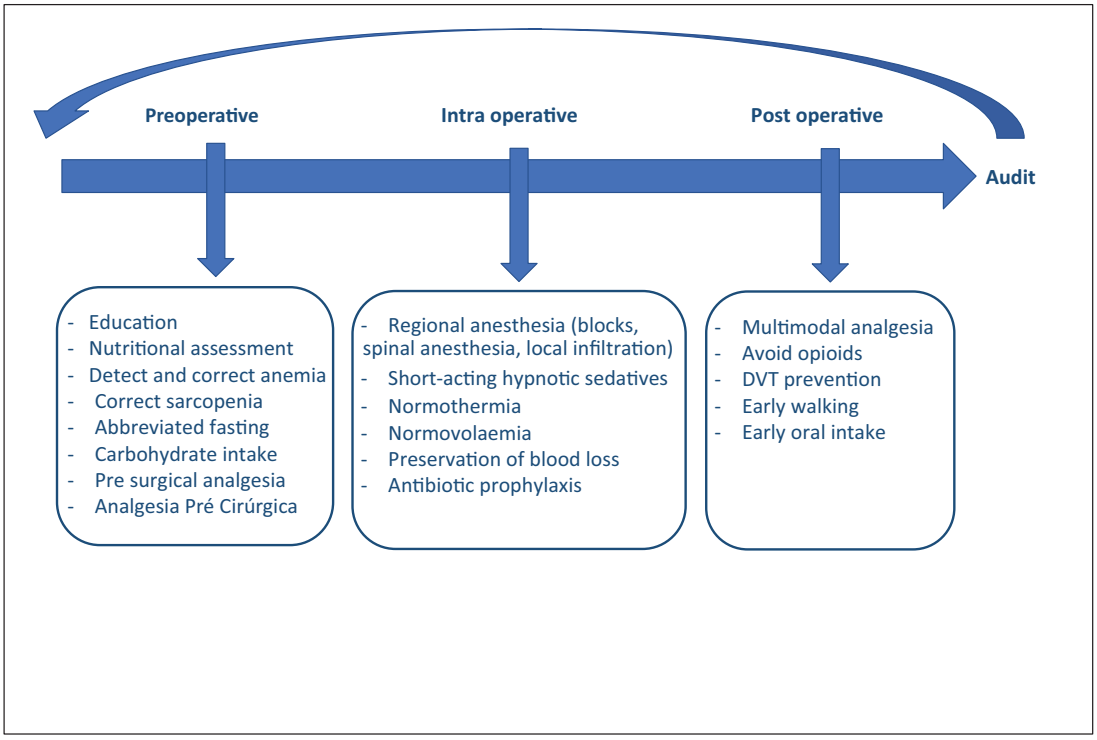


Fig. 1 Pre, intra, and postoperative care for FTP implantation. (Adapted from Soffin EM, YaDeau JT. Enhanced recovery after surgery for primary hip and knee arthroplasty: a review of the evidence. Br J Anaesth. 2016 Dec;117).

During the meetings for the FTP to be implemented, questions were discussed together, establishing a goal of actions to be fulfilled. The personal engagement of each professional was essential for these actions to be implemented, since the communication of these new concepts to the respective professionals of each specialty involved was the responsibility of the professional participating in the FTP Implementation Group (►**Fig. 1**).

Statistical analysis

Descriptive analyzes were carried out where the quantitative data that presented normal distribution were presented with means accompanied by the respective standard deviations. Data that did not show normal distribution were presented with medians and IQ interquartile ranges (25%-75%). Categorical variables were presented with frequency and percentage. The normal distribution in each group and the homogeneity of the variances between the groups were evaluated, respectively, with the Shapiro-Wilk test and the Levene test.

The Wilcoxon test for a sample and the Kruskal Wallis test were used for the analysis of numerical variables for multiple comparisons, the Dunn test was used.

To compare proportions, the chi-square or Fisher's exact test was used when necessary.

A statistical significance value less than or equal to 5% ($p \leq 0.05$) was used for all analyzes.

Statistical modeling and tests were performed using SPSS software version 21.0.

Results

All data from the study of 98 patients who underwent total hip arthroplasty from December 2018 to March 2020 were recorded in medical records and had a mean age of 62.8 years (34 to 81), 56 men and 43 women divided into the following age groups shown in ►**Fig. 2**. 94 patients (95%) were operated on for primary osteoarthritis and 4 for osteoarthritis secondary to other pathologies, with the following associated comorbidities (►**Fig. 3**).

Of the 98 patients, 54 were operated on through AA access, 35 through the DAA and 9 through the PA.

In the studied population, we had 14 (14.29%) of the patients classified as ASA1; 71 (72.45%) of the patients classified as ASA 2 and 13 (13.27%) of the patients classified as ASA 3 as shown in ►**Fig. 4**.

The average length of hospital stay was 2.8 days (►**Fig. 4**) with 3 (3.06%) patients staying 1 day, 45 (45.92%) staying 2 days, 30 (30.61%) staying 3 days, 15 (15.41%) staying 4 days, 2 (2.04%) 5 days, 2 (2.04%) 6 days and 1 (1.02%) staying 12 days according to ►**Fig. 5**.

The average length of hospital stay for DAA was 2.1 days, 3 days for AA and 4.11 days for PA as seen in ►**Fig. 6**.

The average surgery time was 90 minutes, 4 (4%) patients required transfusion of blood products, 19 (19%) of the patients were referred to the ICU in the postoperative period, with 14 (76%) remaining 1 day and 5 (26%) 2 days.

Of the 35 patients operated by DAA, none went to the ICU in the postoperative period, while 19 (30.15%) operated by other means went to the ICU, as shown in ►**Fig. 7**.

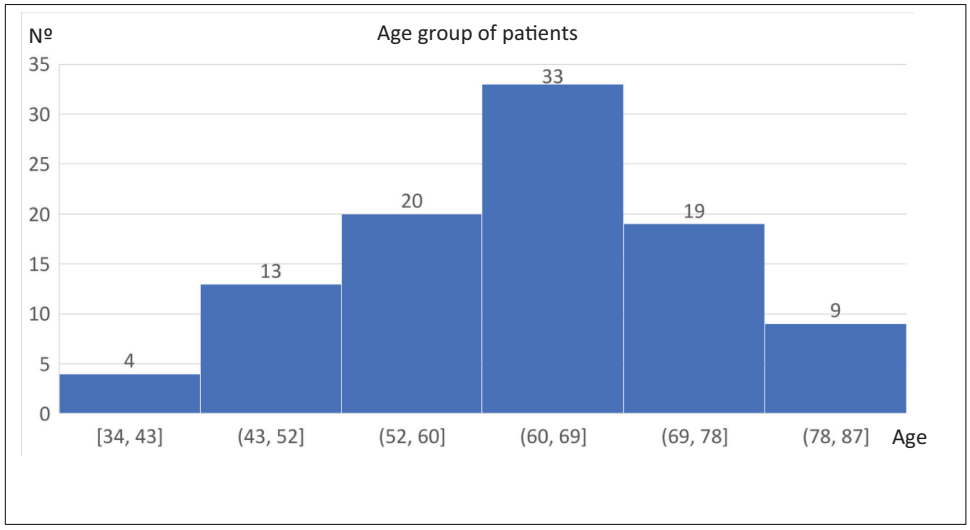


Fig. 2 Age group of sample patients.

Of the total sample of 98 patients, 4 (4.08%) required transfusion of blood products during the surgical procedure, 1 (1.02%) operated through DAA and 3 (3.06%) through AA. There were no patients who received transfusions after the end of the surgical procedure, as shown in ►**Fig. 8** below.

During the hospitalization period, the stimulus for early walking was followed according to the methodology and all patients were discharged walking with the help of a walker.

As for immediate postoperative complications during the hospitalization period, we had no cases of deep vein thrombosis (DVT), pulmonary embolism (PTE) or neurological injury, 19 (19.39%) patients had postoperative bleeding requiring replacement of dressing, 4 (4.08%) needed blood transfusion, 2 (2.04%) patients had implant instability verified during hospitalization, 1 by anterolateral approach and 1 by a posterior approach, and were treated conservatively, 1 (1.02%) patient had a fracture during surgery, with femur cerclage being performed, and 1 (1.02%) patient died of cardiac complications, as shown in ►**Fig. 9**.

In the postoperative follow-up of up to 3 months, we had the following complications: 2 (2.04%) patients had a superficial infection in the access route treated with oral antibiotic therapy, 1 (1.02%) patient had a femur fracture without deviation due to a fall from own height 2 months after the initial surgical procedure and was treated conservatively and 1 (1.02%) patient had DVT diagnosed in the operated limb

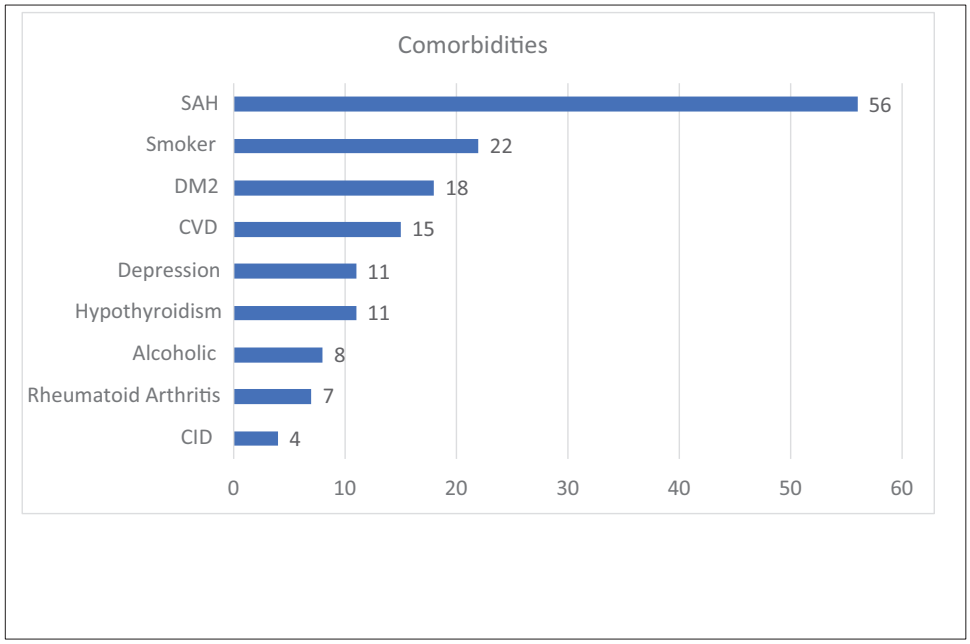


Fig. 3 Incidence of comorbidities in the studied population. CID – Contagious Infectious Disease, CVD – Cardiovascular Disease, SAH – Systemic Arterial Hypertension, DM2–Type 2 Diabetes Mellitus.

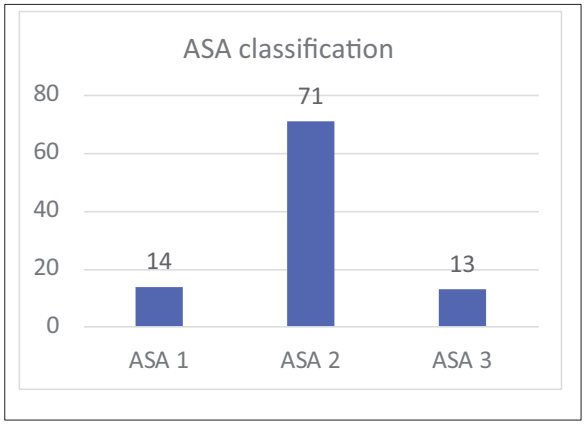


Fig. 4 Distribution of patients according to the ASA classification of the American Society of Anesthesiology.

15 days after the surgical procedure, however it was found that the patient did not take the prophylaxis recommended as can be seen in ►**Fig. 10**.

Discussion

Our overall length of hospital stay (LHS) was 2.8 days, 2.1 days for the anterior route, 3.0 days for the anterolateral route, and 4.1 days for the posterior route.

According to Marcio de Castro Ferreira, in his article "Total knee and hip arthroplasty: The worrying reality of care in the Brazilian Unified Health System", the national average length of hospital stay for elective total hip arthroplasty is 7.1 days[2] (►**Fig. 11**).

Overall, there is little evidence to support the use of structured preoperative education to reduce postoperative adverse events, improve pain, facilitate functional recovery, or reduce length of stay. However, a significant reduction in preoperative anxiety can be achieved. Preoperative education may benefit more patients with depression, anxiety, unrealistic expectations or limited social support.[7–9]

Decreased length of stay is consistently associated with the use of neuraxial anesthesia (anesthetic block) compared with the use of general anesthesia. In a multicenter retrospective study associating the use of general anesthesia with an 8.5-fold increased risk of moderate to severe postoperative pain and a 2.5-fold increased risk of persistent postoperative pain, for hip arthroplasty and knee.[10,11] These data provide additional motivation for the use of neuraxial anesthesia or plexus block.

Non-opioid spinal anesthesia supplemented with local infiltration analgesia (LIA) is a recent technique for early postoperative analgesia after knee and hip arthroplasty, and was administered by surgeons shortly after completion of the surgical procedure, providing 6–12 hours of pain relief so patients benefit from multimodal analgesia and oral opioids only if needed.[12,13]

Our results with a total sample of 98 patients showed that 19 (19.39%) had bleeding in the immediate postoperative period with the need to change the surgical dressing, 4 (4.08%) required transfusion of blood products, 2 (2 .04%)

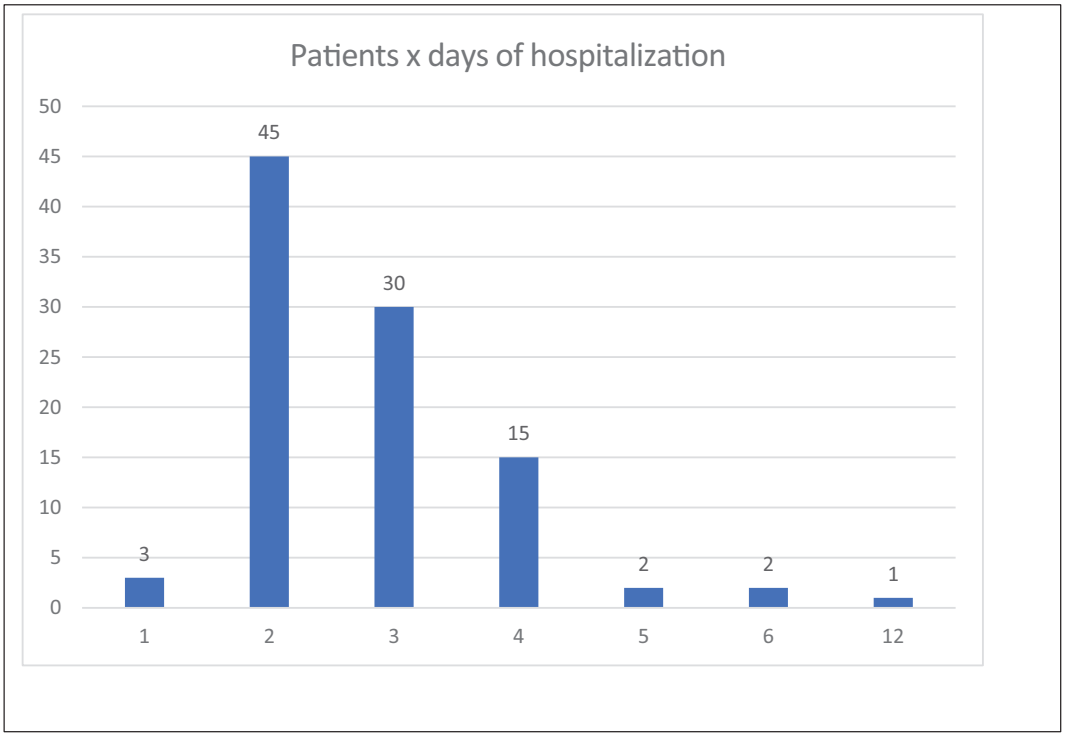


Fig. 5 Hospital stay: 3 patients stayed 1 day, 45 patients stayed 2 days, 30 patients stayed 3 days, 15 patients stayed 4 days, 2 patients stayed 5 days, 2 patients stayed 6 days and 1 patient 12 days.

