

Correlation of the CT Scan Findings and Neurologic Impairment in Thoracolumbar Burst Fractures

Umesh Kumar Sharma¹, Dinesh Kumar Thapa², Suraj Thapaliya¹, Abishek Pokhrel¹, Man Mohan

Bir Shrestha¹, Pankaj Raj Nepal², Nirajan Prasad Parajuli³

¹Department of Radiology, B&C Medical College Teaching Hospital, Jhapa, Birtamode, Nepal

²Department of Neurosurgery, B&C Medical College Teaching Hospital, Jhapa, Birtamode, Nepal

³Department of Orthopedics, B&C Medical College Teaching Hospital, Jhapa, Birtamode, Nepal

Correspondence:

Dr. Umesh Kumar Sharma

Department of Radiology

B&C Medical College Teaching Hospital, Jhapa, Birtamode, Nepal

Email: druksharma@hotmail.com

Background: Spinal injury is the most common injury which may lead to devastating disability. Such fractures are relatively rare but frequently result in neurologic damage due in part to retro-pulsed fragments that narrow the spinal canal. Hereby we would like to correlate the CT scan findings and neurologic impairment in thoracolumbar burst fractures at our center. **Materials and Methods:** This prospective observational study was conducted at B&C teaching hospital, Birtamode, Nepal. Patients were evaluated by CT scan between July 2016 to December 2018 referred from the emergency department with a history of trauma and suspected thoracolumbar vertebral fractures with or without neurological deficit were included in the study. The different demographic variables like gender, age were included and injury at the level of the spine and neurological deficit was studied. Thus, obtained data were processed in statistical software and expressed in percentage and frequency. **Results:** The total number of patients was 34 (male: 19, female: 15). The age ranged from 16 years to 77 years with a mean age of 39.1 years. The neurologic deficit was detected in 10 cases (29.4%), out of which complete deficit in 6 (60%) and incomplete deficit in 4 (40%). The neurologic deficit was absent in 24 cases (70.6%). An associated laminar fracture was detected in 17 patients (50%). Laminar fracture associated with the neurologic deficit was found in 10 patients. **Conclusion:** CT scan is an excellent imaging modality for the evaluation of thoracolumbar fractures. Measurement of central canal ratio and assessment of associated laminar fracture can be useful information to predict the neurologic deficit and plan for further management.

Key words: Burst Fracture, Laminar fracture, Spinal Injury, Thoracolumbar spine.

Spinal cord injury is one of the commonest complications of trauma which could lead to life-threatening disability. Eastern Nepal has high incidence of head and spinal trauma.¹ The burst fracture of the thoracolumbar spine results from severe axial loading of the spine with or without flexion. About 90% of all spinal fractures occur between T11 and L4, while from L4 to L1 are classified as a burst.¹⁻⁴ About 44% to 60% of thoracolumbar fractures occur from T11 to L1 with the presence of neurological impairment in 26% of the patients.²⁻⁵

The mechanism of injury is usually due to rapid deceleration i.e. fall, road traffic accident. They are relatively rare but frequently result in neurologic damage due in part to retropulsed fragments that narrow the spinal canal. The study is focused to assess the neurologic impairment in relation to the retropulsion of fracture fragment compromising the spinal canal and the degree of associated laminar fractures.

By using a multi-slice (16 slice) CT scan, the extent of canal compression by retro-pulsed

fragments can be quantified. We aimed to assess whether canal compromise and fracture type determine neurologic deficit in burst fractures of the thoracolumbar spine.

Methods and Materials:

The study was approved by the institutional review committee and the written consent of the patients was waived in B&C teaching hospital, Birtamode, Nepal. There were total 34 patients were evaluated by CT scan (16 slice GE BRIVO 385) between July 2016 to December 2018 referred from the emergency department with a history of trauma and suspected thoracolumbar vertebral fractures with or without neurological deficit. Patients with the cervical spine and head injuries were excluded from the study.

The scan was 5 mm thick, and obtained from T1 to L5 level. Scans of cervical spine were obtained, whenever necessary to rule out any occult cervical spine injury. Multiplanar reformations of the axial images were obtained for further evaluation of the spinal injury. The patients with a burst fracture with and without a neurologic deficit were divided in three spinal levels, i.e thoracic above T11, thoracolumbar T12-L1, Lumbar L2-L5. They were further divided into the groups with or without neurological deficiencies. The patients with neurological deficiencies, were divided into complete having paraplegia and incomplete with either motor or sensory nerves impairment.

