ORIGINAL ARTICLE

The AOSpine thoracolumbar spine injury classification system: A reliability and agreement study

Parisa Azimi, Hassan Reza Mohammadi, Shirzad Azhari, Pooyan Alizadeh, Ali Montazeri[1]

Department of Neurosurgery, Shahid Beheshti University of Medical Sciences, [1]Mental Health Research Group, Health Metrics Research Centre, Iranian Institute for Health Sciences Research, ACECR, Tehran, Iran

ABSTRACT

Aim: Recently, AOSpine trauma knowledge forum proposed the AOSpine thoracolumbar injury classification (AOSTLIC) system and suggested that it was reliable. However, reliability data from additional institutions for the AOSTLIC system are not available. This study was to examine the reliability of the AOSTLIC system in patients with thoracolumbar (TL) fractures.

Materials and Methods: Between August 2009 and June 2012, 56 patients with 74 levels traumatic TL spinal injuries were recruited. Two classifiers, consisting of two spine surgeons, assessed clinical and imaging data. Initially, one surgeon reviewed the data in order to classify and calculate injury severity score according to the AOSTSIC system. This process was repeated on a 5-week interval by another surgeon. Then we analyzed data for intra-observer and inter-observer reliability using the kappa statistic (κ). Finally, validity was assessed using the known-groups comparison.

Results: The mean age of patients was 59.5 ± 11.5 years. The κ values for the AOSTSIC system for intra-observer and inter-observer reliability ranged from 0.83 to 0.89, indicating nearly perfect agreement agreements. Known-groups analysis showed satisfactory results. The AOSTSIC system discriminated well between sub-groups of patients who differed in Oswestry disability index.

Conclusion: The findings showed that the morphologic classification in AOSTSIC system appears to be reliable and reproducible classification.

Key words: AOSTSIC system, reliability, spine injury classification, thoracolumbar fracture

Introduction

Thoracolumbar (TL) fractures are usually related with major trauma and can cause spinal cord impairment that result in neural deficits.[1,2] The correct management of TL fractures contains several steps including an accurate diagnosis by imaging, classification, and treatment.[1,2] The goals of treatment are to achieve a painless, balanced, stable spine with optimum neurological function and maximum spine mobility. Classification of TL fractures is an on-going endeavor for the medical community in order to improve the decision-making process. Several classifications of TL fractures have been proposed over recent decades. Many investigators such as Nicoll, Holdsworth, Louis, and Denis, Magerl *et al*., and Vaccaro *et al*. have contributed to the evolution of fracture classification.[1-6] However, proposed systems have used various injury characteristics, and none has achieved universal approval.[7]

Recently, to develop a widely accepted classification system including both fractures morphology and clinical factors relevant for surgical decision-making, the association for the study of internal fixation (AOSpine) proposed the AOSpine thoracolumbar injury classification (AOSTLIC) system and found that it is a reliable measure. A primary management decision in the treatment of TL injuries may decrease using this type of classification system.[7] However, reliability data from additional institutions for the AOSTLIC system are not

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Address for correspondence:
Dr. Parisa Azimi, Department of Neurosurgery, Imam Hossain Medical Center, University of Shahid Beheshti Medical Sciences, Shahid Madani Street, Tehran, PA 1617763141, Iran.
E-mail: parisa.azimi@gmail.com

available. This study aimed to examine the reliability of the AOSTLIC system in patients with TL fractures.

Materials and Methods

Patients and data collection

In this retrospective study, we included 56 patients with 74 levels of TL spinal injuries who had treated between August 2010 and June 2012 at a teaching hospital, in Tehran, Iran. All cases were initially assessed in the emergency department or referred from an outside institution for treatment of their spinal injuries. Diagnosis of TL injury was established using clinical symptoms, description of the traumatic injury, neurological examinations, and imaging including combinations of X-ray, computed tomography and magnetic resonance images and was confirmed by experienced spine surgeons. Demographics variables were extracted from case records. Each case was classified according to AOSTLIC system. The methods that presented by Vaccaro *et al*. were considered for type A, type B, and type C injuries to confirm that the surgeons were evaluating the same injury.[7] There were no limitations on patient selection with regard to types of TL fracture, age or other characteristics. The exclusion criteria were prior lumbar spine surgery, spinal anomalies, and polyneuropathy. Patients underwent surgery or conservative treatment.