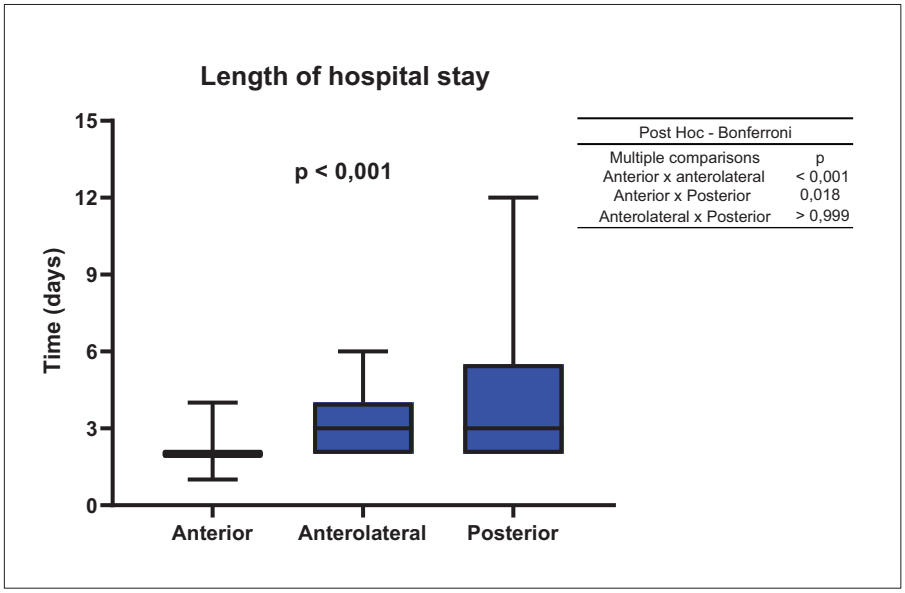


Fig. 6 Length of hospital stay of 2.1 days for the anterior approach, 3.0 days for the anterolateral approach and 4.11 days for the posterior approach.

had implant instability with signs of subluxation of the prosthesis, one patient operated via an anterolateral approach and one patient operated via a posterior approach, both of which were treated conservatively and followed up on an outpatient basis, 1 (1.02%) had a fracture of the femur during the surgical procedure, fixation with cerclage using steel wires was performed, 1 (1.02%) died of cardiac complications.

The results obtained corroborate Starks et al. who applied the FTP in patients undergoing total hip or knee arthroplasty, observed that the mortality rate for total knee arthroplasty decreased from 0.44 to 0.07%. Starks' work can be seen as an early model for FTP in orthopedic surgery.[5]

Nutritional guidelines now allow fluid intake up to 3 hours before induction of anesthesia and 6-hour fasting for solid food. In addition to the reduced fasting time, the FTP recommends that patients consume up to 300 ml of a clear carbohydrate-rich drink 3 hours before surgery, with the aim of presenting the patient for surgery in a metabolically "fed" state, avoiding catabolism.[14–17]

In our sample, we did not have any DVT or PTE events during the hospitalization period. Early mobilization is a key component of the FTP. Adverse physiological effects of prolonged bed rest include increased insulin resistance, myopathy, reduced lung function, impaired tissue oxygenation, and increased risk of pulmonary thromboembolism.[18]

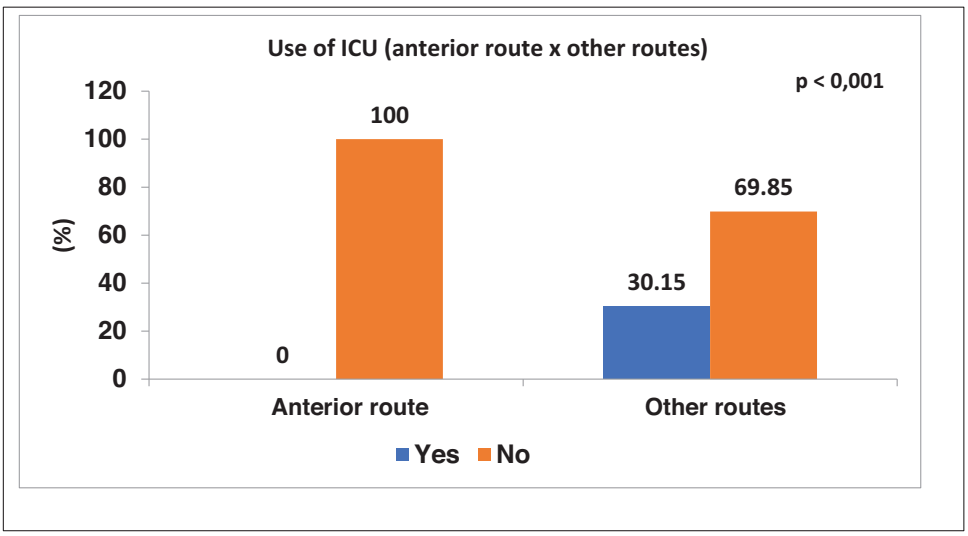


Fig. 7 No patient operated via the anterior approach went to the ICU postoperatively. 30.15% of patients operated on by other approaches went to the ICU and 69.85% were not.

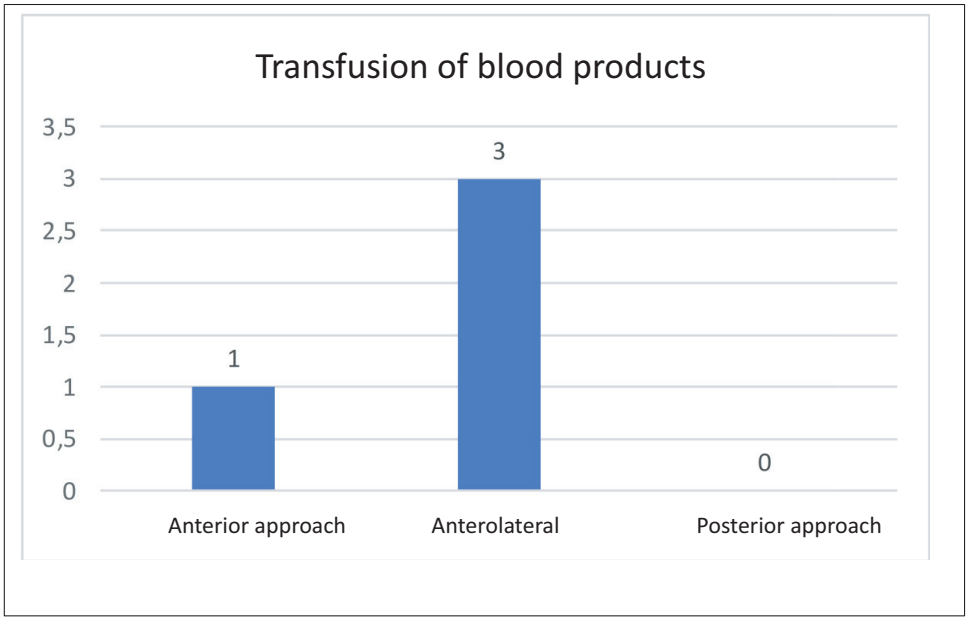


Fig. 8 Of the total sample of 98 patients, 4 (4.08%) received transfusion of blood products, 1 (1.02%) operated through the anterior approach and 3 (3.06%) through the lateral approach.

Pua et al.[19] demonstrated a significant reduction in length of stay of 1.8 days when patients walked within 24 hours of surgery. Early mobilization after knee arthroplasty is also associated with improved functional recovery and lower incidence of DVT.[20,21]

The stimulus for early walking was followed according to the methodology criteria and all patients were discharged walking with the help of a walker and safety recommendations made by the physiotherapy and nursing team.

In our sample, only 4 (4.08%) patients received transfusion of blood products during the surgical procedure. A strategy that preserves the need for blood administration is crucial to the success of the FTP. Allogeneic blood transfusion is associated with immunomodulation and systemic volume overload.[22]

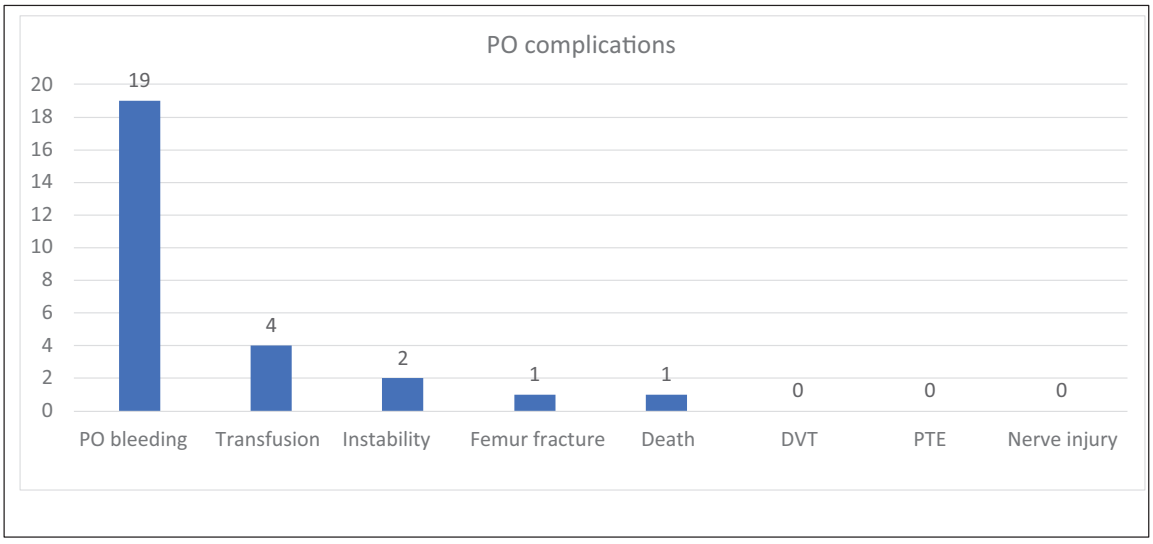


Fig. 9 Total sample 98 patients, 19 (19.39%) of the patients had bleeding in the immediate postoperative period, 4 (4.08%) required transfusion of blood products, 2 (2.04%) had implant instability, 1 (1.02%) had a femur fracture, 1 (1.02%) died. There were no cases of Deep Vein Thrombosis (DVT), Pulmonary Thromboembolism (PTE) or Peripheral Nerve Injury.

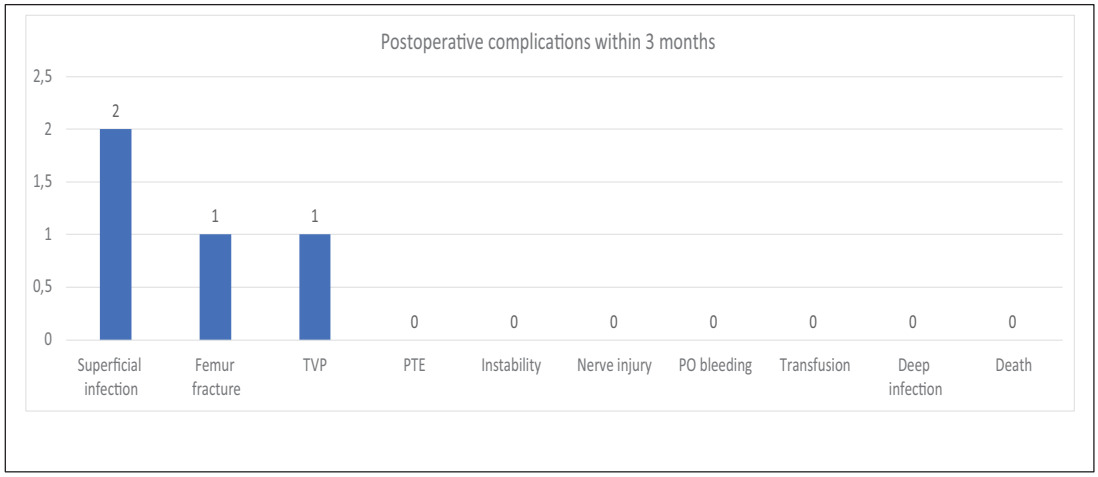


Fig. 10 Postoperative complications within 3 months. We had 2 (2.04%) cases of superficial infection of the surgical wound, 1 (1.02%) of femur fractures and 1 (1.02%) case of DVT.

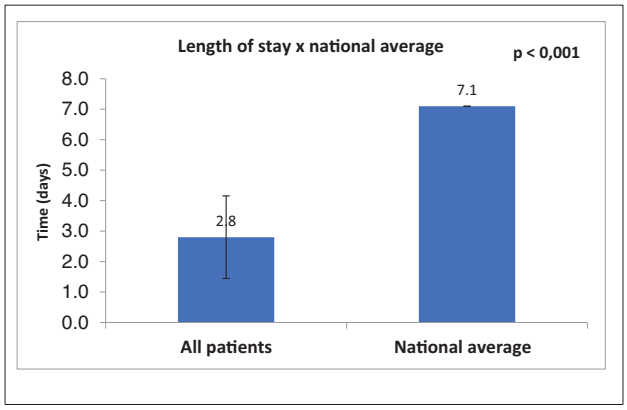


Fig. 11 The length of stay for all patients in the sample was 2.8 days and the national average is 7.1 days ($p < 0.001$).

Although initially adopted in orthopedic surgeries for primary hip and knee arthroplasties, the FTP has been increasingly applied to other orthopedic procedures, bringing benefits to patients and reducing procedure costs.[23–27]

Recently, an article by the Mayo Clinic, an important reference hospital in orthopedic surgeries in the United States, reported the benefits obtained in arthroplasty surgeries reconciled with FTP, where patients undergoing surgery had fewer side effects related to opioids, fewer postoperative complications, shorter hospital stay and greater cost savings for the clinic.[28,29]

We believe that the reasons for the early discharge of these clinically stable patients include several aspects, including the preoperative guidance that reduces anxiety about the procedure and establishes that it is not necessary to stay in hospital for a long period to recover properly, the use of the mixed anesthesia technique - spinal anesthesia and anesthesia by local infiltration, providing more comfort to the patient for a longer time, contributing for them to leave the acute inflammatory phase of the postoperative period - the adequate use of blood products, contributing to avoid a physiological lowering of the patient due to transfusion of exogenous elements, encouraging early mobilization contributing to the return of gastrointestinal functions, peripheral circulation of the limbs and deep circulation of the operated region, increasing tissue perfusion with oxygen and contributing to the reduction of the inflammatory process and finally the absence of complications such as PTE and DVT in the immediate postoperative period.

Conclusion

The implementation of the FTP requires that a multidisciplinary team composed of surgeons, anesthesiologists, nurses, physiotherapists, nutritionists and social workers work together so that the steps are fulfilled and the needs are implemented, verified and constantly evaluated to reach an acceptable index, fulfilling all the planned actions.

The FTP only works well when all parties contribute to the overall result, and weekly follow-up and planning meetings, not only in the implementation phase, but also in daily execution, are essential for the project to be executed correctly and effectively.

The FTP has the ability to reduce the length of hospital stay, reduce the need for ICU use, use of blood products and high-cost analgesics, contributing to an early and more efficient recovery of the patient, as well as reducing hospital and social costs of returning this patient to their activities of daily living.

I draw attention to the effectiveness of the FTP in a Public Hospital and emphasize the importance of multidisciplinary work and data auditing to better substantiate the conclusions.

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Conflict of Interests

To carry out the procedures via the anterior direct approach, we used implants from the Swiss company Medacta, which were provided subsidized at the amount paid by the SUS.

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A Novel Fixation Method of the Graft to the Fibular Head in Knee Lateral Collateral Ligament Reconstruction: Technical Note

Um novo método de fixação do enxerto para a cabeça fibular na reconstrução do ligamento colateral lateral do joelho: Nota técnica

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Abstract

The lateral collateral ligament (LCL) is the strongest lateral stabilizer of the knee. It provides support against varus stress and posterolateral rotation of the knee. Lateral collateral ligament injuries mostly occur together with anterior and/or posterior cruciate ligament injuries. While grades 1 and 2 injuries are treated conservatively since they are partial injuries, total ruptures, as in grade 3, require surgical treatment. In conventional LCL reconstruction methods, hamstring grafts are used, and bioscrews are used in bone-tendon fixation. Lateral collateral ligament reconstruction is usually performed as a component of multiple ligament surgery. Therefore, there is a need for a contralateral hamstring tendon or allograft. The present article aims to define a technique that does not require tendon grafts and bioscrews in fibular fixation.

Keywords

- anterior cruciate ligament reconstruction
- collateral ligaments
- joint instability
- knee injuries
- sports injury

Resumo

O ligamento colateral lateral (LCL) é o estabilizador lateral mais forte do joelho. Ele fornece suporte contra o estresse varus e a rotação de posterolateral do joelho. As lesões de LCL ocorrem principalmente com lesões do ligamento cruzado anterior e/ou posterior. Enquanto as lesões grau 1 e 2 são tratadas de forma conservadora, uma vez que são lesões parciais, rupturas totais, como no grau 3, requerem tratamento cirúrgico. Utilizam-se enxertos isquiotibiais nos métodos convencionais de reconstrução da LCL e bioscrews na fixação do tendão ósseo. A reconstrução do LCL é geralmente realizada como um componente de cirurgia de ligamento múltiplo. Portanto, há necessidade de um tendão contralateral ou aloenxerto. O presente artigo tem como objetivo definir uma técnica que não exija enxertos tendíneos e bioscrews na fixação fibular.