For the level of the neurologic deficit, the vertebral position with the retropulsed fractures is based on the thoracic vertebrae upto T11 (cord level), the T12 to endplate below the 1st lumbar vertebra (cord/conus level), and from the 2nd upper endplate to the 5th lumbar vertebral position (cauda equina level). The value of the central canal ratio is the narrowest diameter of the spinal canal divided by the normal antero-posterior diameter on axial CT scan (Fig 1). Laminar fractures were divided into non-fractured, linear fracture, separated fracture, and displaced fractures. The central canal ratio (CCR) was divided into less than 0.5 and more than 0.5. The CCRs and laminar fractures are used to assess the relations with the presence and absence of the neurologic impairments.

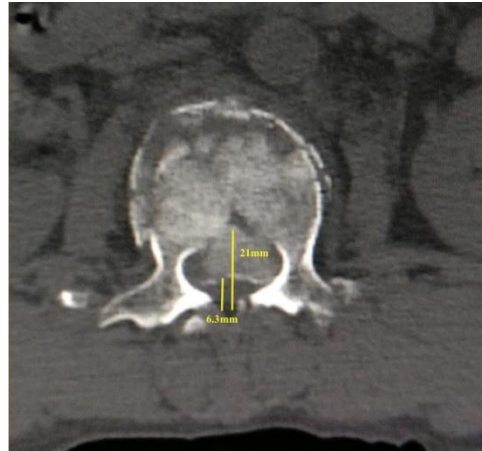


Fig 1. Measurement of central canal ratio in the axial image. The anteroposterior length of the spinal canal and maximum anteroposterior length of the spinal canal at the level of retropulsed bone fragment is measured and the ratio is calculated. The ratio is less than 0.5.

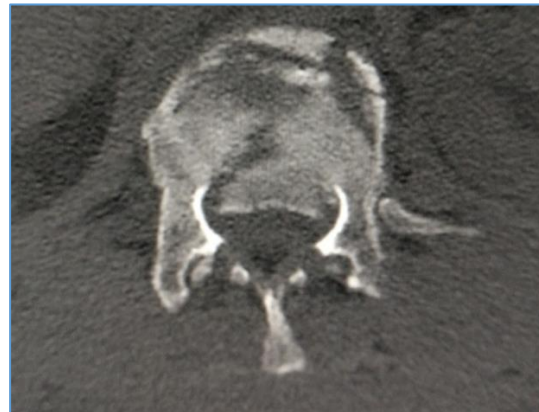


Fig 2: 25 year's male with a history of a road traffic accident without neurologic deficit. Large retropulsed bone fragment in the spinal canal at L1 level. The CCR is 0.5.



Figure 3A, 3B:61-year-old Female with a history of fall injury and neurologic deficit. Burst fracture of L1 with CCR 0.5.



Figure 4: 38 year’s male with a history of a road traffic accident without neurologic deficit. Burst fracture of L2 with a displaced lamina fracture.

Results:

The total number of patients was 34 (male: 19, female: 15). The age ranged from 16 years to 77 years with a mean age of 39.1 years. (Table 1). There were 20 patients with a history of fall injury and 14 patients had a road traffic accident.

Table 1: Participant characteristics

Characteristics	Number	Percentage
Age group (years)		
<20	4	11.8
20-40	14	41.2
41-60	8	23.5
>60	8	23.5
Gender		
Male	19	55.8
Female	15	44.2

The neurological deficit was detected in 10 cases (29.4%), out of which complete deficit in 6 (60%) and incomplete deficit in 4 (40%) (Table 2).

Table 2: Number and percentage of patients with a burst fracture with and without a neurologic deficit at three spinal levels

Spinal level	Neurologic deficit	
	With	without
Thoracic above T11	4	5
Thoracolumbar T12-L1	2	10
Lumbar L2-L5	4	9

The neurological deficit was absent in 24 cases (70.6%). CCR was less than 0.5 in 15 cases (44.1%), whereas more than 0.5 in 19 patients (55.8%) (Table 3).

Table 3: Neurologic deficit related to CCRs

Neurologic Deficits	CCR≤0.5	CCR>0.5	Total	P Value
Positive	8	2	10	0.001
Complete	3	2	5	
Incomplete	5	0	5	
Negative	7	17	24	
Total	15	19	34	

Among the patients with neurologic deficit the CCR was less than 0.5 in 8 patients (80%) and more than 0.5 in 2 patients (20%). In 24 patients with absence of neurologic deficit, CCR with less than 0.5 was found in 7 patients (29.2%) and more than 0.5 in 17 patients (70.8%). The correlation of neurological deficit was significantly associated with the CCR (P= 0.001). Associated laminar fracture was detected in 17 patients (50%) (Table 4). These findings were statistically significant (P= 0.45). In these patients displaced laminar fracture was found in 5 patients, separated fracture in 7 and linear fracture in 5. Laminar fracture associated with neurologic deficit was found in 9 (52.9%) patients (complete deficit in 4, incomplete deficit in 5). Out of 24 patients without neurologic deficit, laminar fracture was found in 8 patients (33.3%), there was absence of laminar fracture in 16 (66.6%). In six patients without neurologic deficit, the laminar fracture was found at L1 and L2 level, and one patient each had fracture at D12 and L3 level.

