THORACOLUMBAR BURST FRACTURE: RELIABILITY OF THE GUERRA'S METHOD ON TOMOGRAPHIC ANALYSIS

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ABSTRACT

Objectives: The objective of the current study was to evaluate the correlation between neurological deficits and the characteristics of retropulsed fragment into the spinal canal in patients with thoracolumbar burst fractures. Material and Methods: From 1983 to 2004, 135 patients with thoracolumbar burst fractures according to Denis' criteria were evaluated at a tertiary teaching institution by two different observers. CT-Scans of the fractured spine were analyzed in order to assess the narrowing of the spinal canal. Neurological deficit was evaluated by using the Franke's classification. Results: A significant correlation was found between two independent observers ($P<0.05$). The observed characteristics of the retropulsed fragment into the spinal canal were: triangular form, rotation dislocation with average of 20 degrees and cranial dislocation with average of eight millimeters. There was no statistical correlation between neurological deficits and the characteristics of retropulsed fragment of the spinal canal. Conclusion: There was no statistical correlation between neurological deficits and the characteristics of retropulsed fragment of the spinal canal.

Keywords: *Spinal fractures. Tomography, X-Ray Computed. Wounds and I injuries. Thoracic vertebrae. Lumbar vertebrae.*

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INTRODUCTION

Thoracolumbar fractures are frequently found in multiple-trauma patients after cephalocaudal trauma[1], accounting for about 60% of the fractures in this region.[2] According to Holdsworth[3], this fracture compromises vertebral canal, thus presenting risk of associated neurological injury.

Denis[4], redefined these fractures by dividing the vertebra into three columns. The anterior column comprehends the anterior longitudinal ligament and the anterior half of the vertebral body and of the fibrous ring of the intervertebral disc; the mid column comprehends the posterior longitudinal ligament and the posterior half of the vertebral body and the fibrous ring of the intervertebral disc, and; the posterior column, by joint processes hinges, the spinous process and the posterior ligaments of vertebral spine. By definition, burst-type fractures reach the anterior and mid column, resulting in vertebral canal narrowing.[5,6]

With the advent of Computed Tomography (CT)[7], assessing the vertebral canal narrowing in a clearer and more objective way compared to plain X-ray images became possible. Canal narrowing at the axial section is suggestive of neurological injury.[8] However, there are few studies assessing retropulsed fragments on sagittal CT sections.[9] The anatomical site of this fragment and its correlation with neurological deficit may influence treatment strategies for surgical decompression of the vertebral canal.[10] In this study, we assessed the characteristics of a retropulsed bone fragment at sagittal plane, upon a retrospective analysis of medical files and CT scans in 11 years of experience in treating these patients. We also checked for the reproducibility of the fragment rotation measurement method between two independent investigators and its relationship with neurological deficit.

CASE SERIES AND METHODS

We conducted a cross-sectional retrospective study on patients with thoracolumbar burst fractures hospitalized between January 1983 and October 2004 upon approval by the Committee of Ethics in Research on Human Beings at our service. All tests were documented with computed Tomography scans taken with Tomoscan Philips equipment (300, 350, CX/Q, AV, EG) targeting bone tissue with mean width window of 2000 - 3200 Hounsfield[7] Units and mean window level of 200 - 300 Hounsfield[7] Units with 3 to 5mm-thick axial sections perpendicularly oriented to the longitudinal axis of the fractured vertebra's vertebral canal and its adjacent levels. For sagittal reconstruction, the interpolation technique was employed with 3 to 5mm-thick sections.

Exclusion criteria were: absence of tomographic studies with axial and sagittal sections, vertebral fractures on more than one level, gunshot injuries, pathological fracture, and fractures with over 10 days of evolution.

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Of the 138 patients included in the study, 100 were men (72.5%) and 38 were women (27.5%). Age ranged from 12 to 96 years (mean: 36.5 years). High fall was the most common mechanism of trauma, found in 106 cases (76.8%), followed by traffic accident, with 29 cases (20.9%). (Table 1)

Table 1 – *Frequency of patients vs. mechanism of trauma.*

TRAUMA	FREQUENCY	PERCENTAGE
High falls	106	76.8%
Car accident	14	10.1%
Motorcycle accident	6	4.3%
Crumbling	3	2.2%
Trampling	9	6.5%
Total	138	100.0%

Source: Medical File Service, ISCMSP

The most frequent injury level was L1 with 57 cases (41.3%), followed by L2 and T12, found in 51 patients (38%). (Table 2)

