RELATIONSHIP BETWEEN TRAUMATIC SPINAL CANAL ENCROACHMENT AND NEURODEFICIT IN THORACOLUMBAR BURST FRACTURES

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ABSTRACT :

Thoracolumbar burst fracture is an unstable spine injury. In such fractures, neurologic injury may occur due to spinal canal encroachment. The purpose of this study is, to detect whether there is a correlation between % loss of anterior vertebral height (AVH), Cobb's angle, vertebral body angle (VBA) and medullary canal encroachment in (CT), and risk of neurodeficit occurence, or not.

114 cases with burst fractures in thoracolumbar junction were evaluated. Their mean age was 38.7, and 45 of them were female and 69 of them were male. Fractures as to the levels were as follows. T11-12 (29 cases), L1 (55 cases) and L2 (30 cases). In 11 cases of T11-12, 19 cases of L1 and 7 cases of L2 fractures there were neurodeficits. Correlation test was used in statistical analysis.

Finally, there was no correlation between spinal canal encroachment amounts in CT, fracture level and type of Burst fracture (Denis). In contrary, there was significant correlation between vertebral body angle (VBA), Cobb's angle and % loss of Anterior Vertebral Height. However, there was a correlation between worse neurological status and increasingly % of medullary canal encroachment in (CT) (r = 0,5775 , p = 0.000).

Key words: *Thoracolumbar spine injury, Burst fractures, spinal canal encroachment.*

INTRODUCTION

Thoracolumbar burst fractures are neurologically unstable (4). Not only anterior and middle columns but also posterior column is injured (4, 8, 15). Spinal canal encroachment due to these structures may cause neurologic signs (4). Neurologic lesion vary with respect to the level of injury (5, 7, 9).

The purpose of this study is to detect the relation between the amount of spinal canal encroachment and neurodeficit in burst fractures of thoracolumbar junction (T11-12, L1-2).

MATERIAL AND METHOD

Between October 1982 and February 1996, 507 patients with thoracolumbar spine fractures (compression, burst, seat-belt, fracture-dislocation) (4) were treated either conservatively or surgically at the 1st and 2nd Department of Orthopaedics and Traumatology, İzmir State Hospital.

Among these patients, 114 patients, with single level thoracolumbar burst fractures whose documents were complete, (preoperative AP and Lateral radiographs, CT scans and neurological status records according to Frankel's classification) were evaluated.

Mean age of patients was 38.7 (range 16 to 81). 45 of them were females and 69 of them were males. Time form injury to CAT Scan was ranging 1,5 hours to 24 hours. Distribution of fracture levels were as follows: T11 (5 cases), T12 (24 cases), L1 (55 cases) and L2 (30 cases). While 37 patients had neurodeficits following injury, 77 patients had no neurological signs. Levels of lesions with neurodeficits were as follows: T11 (1 cases), T12 (10 cases), L1 (19 cases) and L2 (7 cases).

114 cases with burst fractures were divided into 3 groups. With respect to this, 29 cases of T11 and T12 were at epiconus level, 55 cases of L1 were at conus

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medullaris level and 30 cases of L2 were at cauda equina level.

Cases were evaluated neurologically according to Frankel's Classification (Table 1) (6).

CT scans in 114 patients were performed with Hitachi W 950 S.R; GE C.T. Max 640 and Toshiba TCT 600S CT Scanners. Windows Setting of CT scanner was 80 + 35 / 1800 + 150 Hounsfield unit. Thickness of sections in the injured vertebrae were 2 to 4 or 5mm. The narrowest level of vertebra was labeled and then medullary encroachment was calculated multiplying the original size by 100.

Spinal canal size of fractured vertebra was calculated by taking the average of spinal canal sizes of upper and lower vertebrae.

Burst fractures were classified as to Denis' (4) and summarized in Table 2.