Palavras-chave

- instabilidade articular
- lesões do esporte
- ligamentos colaterais
- reconstrução do ligamento cruzado anterior
- traumatismos do joelho

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Introduction

Knee ligament injuries are among the injuries that orthopedists and traumatologists encounter quite often. Posterolateral and lateral ligament injuries account for 18 to 26% of significant knee ligament injuries.[1] Structures that support knee stability on the lateral side consist of the lateral collateral ligament (LCL), the fabelofibular ligament, the joint capsule, the popliteus tendon, the popliteofibular ligament, and the arcuate ligament.[2] Among these, the LCL is the primary stabilizer in preventing the varus angulation of the knee. Moreover, it supports the PCL in resisting external rotation and the ACL in resisting anterior translation.[3] If untreated, it may lead to permanent instability and pain in the knee. With increased varus gait, it may cause medial meniscus lesion and then medial osteoarthritis. Lateral complex injuries emerge with ACL/PCL injuries in many cases. In cases of LCL failure that is not noticed at the stage of diagnosis, the success of cruciate ligament reconstructions decreases over time. Many open, percutaneous, and endoscopic techniques have been described in LCL reconstruction.[4] Hamstring autografts are used in almost all these techniques. However, particularly in multiligament reconstructions, the need for a patellar tendon or allograft comes into prominence in addition to the hamstring autograft.[5] Donor site problems of the patient, who has already undergone surgical trauma, caused by taking the patellar tendon graft, and difficulties in reaching the allograft are obvious. A tensor fascia lata graft, which can be reached without making a significant incision in addition to the incision made in standard surgery, was used in the technique we describe.

In a study, a 7-mm tensor fascia lata graft was found to be significantly stronger than a 10-mm bone-patellar bone graft and a T. posterior graft.[6] In their study, Donahue et al. compared the T. anterior tendon, the T. posterior tendon, and hamstring tendon grafts. The authors reported that the hamstring graft was significantly weaker than the other two grafts. In the same study, they showed that the fascia lata graft became thicker as it distally approached the Gerdy tubercle.[7] In the technique we propose, we obtain a biomechanically quite strong graft since we take the fascia lata graft by starting from the place of adhesion to the Gerdy tubercle and proceeding proximally.

Moreover, bioscrews are used in fibular fixation in most of the techniques that are currently performed. Due to the metaphysis of the fibular head and the weakness of the cortex structure, a fracture may occur around the tunnel during screwing.[8,9] This risk is lower in the technique we describe. We aimed to describe a safe and easy technique to be used in isolated LCL or multiligament injuries.

Indications

Lateral collateral ligament injuries are usually observed together with ACL and/or PCL injuries.[10] Grade 1 and 2 injuries are conservatively treated because there is no total rupture. We implement this method in grade 3, in which the ligament is totally ruptured.

Surgical Technique

Graft Harvesting and Preparation

The anesthetized patient is placed in the supine position. A tourniquet is placed around the proximal thigh, the leg is released down, and the tourniquet is inflated. The leg is disinfected and draped appropriately for asepsis. The fibular head and the lateral epicondyle are marked with a sterile pen. The plan for taking the tensor fascia lata graft is prepared. The fascia is reached by making an oblique longitudinal incision 2 cm anterior to the lateral condyle. Starting from the Gerdy tubercle and proceeding proximally, a graft with a thickness of 8 mm and a length of 10 cm is taken. It is put on a separate sterile table, and one end is longitudinally separated into two in the middle. The length of the separated legs should be longer than the anterior-posterior distance of the fibular head. It is prepared using nonabsorbable sutures (Ethibond No:2) via the Krackow suture technique with one end on one side and two ends on the other side (►**Fig. 1**). The graft thickness is measured, and the graft is wrapped in a sponge soaked with physiological saline.

Fibular Tunnel and Fibular Fixation of the Graft

A 5-cm vertical skin incision is made on the fibular head. The tunnel location is decided, and the guidewire is sent in the anteroposterior direction first. A tunnel is opened with a cannulated drill according to the graft thickness measured. At this stage, care should be taken against the risk of peroneal nerve injury. Before the distal graft is divided into two, its thickness should be measured. According to this measurement, the thickness of the tunnel at the head of the



Fig. 1 Image of the prepared graft.

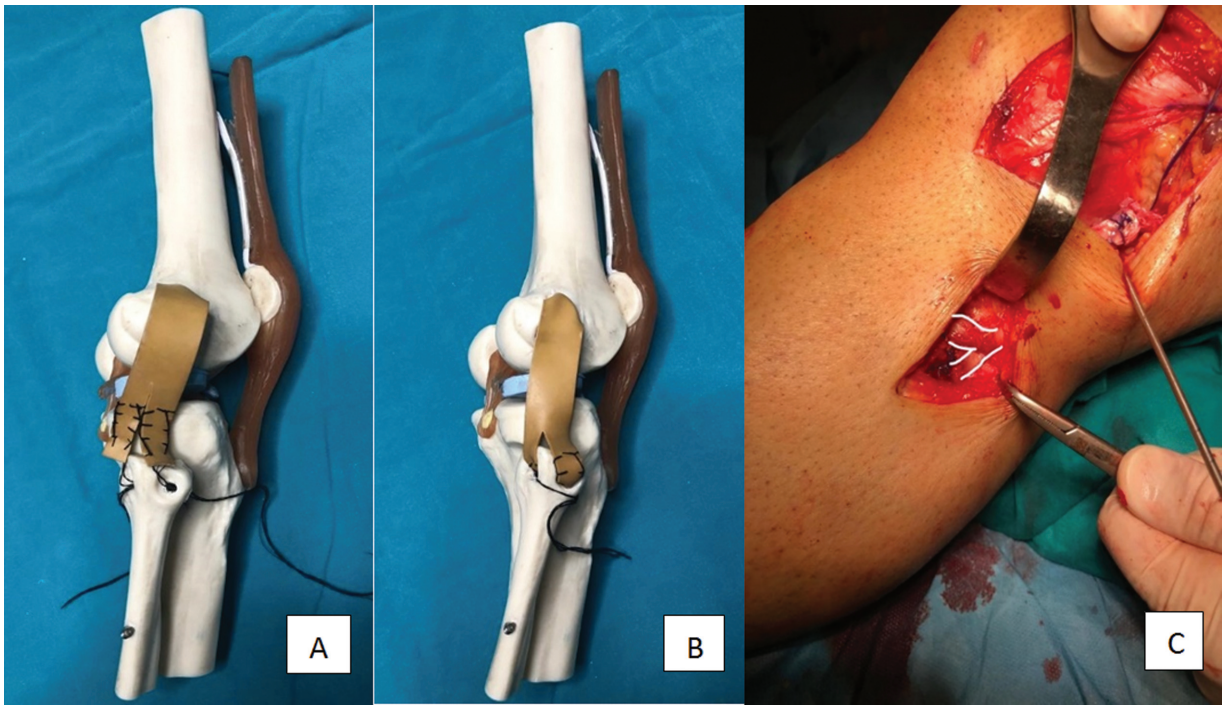


Fig. 2 (A) Drawing of the graft carried to the tunnels **(B)** Drawing of the fixation of the graft passed through the tunnels **(C)** Intraoperative image of fibular fixation.

fibula is decided. The distal graft is divided into two longitudinally and sutured. Two looped carrier sutures are passed through the tunnel simultaneously. The length of the tunnel is measured to ensure that the separated leg length of the graft is longer than the tunnel. One of the graft legs is carried from anterior to posterior and the other from posterior to anterior with carrier sutures (►**Fig. 2A**). Sutures are pulled from both sides, and the graft legs are seen to enter the tunnel. The sutures coming out of both sides are firmly tied on the fibula head to achieve fibular fixation (►**Fig. 2B-C**).

Femoral Tunnel and Femoral Fixation of the Graft

The lateral femoral epicondyle is found through the incision previously made to take a tensor fascia lata graft. The guidewire is proceeded toward the superomedial, and a scopy check is performed. The other end of the graft fixed to the fibula is carried from under the iliotibial band to the proximal incision by means of a clamp. The length of the graft, which will be stretched toward the guidewire and remain in the tunnel, is measured (►**Fig. 3A**). The femoral tunnel is opened by a cannulated drill with an appropriate thickness for the graft. The tunnel is carved 10 mm longer than the length of the graft planned to be kept in the tunnel. The carrier suture is passed using the guidewire. Graft sutures are carried to the medial with carrier sutures. The sutures coming out of the medial are pulled strongly to help the graft enter the tunnel. It is fixed with a bioscrew while the knee is forced for valgus in 30° flexion (►**Fig. 3B**). Upon checking with the varus stress test, the fascia lata defect is carefully closed.

Postoperative Follow-up and Rehabilitation

In the rehabilitation of isolated LCL reconstruction, an angle-adjusted brace should be placed on the knee and fixed at 30°. In the first 2 weeks, aggressive patella mobilization and knee movement with range of movement (ROM) between 30° and 90° should be started. After 2 weeks, movement between 0° and 90° degrees is allowed, whereas no load is put on the knee until the 6th week. The knee brace can be removed except for the periods when load is put on the knee. Between the 6th and 12th weeks, gradual loading and flexion tolerated up to 120 degrees are allowed. If there is no instability in the 6th-month check-up, full movement without restriction is allowed. Moreover, if there are coperformed ACL/PCL reconstructions, they should also be considered during follow-up. Preoperative orthorontronogram shows varus deformity in the knee joint. This is an indication of lateral instability of the knee. It is seen that stability has been achieved in the standing x-ray at 6 months postoperatively (►**Fig. 4**). Lateral collateral ligament injury is seen in the preoperative magnetic resonance imaging (MRI) (coronal) (►**Fig. 5A**). On the MRI images taken at the 6th postoperative month, the reconstructed LCL is seen as intact (►**Fig. 5B-C**).

Discussion

The strongest aspects of the technique we have described are that tendon grafts are not needed and there is no need for bioscrews for fibular fixation. Many techniques have been described for LCL reconstruction. Tendon grafts are used in commonly applied techniques.[4] Considering that it is usually applied together with ACL or PCL reconstruction, there is a

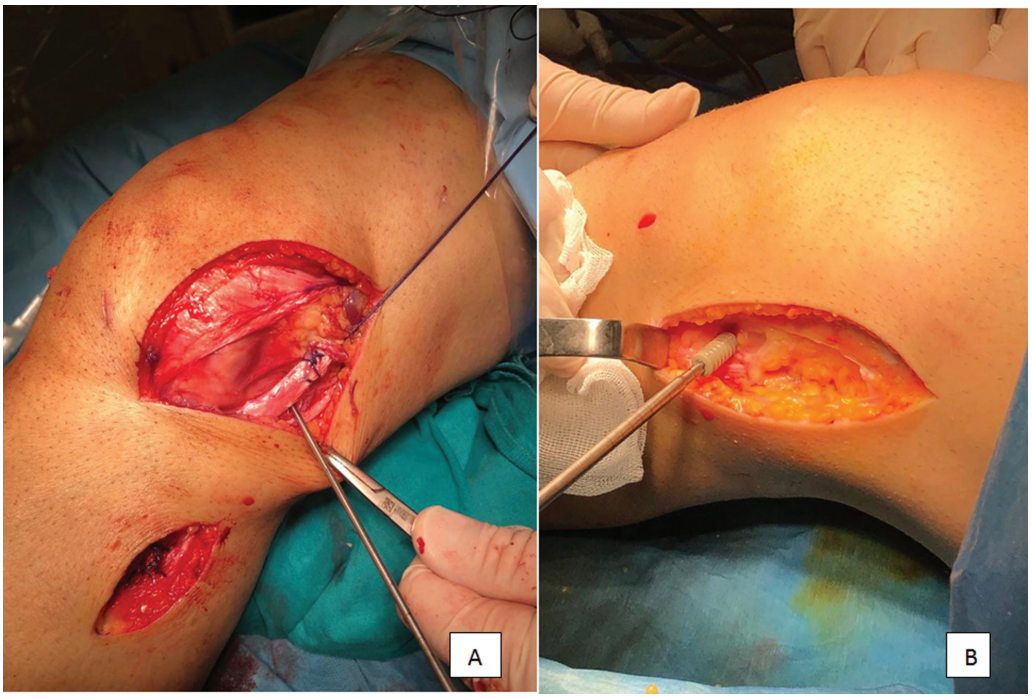


Fig. 3 (A) Measurement of the graft taken to the proximal side with a guidewire, calculation of the femoral tunnel length **(B)** Femoral fixation of tendon graft.

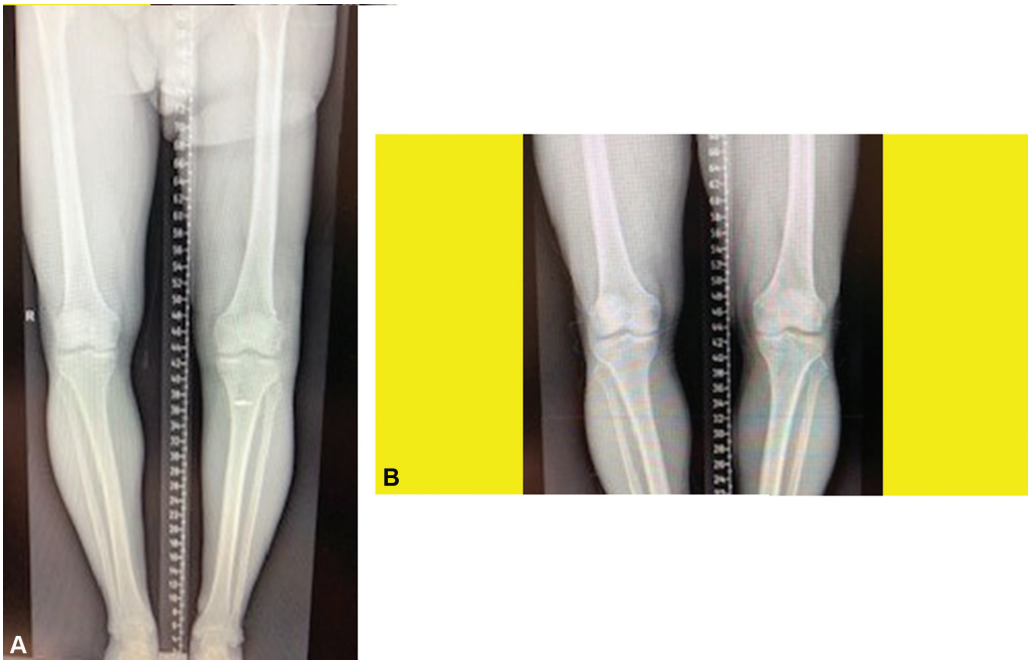


Fig. 4 (A) Preoperative orthorontronogram **(B)** Postoperative 6th month orthorontronogram.

need for ipsilateral patellar tendon, contralateral hamstring tendons, or an allograft. There is no need for tendon grafts in the technique we have described. Since the grafted area is already in the area of the incision made for LCL reconstruction surgery, it does not cause any serious additional morbidity. In another technique, which was suggested to reduce the size of incision and the complication rate, the fibular-tibial tunnel was opened, and the graft was fixed from the medial of the tibia with the EndoButton. Thus, it was aimed to increase the strength of fibular fixation. However, it was emphasized that there was a risk of tunnel collision if ACL and PCL reconstructions were performed simultaneously. We think that our fibular fixation strength is satisfactory in the technique we have proposed. In our technique, since the graft has two legs in the distal, the leg in the anterior position resists varus stress by imitating the LCL. The leg in the posterior position provides partial support for the resistance to rotation, as in the Larson technique. In the technique



Fig. 5 (A) Preoperative magnetic resonance imaging (coronal) **(B)** Postoperative 6th month magnetic resonance imaging (coronal) **(C)** Postoperative 6th month magnetic resonance imaging (sagital).

we have described, there are fewer incisions than in conventional techniques, and no extra fixation material (bioscrew, EndoButton) is used for fibular fixation. There are studies stating that the most common intraoperative complication is a complete or incomplete fracture of the fibular head.[8,9] Especially the use of no bioscrews in fibular fixation considerably reduces the risk of fracture of the fibular head. This aspect is also an important advantage of our technique.

In multiligament injuries, it can be used together with the "Lemaire technique" if ALL reconstruction is to be added to the patient's operation. Two grafts of 8 mm can be taken from the tensor fascia lata, and the same procedure can be applied using the same tunnel in the femur.

The fixation method applied in this technique and the bioscrew method should be biomechanically compared. We are aware that this biomechanical study is imperative. Therefore, we also initiated the biomechanical study of this technique. So far, we have used this technique in nine of our patients. We have a clinical study plan by increasing the number of patients. The absence of biomechanical studies and the low number of patients are limitations of our study.

Conclusion

In the present study, the tensor fascia lata graft is used, and screw fixation is not required for fibular fixation. The advantages and disadvantages of this technique compared with conventional methods are presented in ►**Table 1**. This technique appears as an easy, safe, and less costly technique.

