THORACOLUMBAR BURST FRACTURES: CORRELATION BETWEEN KYPHOSIS AND FUNCTION POST NON-OPERATIVE TREATMENT

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ABSTRACT

Objective: To assess the correlation between kyphosis and post-traumatic symptoms in patients undergoing conservative treatment for thoracolumbar burst fractures. Methods: A retrospective study was carried out with 36 patients meeting the inclusion criteria for this kind of fracture classified as Denis and Magerl's subtype A3 and treated with anti-gravitational casting or TLSO. The mean age of patients was 50.83 years, ranging from 13 to 83 years, being 20 male and 16 female subjects. The treatment outcome was evaluated based on the SF-36 questionnaire, on Denis scores for pain and work and Frankel clinical and neurological scale. The quantification of pain was based on the visual analogue scale for pain. The measurement of the residual kyphosis was obtained by the Cobb method at admission and at the end of the follow-up. Results: A weak positive correlation ($r = 0.563$; $p < 0.001$) was found between residual kyphosis and pain score (EVA). No correlation was found between final kyphosis and SF-36 and Denis scores ($p > 0.05$). Conclusion: There is no evident correlation between residual kyphosis, functional outcome and patients' symptoms.

Keywords – *Spinal fractures/therapy; Spinal fractures/complications; Kyphosis; Treatment outcome*

INTRODUCTION

Thoracolumbar burst fractures result from axial compression with rupture of the anterior and medial columns of the vertebral body, with retropulsion of bone fragments into the spinal canal and an increased interpedicular distance[1]. This region is a common site of injury, with an incidence ranging from 10% to 45%[1-3].

This type of injury is common in young individuals of productive age, resulting from high-energy trauma. It can be associated with other injuries such as fractures at other levels of the spine, the limbs, the pelvis and injuries to the chest and abdomen[4].

About 90% of all fractures of the spine occur between T11 and L4 and around 14 to 17% are classified as burst fractures. This region is sensitive to injury for three reasons: the loss of stabilization provided by the ribs and chest muscles, the transition of thoracic kyphotic curvature into lumbar lordotic curvature and changes in the orientation of joint facets from coronal in the thoracic spine to sagittal in the lumbar spine[4].

Some patients with burst fractures develop progressive mechanical instability, characterized by increased kyphosis, back pain, and neurological sequelae[1,5-7].

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Watson-Jones[5] considered simple treatment with bed rest for a few weeks to be inappropriate because the kyphotic deformity was progressive, leading to the mechanical instability of the spine, resulting in symptoms such as persistent local pain and early degenerative changes. He concluded that the solution would be to treat the injury as any fracture or dislocation of other regions of the body by reducing in extension and immobilization with a plaster cast until there was consolidation.

Nicoll[6] reported that the recurrence of deformity after reduction and prolonged immobilization was more common than expected and defined the comminution of the vertebral body, intervertebral disc injury, and disruption of the interspinous ligament as the most important factors for the loss of reduction. He also stated that good anatomic results were essential for a good functional outcome. Stable fractures (anterior and lateral wedging, lamina fractures above L4) were treated "functionally" with bed rest and progressive exercises, and unstable fractures (fracture-dislocation and lamina fractures below L4) with ortheses in a neutral position or the physiological position of the torso.

Unstable fractures with kyphosis > 30°, height loss > 50%, compression of the spinal canal > 50%, lesion of the posterior ligament complex and associated with neurological deficits usually present indication for surgical treatment by most authors[8-17].

However, in thoracolumbar burst fractures without signs of instability and a normal neurological examination, treatment is controversial. Proponents of surgery argue that this provides a better kyphosis correction, decreases pain and future degenerative changes, prevents neurological deterioration and recurrence of the deformity, reduces immobilization, rest and hospitalization[11,13,14]. In contrast, other authors report a good functional outcome in long-term follow-up, small progression of the deformity, a low incidence of neurological deficits, lower cost and fewer complications to be the advantages of conservative treatment compared with surgical treatment[2-23].

Despite the large number of publications on the conservative treatment of thoracolumbar burst fractures, most of the studies do not address or discuss the relationship between the final kyphosis and functional outcome in patients that are treated conservatively. When we look at this analysis, in general, the authors use their own questionnaires or the patient's subjective interpretation of pain, making interpretation of results difficult[14,16,23].

The objective of this study was to observe the correlation between post-traumatic kyphosis and the function and symptoms of patients undergoing conservative treatment of thoracolumbar burst fractures.

