RESEARCH ARTICLE

Predictive Value of Computed Tomography Scan for Posterior Ligamentous Complex Injuries in Patients with Thoracolumbar Spinal Fractures

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Abstract

Background: Thoracolumbar spinal fractures include a range of injuries of various severities from simple apophyseal fractures to neurological injury and complex fractures associated with vertebral dislocation. The treatment of thoracolumbar fractures is challenging, especially due to the difficulty of evaluating the posterior ligamentous complex (PLC). The purpose of this study was to evaluate the diagnostic value of computed tomography (CT) scan in predicting PLC injuries in the patients with thoracolumbar spinal fractures referring to the referral center of spinal trauma in the east north of Iran in 2016.

Methods: This retrospective study was conducted on patients with thoracolumbar injuries referring to Shahid Kamyab Hospital in Mashhad, east north of Iran, in 2016. The data were collected by entering the data of medical records into special forms. The classification of spinal fractures was accomplished using the AO Spine Classification System.

Results: According to the results, 71 (71.7%) patients were male, and the subjects had a mean age of 44.6±17.7 years. The PLC injury was observed in 28 (28.3%) patients. The PLC injury showed a significant relationship with facet joint widening, increased interspinous process distance, and spinous process avulsion fracture ($P<0.05$).

Conclusion: As the findings of this study indicated, the diagnostic results of PLC injury by means of CT scan was similar to those obtained by magnetic resonance imaging in patients with thoracolumbar spinal fractures.

Level of evidence: III

Keywords: CT scan, MRI, Posterior ligamentous complex (PLC), Thoracolumbar spinal injury Trauma

Introduction

Thoracolumbar fractures include a range of injuries of various severities from simple apophyseal fractures to neurological injuries and complex fractures associated with vertebral dislocation. Generally, about 50% of these fractures in the thoracolumbar region are associated with deformity, instability, and neurological deficits (1, 2). Road traffic accidents are reportedly the most common causes of spinal cord injury, and the thoracolumbar region is the most frequently affected area (3). In a study, burst fractures were the most common fracture type observed in 43% of cases, and spinal cord injury was seen in 17.3% of cases (4).

The implementation of complete spinal imaging is a very important measure in the initial general evaluation

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of the cases with spinal trauma because the delayed diagnosis of fractures increases the neurological damage by about eight times (5). The examination of patients with spinal trauma is generally performed by means of three diagnostic modalities, including radiography, vertebral computed tomography (CT) scan, and magnetic resonance imaging (MRI) (5).

A large number of the primary techniques adopted for the classification of spinal injuries are based on only imaging regardless of clinical aspects that may affect the surgical treatment strategies and prognosis. However, radiography has been replaced by CT scan for evaluating thoracolumbar spinal injuries in many trauma centers due to its low sensitivity (6, 7).

The treatment of thoracolumbar fractures is challenging, mainly due to the difficulty of evaluating the posterior ligamentous complex (PLC). Recently, many attempts have been made to classify the injuries and standardize the associated therapeutic practices (2, 8, 9). Recent studies maintain that CT scan can solely detect the evidence of thoracolumbar PLC injury. Meanwhile, MRI may not be required to confirm the spinal instability associated with the injury of the posterior elements.

Increased distance between spinous processes in the reconstructed sagittal view of the CT scan can predict PLC injury, which is helpful in the evaluation of the thoracolumbar spine and investigation of the possibility of executing a surgical plan. The implementation of MRI on this group of patients before an emergency or elective surgery can provide valuable information regarding the status of the bone marrow or other lesions in the spinal canal. However, compared to MRI, CT scan has a lower efficiency (74%) in detecting the complex injuries of the posterior elements in patients with wedge fracture and flexion, as well as a normal spinous process distance.

Nonetheless, in cases with complicated injury mechanisms, MRI is required for a complete evaluation because even a normal spinous process distance cannot confirm the integrity of the PLC (6, 10). Considering the aforementioned cases, the present study was targeted toward examining the diagnostic value of CT scan in the prediction of PLC injuries in the patients with thoracolumbar spinal fractures referring to Shahid Kamyab Trauma Center in Mashhad, Iran, in 2016.

Materials and Methods

This retrospective study was conducted on the medical records of 585 patients with thoracolumbar trauma and 252 patients with thoracolumbar vertebral fractures in Shahid Kamyab Hospital in 2016. The diagnosis of thoracolumbar trauma was the only inclusion criterion. In addition to the data of the medical records, vertebral MRI and CT scan findings of 98 patients were registered and analyzed in the current study.