Table 1 Advantages and disadvantages of the technique described

Advantage	Disadvantage
It is a convenient method that can be applied in lateral instabilities in which rotation instability is not at the forefront.	It makes a limited contribution to rotational stability. In case of rotational instability, a relevant technique should be added.
There is no need for a significant additional incision during graft taking.	The incision is longer compared with percutaneous and endoscopic techniques.
There is no need for tendon grafts (allo/autograft).	
There is no need for implants for fibular fixation.	
Since no bioscrews are used, the risk of fibular head fracture is extremely low.	
It costs less than conventional methods.	

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Conflict of Interests
The authors have no conflict of interests to declare.

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Description of the Anterior Cruciate Ligament Reconstruction Technique with Mini-Lemaire Type Anterolateral Tenodesis through a Single Femoral Tunnel

Descrição de técnica de reconstrução do ligamento cruzado anterior com tenodese ântero-lateral tipo mini-Lemaire através de túnel único femoral

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Abstract

The anterior cruciate ligament (ACL) injury causes anteroposterior and rotational instability in the knee. Intra-articular reconstructions often fail to achieve satisfactory rotational control, leading to persistent complaints of instability and subjecting the neo-ligament to increased stress. Young patients with high athletic demands and grade 2 or 3 pivot-shift often have a higher risk of re-rupture after isolated ACL reconstruction. Over the years, various techniques have been developed to address such situations. Among the described techniques, one of the most commonly used is the modified or "mini-Lemaire" lateral extra-articular tenodesis. Biomechanical studies demonstrate the versatility of the technique due to its relatively isometric behavior in flexion angles of 0-60° when the graft is introduced deeply to the lateral collateral ligament. It offers the possibility of fixation at different anatomical positions on the lateral femoral condyle and at different degrees of flexion. The objective of this study is to describe an accessible, reproducible technique that relies on materials widely available in our environment.

Keywords

- anterior cruciate ligament injuries
- anterior cruciate ligament reconstruction
- tenodesis

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Resumo

A lesão do ligamento cruzado anterior (LCA) causa instabilidade anteroposterior e rotatória do joelho. Reconstruções isoladas intra-articulares muitas vezes não obtêm controle rotacional satisfatório, mantendo queixa de instabilidade e impondo ao neoligamento um maior estresse. Pacientes jovens, com alta demanda atlética e com pivot-shift grau 2 ou 3 apresentam um maior risco de rerrotura após reconstrução isolada do LCA. Ao longo dos anos diversas técnicas foram desenvolvidas na tentativa de mitigar tais situações. Dentre as técnicas descritas, uma das mais utilizadas é a Tenodese extra-articular Lateral tipo Lemaire modificada ou "mini-Lemaire". Estudos biomecânicos demonstram versatilidade da técnica devido a seu comportamento relativamente isométrico em graus de flexão de 0-60° quando a fita é introduzida profundamente ao ligamento colateral lateral, com possibilidade de fixação em diferentes posições anatômicas no côndilo femoral lateral e em diferentes graus de flexão. O objetivo do estudo é descrever uma técnica acessível, reprodutível e dependente de material amplamente disponível em nosso meio.

Palavras-chave

- lesões do ligamento cruzado anterior
- reconstrução do ligamento cruzado anterior
- tenodese

Introduction

Anterior cruciate ligament (ACL) injury causes anteroposterior and rotational instability of the knee. Isolated intra-articular reconstructions often do not achieve satisfactory rotational control, maintaining instability and imposing greater stress on the neoligament. Young patients, with high athletic demands, who practice sports with rotation on the knee and with grade 2 or 3 pivot-shift have a higher risk of re-rupture after isolated ACL reconstruction.[1–3]

In order to reduce residual instability and re-rupture, lateral extra-articular reconstructions are performed concomitantly with ACL reconstruction. Among the techniques described, one of the most used is the modified Lemaire-type or "mini-Lemaire" lateral extra-articular tenodesis (LET). Biomechanical studies show great versatility of the technique due to its close to isometric stretching pattern between 0-60° when the iliotibial band (ITB) tape is passed deep to the fibular collateral ligament (FCL). This allows its fixation to the femur to be carried out at different degrees of flexion (0-60°).[3,4] Studies also demonstrate that due to the dynamic tensioning effect that the FCL imposes on the graft, its fixation can be done at different anatomical points in the metaphyseal region of the lateral femoral condyle, as long as it is proximal to the femoral insertion of the FCL, providing the same rotational control characteristics.[3–5]

It is important to highlight that the mini-Lemaire fixation point is often close to the femoral fixation of the ACL graft, with the confluence of the tunnels or small bone wall between them being a concern when using an interference screw, which is very common in our country.[6] Due to these concerns, staples or anchors are often used for this purpose, which can cause irritation and pain due to the material protusion, requiring removal.[2] Therefore, a technique that avoids such difficulties is desirable.

The indications for performing LET as well as technical variations are constantly evolving.[1,2,7] The objective of the present work is to describe an accessible and reproducible technique for anterolateral extra-articular reconstruction of the mini-Lemaire type, using the same femoral tunnel as the ACL, and fixing them together with a single interference screw, minimizing the risk of tunnel confluence and providing adequate fixation of the grafts with less material.

The present study did not require approval by an ethics committee because the technique described is a modification of widely performed procedures.

Description of the Technique

Conventional patient positioning for knee arthroscopy. After intra-articular procedures, the femoral tunnel described below is created and then the ACL tibial tunnel in the usual way.

Lateral Incision

Make an incision of approximately 3cm on the lateral aspect of the knee, about 2cm proximal to Gerdy's tubercle, proceeding proximally along the lateral aspect of the distal femur, at the level of the lateral epicondyle. Variations in length and position may be necessary depending on associated procedures and the thickness of the adipose tissue.

Dissect the subcutaneous tissue to achieve adequate exposure of the ITB, from Gerdy's tubercle to approximately 5cm proximal to the lateral epicondyle.

Graft Removal

Remove a strip from the posterior half of the iliotibial tract measuring approximately 1×8cm. Release the strip from lateral adhesions, taking care not to damage adjacent structures such as the joint capsule, lateral collateral ligament, capsulo-osseous layer of the IT band, while maintaining its insertion on the proximal tibia at Gerdy's tubercle.

Perform repair of the proximal stump using absorbable Vicryl suture size 1 (►**Fig. 1**).

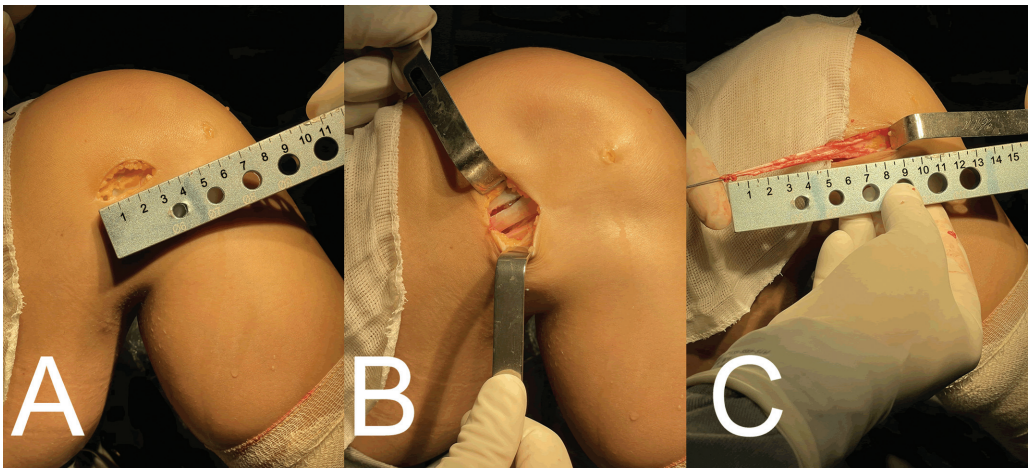


Fig. 1 (A) Access with dissected ITB. (B) Demarcation of the graft donor area. (C) Graft removed and repaired.

Femoral tunnel

Identify the FCL and lateral epicondyle by palpation through the gap of the previous ITB strip incision the previous incision to remove the ITB strip. If there is difficulty, perform varus with the knee in flexion to tension the ligament (figure "4" with lower limb).

Pass the guide wire using the "outside-in" technique, ensuring that the wire entry point into the lateral femoral condyle is approximately 1 cm away from the lateral epicondyle (►**Fig. 2**).

The tunnel must be made with a drill with a diameter 1mm larger than the ACL graft, in order to allow joint passage of the ACL graft and the ITB strip into the tunnel.

Then drill the tibial tunnel in the usual way according to the size of the graft removed for the ACL.

Deep Passage to the FCL

On the posterior and proximal margin of the FCL, make a small longitudinal incision with a scalpel to allow the introduction of a hemostatic clamp, taking care not to damage its fibers.

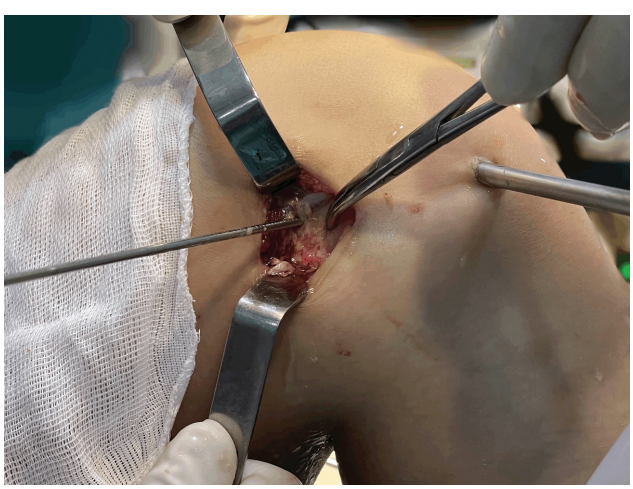


Fig. 2 Identification of the lateral epicondyle (clamp) and femoral point of the mini-Lemaire (guide wire).

Insert the hemostatic clamp deep to the FCL through the incision made. It is possible to palpate the clamp immediately anterior to the FCL, where a new incision should be made to expose its tip. The clamp should always stay close to the ligament, being careful not to inadvertently damage the popliteal tendon or penetrate the intra-articular space.

After creating the tunnel deep to the FCL, pass the graft from anterior to posterior through it (►**Fig. 3**).

Introduction of ACL and LET Grafts Through the Femoral Tunnel

After passing the LET graft deep into the FCL, use grasper forceps to pass the graft repair (Vicryl) through the femoral tunnel in order to visualize it in the intra-articular space. After, use the grasper again to expose the repair through the anteromedial portal. Then pull it so that the graft enters the tunnel.

Pass an Ethibond 5 thread through the femoral and tibial tunnels, where the ACL graft will be located, in the usual way.

During the introduction of the ACL graft, slight traction must be maintained on the ITB strip repair through its end in the anteromedial portal in order to prevent its extrusion through the external orifice of the femoral tunnel. Using the Ethibond 5 thread, introduce the ACL graft in a retrograde manner, first into the tibial tunnel and then into the femoral tunnel (►**Fig. 4**).

Femoral Fixation of Grafts

The grafts are fixed to the femur with the knee in full extension.

Keep the knee in neutral varus/valgus and internal/external rotation.

Maintaining gentle traction on the LET and ACL graft, fixation is performed with an interference screw (►**Fig. 5**).

Be careful not to over-tension the LET graft, in order to avoid increased pressure in the lateral compartment postoperatively. Do not leave a segment of the ACL protruding

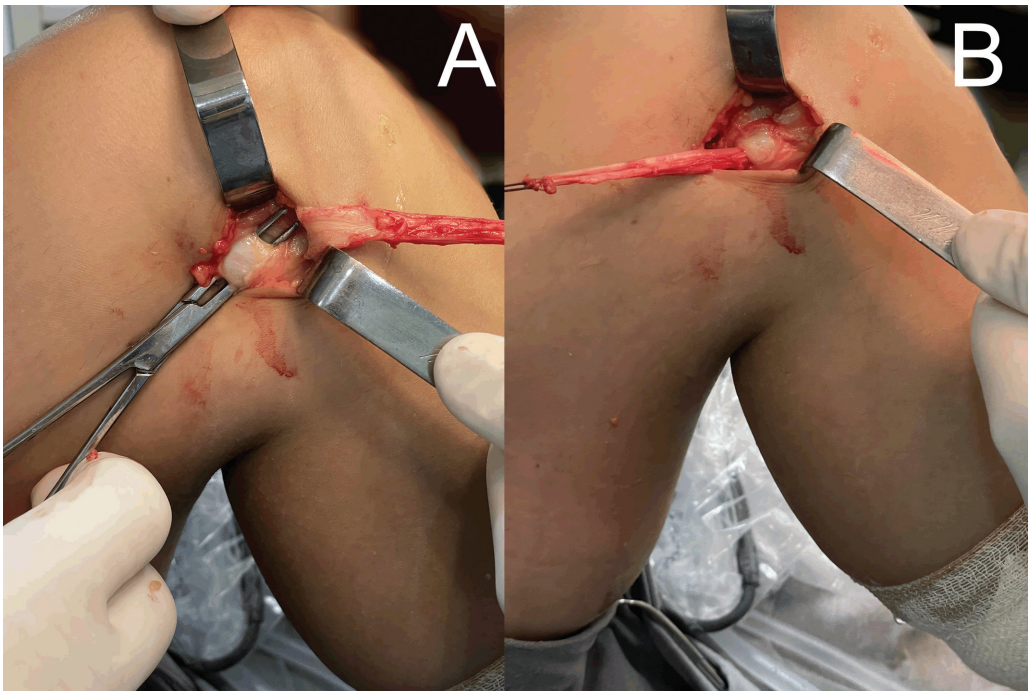


Fig. 3 (A) Passage of the deep hemostat to the LCL. (B) Passage of the deep graft to the LCL.

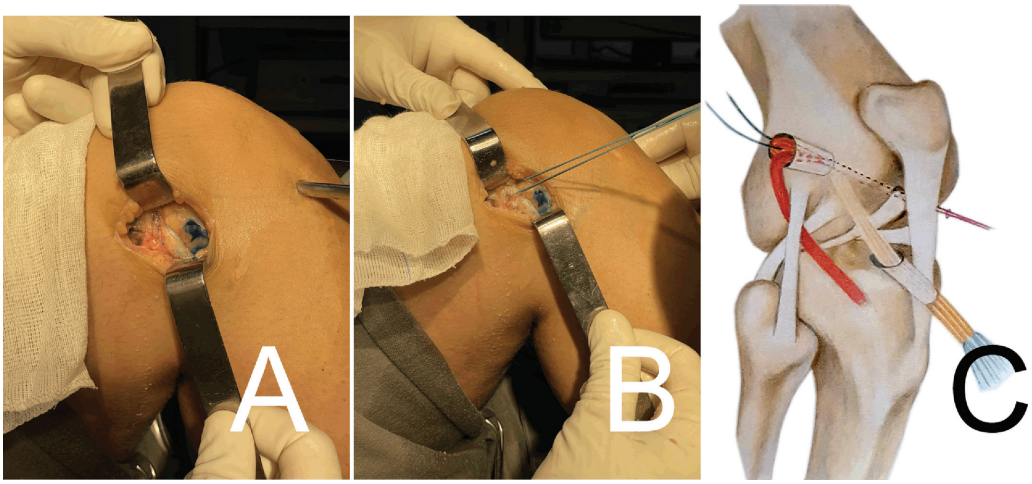


Fig. 4 (A) Passage of the LET in the femoral tunnel. (B) Passage of the flexor graft in the femoral tunnel. (C) Schematic drawing demonstrating position of grafts and tunnels.

from the lateral femoral condyle, which could cause friction and subsequent pain.

ACL Tibial Fixation

Fix the graft to the tibia in the usual way with an interference screw, maintaining distal traction on the graft, knee at 20-30°, neutral varus/valgus and internal/external rotation.

Remove a spare segment of the ACL graft from the tibia if necessary.

Removal of Intra-articular Segment of LET

Remove the LET repair wire and, if necessary, a spare segment of the graft through arthroscopy with basket forceps (►**Fig. 5**).

Iliotibial Band Closure

Suture the gap in the iliotibial tract corresponding to the donor area with interrupted stitches with Vicryl 1.

Final Considerations

Studies indicate that any point proximal to the lateral epicondyle in the distal femoral metaphysis is suitable for mini-Lemaire reconstruction. A distance of 1cm is adopted, considering that ACL grafts should have a minimum diameter of 8mm, which can be larger. Thus, after drilling the ACL tunnel, a safe distance is preserved between the tunnel and the origin of the FCL. This distance can be increased if necessary.