METHODS

A retrospective, cross-sectional study was conducted at the Department of Orthopedics and Traumatology, Santa Casa de Misericórdia de São Paulo. All of the records, radiographs, and axial slices of computed tomography (CT) of patients with burst fracture of the thoracolumbar spine were collected according to the Denis criteria(1), at the Medical Records and Statistics Department (SAME, Serviço de Arquivo Médico e Estatística), admitted between 1991 and 2008. This research project was approved by the Research Ethics Committee of the Department of Orthopedics and Traumatology, Santa Casa de São Paulo.

The patients included in this study had burst fractures according to the Denis criteria and the Magerl classification, subtype A3[24], with a time of injury less than 10 days prior to admission, affecting a single vertebra, without neurological impairment, with at least six months follow-up with conservative treatment, had been placed in a antigravitational plaster cast or a thoracolumbosacral orthosis (TLSO), and responded to the call for clinical re-evaluation through questionnaires and radiographs.

Exclusion criteria were fractures in two or more vertebrae, incomplete documentation (medical records, radiography, and CT), not responding to the call and having a pathological fracture, victims of gunshot injury, or with neurological deficits. We also excluded patients who were admitted more than 10 days after the date of the fracture (late fractures).

Patients were evaluated based on the Short-Form 36 quality of life questionnaire (SF-36)[25], using the validated Portuguese version. The Denis pain and work scales[1] were also used (Tables 1 and 2) and the neurological clinical status was evaluated according to the Frankel classification[26] (Table 3).

Table 1 – Functional pain scale according to Denis[1].

Score	Pain scale criterion
1	*No pain*
2	*Slight pain with no need for medication*
3	*Moderate pain with a need for occasional medication*
4	*Moderate to severe pain with a need for frequent medication*
5	*Severe pain and a chronic need for medication*

Source: Translated from Denis F.[1]

Table 2 – Denis functional work scale[1]

Score	Work scale criterion
1	*Returned to hard labor*
2	*Returned to sedentary work, without lifting restrictions*
3	*Returned to work, but changed work activities*
4	*Returned to work, reduced to part-time*
5	*Incapable of working*

Source: Translated from Denis F.[1]

Table 3 – Frankel classification[26].

Classification	Motricity	Sensitivity
A	*Absent*	*Absent*
B	*Absent*	*Present*
C	*Present, not useful*	*Present*
D	*Present, useful*	*Present*
E	*Normal*	*Normal*

Source: Translated from Frankel HL *et al.*[26]

The measurement of kyphosis was performed according to the Cobb method[27] upon admission to the hospital and at the end of treatment. The percentage of involvement of the spinal canal was measured on CT with millimetric ruler, according to the method described by Trafton and Boyd[28], using as normal value the average of the adjacent vertebrae.

A significance level of 5% was considered for the statistical analysis of this study. We used SPSS (Statistical Package for Social Sciences) version 13.0 to obtain the results.

Spearman correlation analysis was applied in order to ascertain the degree of relationship between the variables of interest, when studied in pairs. A further assessment was also carried out in the subgroup of patients with severe deformity (final kyphosis $\geq 30°$), in which we compared the means of the SF-36, Denis pain scale, and Denis work scale with the rest of the study population, using the Mann-Whitney test. We used the Wilcoxon test to determine the difference between the initial and final kyphosis during follow-up (Table 4).

Table 4 – Correlation between final kyphosis and pain score, SF-36, and the Denis pain and work scales[1].

Variable/final kyphosis	Correlation coefficient	P
Pain score	*0.563*	*< 0.001**
SF-36	*-0.120*	*0.484*
Denis pain	*0.149*	*0.386*
Denis work	*0.281*	*0.097*

Thirty-six patients met the inclusion criteria for this sample. The average age of patients was 50.83 years, with a minimum of 13 and maximum of 83 years; 20 were male and 16 female. The mechanism of injury was fall from a height for 24 patients, automobile accident for five, falling from standing height in five cases, and being buried by a landslide in one case. As for the fractured vertebra, we observed the T11 in one case, T12 in seven cases, L1 in 15 patients, L2 in 11 patients, and two at L3. All patients were without neurologic impairment at admission (Frankel E). The mean follow-up was 66.38 months, ranging from 13 to 185 months. The involvement of the spinal canal averaged 19.25%, ranging from 5 to 60%.

