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Prognostic Analysis of Traumatic Vertebral Injury of Thoracolumbar Junction in a Tertiary Centre

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I. INTRODUCTION

About incidence

The thoracolumbar junction represents a transitional area in relation to anatomy and stress, rendering it particularly vulnerable to fracture and dislocation. The thoracic vertebrae (T1–T10) above the thoracolumbar junction are stabilized by the rib cage and intercostal muscles. The lumbar vertebrae (L3–L5) below the thoracolumbar junction are increasingly more stable because they are larger, stronger and have substantial muscular support. Thus, the majority of thoracic and lumbar spine injuries occur in T11–L2 as a result of the fact that it forms a transitional zone between the very long lever arm of the chest and the very mobile lumbar spine [3, 4].

1. Scher AT. Radiological assessment of thoracolumbar spinal injuries. S Afr Med J. 1983;64:384–387. [Abstract] [Google Scholar]
Levine AM. Classification of spinal injury. In: Levine AM, Eismont FJ, Garfin SR, Zigler JE, editors. Spine trauma. Philadelphia: W.B. Saunders Company; 1998. pp. 113–132. [Google Scholar]

It is widely accepted that the conus medullaris terminates in the lower third of the L1 vertebra. However, the position of the termination varies in an adult population, and the range span extends from the lower third of the T11 to the upper third of L3 [5, 6].

Hence, the fracture at the thoracolumbar junction may cause damage to cord, conus medullaris or cauda equina (spinal roots) and result in upper motor neuron (UMN), or lower motor neuron (LMN) or mixed lesions over legs and bladder/bowel [7].

The primary concern of spinal cord injured (SCI) patients and their families is whether they will be able to walk following an injury. Among professional staff, walking is also of high priority [8–10].

Previous studies revealed that the total lower extremity motor score (LEMS) was significantly related to both walking level and walking performances. Greater muscle strength produces better endurance, higher walking speed, and lower oxygen consumption per meter [11, 12].

The purpose of this study was to present the motor deficits and type of neurogenic bladder dysfunction (NBD) in patients with fractures at the thoracolumbar junction, and to analyze the requirements of LEMS for functional walking in community.

II. SUBJECTS AND METHODS

All patients who sustained traumatic vertebral fractures in the thoracolumbar junction (T11–L2) and admitted to neurosurgical department were considered for this study.

From January 2007 to December 2009, were recruited for this study. inclusion criteria

The patients who had single level traumatic vertebra fracture over T11–L2 with onset duration of more than 3 years were included in this study. All of them were stabilized for spinal injuries and were wheel chair bound at the time of discharge before being snt for rehabilitation. Patients with non traumatic causes such as multi level fractures, pathological fractures, pre-existing neurologic lesions or musculoskeletal diseases were excluded.

The study was approved by the local ethics committee; all subjects gave their informed consent to participate in this study.

The basic demographic data of the patients were collected from the medical records. The location of fracture site was confirmed based on the X-ray, magnetic resonance imaging or computed tomography taken at the acute stage of injury.

Neurologic examinations were taken according to the standards from American Spinal Injury Association (ASIA) and included deep tendon reflexes, muscle power and sensation of lower extremities [10]. We also examined the sacral reflex including anal tone and anal reflex. All of the participants reported their ambulatory status at home and in community. A functional walker was defined as someone who could walk

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independently in the community, with or without the use of devices and braces [10].

According to neurological examinations and results of urodynamic studies, the patients were further classified into three groups with different neurologic injury sites. Group A included the patients with upper lumbar cord lesions, who had increased knee and ankle jerks and spastic bladder and urethral sphincter. Group B included patients with epiconus lesions with or without other lumbar root injuries, who had decreased knee jerks and spastic bladder and/or urethral sphincter. Group C included patients with conus medullaris and/or cauda equina lesions, who had decreased knee jerks and flaccid bladder and urethral sphincter.

III. STATISTICAL ANALYSIS

Kruskal–Wallis test was used to compare the LEMS scores in different groups of vertebral fracture levels, and neurologic injury sites. Mann–Whitney U test with Bonferroni correction was used for post hoc analysis. The differences in the distribution of NBD types, neurologic injury sites and functional walkers in patients with different levels of vertebral injury were analyzed by Chi-square test. This test was also used to analyze the association of spasticity in knee/ankle and spasticity in bladder/sphincter. Receiver operating characteristic (ROC) curve analysis was used to define the cutoff value of LEMS in functional walker and non-walker.