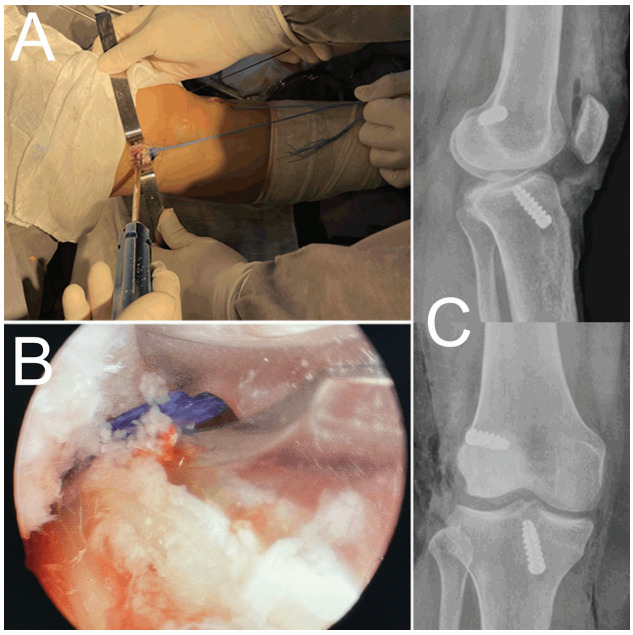


Fig. 5 (**A**) Panoramic photo with both grafts passed, position of fixation of the graft on the femur. (**B**) Photo of the intra-articular removal of Vicryl used to repair the TEL. It is possible to identify the ACL graft below the clamp to the left of the lateral wall of the intercondyle. (**C**) Post-operative X-ray of the described technique.

Exposing the repair thread of the iliotibial tract through the anteromedial portal facilitates the retrograde passage of the ACL graft. After both are passed, the repair thread can be switched between portals as needed.

The decision is made to fix the mini-Lemaire graft on the femur with the knee in extension to ensure proper joint reduction and positioning of the graft in the distal femoral tunnel. This prevents joint malreduction, graft laxity, or over-tensioning, ensuring the maintenance of full knee extension.

It is not uncommon for the quadrupled hamstring graft (authors' preference) to have a greater length than the ACL tunnels. Retrograde introduction allows excess removal in the tibia without risking injury to the graft and facilitates tensioning. If anterograde introduction leads to excess graft in the femur, its removal may cause inadvertent injury to the graft or generate friction and pain if prominent.

If the described steps are followed, the occurrence of an intra-articular excess segment of the iliotibial tract at the end of the procedure is uncommon, requiring only the removal of the absorbable suture used at the femoral tunnel level in the intercondylar area. If there is an intra-articular segment of the ITB, it can be easily removed in the same way, taking care not to damage the ACL graft.

Postoperative rehabilitation is independent of ITB tenodesis and can be carried out in the usual manner for ACL reconstruction.

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Conflict of Interests
The authors declare that there are no conflicts of interest.

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Tibial Eminence Avulsion in a Tibial Plateau Fracture – Our Approach: A Clinical Case

Avulsão da eminência tibial em uma fratura do platô tibial – Nossa abordagem: Um caso clínico

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Abstract

A middle-aged female patient with a tibial plateau fracture combined with an avulsion of the tibial eminence was treated with a combination of medial plate fixation for the plateau and an arthroscopic aided nonabsorbable suture of the eminence.
Our technique for tibial eminence avulsion fractures has no interference with tibial plateau osteosynthesis materials and has proven, once again, to have good results in the treatment of combined and complex injuries of the knee.

Keywords
- knee
- trauma
- tibial fractures
- arthroscopy
- fracture fixation, internal

Resumo

Uma paciente de meia-idade com fratura do platô tibial e avulsão da eminência tibial foi tratada com uma combinação de fixação do platô com placa medial e sutura da eminência com fio não absorvível auxiliada por artroscopia.
Nossa técnica para fraturas com avulsão da eminência tibial não interfere nos materiais de osteossíntese do platô tibial e, mais uma vez, teve bons resultados no tratamento de lesões combinadas e complexas do joelho.

Palavras-chave
- joelho
- trauma
- fraturas da tíbia
- artroscopia
- fixação interna de fraturas

Introduction

The avulsion of the tibial eminence is one of the most common injuries associated with the tibial plateau fractures.[1–4] The literature regarding this association is scarce.[5] This combination results on a complex injury pattern that demands a more elaborate approach.[1,2]

Regarding fracture patterns, higher Schatzker injury types (V and VI) are more frequently found in this type of lesion.[3] There has been a major uprising of arthroscopic reduction and internal fixation (ARIF) in the treatment of persistently displaced injuries[2,3] and the importance of arthroscopy in the approach of intra-articular lesions is well documented.[2,6–10]

Work carried out at the Department of Orthopaedics and Traumatology, Unidade Local de Health Unit (ULSAM), Viana do Castelo, Portugal.

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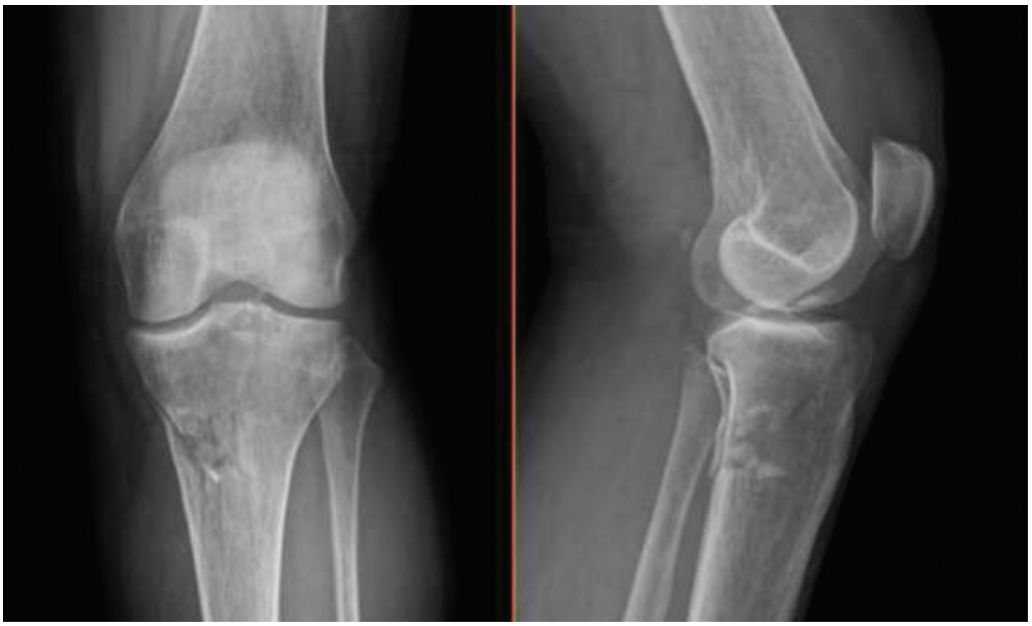


Fig. 1 Anteroposterior and lateral radiograph in the emergency room.

We present a clinical case with a combination of a medial tibial plateau fracture with an avulsion of the tibial eminence, where we expose the approach of our institution for this type of injuries.

Case Report

A 52 year-old female with a history of dyslipidemia suffered a fall from a chair with resultant knee trauma. She presented to the emergency room with significant knee effusion and pain, no major deformity and no neurovascular deficit. We performed an imagiological survey with radiographs (►**Fig. 1**) and CT scan (►**Fig. 2** and **3**), which showed a split fracture of the medial plateau through the tibial eminence, with dislocation and fragmentation of the eminence. The CT scan also reported a small fracture of the posterior margin of the external plateau. The patient was immobilized with a posterior splint and was prepared for the operating room.

First, we approached the medial tibial plateau with a posteromedial incision, reduced the split fracture with help from fluoroscopy and temporarily placed the medial plate with Kirschner wires. We then advanced to a two-portal arthroscopic procedure, with removal of debris and lavage, followed by exploration of the tibial plateau fracture, and searched for associated intra-articular lesions. When

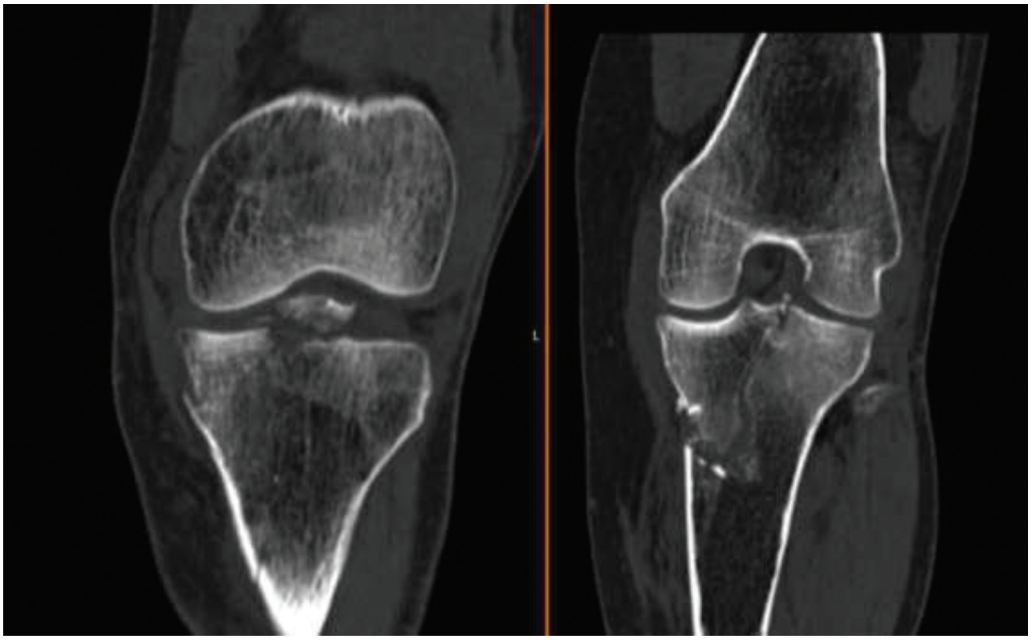


Fig. 2 Coronal cuts of the knee computed tomography scan.

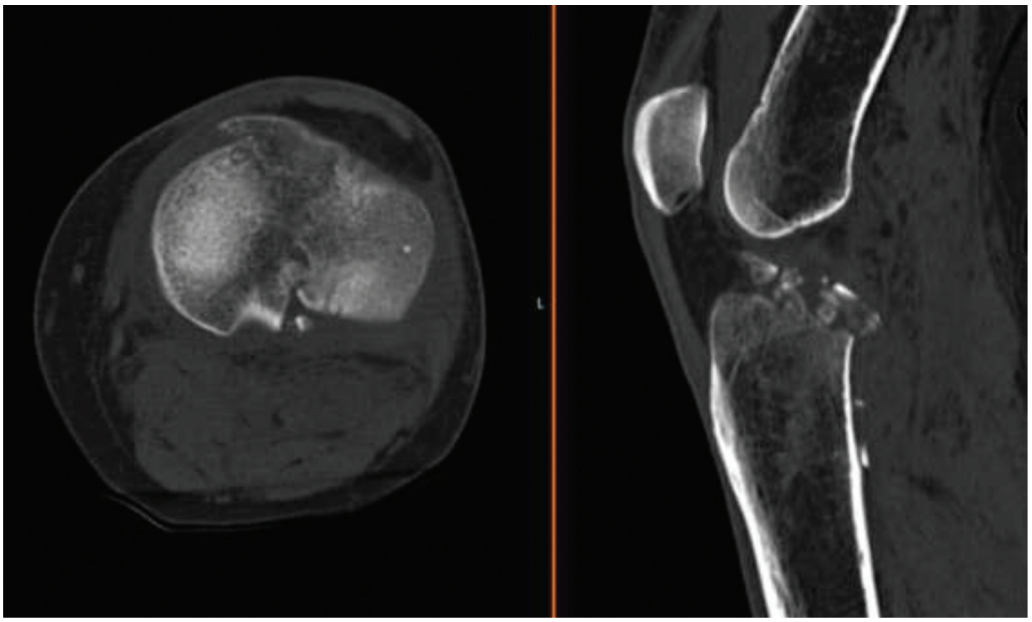


Fig. 3 Axial and sagittal cuts of the knee computed tomography scan.

satisfied with the reduction of the medial plateau, we proceeded to permanently fixate the plate in place. After this step, we went on to the tibial eminence: Since the debridement was already done and no entrapment of the meniscus was observed, we placed the ACUFEX Director Drill Guide (Smith and Nephew, Watford, England, UK), from the cruciate ligaments instrumental, in the anterior aspect of the eminence's fracture bed, and created a single tunnel through the anterior border of the proximal tibia. The next step was to pass an ULTRATAPE Suture (Smith and Nephew, Watford, England, UK) by the arthroscopic portals, then to transfix the fibers of the anterior cruciate ligament as closely as possible to the inferior bony fragment (►**Fig. 4**); then it was inserted through the tibial tunnel, reducing the eminence fracture, and fixated via an endobutton with the knee in full extension (►**Fig. 5**).

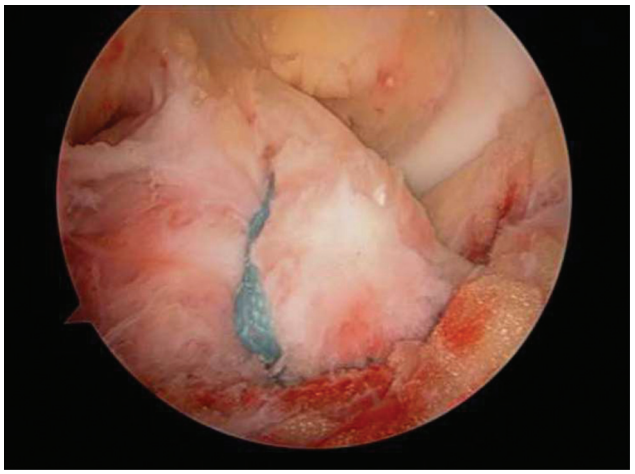


Fig. 4 Arthroscopic view of the tape transfixing the anterior cruciate ligament and pulling down the eminence fracture.

Postoperatively, the patient was placed in a De Puy (generic 0° knee imobilizing) brace with no weight bearing for 15 days. The rehabilitation program was initiated immediately postsurgery in an outpatient setting with neuromuscular electrical stimulation of the quadriceps and hamstrings with the knee in full extension. The following stage of the rehabilitation program comprehended isometric strengthening of the hip adductors and abductors, gradual removal of the brace, and passive knee mobilization with progressive degrees of flexion, with the main goal being the improvement of range of motion (ROM). At 1 month postsurgery, pain-free weight bearing was allowed, and the focus was muscular strengthening of the quadriceps, hamstrings, and gastrocnemius, starting with isometric exercises and progressing at 6 weeks postsurgery to dynamic and plyometric exercises with resisted flexion allowed in full range of motion and resisted extension at between 30 and 90° of flexion. Resisted extension at between 0 and 30° was allowed at 3 months postsurgery. Open kinetic chain proprioceptive exercises were initiated at 6 weeks, with progression to closed kinetic chain exercises.

At 3 months, the patient presented no pain, good radiographic alignment (►**Fig. 6**), full weight bearing, knee ROM between 0 and 90° and no crutches (►**Figs. 7** and **8**).

In the 1-year follow-up, the patient reported no limitation on her activities of daily living, with an IDKC score of 74.7, negative anterior Lachman and Drawer tests, and no impediment to everyday activities.

Discussion

The relevance of tibial eminence fracture in the context of a tibial plateau fracture is poorly identified in the current literature,[5] but information suggests that 19.4% of tibial

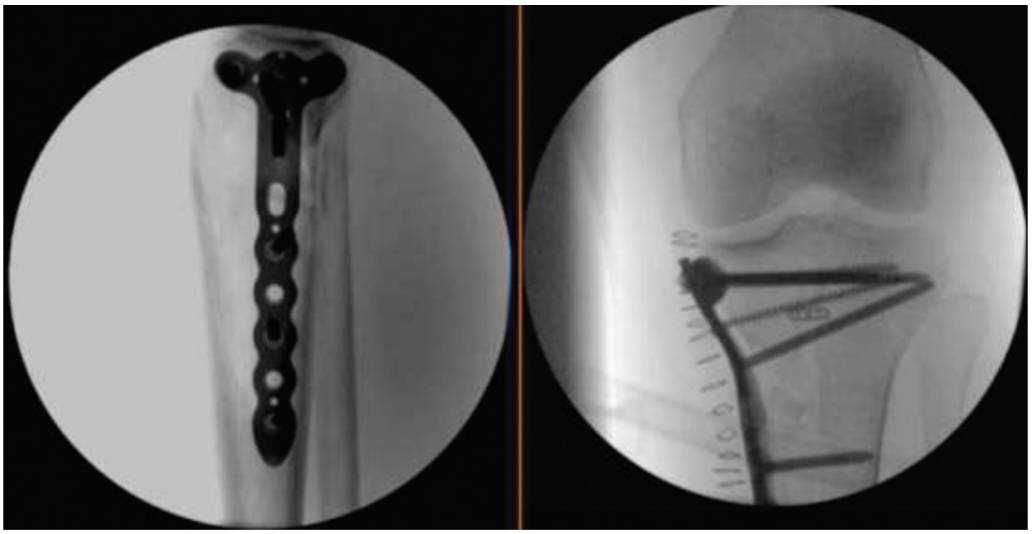


Fig. 5 Intraoperative anteroposterior and lateral fluoroscopy views.