RESULTS

The mean initial kyphosis in the radiographic evaluation was 12.16°, ranging from 0 to 40° and the mean final kyphosis was 13.41°, ranging from 0 to 45°. There was no significant difference between the initial Cobb values and those at the end of treatment (12.1 vs. 13.4, $p > 0.05$). The difference of these values ranged from -11 to 45°, with an average of 1.38° (Table 5). All patients presented no neurological deficit (Frankel E) at the last examination (Figure 1).

In relation to pain, five patients were pain free, 15 had mild pain, 13 had moderate pain, and three had severe pain. As for work, 12 patients returned to hard labor, 10 returned to sedentary work, eight changed activities, one returned part-time, and five were unable to work.

There was positive correlation ($p < 0.05$, $r = 0.563$) between the final kyphosis and pain score (VAS), although this correlation was weak (Figure 2). There

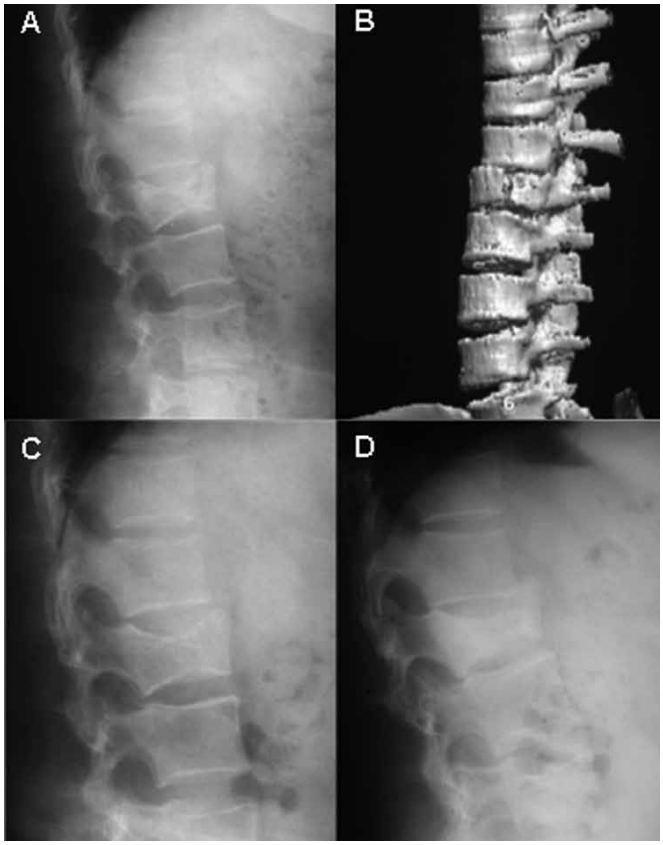

Figure 1 – A) Burst fracture of the first lumbar vertebra. B) Note the fragmentation of the vertebral body on the CT with reconstruction. C) Improved thoracolumbar alignment after plaster casting in hyperextension. D) Despite the loss of correction, the patient. is asymptomatic.

Table 5 – Correlation between final kyphosis and subdivisions of the SF-36[25].

Variable/final kyphosis	Correlation coefficient	P
Functional capacity	*-0.195*	*0.253*
Physical aspects	*-0.180*	*0.294*
Pain	*0.126*	*0.463*
General health status	*0.014*	*0.936*
Vigor	*0.060*	*0.728*
Social aspects	*-0.055*	*0.751*
Emotional aspects	*0.140*	*0.415*
Mental health	*0.032*	*0.852*

was no correlation between the final kyphosis and the score on the SF-36 questionnaires and the Denis scales, including their subdivisions (Table 6).

There was no difference between the mean scores of the SF-36 questionnaires (p = 0.450), the Denis pain scale (p = 0.142), and the Denis work scale (p = 0.081) in patients with kyphosis greater than or equal to 30° (five patients) or less than 30° (31 patients).

