# Intravenous Use of Tranexamic Acid in Total Knee Arthroplasty with no Tourniquet*

## *O uso endovenoso de ácido tranexâmico na artroplastia total de joelho sem uso de torniquete*

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**Abstract**

**Objective:** To identify blood transfusion requirements and postoperative complications in patients undergoing total knee arthroplasty (TKA) with no tourniquet and intraoperative intravenous administration of tranexamic acid.

**Methods:** This retrospective observational study analyzed 49 preopeative and postoperative medical records of patients undergoing TKA. A paired t-test compared changes in hemoglobin (HB) and packed cell volume (PCV), and an independent t-test with Welch correction compared HB and PCV changes between genders. A Spearman correlation test determined associations between age and days of postoperative hospitalization with HB and PCV changes. The significance level adopted was $p < 0.05$.

**Results:** The patients' mean age was $71.9 \pm 6.7$ years; most subjects were women (73.5%). The right side (59.2%) was the most affected. Only one participant required a blood transfusion, while three subjects had complications during the postoperative follow-up. No patient had a thromboembolic event. The median length of postoperative hospital stay was 2 days (interquartile range [IQR] = 1.0). There were reductions in HB and PCV levels between the pre-operative and postoperative period, and female patients had a higher HB reduction.

**Conclusion:** TKA with tranexamic acid and no tourniquet did not cause significant postoperative complications or require blood transfusions.

**Keywords**
- tranexamic acid
- arthroplasty, replacement, knee
- tourniquet

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## Resumo

**Objetivo:** Identificar a necessidade de transfusão sanguínea e intercorrências inerentes ao pós-operatório de pacientes submetidos à artroplastia total de joelho (ATJ), a partir de manejos realizados sem o uso de torniquete e com administração de ácido tranexâmico endovenoso intra-operatório.

**Métodos:** Trata-se de um estudo observacional retrospectivo, a partir da observação de 49 prontuários médicos de pacientes submetidos à ATJ em pré e pós-operatório. Foi utilizado o teste t pareado para fazer comparações das modificações de hemoglobina (HB) e hematócrito (HT) e o teste t independente com correção de Welch para comparar as modificações de HB e HT entre os sexos. As associações de idade e dias de internação no pós-operatório com as modificações de HB e HT foram testadas pela correlação de Spearman. O nível de significância adotado foi $p < 0,05$.

**Resultados:** Os pacientes apresentaram idade média de $71,9 \pm 6,7$ anos. A maioria da amostra foi composta por mulheres (73,5%) e o lado direito (59,2%) foi o mais acometido. Apenas um participante necessitou de transfusão de sangue e três participantes apresentaram intercorrências durante o seguimento pós-operatório. Nenhum paciente apresentou evento tromboembólico. A mediana da duração da internação no pós-operatório foi de dois dias (IIQ= 1,0). Verificaram-se reduções nas dosagens de HB e HT entre o pré e pós-operatório, e pacientes do sexo feminino apresentaram maior redução de HB.

**Conclusão:** ATJ com uso de ácido tranexâmico e sem uso de torniquete não acarretou complicações pós-operatórias ou necessidade de transfusão sanguínea significativas.



**Palavras-chave**

- ácido tranexâmico
- artroplastia do joelho
- torniquete


## Introduction

Population aging and the growing demand for quality of life have increased the indication for total knee arthroplasty (TKA). Approximately 4% of the conditions in the Brazilian population are related to osteoarthritis; the knee is the second most affected joint, accounting for 37% of cases.[1,2] It is one of the most successful procedures in orthopedics, with more than 95% implant survival after 15 years. In addition, it significantly improves the patient's quality of life.[3,4]

TKA (►**Fig. 1**) is a surgical procedure often used to treat knee osteoarthritis. It causes considerable blood loss during surgery (on average, 1,000 milliliters [mL]), which relatively increases the need for blood transfusion. As such, TKA is usually performed with a high-pressure tourniquet around the leg during all or part of the procedure, creating a cleaner surgical field and restricting blood flow. It is worth noting that tourniquet is routinely used for TKA by more than 90% of surgeons in the United Kingdom, the United States, and Europe, being an uncontested practice for decades.[5,6]

At the same time, a study from Ahmed et al.[7] emphasizes that using a tourniquet during TKA is a practice focused only on benefits, with little consideration for potential harm. In addition, it presents substantial evidence-based




**Fig. 1** Total knee replacement.

risks since the tourniquet increases the risk of postoperative venous thromboembolism and contributes to higher pain levels. Therefore, it does not have a relevant advantage for the patients, making its use questionable in this context.

We emphasize the investigation of outcomes using tranexamic acid (TXA) as a strategy to reduce bleeding in major surgeries, such as TKA, due to the higher risk of blood transfusion-related infections and immune reactions. Guerreiro et al.[8] revealed that TXA at a dose of 1.0 g (at a 50 mg/mL concentration) decreased bleeding, minimized pain, and improved functional and flexion gain recovery, greatly contributing to postoperative recovery.