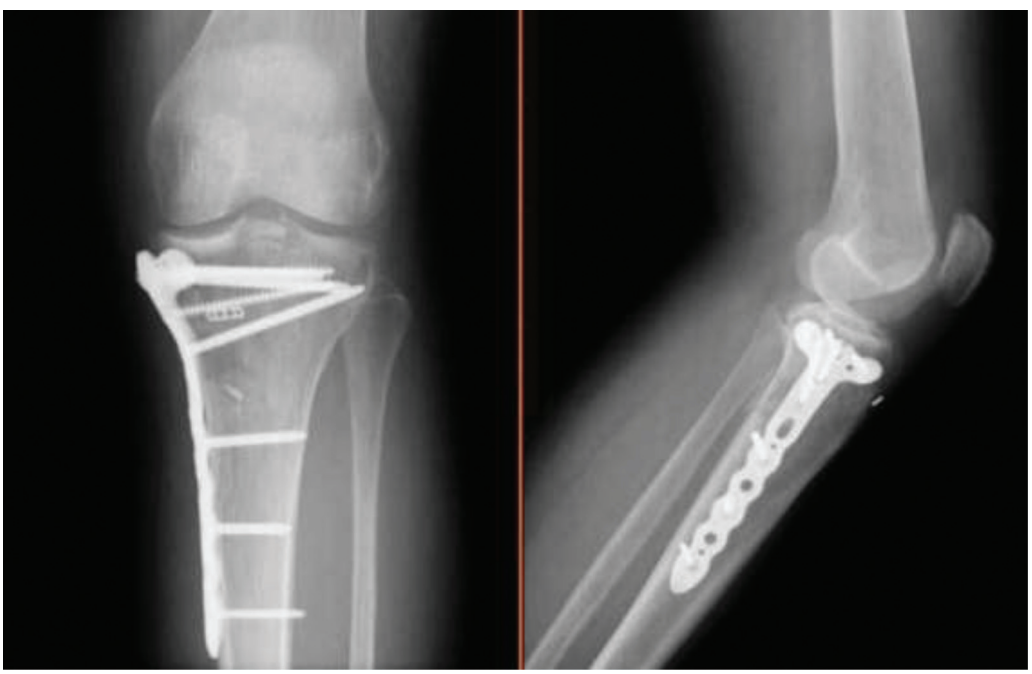


Fig. 6 Anteroposterior and lateral radiograph at the 3-month follow-up.

plateau fractures are associated with a tibial eminence fracture, and that 84.3% of the tibial spine fractures in adults coexist with a tibial plateau fracture.[2]

Regarding this specific combination of injuries, we found in the literature some reports on the approaches and outcomes.

Di Caprio et al.[2] performed a study with 29 patients with fracture of the tibial plateau and of the tibial eminence and described 2 arthroscopic techniques, similar to our own, to approach these injuries, with good results. As advantages of these arthroscopic and pull-out suture techniques, they pointed out the simplicity, low rate of intraoperative complications, and the ability to properly tension the anterior cruciate ligament. This study had the particularity that all the tibial plateau fractures were treated with percutaneous screw fixation.

Huang et al.[1] also studied this combined injury in a retrospective study with a minimal follow up of 5 years, using an identical 2 tunnel technique, with results comparable to those of Di Caprio,[2] but also stating that the technique did not interfere with the plate and screw fixation of the tibial plateau fracture, which is in line with our case.

Lubowitz et al.[3] describe another equivalent technique for fixation of the tibial eminence with nonabsorbable sutures, reporting advantages of eliminating the risk of comminution of the fracture fragment, need for hardware removal and posterior neurovascular injury.

Regarding the outcomes, Konda et al.,[5] when comparing patients with this combined injury with those with tibial plateau fractures alone, found slower recovery rates in the first group, but comparable functional outcomes at the 1-



Fig. 7 Third month post-operative flexion.

year follow up. Sapre et al.[11] also found good results with anatomic reduction with various arthroscopic techniques.

In the present article, we describe yet another combined surgical technique involving arthroscopy, nonabsorbable suture and plate fixation of this combined injury, with a good result at the 1-year follow-up. A timely and tailor-made rehabilitation program is also crucial to the clinical outcome. This data supports the aforementioned studies as an excellent surgical time approach to a complex lesion of the knee, with no incompatibility between the material for the tibial plateau and the fixation method for the eminence, good recovery times, and satisfiability.

Statement of Informed Consent

The patient was informed that data concerning the case would be submitted for publication and agreed.

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There was no financial support from public, commercial or non-profit sources.

Conflict of Interests

The authors have no conflict of interests to declare.



Fig. 8 Third month post-operative extension.

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Sensory and Motor Median Nerve Neuropathy Due to a Deep Giant Hand Lipoma: A Case Report

Neuropatia sensorial e motora do nervo mediano por um lipoma gigante na mão: Relato de caso

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Abstract

Lipomas are the most common soft-tissue tumors in the human body, but their location in the hand is rare. Symptomatic hand lipomas, due to nerve compression, are even rarer. We present a case of median nerve neuropathy as a result of a giant palm lipoma, located on the thenar and hypothenar areas of the hand. The patient had typical symptoms of carpal tunnel syndrome, along with compromised thumb motion. Intraoperatively, the recurrent motor branch of the median nerve was sitting on the lipoma under a great tension. This particular location of the motor branch of the median nerve in relation to the lipoma makes this case unique. The tumor was excised protecting the neurovascular structures, and a few weeks later the patient regained full thumb motion, grip strength, and resolution of dysesthesia.

Keywords

- carpal tunnel syndrome
- hand
- lipoma
- soft tissue neoplasms
- median nerve neuropathy

Resumo

Os lipomas são os tumores de partes moles mais comuns no corpo humano, mas sua localização na mão é rara. Os lipomas de mão que causam sintomas por compressão do nervo são ainda mais raros. Apresentamos um caso de neuropatia do nervo mediano decorrente de um lipoma palmar gigante, localizado nas regiões tenar e hipotenar da mão. A paciente apresentava sintomas típicos de síndrome do túnel do carpo, além de comprometimento dos movimentos do polegar. Durante a cirurgia, o ramo motor recorrente do nervo mediano repousava sobre o lipoma sob grande tensão. Esta localização particular do ramo motor do nervo mediano em relação ao lipoma torna este caso único. O tumor foi extirpado, protegendo as estruturas neurovasculares e, poucas semanas depois, a paciente havia recuperado totalmente os movimentos do polegar e força de preensão, além de apresentar resolução da disestesia.

Palavras-chave

- síndrome do túnel do carpo
- lipoma
- mão
- neoplasias de tecido mole
- neuropatia do nervo mediano

Introduction

Hand lipomas represent ~ 15% of all soft-tissue tumors in the body.[1] Their occurrence in the hand is rare, accounting to 1 to

Work carried out at the Orthopaedics Department, Agios Nikolaos General Hospital, Crete, Greece.

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3.8% of all benign hand soft-tissue tumors.[2] Their etiology remains unclear, but there is evidence supporting that either genetic, traumatic, or metabolic factors can cause them.[1,3] They are mainly asymptomatic, but neuropathy might develop, due to nerve compression, with subsequent pain and functional disability.[4] The main indications for surgical excision are pain, compromised function, cosmetic reasons, and large size.[5] We present the case of a female patient, who presented with a soft, enlarged mass on her right palm. She also described symptoms compatible with carpal tunnel syndrome, as well as compromised thumb movements. The patient was successfully treated with tumor excision. This case highlights a rare location of the recurrent motor branch of the median nerve in contact to a hand lipoma. Appropriate intraoperative figures are provided as well, to present this rare image adequately. This case presentation was performed in compliance with the world medical association of Helsinki on ethical principles for medical research involving human subjects and was reviewed by the Institutional Review Board.

Case Presentation

A 49-year-old female patient presented to our institution reporting a relatively large mass over her right palm. The patient noticed its presence 6 months prior to the appointment. She mentioned that this mass had gotten progressively larger over the last 3 months. During the same period, she developed tingling on the three radial digits, as well as compromised motion of her thumb and reduced grip strength. The patient had a few lipomas removed from her skull in the past. Her mother also had the same problem.

On examination, a soft, firm, mildly tender mass was located on the mid palm, extending from the thenar to the hypothenar area (►**Fig. 1**). Tumor's percussion reproduced tingling on the radial three digits, indicating a strongly positive Tinel sign. Palmar abduction of the thumb was weak as well. No thenar atrophy was identified, though, probably because patient's symptoms were not present for a long time. Carpal tunnel syndrome associated to median nerve compression caused by a hand lipoma was suspected. The patient underwent electromyography (EMG), which confirmed median nerve neuropathy. Magnetic resonance imaging (MRI) revealed a deep 5,7 × 2,4 × 2 cm palmar lipoma, and surgical excision was scheduled.

Under general anesthesia and humeral tourniquet application, a midline longitudinal volar incision, extending from the wrist crease all the way distally across the "lifeline," was performed. A large bilobulated yellowish tumor was identified between the palmar aponeurosis and underlying flexor tendons, occupying the thenar and hypothenar areas. It originated from the distal part of the carpal tunnel in close proximity to the median nerve. The recurrent motor branch of the median nerve was found to be under great tension, on the lipoma, and it was literally splitting the tumor into two lobes (►**Figs. 2**, **3**). We believe that this intraoperative image is unique. The lipoma had to be dissected for it to be removed safely, without damaging the nerve (►**Fig. 4**). The carpal tunnel was also released to achieve an adequate decompression of the median nerve (►**Fig. 5**).

The wound healed uneventfully and 3 months later, the patient reported complete resolution of dysesthesia and improved thumb motion. It is though noticed mild stiffness of the fingers, probably due to some form of algodystrophy, which is currently managed with physiotherapy.

Discussion

Lipomas, although common benign tumors, rarely present in the hand. They are predominantly superficial and asymptomatic. Hand lipomas located in the deep palmar space are more infrequent.[6] Their etiology is multifactorial. Traumatic, genetic, and metabolic factors have been considered as potential causes. Genetic mutations in the chromosomal region 12q13–15 have been incriminated.[1,6] Our patient reported the excision of multiple lipomas' from her skull in the past, as well as a genetic predisposition, indicating a probable familial multiple lipomatosis. Blunt trauma may lead to a lipoma formation through preadipocyte tissue differentiation, stimulated by inflammatory mediators' release and hematoma creation. Metabolic disorders, such as diabetes, hyperlipidemia, and endocrinopathies have also been related to lipomas.[3]

It is widely accepted that tumors larger than 5 cm are considered giant lipomas,[1,2,4] and they present a higher possibility of malignancy.[7] Hand lipomas can be either superficial or deep. Deep lipomas are categorized as



Fig. 1 Clinical Image of the patient's right palm. A soft-tissue mass of the thenar and hypothenar area is visible.

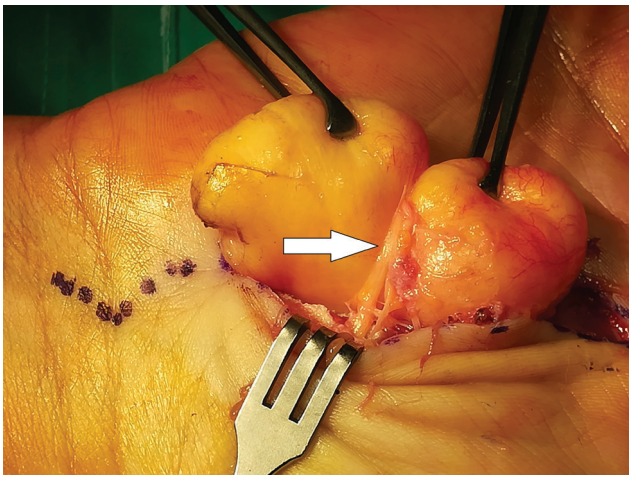


Fig. 2 Intraoperative view showing the recurrent motor branch of the median nerve (white arrow), sitting between the lipoma's two lobes. The nerve is obviously under tension.

endovaginal, if they are located inside the tendon sheath, or epivaginal, if they are located outside of it.[6,8] Depending on their location, hand lipomas can be either asymptomatic or they can produce pain, tingling or motor deficits via compressing adjacent structures, such as nerves or tendons. The former symptoms along with tumor size and cosmetic concerns, are indications for surgery.[3,9]

Several cases of median nerve compression have been reported in the literature, mimicking a carpal tunnel syndrome,[1,2,5,6] but very few cases are reported having a compromised thumb motion due to compression of the median nerve's motor branch.[9] Our case involved dysfunction of the thenar muscles, confirmed by EMG studies, in addition to fingers' tingling due to median nerve neuropathy, which was caused by compression of the lipoma. Most lipomas are superficial, and they might compress palmar structures from above, whereas deep lipomas can blend with nerves or tendons in various ways. One can find them passing either above[10] or even through the tumor.[9] Our case represents a very rare image of the recurrent motor branch of the



Fig. 4 Excised lipoma. It had to be dissected into two parts, to avoid damaging the motor branch of the median nerve. The two pieces are approximated in this photo.

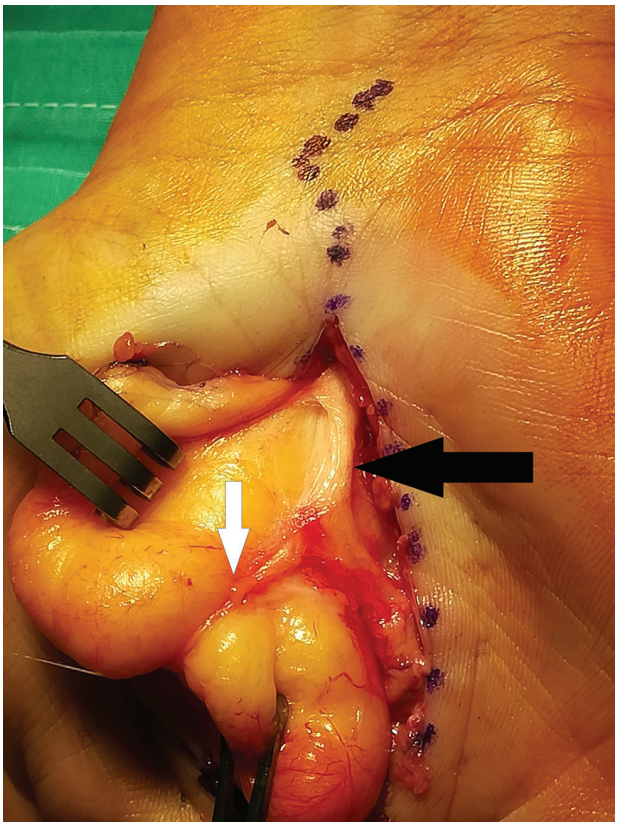


Fig. 3 Intraoperative view after releasing the distal part of the carpal tunnel. The median nerve (black arrow) and its motor branch (white arrow) are lying onto the tumor.



Fig. 5 View of the palm after lipoma excision. White arrow is pointing at the recurrent motor branch of the median nerve.

median nerve, which was passing above the tumor, between its two lobes, making the nerve vulnerable during excision.

Surgical excision, when indicated, is the treatment of choice for hand lipomas. Few complications are possible, such as hematoma, and paresis or dysesthesia due to iatrogenic nerve injury. Recurrence is very rare and concerns mainly incompletely resected deep lipomas.[3] Malignant transformation is also extremely rare.[9]

Conclusion

We report a rare case of sensory and motor median nerve neuropathy caused by a deep palmar giant lipoma. The close relation of the recurrent motor branch of the median nerve to the lipoma, which is described in our case, highlights the attention required from the surgeon during surgery to avoid a devastating iatrogenic injury.

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Conflict of Interests
The authors declare that there is no conflict of interests.

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Osteoblastoma of the Capitate Bone: Case Report

Osteoblastoma do capitato: Relato de caso

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Abstract

Carpal bone tumors must be investigated in clinical cases of chronic wrist pain with no previous trauma. Intraosseous ganglion, enchondroma, osteoid osteoma, and, less commonly, osteoblastoma are potential causes of osteolytic lesions affecting the carpal bones. In most cases, the clinical presentation alone is not enough to differentiate such lesions. Knowledge of certain characteristics, including the radiological and histopathological aspects of each of these tumors, is critical in order to make the differential diagnosis. We present a rare case of osteoblastoma of the capitate bone and review the literature on the subject.