Table 1. Neurologic Status as to Fracture Levels

	1. Group T11-12 Epiconus	2. Group L1 Conus Medullaris	3. Group L2 Cauda equina	Total
Frankel A	3	4	1	8
Frankel B	2	7	1	10
Frankel C	2	5	1	8
Frankel D	4	3	4	11
Frankel E	18	36	23	77
Total	29	55	30	114

Table 2. Subgroups of Burst Fractures (Denis) (9)

	1. Group T11-12 Epiconus	2. Group L1 Conus Medullaris	3. Group L2 Cauda equina	Total
Type A	4	16	4	24
Type B	20	34	18	72
Type C	4	4	3	11
Type D	–	–	4	4
Type E	1	1	1	3
Total	29	55	30	114

In addition, 114 patients with burst fractures were classified with respect to the structures causing medullary encroachment according to Hashimato et Colleagues' (9) CT Scan criterian. 43 cases were oval type, 24 cases were semicircular type, 11 cases were horseshoe type and 36 cases were crescent type.

In all cases, Vertebral Body Angle (VBA), Cobb's angle and Anterior Vertebral Height (%) were determined as described by Denis (4).

In each case, for statistical analysis, sex, age, fracture type (Denis) (4), neurological status (Frankel) (6), percent spinal encroachment in CT (9), Cobb's angle, percent of anterior vertebral height loss and vertebral body angle values were recorded in computer. Excel and S.P.S.S. software were used for statistical analysis. Correlation symbol was "r".

RESULTS

When fractures were divided into subgroups as to Denis (4) the most common type was Type-B (72 cases).

There was no significant correlation between spinal encroachment (%) in CT and fracture levels ($r = 0.1080$, $p = 0.253$) and fracture type ($r = 0.1413$, $p = 0.137$). However, there was significant correlation between percent of spinal canal encroachment in CT and vertebral body angle ($r = 0.4089$, $p = 0.000$), Cobb's angle ($r = 0.3376$, $p = 0.000$) and (%) of anterior vertebral height loss ($r = 0.4018$, $p = 0.000$).

There was also significant correlation between percent of spinal canal encroachment in CT and patients' neurological status as to Frankel's ($r = 0.5775$, $p = 0.000$). There fore, neurological status was becoming worse parallel to increasingly high percent of medullary encroachment in CT (Table 4).

DISCUSSION

Burst fracture is a kind of unstable spine injury in which both anterior and middle columns are fractured (4). Experimental studies suggested that in such fractures trauma at the time of accident is greater than as shown by CT (5). But, CT is a very useful method in definitive diagnosis and in calculation of spinal canal encroachment (2, 4, 8, 14, 16, 17).

There are studies, suggesting the relation of structures causing spinal canal encroachment neurological

Table 3. Correlation of medullary encroachment in CT, Burst fracture type, Fracture Level, Vertebral Body Angle (VBA), Cobb's Angle and percent of Anterior Vertebral Height Loss (AVH).

	Medullary Encroachment in CT	Fracture Type	Fracture Level	Vertebral Body Angle	Cobb's Angle	% of Anterior Vertebral Height Loss
Medullary Encroachment in CT	1.000 (114) p = .	–0.1413 (114) p = 0.137	0.1080 (114) p = 0.253	0.4089 (114) p = 0.000	0.3376 (114) p = 0.000	0.4018 (114) p = 0.000
Fracture Type	–0.1413 (114) p = 0.153	1.0000 (114) p = .	–0.0224 (114) p = 0.805	–0.0333 (114) p = 0.716	–0.0419 (114) p = 0.645	–0.1632 (114) p = 0.071
Fracture Level	0.1080 (114) p = 0.253	–0.0224 (114) p = 0.805	1.000 (114) p = .	0.0261 (114) p = 0.768	0.1255 (114) p = 0.153	0.0506 (114) p = 0.566
Vertebral Body Angle (VBA)	0.4089 (114) p = 0.000	–0.0333 (114) p = 0.716	0.0261 (114) p = 0.768	1.0000 (114) p = .	0.6593 (114) p = 0.000	0.4716 (114) p = 0.000
Cobb's Angle	0.3376 (114) p = 0.000	–0.0419 (114) p = 0.645	0.1255 (114) p = 0.153	0.6593 (114) p = 0.000	1.0000 (114) p = .	0.4250 (114) p = 0.000
% of Anterior Vertebral Height Loss (AVH)	0.4018 (114) p = 0.000	–0.1632 (114) p = 0.071	0.0506 (114) p = 0.566	0.4716 (114) p = 0.000	0.4250 (114) p = 0.000	1.0000 (114) p = .