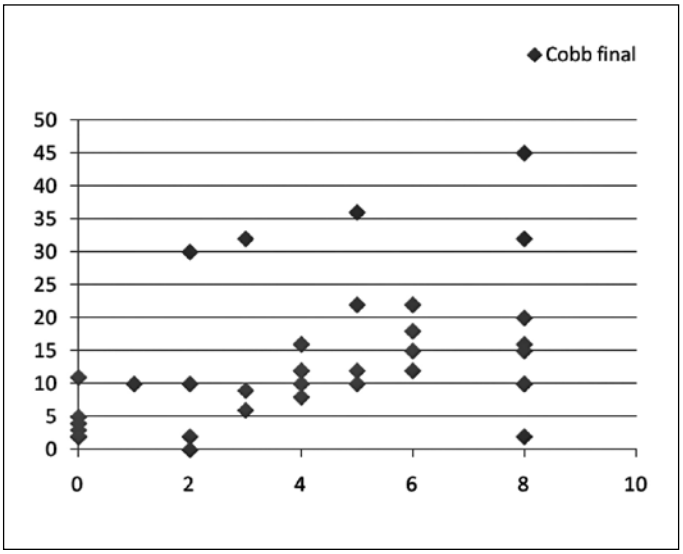

Figure 2 – Correlation between the VAS and final kyphosis.

Table 6 – Correlation between final kyphosis and subdivisions of the SF-36[25].

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DISCUSSION

Treatment of thoracolumbar burst fractures is a controversial topic. One of the arguments in favor of conservative treatment is the thesis of a reduced risk of patients developing post-traumatic painful kyphosis[1,5-7,29]. We found that the evaluation of conservative treatment is usually performed based on radiographic criteria. Moreover, most studies do not assess functional outcomes with cross-culturally validated scales. Some case series do not suggest a correlation between post-traumatic kyphosis and symptoms after conservative treatment of these fractures; however, many studies have small numbers of patients, subjective evaluation criteria, or do not consider Magerl subtypes[24] in their patients (Tables 1 and 2)[8,14,16,23]. In addition, some authors have suggested that kyphosis above

30° would indicate worse functional outcomes and, therefore, would indicate operative treatment[9-17,29], but we observed a lack of separate assessment in this group of patients submitted to conservative treatment. Gertzbein[29], with a multicenter series of 641 patients, associated kyphosis with pain; however, the evaluated group was heterogeneous (545 operated patients), and patients with kyphosis above 30° were not evaluated separately.

In contrast to the findings of Weinstein *et al.*[16] and Mumford *et al.*[23], we observed a correlation between the VAS score and the final kyphosis. But it is noteworthy that this correlation was weak. This assessment tool, which goes from 0 to 10, compared with Denis scales ranging from 1 to 5, can facilitate the numerical analysis of statistical estimation of pain in these patients. Future studies with larger series of cases may show a tendency that has not been observed in current studies with fewer patients.

Chart 1 – Distribution of patients with thoracolumbar burst fractures admitted into SCMSP between 1991 and 2008.

Patient	Sex	Age	Trauma	Level	Months	Initial kyphosis	Final kyphosis	Progression of deformity	VAS	SF-36	Denis pain	Denis work
1	F	63	Fall from a height	L2	121	13	2	-9	8	86	5	3
2	F	68	Fall from a height	L1	70	7	10	3	8	98	4	2
3	M	30	Automobile accident	T12	46	10	9	-1	3	98	2	1
4	M	56	Fall from a height	L3	35	3	6	3	3	98	2	1
5	M	63	Fall from a height	L2	52	0	2	2	0	89	2	1
6	M	75	Automobile accident	L2	60	3	0	-3	2	79	2	2
7	F	65	Fall from a height	L1	120	9	18	9	6	83	4	3
8	F	38	Fall from a height	T12	114	12	15	3	6	84	1	2
9	F	53	Fall from a height	L2	106	14	10	-4	5	85	3	2
10	M	35	Fall from a height	T12	42	10	3	-7	0	81	1	1
11	F	59	Fall from a height	T12	185	22	11	-11	0	98	2	3
12	F	50	Automobile accident	L1	128	1	4	3	0	99	5	2
13	F	57	Crushing	L1	66	10	15	5	8	99	1	3
14	M	41	Fall from a height	L1	51	20	22	2	6	82	3	1
15	F	28	Fall from a height	L2	45	10	2	-8	0	100	4	4
16	M	83	Fall from a height	L1	39	3	5	2	0	100	4	5
17	F	49	Fall from a height	L2	47	40	32	-8	3	100	3	2
18	M	13	Automobile accident	L1	14	3	2	-1	0	100	1	1
19	M	31	Fall from a height	L2	13	0	2	2	2	100	2	2
20	M	60	Fall from a height	L1	50	10	16	6	4	90	2	5
21	F	74	Fall from a height	L2	28	4	20	16	8	87	3	3
22	F	56	Fall from a height	T12	100	32	45	13	8	93	4	3
23	M	51	Fall from a height	T12	30	8	8	0	4	84	2	2
24	M	51	Fall from a height	L1	70	10	10	0	4	98	2	2
25	M	44	Fall from a height	L1	66	26	32	6	8	68	4	3
26	M	50	Fall from a height	L3	48	4	10	6	1	95	2	1
27	F	48	Fall from standing height	T12	31	16	22	6	5	89	3	2
28	M	70	Fall from standing height	L1	96	10	16	6	8	84	2	5
29	M	36	Fall from a height	L1	96	36	30	-6	2	100	2	5
30	M	35	Fall from a height	L1	36	6	12	6	4	90	2	1
31	F	73	Fall from standing height	L1	36	12	12	0	6	90	1	1
32	F	70	Fall from standing height	L1	62	8	12	4	5	100	2	1
33	M	51	Fall from a height	L2	93	10	10	0	8	89	3	5
34	F	29	Fall from a height	T11	25	30	36	6	5	96	3	3
35	M	40	Fall from a height	L2	60	10	10	0	2	96	2	1
36	M	35	Automobile accident	L2	109	16	12	-4	4	90	3	1