Keywords

- carpal bones
- osteoblastoma
- bone neoplasms
- hand

Resumo

Os tumores dos ossos do carpo devem ser investigados em quadros clínicos de dor crônica no punho sem trauma prévio. Gânglio intraósseo, encondroma, osteoma osteoide, e, menos comumente, osteoblastoma são possíveis causas de lesões osteolíticas que afetam os ossos carpais. Na maioria dos casos, a apresentação clínica por si só não é suficiente para diferenciar essas lesões. Conhecer características como o aspecto radiológico e histopatológico de cada uma delas é parte fundamental do diagnóstico diferencial. Apresentamos um caso raro de osteoblastoma do osso capitato, e também fazemos uma revisão da literatura sobre o assunto.

Palavras-chave

- ossos do carpo
- osteoblastoma
- neoplasias ósseas
- mão

Introduction

Carpal bone tumors are suspected in clinical presentations of chronic wrist pain with no history of previous trauma. Injuries with osteolytic features are often intraosseous ganglia, enchondroma, osteoid osteoma, and, less commonly, osteoblastoma.

Osteoblastomas are benign neoplasms that form bone cells. They represent 1% of tumors, and their most common locations are the posterior elements of the spine, pelvis, and long bones. The carpal bones are rarely affected, and involvement of the capitate bone is even less common.[1–3] The present study describes a case of osteoblastoma of the capitate bone and reviews the current literature on the subject.

Case Report

A 40-year-old, female, right-handed patient with a history of progressive pain on the dorsal face of the right hand for 2 years. The patient denied previous traumas, infections or other symptoms associated with the condition.

Work carried out at the Hospital das Clínicas, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil.

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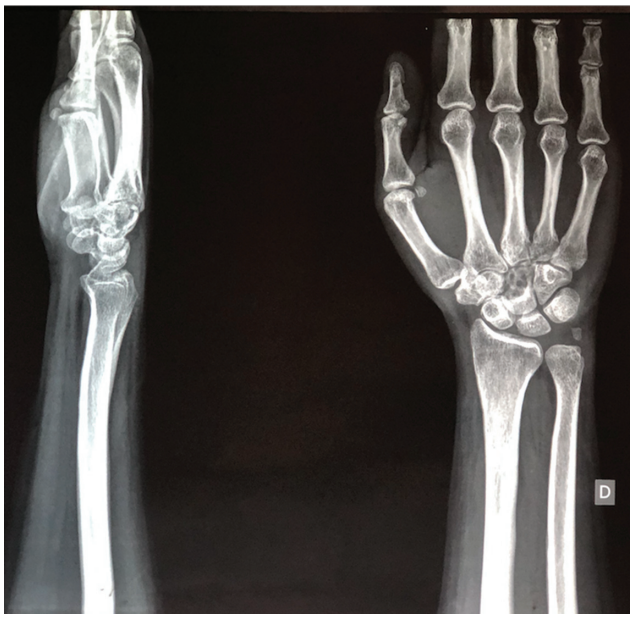


Fig. 1 Initial radiograph of the right wrist, revealing a well-defined osteolytic lesion at the capitate bone.

The patient presented a swelling at the affected area and functional impairment to perform basic activities of daily living.

An examination revealed a slight reduction in flexion in the right wrist, decreased grip strength, and pain on palpation of the capitate bone. The ectoscopy showed no changes.

Initial radiographs showed a well-defined osteolytic lesion with a sclerotic margin and a lobulated aspect at the capitate bone (►**Fig. 1**).

There were no calcifications or extensions to soft parts or other bones. Due to the non-specific aspect on radiography, a computed tomography was requested, revealing a lesion with a central hypodense component and well-defined hyperdense margins restricted to the distal portion of the capitate bone (►**Fig. 2**).

Surgical treatment with intralesional resection and an ipsilateral olecranon bone graft was indicated because of the significant pain and functional impairment. The resected specimen was sent for an anatomopathological study (►**Fig. 3**).

The histopathological analysis of the bone-tissue fragments revealed a benign lesion consisting of young and mature bone tissue, with no atypia, permeated by fibrous tissue, diagnosed as an osteoblastoma (►**Fig. 4**).

One week after the procedure, the patient presented a significant improvement in pain, which was sustained at subsequent evaluations at 3, 6 and 12 weeks after the procedure (►**Fig. 5**).

The patient showed good functional recovery according to the Disability of the Arm Shoulder and Hand (DASH) questionnaire, and gradually resumed her activities.

Discussion

Reports of carpal bone osteoblastoma are infrequent, and the involvement of the capitate bone is even rarer. Kaptan and

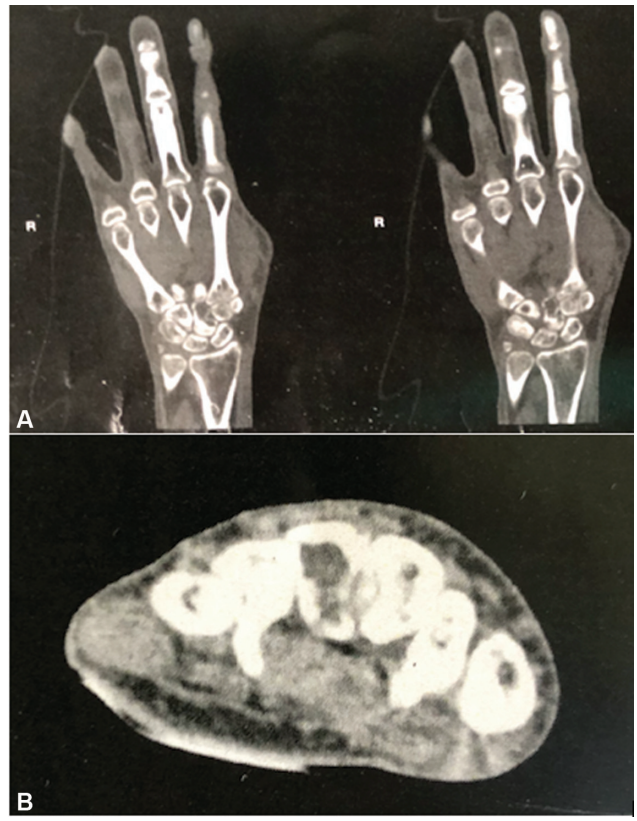


Fig. 2 Computed tomography of the right hand. Coronal (**A**) and axial (**B**) sections. There is a well-defined hypodense lesion at the right capitate bone, with hyperdense margins, and no involvement of other hand bones.

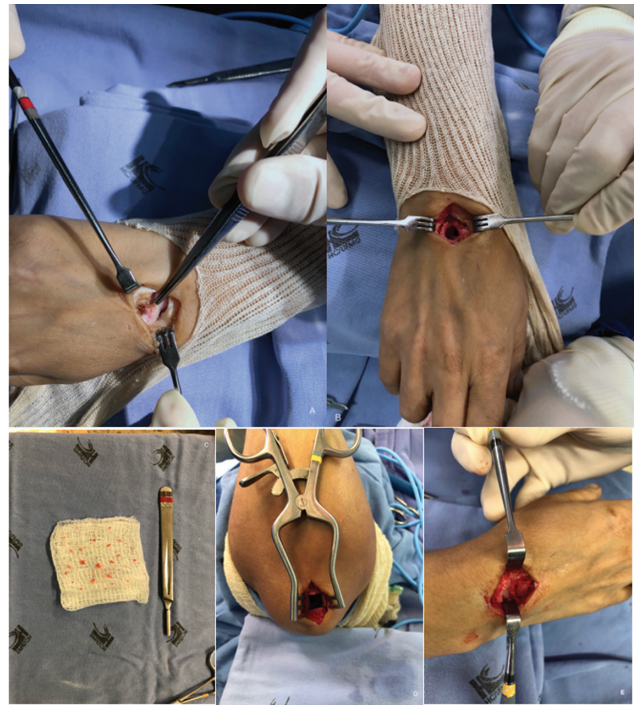


Fig. 3 Perioperative period. (**A**) Perioperative aspect of the lesion at the right capitate bone. (**B**) Bone cavity after lesion curettage. (**C**) Resected specimen sent for an anatomopathological examination. (**D**) Bone-graft donor area at the right olecranon. (**E**) Bone defect filled with an olecranon graft.

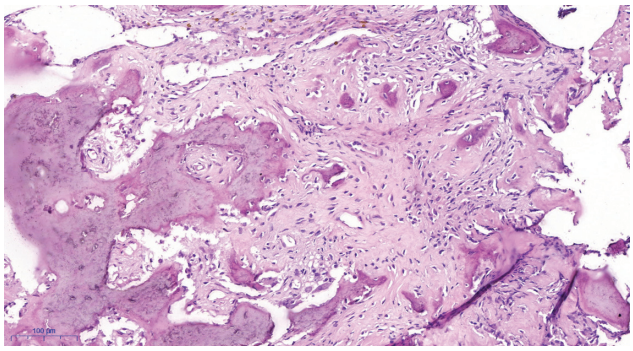


Fig. 4 Histopathological aspect of the resected specimen, revealing young bone tissue and some trabeculae of mature bone tissue, with no atypia, permeated by fibrous tissue.

Atmaka[2] and Afshar[3] reported this tumor location in their respective studies, while Murray et al.,[4] in their series with 26,800 primary bone tumors, cite a single case of osteoblastoma of the capitate bone.

Osteoblastomas are benign neoplasms arising from bone tissue. Microscopically, they are characterized by trabecular bone and fibrovascular stroma with the production of primitive osteoid tissue.[1,5]

These tumors affect mainly patients in their second and third decades of life, preferably males, in a 2-3:1 ratio.[1–3] Our patient, a 40-year-old woman, was did not fit the most common epidemiological profile.

Although they can affect any bone, 40% to 50% of the lesions are at the spine, preferably its posterior elements.[1] They rarely affect hand bones.[2,3] As such, the diagnosis of osteoblastoma is often not considered in cases of primary carpal bone tumors.

Radiographically, osteoblastoma presents as a centralized, mineralized nidus with a surrounding radiolucent halo and reactive sclerosis, or as a well-defined, mixed (both lytic and blastic) mass with sclerotic margins.[1,5] Computed tomography and magnetic resonance imaging reveal a heterogeneous, circumscribed mass, with cystic components, edema, and reactive bone.[5] Progressive, constant pain unresponsive to salicylates is the most common symptom,[6] as in our case.

Osteolytic lesions are not a frequent cause of chronic wrist pain,[6] but they must be considered, especially when there is no history of local trauma. Some examples are intraosseous ganglion, osteoid osteoma, enchondroma and osteoblastoma.[6,7] Knowledge of the clinical characteristics of each of these lesions is essential to differentiate them.

The differentiation of osteoblastomas and osteoid osteomas is a frequent challenge. Osteoid osteomas are more frequent in the hand.[8] It typically presents as a lesion < 1.5 cm, with a central nidus surrounded by a sclerotic zone. The pain is severe, worse at night, and relieved by salicylates.[5]

Microscopically, both lesions are very similar; bone trabeculae lined by a single layer of osteoblasts, a tapered circumscription, and a loose arrangement of tissue are the characteristics that favor the diagnosis of osteoblastoma.[1]

In bone tumors of the hand, enchondromas are an important differential diagnosis, since they are the most common primary bone tumor of the hand.[6,8] Their classic radiographic appearance is that of a a well-defined osteolytic lesion with dotted calcifications.[6]

Another differential diagnosis, the intraosseous ganglion is an asymptomatic, benign cystic lesion, and an incidental

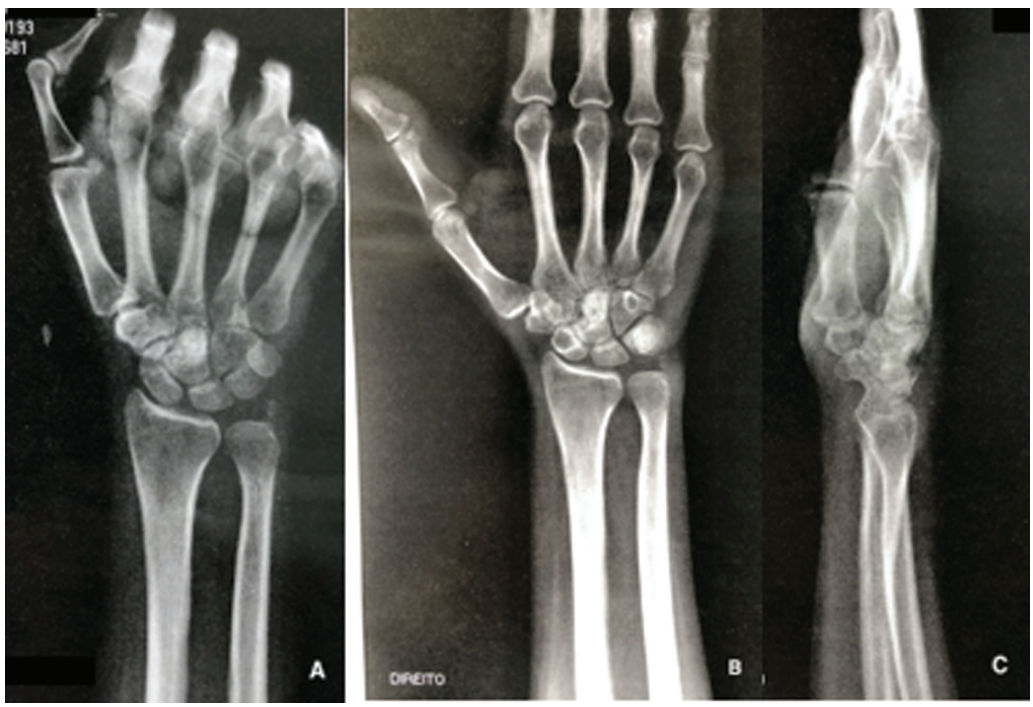


Fig. 5 Radiographs of the right wrist eight weeks after surgery. Good integration of the bone graft into the right capitate bone, with no signs of lesion recurrence. Posteroanterior view with clenched fist (**A**), posteroanterior view (**B**), and lateral view (**C**) of the right wrist.

finding on imaging studies in approximately 80% of the cases.[9]

Radiographically, it presents as a cystic, unilocular, non-expansive, well-defined lesion with sclerotic borders. Magnetic resonance imaging shows a hyposignal lesion in T1-weighted images with hypersignal in fat-suppressed sequences. Microscopically, it is characterized by mucoid tissue, myxomatous degeneration of connective tissue, and fibrous walls.[7]

The treatment of osteoblastomas is still a matter of debate. Studies suggest that the tumor may undergo malignant transformation,[7] and recurrence rates between 10% and 20% are reported.[3,5] Therefore, some authors indicate a range of procedures, from complete lesion resection to curettage with or without bone grafting.[3,10] Castelló et al.[10] described good outcomes after curettage and defect filling with a bone graft.

In the case herein reported, the clinical presentation and radiographic appearance initially did not enable a specific diagnosis of an osteolytic lesion. However, due to the non-aggressive behavior of the lesion, its benign characteristics, and the lack of extension to soft parts or other bones on imaging tests, we decided for curettage and defect filling with a bone graft. The resected specimen was sent for an anatomopathological examination, which later suggested the diagnosis of an osteoblastoma.

We presented a rare case of osteoblastoma of the capitate bone as a cause of chronic wrist pain, in addition to a review on the subject. Thus, osteoblastomas can be considered a diagnosis of exclusion for an osteolytic lesion at the level of the carpal bone.

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Conflict of Interests
The authors have no conflict of interests to declare.

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Letter to the Editor – Brazilian and US-American Researchers Cite Articles Written by Brazilian Authors in Revista Brasileira de Ortopedia

Carta ao editor – Pesquisadores brasileiros e norte-americanos citam artigos escritos por autores brasileiros na Revista Brasileira de Ortopedia

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In a previous work Giordano et al.[1] studied the frequency of citations to articles previously published in RBO. They had focused on the reference lists of the last 15 articles published in 2020 in RBO and 5 international orthopedic journals. They found 10 citations among 386 papers (2.6%) of the journal, but could not find any citation to RBO in the international journals. So the authors concluded that Brazilians do not cite Brazilians.

We re-analyzed this issue using a considerably larger database and two different statistical approaches:

We based our study on Clarivate's Data which contains bibliographic information and citations of more than 20,000 indexed scientific journals. We restricted all searches to original articles, reviews and case reports. For the first mathematical evaluation we looked for all RBO articles published between 2007 and 2020 and citations to them in 2020-2021. There were 1,318 publications written by Brazilian authors with 794 citations to them in 2020 (with 34 self-citations). Among these citations, 163 (20.7%; CI95%: 17.9%-23.7%) had Brazilian, 176 (22.0%; CI95%: 19.5%-25.4%) had US-American, and 106 (13.4%; CI95%: 11.1%-16,0%) had Chinese authors or co-authors. The confidence intervals suggested that Brazilians and US-Americans cited RBO articles of Brazilian origin with a similar frequency.[2]

In the second approach we collected separately for each year between 2013 and 2020 RBO articles written by Brazilian authors (►**Table 1**). Then, we looked for the citing articles which had been published in the same year or the following biennium (now called three-years-period) and counted separately the number of articles written by Brazilian, US-American or Chinese authors/coauthors.