After the extraction of patients' data, they were entered into checklists. Subsequently, all thoracolumbar fractures were classified according to the AO Classification System (11). The MRI is the gold standard method for the assessment of PLC injuries. The imaging findings were examined by two spine surgeons. The CT scan findings included increased spinous processes distance, increased facet joint space, and spinous process avulsion. These data were entered into special forms designed for this purpose. The data were analyzed in SPSS software (version 18) using the Chi-square test and independent sample t-test.

Ethical considerations

The ethical principles were observed throughout the study procedure. In addition, the study was approved by the Ministry of Health of Iran. All patients' data were respected, kept confidential to the researchers, and used only for research purposes.

Results

The data analysis showed that 71 (71.7%) patients were male. The mean age of the participants was obtained as 44.6±17.7 years. Table 1 presents the AO classification in the patients.

According to the results of MRI, the PLC was intact in 70 (70.7%) patients. However, intermediate and complete disruptions were recorded in 10 (10.1%) and 18 (18.2%) patients, respectively. Furthermore, the results of CT scan imaging revealed facet joint widening, increased interspinous process distance, and spinous process avulsion fracture in 12 (12.1%), 13 (13.1%), and 9 (9.1%) patients, respectively.

The results of the Chi-square test showed a significant relationship between facet joint widening and disruption of the PLC ($P<0.001$). In addition, the disruption of PLC demonstrated a significant relationship with increased interspinous process distance and spinous process avulsion fracture ($P<0.001$). Based on the Chi-square test, type A1 fractures were correlated with facet joint widening, increased interspinous process distance, and spinous process avulsion. Furthermore, type A3 fractures showed a correlation with spinous process avulsion. Additionally, types B2 and C fractures had a significant relationship with facet joint widening and increased

Table 1. Distribution of initial data related to patients with thoracolumbar fractures

Variable		
Gender N(%)	Male Female	71 (71.7) 28 (28.3)
Age (mean ± SD)	Male Female	43.53 ± 18.14 49.09 ± 17.88
Frequency of fracture type A N(%)	A1 A2 A3 A4	53 (53.5) 8 (8.1) 25 (25.3) 2 (2.0)
Frequency of fracture type B N(%)	B1 B2 B3	2 (2.0) 7 (7.1) 0 (0)
Frequency of fracture type C N(%)	C	2 (2.0)

Table 2. Relation between AO Classification and CT Scan Findings

Finding A1		AO Classification							
		A2	A3	A4	B1	B2	B3	C	
Facet Joint Widening	N(%)	3 (3.1)	1 (1.0)	5 (5.1)	0 (0)	0 (0)	4 (4.1)	-	2 (2.0)
	P value	0.032	0.663	0.154	0.769	0.769	0.004	-	0.014
Increasing Interspinous Distance	N(%)	2 (2.0)	2 (2.0)	6 (6.1)	0 (0)	0 (0)	3 (3.1)	-	2 (2.0)
	P value	0.003	0.291	0.076	0.749	0.749	0.030	-	0.017
Spinous Process Avulsion	N(%)	2 (2.0)	1 (1.0)	5 (5.1)	0 (0)	0 (0)	2 (2.0)	-	1 (1.0)
	P value	0.048	0.551	0.045	0.824	0.824	0.124	-	0.126

interspinous process distance (*P<0.05*; Table 2).

Discussion

In this study, the majority of the patients were male; in addition, the mean age of the patients showed that most of them were in the middle age. The results also revealed that posterior ligament injuries had a significant relationship with fracture types B2, A1, and C. In addition, the data indicated that the diagnostic results of PLC injuries by means of CT scan findings were similar to those obtained by MRI in patients with thoracolumbar spinal fractures.

The diagnosis of spinal instability is one of the most challenging issues in spinal surgery and despite attempts to attain more reliable methods; there are still many challenges in this domain. According to White and Panjabi, mechanical instability of the spine can lead to abnormal dislocations, immediately followed by the induction of stress and stretch. Under this condition, the maintenance of the balance can be accomplished by the induction of flexion, as well as the straightening and rotation of the spine, which will in turn lead to further dislocation, angulation, and neurological damage (12). The identification of these components will lead to the diagnosis of instability. In a study conducted in the USA, Dahdaleh et al. demonstrated an association between ligament injury and poor prognosis. They concluded that this injury should be treated at best by means of surgery (13).

In a study carried out in Spain, Pizones et al. performing MRI analysis reported starting posterior distorting pressures on the facet joint and its extension through interspinous ligaments and supraspinous ligaments, and ultimately ligamentum flavum injury. In the mentioned study, radiographic and CT scan findings revealed PLC injury by the identification of instability caused by the angulation and dislocation of the bone structures. The MRI showed the components that form the PLC (14). However, in a study conducted by van Middendorp et al. in the United Kingdom, it was reported that MRI tends to show a relatively high negative predictive value in the PLC, which means that there are false positive cases (15). Therefore, although CT scan may incorrectly detect some cases of PLC injury, MRI may overestimate instability as it also shows some of the mild injuries of the PLC (16). Vaccaro et al. in the USA showed that disagreement about PLC status in CT scan occurs only among the cases that are neurologically intact and in the American Spinal Injury Association grade D group. Compared to the findings in the operating room, MRI has a better diagnostic value for PLC injuries in cases with severe neurological injuries than in those with moderate injuries or without neurological injuries (17).