Table 2 – *Frequency of patients vs. fracture level.*

LEVEL	FREQUENCY	PERCENTAGE
T7	1	0.7%
T9	1	0.7%
T10	1	0.7%
T11	1	0.7%
T12	20	14.5%
L1	57	41.3%
L2	31	22.5%
L3	14	10.1%
L4	9	6.5%
L5	3	2.2%
Total	138	100.0%

Source: Medical File Service, ISCMSP

Neurological picture severity was determined at hospital admission, according to the scale by Frankel et al.[11]. (Chart 1)

Chart 1 – *Scale by Frankel et al.11, 1969*

FRANKEL	NEUROLOGICAL DEFICIT
A	Full sensitive and motor palsy below injury level
B	Full motor palsy, but some residual sensitivity present
C	Presence of sensitivity with residual motor function, not useful for the patient
D	Presence of sensitivity and motor function, but below normal levels
E	No neurological change

Vertebral canal compromising was checked out on axial tomographic sections with clear millimeter-graded rule and based on the mean sagittal diameter. Vertebral canal diameter was estimated by the average of values found on the anatomical match of adjacent vertebrae to the fractured site (Trafton and Boyd, 1984). On sagittal tomographic sections, cranial or tail displacement of retropulsed fragment was measured in millimeters. Based on the upper cortical of the vertebral body, rotation (in degrees) was divided into four groups (A-*0 -59*^{o}; B-*60 at 89*^{o}s; C-*90 at 149*^{o}; D- from *150*^{o}), according to the method recommended by Guerra et al.[9]

In order to check for reproducibility and reliability of the method of rotation measurements between two independent investigators, we used the Wilcoxon test. The non-parametric Kruskal-Wallis tests were used for studying differences on the mean values for vertebral canal narrowing between the different rotation groups; the Mann-Whitney test to assess the difference of mean values for rotation among patients with and without neurological dysfunction, and; the Spearmann test for assessing the correlation between vertebral canal narrowing and fragment rotation. For all tests, the adopted significance level was 5%.

RESULTS

Of the 138 patients admitted in our service, 24 showed neurological dysfunction, four of them (2.9%) graded as Frankel A; two (1.4%), as Frankel B; eight (5.8%), as Frankel C; ten (7.2%), as Frankel D; and 114 did not show neurological deficit (82.6%), being graded as Frankel E according to Table 3. The mean value for canal narrowing was 37^{o}, ranging from 5 to 100%.

Table 3 – *Frequency of patients vs. Frankel scale*

FRANKEL	FREQUENCY	PERCENTAGE
A	4	2.9%
B	2	1.4%
C	8	5.8%
D	10	7.2%
E	114	82.6%
Total	138	100.0%

Source: Medical File Service, ISCMSP

The 138 assessed cases showed a triangle-shaped retropulsed fragment originated at the posterosuperior region of the vertebral body. (Figure 1) Displacement occurred at sagittal plane in 119 patients (86.2%), ranging from 1 to 8 millimeters, 117 (98.3%) towards head and 2 (1.7%) towards tail. Concerning bone fragment rotation, the mean value was 20.1^{o}, ranging from zero to 150^{o}. The large majority of cases were included on group A, with 131 cases (94.9%). On groups B and C, only 6 cases (5%) were included. One patient showed 150° of rotation. (Table 4)

We found that the method of measuring rotation measurement findings, according to the method by Guerra et al.[9] is reproducible between two independent investigators ($p<0.005$). Also, no significant difference was found between mean values for vertebral canal narrowing on each studied rotation group ($p=0.052$). We

Table 4 – *Groups division and frequency of patients for rotation degree.*

GROUPS	DEGREE	FREQUENCY	PERCENTAGE
A	0º - 59º	131	94.9%
B	60º - 89º	2	1.4%
C	90º - 149º	4	2.8%
D	≥150º	1	0.7%

Source: Medical File Service, ISCMSP

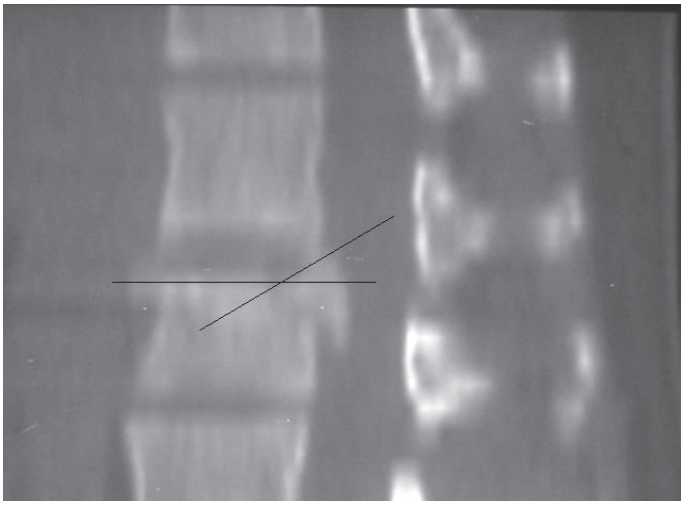

Figure 1 – *Note the trace for measuring bone fragment rotation protruding into the vertebral canal.*