IV. RESULTS

1. Total no. of patients 30
2. Gender 24 men and 6 women
3. Age distribution

Age distribution	
Age group	Total No. of patients
11 – 20	2
21 – 30	5
31 – 40	6
41 – 50	8
51 – 60	7
61 – 70	2
TOTAL	30

4. Education

Most had only secondary level schooling

Literacy level	
Education	Total No. of patients
7^{th} standard	3
8^{th} standard	3
9^{th} standard	3
10^{th} standard	8
11^{th} standard	5
12^{th} standard	4
Bachler's degree	3
Uneducated	1
TOTAL	30

5. Occupation
Majority were manual labourers

Occupation	
Education	Total No. of patients
Accountant	1
Clerk	1
Farmer	2
Fisherman	3
Homemaker	3
Manual labourer	14
Salesman	1
Store keeper	3
Student	2
TOTAL	30

6. Marital status
8 Unmarried & 22 were married

Marital status	Total No. of patients
Unmarried	8
Married	22
TOTAL	30

7. SES
27 among 30 were from low SES

Socio-economic status	Total No. of patients
Low	27
Medium	3
TOTAL	30

8. Mode of injury
27 had history of fall and rest were due to RTA

Mode of injury	Total No. of patients
Fall	27
RTA	3
TOTAL	30

9. Mode of transportation
16 – self 14 – ambulance

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Mode of transport	Total No. of patients
Ambulance	14
Self transportation	16
TOTAL	30

10. Position of the patient during transportation
Position
15 supine & 15 sitting

Position during transportation	Total No. of patients
Supine	15
Sitting	15
TOTAL	30

11. Time delay> 6hrs - 5
12. Previous treatment 5
13. Associated injuries
7 had Calcaneal fracture, Hemopneumothorax,
Pubic rami fracture, Acetabulam fracture
14. Co- morbidity 7 had DM, HT
15. Level of vertebra fractured

LEVEL OF VERTEBRAE FRACTURED	
Fractured vertebrae	Total No. of patients
D12	11
L1	11
L2	8
TOTAL	30

16. ASIA score at presentation

ASIA SCORE	Total No. of patients
A	2
B	5
C	3
D	0
E	20
TOTAL	30

LEVEL OF VERTEBRAE FRACTURED & ASIA Score						
Fractured vertebrae	Total No. of patients	ASIA SCORE				
		A	B	C	D	E
D12	11	1	3	0	0	7
L1	11	1	1	1	0	8
L2	8	0	1	2	0	5
TOTAL	30	2	5	3	0	20

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17. TLICS at presentation

TLICS	Total No. of patients
4	17
5	2
6	4
7	2
8	5
TOTAL	30

LEVEL OF VERTEBRAE FRACTURED &TLICS						
Fractured vertebrae	Total No. of patients	TLICS				
		4	5	6	7	8
D12	11	7	0	1	0	3
L1	11	6	1	3	0	1
L2	8	4	1	0	2	1
TOTAL	30	17	2	4	2	5

18. Surgery All underwent stabilization
19. Hospital stay 12 – 48 days average 19.8 days
20. Post op comp 2 had bedsore, 2 wound infection 1 had DVT

V. DISCUSSION

The spinal cord transitions to the cauda equina in the thoracolumbar junction and vertebral fractures in this area would result in variable clinical features including UMN and LMN signs.
The conus medullaris, which is the terminal segment of the adult spinal cord, lies at the L1 vertebra for most adults.

The segment above the conus medullaris is termed the epiconus and consists of spinal cord segments L4 through S1 [13, 14].

Kirshblum S, Donovan W. Neurological assessment and classification of traumatic spinal cord injury. In: Kirshblum S, editor. Spinal cord medicine. Philadelphia: Lippincott Williams & Wilkins; 2002. pp. 82–95. [Google Scholar]

Willems J, Chappel R. The epiconus syndrome presenting radicular-type neurological features. Spinal Cord. 1997;35:709–710. doi: 10.1038/sj.sc.3100511. [Abstract] [CrossRef] [Google Scholar]

Lesions of the epiconus affect the lumbar cord and the roots supplying muscles of legs and feet, with sparing of reflex function of sacral segments.

Conus medullaris lesions, which affect neural segments S2 and below, present with LMN deficits of the bladder and sphincter. Injuries of cauda equina, which includes lumbar and sacral root, will cause LMN deficits of legs, feet, bladder, and sphincter [14].