Legend: Age – years; M – male; F – female.

Chart 2 – Case series of thoracolumbar burst fractures.

Author	Initial Cobb	Final Cobb	N	Questionnaire used	Type of study
Weinstein16	26.4°	16.8°	42	VAS, pain scale, own functional questionnaire	Retrospective
Avanzi8	11.1°	12.7°	17	Pain scale, Denis	Retrospective
Cantor14	19°	20°	33	Denis, own functional questionnaire	Prospective
Mumford23	16.24°	20.12°	41	VAS, Roland & Morris, function – activities of daily living questionnaire	Prospective
Chow22	5.3°	7.6°	24	Denis modified (pain), own functional questionnaire	Retrospective
Shen21	20°	24°	38	Denis	Retrospective
Gertzbein27	12.4°	13.9°	96	Function – Frankel, Motor Score Index, (pain) questionnaire based on the use of medication	Prospective

To assess the quality of life and pain of the patients in our study, we used the Short-Form 36 questionnaires and the VAS scale. These instruments have been validated for use in Brazil and are invaluable for the analysis of patient-centered treatment outcome, based not just on radiographic criteria. Similar to our findings, no correlation was evident between kyphosis and symptoms or function in the spine after the conservative treatment in the case series reviewed[16,22,23].

To compare with our findings of 86.1% return to work activities, Mumford *et al*.[23] found that 90.3% of patients returned to work in a prospective study of 41 patients treated conservatively, with an average of two years follow-up. Other studies[8,14,16,21,22] showed values from 75 to 95%.

The pattern of results in relation to pain in this series is consistent with those found in the literature. Of the 33 patients studied by Cantor *et al*.[14], 18 (65%) had some degree of pain from the fracture, and in this series 61% of patients reported residual pain.

The mean progression of the deformity is discussed, however, there has been no statistical analysis more detailed of this finding. We found an average of 1.38° of deformity progression, but the findings had no statistical significance. This suggests that the kyphosis at the end of follow-up is similar to that found in the initial radiograph. Another advantage of this study is its focus on A3 subtype fractures. Most authors only consider the Denis classification based on the CT image, which in more detailed assessment may have components of Magerl subtypes A, B, or C[24], with different biomechanical characteristics.

Another issue to be discussed is the separate evaluation of the group of patients with kyphosis greater than 30°, which some authors consider to be a criterion for surgery due to the possibility of developing post-traumatic painful kyphosis. Despite this opinion, there is no objective assessment of this group of patients treated conservatively in the studies reviewed[1,5-7,30]. There were no worse functional outcomes in these patients; however, we must emphasize that the small number of cases (five) can hamper the final statistical analysis. Studies with a special focus on these patients should be performed.

The limitations observed in this study were its retrospective quality, with its inherent difficulty in monitoring the variables that may confound the findings – adherence to the use of orthoses, financial compensation, and other comorbidities – and the lack of a control group for comparison with operated patients. Other study designs should be made to improve the level of evidence of these results. However, the lack of these studies makes the case series study important.

CONCLUSION

There was no obvious correlation between post-traumatic kyphosis and progression of the deformity with the patient's pain after the conservative treatment of patients with a thoracolumbar burst fracture, Denis subtype A3, without neurological damage.

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