could not assess the statistical correlation between the presence of neurological deficit and degree of rotation between the groups suggested by Guerra et al.[9], because groups B, C and D showed only 1.4%, 2.8% and 0.7% respectively, of the studied patients. We also did not find correlation between vertebral canal narrowing and fragment rotation ($p>0.05$).

DISCUSSION

Typically, burst fractures occur on thoracolumbar transition, in young men after a high fall. The associate morbidity in these cases, particularly in those with neurological deficit, justify the socioeconomic importance of this kind of injury.[3,4,12-15] By comparing to literature data, we reported 41.3% of fractures on L1 vertebra, mostly on male patients (72.5%). The presence of neurological dysfunction was found in 24 patients. The mean age was 36.5 years, and the prevalent mechanism of trauma was high falls (76.1%).

Few studies assessed the sagittal behavior of retropulsed fragments. Jelsma et al.[16], in a study with 40 patients, described the origin of the fragment in these fractures, being sourced from the posterosuperior region of the vertebral body. Guerra et al.[9], in turn, documented 10 cases of thoracolumbar burst fractures, with fragments coming from the posterosuperior margin of vertebral canal, with 30% of the cases migrating 3 to 8 millimeters towards head or tail, and showed 30 - 150º of rotation. Still in that study, the authors described that when rotation was greater than 180°, the tomographic aspect was of inverted posterior vertebral canal wall cortical. In cephalocaudal mechanism of trauma, the posterior longitudinal ligament ruptures above vertebral foramen and remains adhered to the posterior edge of the vertebral body, resulting in fragment rotation by avulsion and displacement towards skull[9]. (Figure 2) There are no literature reports mentioning other kind of rotation and the above description does not explain the reason for caudal displacement of a retropulsed bone fragment.

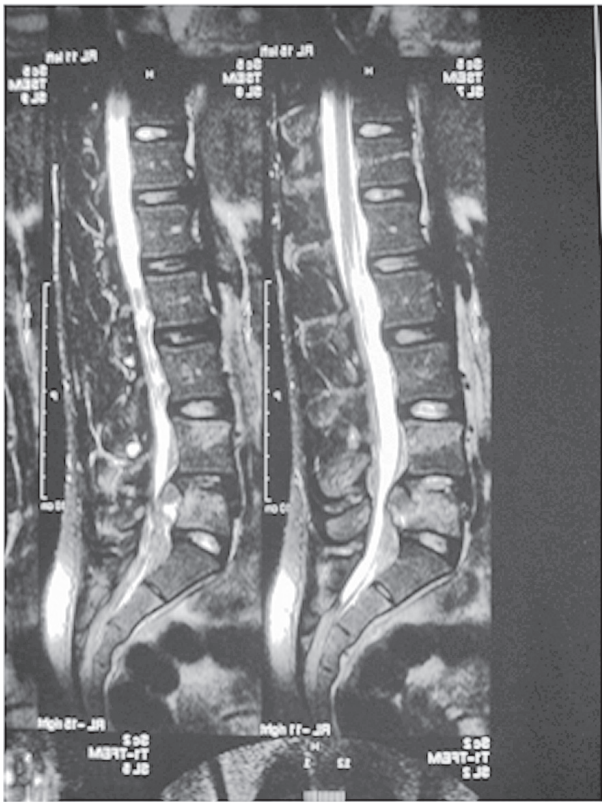

Figure 2 – *Magnetic resonance illustrates bone fragment traction performed by the posterior longitudinal ligament (arrow).*

In our series, the origin of all fragments and the rotation were similar to the findings by Guerra et al.[9] Displacement ranged from 1 to 8 millimeters, with the great majority towards skull (117 cases – 84.7%), followed by cases where no migration occurred (19 cases – 13.7%), against only two caudal cases (1.4%), but we didn't find any case of inverted cortical as described by Guerra et al.[9], even with a significant number of cases.

We found that the vast majority of studies attempts to correlate vertebral canal narrowing to neurological deficit or to provide empirical values to suggest the need of surgical decompression of the vertebral canal based on axial CT section.