Table 2. Correlation of medullary encroachment in CT and Frankel's classification

	Frankel's Classification	Medullary encroachment in CT
Frankel's Classification	1.000 (114) p = .	0.5775 (114) p = 0.000
Medullary encroachment in CT	0.5775 (114) p = 0.000	1.0000 (114) p = .

status (4, 5, 7, 9, 11, 12, 16, 17). In contrary, there are also studies suggesting no relation between these parameters (2, 10, 12). In our study, we detected significant correlation between these parameters. In addition, neurologic status was worsening increasingly with higher amounts of spinal canal encroachment (r = 0.5775, p = 0.000). Our results were similar to 40 patient series of Eren and Collagues' (5) and 139 patient-series of Fontijine and Colleagues' (7) whose level range were wide (range T1 to L5).

In addition, there was also significant correlation between vertebral body angle (VBA), Cobb's angle, (%) loss of anterior vertebral height (AVH) and amount of spinal canal encroachment in CT.

REFERENCES

1. Braakman R, Fontijne WPJ, Zeegens R, Steenbeek JR, Tanghe HLJ: Neurologic Deficit in Injuries of the Throacic and Lumbar Spine. Acta Neurochir., 111: 11-17, 1991.
2. Brant-Zawadski M, Jetfrey RB, Minagi H, Pitts LH: High Resolution CT of Thoracolumbar Fractures, AJNR, 3: 69-74, 1982.
3. Dall BE, Staufer ES: Neurologic Injury and Recovery Patterns in Burst Fractures at the T12 or L1 Motion Segment. Clin. Orthop. 233: 171-176, 1988.

4. Denis, F: The Three Column Spine and Its Significance in the Classification of Acute Thoracolumbar Spinal Injuries. Spine, 8: 817-831, 1983
5. Eren AH, Kılıçkap C, Zaim E, Tecimer T, Berkel: Omurga Burst Kırıklarında Spinal Kanal Daralması ile Nörolojik Yaralanmanın Ağırlığı Arasında İlişki. Acta Orthop. Traumatol. Turc., 29: 189-191, 1995.
6. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, Vernon JDS, Walsh JJ: The Value of Postural Reduction in the Initial Management of Closed Injuries of the Spine with Paraplegia and Tetraplegia. Paraplegia, 7: 179-192, 1969.
7. Fontijine WPJ, De Klerk LWL, Broakman R, Stijnen T, Tanyhe HLJ, Steenback R, Van Linge B: CT Scan Prediction of Neurologic Deficit in Thoracolumbar Burst Fractures, J. Bone Joint Surg., 74-B: 683-685, 1992.
8. Gertzbein SD, Court-Brown CM, Marhs PL, et al.: The Neurological Outcome Following Surgery for Spinal Fractures. Spine, 13: 641-644, 1988.
9. Hashimato T, Kaneda K, Abumi K: Relationship Between Traumatic Spinal Canal Stenosis and Neurological Deficits in the Thoracolumbar Burst Fracture, Spine, 13: 1268-1272.
10. Keene JS, Fischer SP, Vanderby R. Jr., Drummond DS, Turski PA: Significance of Acute Post Traumatic Bony Encroachment of the Neural Canal Spine, 14: 799-802, 1989.
11. Kilcoyne RF, Mack LA, King HA, Ratcliffe SS, Loop JW: Thoracolumbar Spine Injuries Associated with Vertical Plunges Reappraisal with Computed Tomography. Radiology, 146: 147-150, 1983.
12. Lindahl S, Nillen J, Nordwall A, Irstam L: The Crush-cleavage Fracture. Spine, 8: 559-569, 1983.
13. Lindahl S, Willen J, Irstam L: Computed Tomography of Bone Fragments in the Spinal Canal: An Experimental Study. 8: 181-186, 1983.
14. Mc Afee 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. 65-A: 461-473, 1983.
15. Panjabi MM, Kifune M, Wen L, et al.: Dynamic Canal Encroachment During Thoracolumbar Burst Fractures, J. Spinal Disord, 8: 39-48, 1995.
16. Sjöstrom L, Karlström G, Pech, P, Rauschning W: Indirect Spinal Canal Decompression in Burst Fractures Treated with Pedicle Screw Instrumentation. Spine, 21: 113-123, 1996.
17. Trafton PG, Boyd CA: Computed Tomography of Thoracic and Lumbar Spine Injury. J. Trauma, 24: 506-515, 1984.