A total of 971 documents were included, and 862 had been written by Brazilian researchers. These publications yielded a total of 889 citations. Self-citations were not found. Then we calculated for the Brazilian RBO publications, individually for each year, the mean number of citing articles written by Brazilian, US-American or Chinese researchers. The global Friedman exact test for dependent groups showed significant differences ($p = 0.030$). In order to detect differences between individual groups in a post-hoc procedure, we applied the Wilcoxon exact test followed by an adjustment of the alpha-level, which was necessary due to multiple testing.[3] We could not demonstrate a significant difference between mean citations to Brazilian documents coming from Brazilian or the US-American authors ($p = 0.945$). But there were fewer citations made by Chinese researchers, when compared with Brazilian ($p = 0.016$) or US-American authors ($p = 0.023$). The alpha-level was adjusted to $\alpha = 0.025$ did not change these results.

All statistical procedures were performed with SPSS 22 software.

Our two statistical investigations showed that documents published in RBO by Brazilian authors had been cited by Brazilian and US-American researchers to an equal amount

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Table 1 Number of publications and citations in *RBO*

Year	all articles[a]	articles of Brazilian authors[b]	3 years citations to Brazilians[c]	Mean Nr. of all citing articles[d]	Mean Nr of citing articles of Brazilians[e]	Mean Nr of citing articles by US-Americans[f]	Mean Nr of citing articles by Chinese[g]
2013	98	93	17	0.183	0.097	0.032	0.022
2014	119	110	54	0.491	0.209	0.055	0.064
2015	125	118	101	0.856	0.263	0.127	0.119
2016	122	115	141	1.226	0.270	0.374	0.148
2017	130	112	163	1.455	0.241	0.473	0.116
2018	125	101	165	1.634	0.267	0.356	0.277
2019	121	104	125	1.202	0.240	0.231	0.183
2020	131	109	123	1.128	0.248	0211	0.193
mean ± st. dev	121.38 ± 10.2	107.75 ± 8.10	111.13 ± 52.16	1.022 ± 0.487	0.229 ± 0.057	0.232 ± 0.159	0.140 ± 0.079

[a]all articles, reviews and case reports, with authors of all nationalities published in this year in RBO.
[b]articles, reviews and case reports written by Brazilian authors in this year in RBO.
[c]total number of citing articles related to Brazilian publications in the three-years-period.
[d]mean number of all articles (three-years-period) citing publications written by Brazilian authors.
[e]mean number of citing articles (three-years-period) written by Brazilian researchers to Brazilian publications.
[f]mean number of citing articles (three-years-period) written by US-American researchers to Brazilian publications.
[g]mean number of citing articles (three-years-period) written by Chinese researchers to Brazilian publications.

and to some lesser extent by Chinese authors and researchers from other countries. This suggests that Brazilian and US-American authors take Brazilian orthopedic research into consideration in a similar way. Since our study was performed on a very large international database, we believe that our results are highly representative of the reality.

Conflict of Interests

The authors have no conflict of interests to declare.

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Answer to Letter to the Editor Regarding the Article "Brazilian and US-American Researchers Cite Articles Written by Brazilian Authors in Revista Brasileira de Ortopedia"

Resposta à carta ao editor referente ao artigo "Pesquisadores brasileiros e norte-americanos citam artigos escritos por autores brasileiros na Revista Brasileira de Ortopedia"

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Rev Bras Ortop 2024;59(2):e334–e335.

We thank the colleagues for their contribution to the information presented in our 2021 study, corroborating a previous observation made by one of the authors of that article.[1,2] Certainly the study carried out by the colleagues presents a broader evaluation and uses statistical tests that clearly show that Brazilian and North American authors consider Brazilian orthopaedic research in a similar way.[3] This finding is of extreme relevancy, showing that colleagues from another country consider our scientific production. Undoubtedly this reflects one of the great achievements carried out in recent years by placing our largest journal on the largest scientific data search platform in the world.

In the study carried out by colleagues, an increase in the number of articles published by the Revista Brasileira de Ortopedia over the seven years included in **Table 1** is clearly observed, going from 98 in 2013 to 131 in 2020. In parallel, it is noted that the number of citations to Brazilian authors also increased, going from 17 in 2013 to 123 in 2020. Interestingly, the number of articles by Brazilian authors in this same period did not increase significantly, going from 93 in 2013 to 109 in 2020. In the same way, it is observed that the number of citations (excluding self-citations) increased from 2013 (0.097) to 2020 (0.248), however it still seems to us that it remains quite low for the quality of scientific production developed in our country.[3]

It was exactly this aspect what we wanted to raise and bring to the discussion in our article, as currently the most used model both for evaluating scientific journals and the visibility of what is published by the author continues to be the impact factor (IF). IF was proposed the "journal impact factor" to evaluate journals in the Citation Index and to assist librarians in choosing which journals to subscribe to.[4] In a relatively simple formula, a journal's IF is an average of the citations that papers published in the previous two years attracted that year. Although it has become a staple in many types of analyses of a journal's scientific impact, recently the application of the journal impact factor in politics and decision-making in academia has been criticized as it can often be based on false beliefs and unjustified inferences.[5] For sure, a more effective indicator could involve considering the total number of citations a publication receives from its year of publication up to the end of the most recent year.[6]

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While this aspect remains an active and critical point of discussion in academia, including the fact that it is a scientometric index calculated by Clarivate and indexed by the Clarivate Web of Science, in our study we wanted to address which strategies that can be employed so that we can gradually, but solidly, increase the number of citations from Brazilian authors to Brazilian authors. The current study corroborates our thoughts that only the development and implementation of strong strategies can improve the visibility of the journal in the world academic-scientific scenario.

Conflict of Interests

The authors have no conflicts of interest to declare.

References

1 Giordano V, Lyra J, Bonadiman JA, Lech O. Brazilian authors don't cite Brazilian authors: Nothing has changed since 1994. Rev Bras Ortop 2021;56(02):154–160

2 Lech O. Os autores brasileiros não citam os autores brasileiros. [Editorial]Rev Bras Ortop 1994;29(09):

3 Letter to the Editor: Brazilian and US-american researchers cite articles written by Brazilian authors in Revista Brasileira de Ortopedia.

4 Wouters P, Sugimoto CR, Larivière V, et al. Rethinking impact factors: better ways to judge a journal. Nature 2019;569(7758):621–623

5 Paulus FM, Cruz N, Krach S. The Impact Factor Fallacy. Front Psychol 2018;9:1487

6 Ho YS, Giordano V, Mauffrey C, Giannoudis PV. Trends of impact factor contributors to the Injury Journal: A bibliometric analysis. Injury 2024;55(03):111255. Doi: 10.1016/j.injury.2023.111255

Corrigendum: Hip Development Dysplasia – Part 1

Displasia do desenvolvimento do quadril – Parte 1

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Rev Bras Ortop 2024;59(2):e336.

Corrigendum

Dear readers,
In the article "Developmental Dysplasia of the Hip – Part 1" (Rev Bras Ortop 2023;58 (6):e839–e846. Doi 10.1055/s-0042-1758371.), published online in *Rev Bras Ortop* in December 2023,
Where it reads:
developmental dsysplasia of the hip
It should read:
developmental dysplasia of the hip

DOI https://doi.org/10.1055/s-0044-1785684.
ISSN 0102-3616.

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MANUSCRIPT FORMAT

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The following graph shows what types of articles are accepted for publication, and what requirement they may have.

Article Type	Abstract Limit	Keywords Limit	Title Limit	Figures/Tables	Reference
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Update Articles (Up to 4,000 words)	Up to 250 words	Up to 6	N/A	5 (between tabels and figures)	Up to 60 References
Systematic Reviews and Meta-analysis (Up to 4,000 words)	Up to 250 words	Up to 6	N/A	3 Figures e 2 Tables	Up to 60 References
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Technical Notes (Up to 1,500 words)	Up to 250 words	Up to 6	N/A	5 Figures e 2 Tables	Up to 8 References
Letters to the Editor (Up to 500 words	N/A	N/A	N/A	2 Figures	Up to 4 References
Editorial (Up to 500 words)	N/A	N/A	N/A	N/A	N/A

- **Original Article**: It describes prospective or retrospective experimental research or clinical investigations, which may be randomized or double blind. It should have a Title, Structured Abstract (Objective, Methods, Results, and Conclusion), keywords, introduction, materials and methods, results, discussion, conclusions and references. Can have maximum of 6 authors. Maximum of 2,500 words, 30 references, 10 figures and 6 tables.
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Xumer Etoricoxibe | POTÊNCIA QUE ALIVIA

Adium



A FÓRMULA DO ALÍVIO UNE
POTÊNCIA DURADOURA[1-4]
E **SEGURANÇA GI[1,5-9]**

- Comodidade posológica: **1x/dia**[1,5]
- Rápido início de ação: **24 minutos**[1,3]
- Potência **analgésica** e **anti-inflamatória**[1,10]
- **Segurança**: menos riscos para o trato gastrointestinal[1, 5-9]



Apresentações com 7 e 14 comprimidos

Referências: 1. Bula do produto. **2.** Viscusi, Eugene R et al. "Perioperative use of etoricoxib reduces pain and opioid side-effects after total abdominal hysterectomy: a double-blind, randomized, placebo-controlled phase III study." Current medical research and opinion vol. 28,8 (2012): 1323-35. doi:10.1185/03007995.2012.707121. **3.** Harikrishnan, Nishalini, et al. "Pharmacokinetics and Bioequivalence of Generic Etoricoxib in Healthy Volunteers." Generics and Biosimilars Initiative Journal, vol. 10, no. 3, Pro Pharma Communications International, Sept. 2021, pp. 113–18. https://doi.org/10.5639/gabij.2021.1003.013. **4.** Yu, Qi et al. "Etoricoxib in the treatment of primary dysmenorrhea in Chinese patients: a randomized controlled trial." Current medical research and opinion vol. 30,9 (2014): 1863-70. doi:10.1185/03007995.2014.925437. **5.** Nor Azlin, M I et al. "The efficacy of etoricoxib vs mefenamic acid in the treatment of primary dysmenorrhoea: a randomised comparative trial." Journal of obstetrics and gynaecology : the journal of the Institute of Obstetrics and Gynaecology vol. 28,4 (2008): 424-6. doi:10.1080/01443610802150051. **6.** Xie, Long et al. "Preemptive Oral Etoricoxib on Health-Related Quality of Life after Mandibular Third Molar Surgery: A Randomized, Double-Blind, Placebo-Controlled Clinical Trial." BioMed research international vol. 2021 8888151. 6 Mar. 2021, doi:10.1155/2021/8888151. **7.** Capone, Marta L et al. "Clinical pharmacology of etoricoxib." Expert opinion on drug metabolism & toxicology vol. 1,2 (2005): 269-82. doi:10.1517/17425255.1.2.269. **8.** Takemoto, Jody K et al. "Clinical pharmacokinetic and pharmacodynamic profile of etoricoxib." Clinical pharmacokinetics vol. 47,11 (2008): 703-20. doi:10.2165/00003088-200847110-00002. **9.** Cannon, Christopher P et al. "Cardiovascular outcomes with etoricoxib and diclofenac in patients with osteoarthritis and rheumatoid arthritis in the Multinational Etoricoxib and Diclofenac Arthritis Long-term (MEDAL) programme: a randomised comparison." Lancet (London, England) vol. 368,9549 (2006): 1771-81. doi:10.1016/S0140-6736(06)69666-9. **10.** Brooks, Peter, and Paul Kubler. "Etoricoxib for arthritis and pain management." Therapeutics and clinical risk management vol. 2,1 (2006): 45-57.

XUMER® (etoricoxibe). Comprimidos revestidos de 60 mg e 90 mg. **USO ADULTO. USO ORAL. Indicações**: tratamento agudo e crônico dos sinais e sintomas da osteoartrite (OA) e da artrite reumatoide (AR). Tratamento da espondilite anquilosante. Alívio da dor crônica e aguda. Tratamento da dor aguda pós-operatória moderada a grave associada à cirurgia odontológica. Tratamento da dor aguda pós-operatória moderada a grave associada à cirurgia ginecológica abdominal. **Contraindicações**: contraindicado para pacientes com hipersensibilidade a qualquer um de seus componentes, em casos de insuficiência cardíaca congestiva (NYHA II-IV), doença cardíaca isquêmica, doença arterial periférica e/ou doença vascular cerebral estabelecida (incluindo pacientes que tenham sido submetidos recentemente à cirurgia de revascularização do miocárdio ou angioplastia). **Advertências e Precauções**: risco aumentado de eventos trombóticos (particularmente IM e AVC), deve-se utilizar a menor dose efetiva diária pelo período mais curto possível. Pacientes com fatores de risco significativos para eventos cardiovasculares (por exemplo, hipertensão, hiperlipidemia, diabetes *mellitus*, tabagismo) devem ser tratados com etoricoxibe apenas após criteriosa consideração. Há aumento adicional do risco de eventos adversos gastrintestinais (ulceração gastrintestinal ou outras complicações gastrintestinais) com o uso de etoricoxibe, outros inibidores seletivos da COX-2 e AINEs, quando administrados concomitantemente ao ácido acetilsalicílico (mesmo em doses baixas). Não é recomendado para pacientes com doença renal avançada. Cautela por pacientes que já tenham apresentado crises agudas de asma, urticária ou rinite desencadeadas pelo uso de salicilatos ou inibidores não específicos da cicloxigenase. **Categoria de risco na gravidez: C. Este medicamento não deve ser utilizado por mulheres grávidas sem orientação médica ou do cirurgião-dentista**. **Interações**: varfarina: proceder a monitorização padrão dos valores de INR ao se iniciar ou alterar o tratamento com Xumer® (etoricoxibe), principalmente nos primeiros dias tratamento. rifampicina, reduziu em 65% a área sob a curva(AUC) da concentração plasmática do etoricoxibe, metotrexate: monitorização da toxicidade relacionada ao metotrexato deve ser considerada quando este for administrado concomitantemente a doses maiores de 90 mg ao dia. Diuréticos, inibidores da enzima conversora de angiotensina (ECA) e bloqueadores do receptor de angiotensina II (BRAs): diminuem o efeito anti-hipertensivo dos diuréticos, dos inibidores da ECA e dos BRAs. Lítio: uso concomitante de etoricoxibe pode aumentar os níveis plasmáticos de lítio. Ácido acetilsalicílico: uso concomitante com etoricoxibe com baixas doses de ácido acetilsalicílico aumenta a incidência de úlceras ou de outras complicações do trato gastrintestinal. Anticoncepcionais orais: aumento na exposição ao etinilestradiol pode aumentar a incidência de eventos adversos associados aos anticoncepcionais orais, como eventos tromboembólicos. **Reações Adversas**: edema/retenção de líquidos, tonturas, dor de cabeça, palpitações, hipertensão, distúrbios gastrintestinais (por exemplo, dor abdominal, flatulência, pirose), diarreia, dispepsia, desconforto epigástrico, náuseas, aumento da ALT, aumento da AST, equimose, astenia/fadiga, doença semelhante à gripe **Posologia**: Deve ser ingerido com ou sem alimentos e ser administrado pelo menor tempo possível e deve ser utilizada a menor dose diária eficaz. Osteoartrite: a dose recomendada é de 60 mg uma vez ao dia. Artrite reumatoide: a dose recomendada é de 60 mg ou 90 mg uma vez ao dia. A mínima dose eficaz é de 60 mg uma vez ao dia. Em alguns pacientes, 90 mg uma vez ao dia pode proporcionar um aumento do benefício terapêutico. Espondilite anquilosante: a dose recomendada é de 60 mg ou 90 mg uma vez ao dia. A mínima dose eficaz é de 60 mg uma vez ao dia. Em alguns pacientes, 90 mg uma vez ao dia pode proporcionar um aumento do benefício terapêutico. Dor crônica: a dose recomendada é de 60 mg uma vez ao dia. Dor aguda: para condições de dor aguda, a dose recomendada é de 90 mg uma vez ao dia. Deve ser utilizado apenas no período sintomático agudo, limitando-se até 8 dias, no máximo. Dor pós-cirurgia odontológica: a dose recomendada é de 90 mg uma vez ao dia, limitada ao máximo de 3 dias. Dor pós-cirurgia ginecológica: a dose recomendada é de 90 mg uma vez ao dia, limitada ao máximo de 5 dias. A dose inicial deve ser administrada logo antes da cirurgia. **VENDA SOB PRESCRIÇÃO MÉDICA. SÓ PODE SER VENDIDO COM RETENÇÃO DE RECEITA. MS No. 1.2214.0127 SAC: 0800–016-6575. Informações adicionais disponíveis aos profissionais de saúde mediante solicitação a Adium Produtos Farmacêuticos S.A – www.adium.com.br - Para informações completas, consultar a bula do produto.** Cód. 0008.01

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