Despite of the possibility of non-migration of the fragment[17], the additional information provided by a sagittal section are important, especially in what concerns to the documentation where further narrowing of the vertebral canal is present at sagittal plane. At this place, surgical decompression must be provided, through posterior or anterior approach, or avoiding the positioning of metallic implants, such as wires or laminar hooks. There is also a theoretical potential of a too displaced and rotated fragment - either towards head or tail - imposing a more difficult reduction by posterior ligamentotaxis due to an associated longitudinal ligament rupture.[9]

Future studies analyzing fragment behavior at sagittal plane after surgical procedures of posterior metal distention may help on proving this assumption.

We noticed that there was no correlation between the different rotation groups with canal narrowing, although the value of p (0.052) was very close to the significance level adopted in this study (5%), indicating at least a statistical trend. We could not correlate the degree of rotation with neurological deficit, because 95% of the cases were included on group A (0 to 59º), leaving a much reduced sample in other groups to enable a statistical analysis. However, it is worthy to mention some limitations of this study. As the study design was retrospective, the acquisition of images did not follow a uniform and controlled protocol for assessing the analyzed variables. In order to solve this issue, prospective protocols with helicoidal equipment with built-in multi-slice technology for axial and coronal reconstructions are warranted.

CONCLUSIONS

The reproducibility of the method described by Guerra et al.[9] for assessing fragments rotation and migration values was shown to be statistically significant. The retropulsed bone fragment on thoracolumbar burst fractures has a triangle shape, is originated at the posterosuperior region of the vertebral body, shows a cranial displacement in most of the cases and seldom exceeds values above 60° of rotation. A statistical trend with positive relation was found between the different rotation groups and vertebral canal narrowing. Nevertheless, we could not correlate neurological deficit with fragment rotation.

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REFERENCES

1. Aydinli U, Karaeminogullari O, Tiskaya K, Ozturk C. Dural tears in lumbar burst fractures with greenstick lamina fractures. Spine. 2001;26:E410-E5.
2. Dai LY, Yao WF, Cui YM, Zhou Q. Thoracolumbar fractures in patients with multiple injuries: diagnosis and treatment-a review of 147 cases. J Trauma. 2004;56:348-55.
3. Holdsworth FW. Fractures, dislocations, and fractures-dislocations of the spine. J Bone Joint Surg Br. 1963;45:6-20.
4. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 1983; 8:817-31.
5. Ferguson RL, Allen BL Jr. A mechanistic classification of thoracolumbar spine fractures. Clin Orthop Relat Res 1984; 189:77-88.
6. Parthria M. Physical injury spine. In: Resnick D, editor. Diagnosis of bone and joint disorders. 3th ed. Philadelphia:Saunders; 1995. p.2825-98.
7. Hounsfield GN. Computerized transverse axial scanning (tomography). 1. Description of system. Br J Radiol. 1973;46:1016-22.
8. Meves R, Avanzi O. Correlation between neurological deficit and spinal canal compromise in 198 patients with thoracolumbar and lumbar fractures. Spine. 2005;30:787-91.
9. Guerra J Jr, Garfin SR, Resnick D. Vertebral burst fractures: CT analysis of the retropulsed fragment. Radiology 1984;153:769-72.
10. Avanzi O, Chih LY, Meves R. Avaliação do tratamento cirúrgico da fratura toracolombar com material de terceira geração. Rev Bras Ortop. 2002;37:445-53.
11. Frankel HC, Hancocck DO, Hyslop G. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. Paraplegia. 1969;7:179-92.
12. Mumford J, Weinstein JN, Spratt KF, Goel VK. Thoracolumbar burst fractures. The clinical efficacy and ouTCome of nonoperative management. Spine. 1993;18:955-70.
13. Vaccaro R, Nachwalter RS, Klein GR, Sewards JM, Albert TJ, Garfin SR. The significance of thoracolumbar spinal canal size in spinal cord injury patients. Spine. 2001;26:371-6.
14. Wilcox RK, Boerger TO, Allen DJ, Barton DC, Limb D, Dickson RA et al. A dynamic study of thoracolumbar burst fractures. J Bone Joint Surg Am. 2003;85::2184-9.
15. McAfee PC, Yuan HA, Fredrickson BE, Lubicky JP. The value of computed tomography in thoracolumbar fractures. An analysis of one hundred consecutive cases and a new classification J Bone Joint Surg Am. 1983;65:461-73.
16. Jelsma RK, Kirsch PT, Rice JF, Jelsma LF. The radiographic description of thoracolumbar fractures. Surg Neurol. 1982;18:230-6.
17. Defino HLA. Classificação das fraturas da coluna torácica e lombar. Coluna. 2002;1:41-58.