Therefore, the present study aims to identify the need for post-surgical blood transfusion in patients undergoing TKA with no tourniquet and intraoperative administration of intravenous TXA.

## Methods

This is an observational, retrospective study based on pre-operative and postoperative blood red cell indices from patients undergoing TKA. The study occurred in a reference hospital in Orthopedics and Traumatology.

The research sample consists of all TKA procedures performed by the same knee orthopedic surgeon from Orthopedics and Traumatology service clinical staff from this hospital between January/2020 and July/2021, totaling 49 patients. It is a study with a convenience sample, in which the researcher selects the elements with available access. This fact justifies the concentration of the sample group in the same place, making this study feasible in logistical and financial terms.

The inclusion criteria for this study were patients of both genders with knee osteoarthritis who underwent TKA with no pre-operative changes in HB and PCV or blood dyscrasia. Exclusion criteria were the following: evidence of joint infection, congenital or acquired coagulopathies, active intravascular coagulation, acute occlusive vasculopathy, hypersensitivity to Transamin® components, history of severe or moderate allergy to plasma transfusion, and large bone defects requiring bone grafting.

The surgical procedure used spinal anesthesia (15 mg of heavy bupivacaine and 60 to 80 mcg of morphine) and intravenous application of 1 g of TXA (four vials with 5 mL each at a 50 mg/mL concentration) diluted in 250 mL of 0.9% saline solution. The approach was medial parapatellar, followed by eversion and lateral dislocation of the patella, resection of the menisci and anterior cruciate ligament (ACL), a femoral and tibial section with specific guides, placement of prosthetic components, and testing their functionality. After surgery, the patients remained hospitalized in the ward for postoperative clinical and laboratory follow-up.

The criterion to determine the postoperative need for blood transfusion was Hb lower than 7mg/dL, PCV lower than 21%, or both. However, please note that adequate clinical judgment is essential to assess the need for transfusion regardless of laboratory values.

The collection of blood samples from all patients occurred in the intraoperative period before the incision and was repeated 24 hours after the surgical procedure. Outpatient follow-up took place with the first visit 15 days after hospital discharge and then every 30 days for 6 months to perform a routine orthopedic evaluation and observe potential intercurrences (for instance, persistent pain, excessive bleeding in the surgical wound, presence of thromboembolic events, etc.).

Data normality assessment used the Shapiro-Wilk test and visual analysis of the histogram, which indicated a parametric data distribution (except for hospitalization days in the postoperative period). Sample description used central tendency and dispersion measures (mean and standard deviation for variables with a normal distribution and median and interquartile range for variables with no normal distribution) and relative and absolute frequency (for categorical variables).

Comparisons between pre-operative and postoperative HB and PCV values employed the paired t-test. Changes in HB and PCV between the pre-operative and postoperative period were calculated as follows: postoperative values – pre-operative values. Comparisons of HB and PCV changes in HB and HT between genders used the independent t-test with Welch correction for heterogeneity of variances. The Spearman correlation determined the association of age and days of postoperative hospitalization with changes in HB and PCV. All analyses were performed at the statistical software STATA MP 14.1 (StataCorp, College Station, TX, USA), with a significance level set at $p < 0.05$.

The Research Ethics Committee (REC) approved this study with a waiver of the informed consent term (ICF).

## Results

This study obtained data from 49 patients who underwent total knee arthroplasty. Their mean age was $71.9 \pm 6.7$ years. Most patients were women (73.5%), and the right side (59.2%) was the most affected (►**Table 1**). Only one (2.0%) participant required a blood transfusion, while three (6.1%) subjects had complications during the postoperative follow-up (two presented persistent pain at the surgical site and one had excessive bleeding in the surgical wound until hospital discharge). No patient had a thromboembolic event. The median duration of postoperative hospital stay was 2 days (interquartile range [IQR] = 1.0).

►**Table 2** compares HB and PCV levels between the pre-operative and postoperative periods. HB ($t_{(48)} = 20.6$; $p < 0.01$; mean difference = -2.8 mg/dL) and PCV levels ($t_{(48)} = 18.7$; $p < 0.01$; mean difference = -7.8 mg/dL) decreased between the two time points.

►**Fig. 2** compares HB and PCV changes between the pre-operative and postoperative periods between genders. Women showed a higher HB reduction ($t_{(Welch)}$ (18.8) = -2.6; $p = 0.01$; mean difference = -0.8 mg/dL) and PCV ($t_{(Welch)}$ (19.7) = -2.8; $p = 0.01$; mean difference = -2.6 mg/dL) compared to men.