As the findings of the present study indicated, PCL injury had a significant relationship with fractures types B2, A1, and C. In addition, the results revealed that the diagnostic results of PLC injuries shown by CT scan findings were similar to those obtained by MRI in patients with thoracolumbar spinal fractures. There was also a relationship between AO classification in some types and CT scan findings.

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References

1. Heinzelmann M, Wanner GA. Spinal Disorders. Thoracolumbar spinal injuries. New Delhi: Springer; 2008.
2. Rihn JA, Yang N, Fisher C, Saravanja D, Smith H, Morrison WB, Harrop J, Vacaro AR. Using magnetic resonance imaging to accurately assess injury to the posterior ligamentous complex of the spine: a prospective comparison of the surgeon and radiologist. Journal of Neurosurgery: Spine. 2010 Apr;12(4):391-6.
3. Taghippor M, Sherafat Kazemzadeh E. Column and Spinal Cord Injuries in Shiraz Nemazi Hospital, an Epidemiological Study. Armaghane danesh. 2006;10(4):55-62.
4. Fakharian E, Tabesh H, Masoud S. An epidemiologic study on spinal injuries in Kashan. Journal of Guilan University of Medical Sciences. 2004;13(49):80-5.
5. Sixta S, Moore FO, Ditillo MF, Fox AD, Garcia AJ, Holena D, et al. Screening for thoracolumbar spinal injuries in blunt trauma: an Eastern Association for the Surgery of Trauma practice management guideline. Journal of Trauma and Acute Care Surgery. 2012;73(5):S326S32.
6. Barcelos ACES, Joaquim AF, Botelho RV. Reliability of the evaluation of PLC injury in thoracolumbar spine trauma with the use of computed tomography scan. European Spine Journal. 2016;25(4):1135-43.
7. Lee H-M, Kim H-S, Kim D-J, Suk K-S, Park J-O, Kim N-H. Reliability of magnetic resonance imaging in detecting posterior ligament complex injury in thoracolumbar spinal fractures. Spine. 2000;25(16):2079-84.
8. Vaccaro AR, Lehman Jr RA, Hurlbert RJ, Anderson PA, Harris M, Hedlund R, et al. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. Spine. 2005;30(20):2325-33.
9. Vaccaro AR, Lim MR, Hurlbert RJ, Lehman Jr RA, Harrop J, Fisher DC, et al. Surgical decision making for unstable thoracolumbar spine injuries: results of a consensus panel review by the Spine Trauma Study Group. Clinical Spine Surgery. 2006;19(1):1-10.
10. Winn HR. Youmans neurological surgery. Philadelphia: Elsevier/Saunders; 2017.
11. Aebi M. AO spine classification system for thoracolumbar fractures.
12. White AA, Panjabi MM. Clinical biomechanics of the spine: Lippincott Philadelphia; 1990.
13. Dahdaleh NS, Viljoen SV, Dalm BD, Howard MA, Grosland NM. Posterior ligamentous complex healing following disruption in thoracolumbar fractures. Medical hypotheses. 2013;81(1):117-8.
14. Pizones J, Izquierdo E, Sánchez-Mariscal F, Zúñiga L, Álvarez P, Gómez-Rice A. Sequential damage assessment of the different components of the posterior ligamentous complex after magnetic resonance imaging interpretation: prospective study 74 traumatic fractures. Spine. 2012;37(11):E662-E7.
15. van Middendorp JJ, Patel AA, Schuetz M, Joaquim AF. The precision, accuracy and validity of detecting posterior ligamentous complex injuries of the thoracic and lumbar spine: a critical appraisal of the literature. European Spine Journal. 2013;22(3):461-74.
16. Haba H, Taneichi H, Kotani Y, Terae S, Abe S, Yoshikawa H, et al. Diagnostic accuracy of magnetic resonance imaging for detecting posterior ligamentous complex injury associated with thoracic and lumbar fractures. Journal of Neurosurgery: Spine. 2003 Jul;99(1):20-6.
17. Vaccaro AR, Rihn JA, Saravanja D, Anderson DG, Hilibrand AS, Albert TJ, et al. Injury of the posterior ligamentous complex of the thoracolumbar spine: a prospective evaluation of the diagnostic accuracy of magnetic resonance imaging. Spine. 2009;34(23):E841-7.