Willems J, Chappel R. The epiconus syndrome presenting radicular-type neurological features. Spinal Cord. 1997;35:709–710. doi: 10.1038/sj.sc.3100511. [Abstract] [CrossRef] [Google Scholar]

According to UMN or LMN deficits over legs and bladder/sphincter, the neuropathologic damage from vertebral fractures of thoracolumbar junction can be classified into (a) upper lumbar cord, (b) epiconus and lumbar roots, and (c) conus medullaris and/or cauda equina (Fig. 1). It seemed reasonable that higher vertebral levels should result in higher neurologic lesions, but it is not the case in our study. The possible causes might be that the position of cord termination varies in adult populations (extending from T11 to L3) [6] and fractures were caused by different injury mechanisms. On the other hand, we found that half of our patients in the whole group or in each single fracture group, had epiconus and lumbar roots lesions. Patients who have this kind of injuries showed flaccidity of quadriceps (L3) and ankle dorsiflexors (L4, L5), however, their bladder and/or sphincter (S2–4) are spastic. To the best of our knowledge, there have been few reports in the related literature that mention these clinical events [14]

Willems J, Chappel R. The epiconus syndrome presenting radicular-type neurological features. Spinal Cord. 1997;35:709–710. doi: 10.1038/sj.sc.3100511. [Abstract] [CrossRef] [Google Scholar]

Spinal root injuries have a better prognosis for recovery than spinal cord injuries. This is most likely because the rootlets are more mobile than cord, with nerve roots being more resilient to injury, and because many of the biochemical processes that occur in the spinal cord may produce secondary damage [14].

Willems J, Chappel R. The epiconus syndrome presenting radicular-type neurological features. Spinal Cord. 1997;35:709–710. doi: 10.1038/sj.sc.3100511. [Abstract] [CrossRef] [Google Scholar]

Waters et al. found that patients with LEMS ≤20 were limited walkers with slow walking speed and great energy expenditure. Patients with LEMS ≥30 were functional walkers in community; their values regarding gait performance and energy expenditure were reasonably close to comparable values for able-bodied control subjects [15]. In our study, patients who had lower levels of vertebral fracture had higher mean LEMS as well as a higher possibility of functional walking. The cutoff value of LEMS for functional walking was 20 in this study with good sensitivity and specificity and this was compatible with the findings of Waters et al. [15]. In eight of ten functional walkers in this study, their LEMS were between 20 and 30. Although they walked with the help of some walking aids or ankle foot orthoses and had slower walking speed and higher energy expenditure than able-bodied subjects, it was practical and more convenient for them to walk in community than to use a wheelchair.

Spinal cord injuries are well known to cause NBD. The parasympathetic efferent supply of bladder originates from pelvic nerve nucleus located in the intermediolateral gray matter of the S2–4 cord. Somatic efferent supply of external sphincter originates from pudendal nerve nucleus located in the anterior horn of S2–4 gray matter [16]. Suprasacral lesions frequently lead to spastic NBD with hyperreflexic bladder and sphincter. Sacral lesions cause flaccid NBD with areflexic bladder and atonic sphincter [16]. In this study, three patients of L1 fractures with epiconus lesions showed areflexic bladder and hyperreflexic sphincter. Bors [17] classified it as mixed type NBD caused by lower vesicomotor (pelvic nerve) neuron lesion and upper somatomotor (pudendal nerve) neuron lesion. This may happen, when the epiconus lesions extend to the pelvic nucleus with sparing of the pudendal nucleus because the pelvic nucleus is slightly higher and posterior to the pudendal nucleus [16, 17].

Previous studies showed that voiding dysfunction in patients with spinal cord lesions of the thoracolumbar junction could be hyperreflexic or arefleixc. Because the sacral cord is located at thoracolumbar junction, it may be difficult to predict urodynamic dysfunctions merely on the basis of the vertebral body involved [18, 19]. In this study, distribution of NBD types in patients with different fracture levels revealed no statistical difference.

The somatomotor nucleus of quadriceps and calf muscles is mainly located in L3 and S1 cord, respectively. Patients with increased knee or ankle jerks must have a suprasacral lesion. Ankle spasticity has high PPV and specificity for bladder and sphincter spasticity with acceptable sensitivity and NPV. Increased knee jerk indicated higher spinal cord lesions and even better PPV and specificity for predicting bladder and sphincter spasticity (all 100%), but the sensitivity and NPV were much lower than ankle spasticity. Thus, we concluded that after the acute stage of injury, if the ankle spasticity appeared, spastic NBD can be predicted with high accuracy.

This study has some limitations that are worth noting. The number of patients with T11 and L2 fractures is far less than those with T12 and L1 fractures, and the results of statistic analysis might therefore be influenced. Not all patients had MRI, the location of termination of conus medullaris and neural damage could not be defined to correlate their neurological deficits.

VI. CONCLUSION

Thoracolumbar junction fracture involving D12, L1 and L2 who presented with poor ASIA and TLICS scores had no recovery or very minimal recovery. Single level vertebral fracture had variable presentations depending on the extent of fracture and associated cord with the nerve root involvement, inspite of the MRI showing the level of cord ending at L1 in all patients. Though all patients were stabilized with surgical fixation, it helped only in rehabilitating the patient rather than functional recovery. All these patients need some form of assistance in their routine activities necessitating a change in the life styles of the entire family.

Conflict of interest

None.

Glossary

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