**Table 1** Sample characteristics

| | |
|---|---|
| **Age (M ± SD)** | **71.9 ± 6.7** |
| **Gender (n [%])** | |
| Female | 36 (73.5%) |
| Male | 13 (26.5%) |
| **Side (n [%])** | |
| Left | 20 (40.8%) |
| Right | 29 (59.2%) |
| **Transfusion (n [%])** | |
| No | 48 (98.0%) |
| Yes | 1 (2.0%) |
| **Intercurrences (n [%])** | |
| No | 46 (93.9%) |
| Yes | 3 (6.1%) |
| **Postoperative hospitalization days (median [IQR])** | 2.0 (1.0) |

Abbreviations: IQR, interquartile range; M, mean; n, number of participants; SD, standard deviation.

►**Table 3** correlates the age and number of postoperative hospitalization days with HB and PCV changes. There were no significant associations.

## Discussion

The literature regarding blood loss in total knee arthroplasty presents different results. Barros et al.[9] showed that TKA with no tourniquet led to HB and PVC changes of 2.04 and 6.82, respectively. In addition, 33.33% of patients required a blood transfusion. In contrast to our study, these authors did not use TXA. Tan et al.[10] stated that TXA is an essential ally in reducing bleeding. Indeed, in our study, the procedure with no tourniquet associated with intravenous TXA administration led to a single patient (2.04%) requiring a blood transfusion.

Monteiro et al.[11] corroborated these outcomes when comparing TKA procedures, revealing that patients who received intravenous TXA had a statistically significantly lower mean volume of blood drained than the other groups (with topical TXA or no TXA). These authors also observed no adverse effects or thromboembolic events in TXA-treated groups.

Almeida et al.[12] presented similar results in a sample of 101 patients undergoing TKA (51 TXA and 50 placebo). These authors found statistically significant reductions ($p < 0.05$) in the following parameters: HB, PCV, estimated blood loss, and drain output. All values were lower in the TXA group, and only patients from the placebo group required blood transfusions.

Regarding tourniquet use, we found that the surgical procedure without it did not present significant postoperative complications (6.12%). In a systematic review of the literature on TKA using a tourniquet or not, Ahmed et al.[7] observed that tourniquets were associated with a higher rate of serious adverse events, longer hospital stay, and higher mean pain score on the first postoperative day. As such, these authors concluded that the routine use of a tourniquet in TKA is not justified.

Like any study using data from medical records, one of the limitations of our research is the information collected, which is subject to the accuracy of those filling out and even not inserting it in the files.

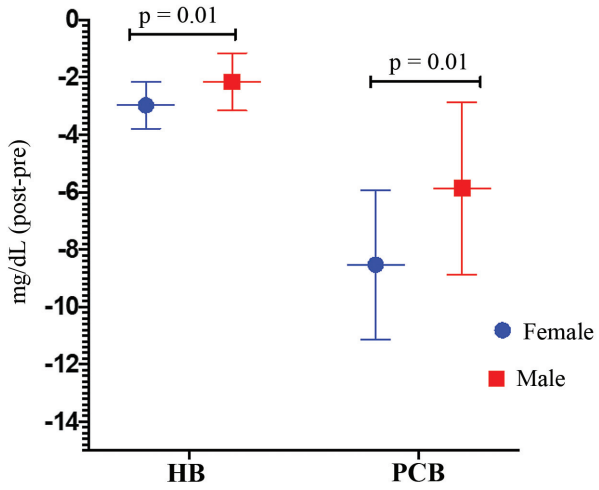


**Fig. 2** Comparison of hemoglobin (HB) and packed cell volume (PCV) between genders (n = 49).

**Table 3** Correlation between age and postoperative hospitalization days and hemoglobin (HB) and packed cell volume (PCV) levels alterations

| | HB alterations | PCV alterations |
|---|---|---|
| | Rho (p) | Rho (p) |
| **Age (years)** | 0.01 (1.00) | 0.02 (0.95) |
| **Postoperative hospitalization period (days)** | -0.12 (0.95) | -0.11 (0.98) |

Abbreviation: Rho, Spearman correlation.

**Table 2** Comparison between pre- and postoperative hemoglobin (HB) and packed cell volume (PCV) levels

| | Pre-operative | | Postoperative | | | | |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | Δ | t* | p* |
| **HB (mg/dL)** | 13.8 | 1.0 | 11.0 | 1.3 | -2.8 | 20.6 | <0.01 |
| **PCV (mg/dL)** | 40.9 | 3.4 | 33.1 | 4.1 | -7.8 | 18.7 | <0.01 |

Abbreviations: M, mean; SD, standard deviation; Δ, mean difference (postoperative – pre-operative levels). *: Paired t test.

## Conclusion

As expected, HB and PCV values diminished from the preoperative to the postoperative period. However, these reductions did not cause significant postoperative complications or require blood transfusions.

It is worth noting that the results of this study should not be analyzed in a generalized way, as they are limited to the sample and the study model adopted. However, they present hypotheses for testing in future research.

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Conflict of Interests
The authors declare no conflict of interests.

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