Table 4: Neurologic deficit related to the laminar fractures

Neurologic Deficits	Laminar fractures				Total
	Displaced	Separated	Linear	No fracture	
Positive					
Complete	3	1	0	0	4
Incomplete	1	2	2	1	6
Negative	1	4	3	16	24
Total	5	7	5	17	34

In these patients, the displaced laminar fracture was found in 5 patients, separated fracture in 7, and linear fracture in 5. Laminar fracture associated with the neurologic deficit was found in 10 patients (complete deficit in 4, an incomplete deficit in 6). Out of 24 patients without neurologic deficit laminar fracture was found in 8 patients (33.3%), there was an absence of laminar fracture in 24 (66.6%).

Discussion:

Thoracolumbar spine fractures have been classified into several types including wedge-compression fracture, Chance fracture, flexion-distraction injury, translational injury, and burst fractures.⁶ Burst fractures are relatively rare; they constitute about 1.5% of spinal fractures.⁸

In our study, the incidence of patients with a neurological deficit was higher at thoracolumbar fractures with involvement of the cord/conus (6/34), whereas at lumbar level (L2-L4) neurologic deficit was found in 4/34 cases. A similar result was seen in the study done by Fontijne et al.⁹ The CCR ratio was less than or equal to 0.5 in patients with the neurologic deficit was significantly higher than those with more than 0.5. However, 7/34 patients with CCR less than 0.5, and 17/34 patients with CCR more than 0.5, did not have a neurologic deficit. There is significant correlation with the level of injury and spinal canal stenosis with lower CCR for the possibility of neurologic deficit. In our study, we were able to predict the presence of a neurologic deficit in patients with burst fractures. However, there is a high probability of the neurologic deficit if the CCR is less than 0.5 and associated displaced/separated laminar fractures (Table 3).

The study done by TY Moon et al has shown that complete neurological deficit was associated with injuries at the cord level (p = 0.000) and displaced laminar fractures (p = 0.000); incomplete neurological deficit was associated with CCRs below 0.5 (p = 0.000) and multiple vertebral injuries (p = 0.002).¹⁰ A few studies suggested that CT scans can predict neurological deficit in patients with thoracic lumbar fractures with a narrowed vertebral cavity.⁸ They reported that the narrower the vertebral cavity, the higher the

frequency of neurological deficit, and higher at the thoracic vertebrae and lower at the lumbar vertebrae. However, they did not share perfect and incomplete deficits.

The correlation between the type of burst fracture and the severity of neurologic deficit was not significant in another study.¹¹ The mean extent of spinal canal compromise in patients with deficits was 50%, whereas in patients with no deficit it was 36%. The difference between the extent of canal compromise and the severity of the neurological deficit at the thoracolumbar and lumbar spine was not significant ($P > 0.05$)

Patients with burst fractures are at significant risk of developing neurologic deficit when canal compromise is $\geq 35\%$ at T11 and T12, $\geq 45\%$ in L1, and $\geq 55\%$ in other lumbar vertebrae.¹² In a study of 139 patients, a significant correlation was found between neurological deficit and spinal canal stenosis. The greater the extent of the injury, the greater the correlation.⁸ However, in a series of 45 burst fractures, no such correlation was found.¹³

In our study, the neurologic deficit was greater in number with a high degree of stenosis showing CCR ≤ 0.5 . However, there was an absence of neurologic impairment in 7 cases with CCR less than 0.5. There was no correlation between the degree of neurologic impairment and the degree of spinal canal narrowing.^{6, 7, 14, 15} The degree of spinal canal narrowing reflects the final resting position of the vertebral body fragments after the trauma; during the trauma event, greater degrees of canal narrowing may be present without pinching the cord or cauda equina.

WP Shuman had found no significant correlation between the degree of improvement in spinal canal cross-sectional area and the degree of eventual neurological recovery.⁶ This suggests that several other variables (edema, hemorrhage, nerve versus cord injury) in addition to spinal canal narrowing are determinants in how much recovery of function is possible.

Association of laminar fracture with spinal burst fracture had a high occurrence of neurologic deficit in our study, 9(52.9%). 9/10 patients with neurologic deficit had associated laminar fractures, out of which 4 had displaced and 3 had separated.

A similar result was observed in the study by Moon et al.¹⁰

Conclusion:

CT scan is an excellent imaging modality for the evaluation of thoracolumbar fractures. Measurement of central canal ratio and assessment of associated laminar fracture can be useful information to predict the neurologic deficit and plan for the further management

The limitation of the study is small sample size for better interpretation of the statistical analysis and results including the p-values for the prediction of the neurological deficit associated with thoracolumbar fractures.

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