The AOSpine thoracolumbar spine injury classification system

An international team developed the AOSTLIC system that includes features of both the Magerl *et al*. and TLICS. In addition to the morphological description, this system considers the neurological status and patient-specific modifiers that are important for surgical decision-making. The morphologic classification is based on three main injury patterns: Type A (compression injuries of the vertebral body), type B (tension band disruption), and type C (displacement/translation injury) injuries. In an accompanying commentary, Vaccaro *et al*. indicate that this new classification scheme may be used to refine patient treatment plans and expand our understanding of TL injury. The AOSTLIC system and their relate subtypes are shown in Table 1.[7]

Additional measure

The Iranian version of the Oswestry disability index (ODI): This is a measure of functionality and contains 10 items. The possible score on the ODI ranges from 0 to 50, with higher scores indicating worse conditions. The psychometric properties of the Iranian version of the questionnaire are well-documented.[8] This was used for known-groups comparison.

Statistical analysis

In order to assess the reliability of the classification system, all patients were randomly selected with all types of TL fracture. Two independent observers classified each case twice within a 5-week interval to measure intra- and inter-observer differences. The weighted kappa coefficient (κ) was calculated for each spine surgeon based on his/her first and second observations for within and between comparisons. κ varies between 0 and 1; the greater the κ, the higher agreement

Table 1: AOSpine thoracolumbar spine injury classification system*

Type A injuries: Compression injuries of the vertebral body	Type A injuries involve the anterior elements (vertebral body and/or disc), and this type includes clinically insignificant injuries to the elements such as transverse or spinous process fractures. Type A injuries are further divided into 5 subtypes
Subtype A0	No injury/process fracture: either designates no fracture of the vertebra or clinically insignificant fractures of the spinous or transverse processes
Subtype A1	Wedge/impaction: injuries are wedge compression or impaction fractures with fracture of a single endplate without involvement of the posterior wall of the vertebral body
Subtype A2	Split/pincer type: injuries are split- or pincer-type fractures in which the fracture line involves both endplates but does not involve the posterior vertebral wall
Subtype A3	Incomplete burst: injuries are vertebral fractures affecting a single endplate with any involvement of the posterior vertebral wall and the spinal canal
Subtype A4	Complete burst: injuries are vertebral body fractures involving both endplates as well as the posterior wall. A4 injuries are similar to A3 injuries but involve both endplates
Type B Injuries: Tension band injury	Type B injuries affect either anterior or posterior tension band. These injuries may be seen in combination with type A fractures of the vertebral body. They are further divided in 3 subgroups
Subtype B1	Posterior transosseous disruption: injuries are monosegmental osseous failure of the posterior tension band extending into the vertebral body
Subtype B2	Posterior ligamentous disruption: injuries demonstrate a disruption of the posterior tension band with or without osseous involvement
Subtype B3	Anterior ligamentous disruption: injuries disrupt the anterior longitudinal ligament that serves as the anterior tension band of the spine, preventing hyperextension. The injury may pass through either the intervertebral disc or through the vertebral body itself (particularly in the ankylosed spine), but there is an intact posterior element hinge preventing gross displacement
Type C Injuries: Displacement/ translational injury	Type C injuries are characterized by displacement beyond physiological range of the cranial and caudal parts of the spinal column in any plane. Type C injuries also occur in the presence of distraction of both the anterior and posterior vertebral elements without any remaining intact anterior or posterior structure, there may be complete separation of the vertebral elements

*Derived from association for the study of internal fixation [7]

rate. κ value of 0–0.20 indicate slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial perfect agreement and ≥0.81 is regard as almost perfect agreement according to the interpretation by Landis and Koch.[9] κ coefficients were calculated for injury type (A, B, or C), and their subtype (A0, A1, A2, A3, or A4 and B1, B2, B3).

Known groups comparison

Validity

We used known-groups comparison (discriminant validity). It was carried out to test how well the AOSTLIC system discriminates between sub-groups of patients who differed in functionality as measured by the ODI. It was hypothesized that patients with a higher score on the ODI would have a lower condition on the AOSTLIC. One-way analysis of variance was performed to test the hypothesis.[10]

The statistical software was SPSS for Windows (Version 17.0, IBM, SPSS Inc., Chicago, Illinois, USA).

Ethics

The Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran approved the study.

Results

The characteristics of patients and their scores on the AOSTLIC system based on two observers are shown in Table 2.

Kappa statistics was calculated for the AOSTLIC system and its domain and are shown in Table 3. The κ values of the AOSTLIC system for the intra-observer and inter-observer ranged from 0.83 to 0.89, indicating almost perfect agreement.

Validity of the AOSTLIC system was examined using the known groups comparison. The AOSTLIC system discriminated well between sub-groups of patients who differed in functionality as measured by the ODI ($P < 0.001$). The results are shown in Table 4.

Discussion

Decision-making is of prime importance for patients suffering from TL injuries. As such the AOSTLIC is a tool that could help clinicians to make a fair decision and in turn provide better outcomes for patients. In fact, the fundamental intent of the AOSTLIC system is to improve the management of TL injury through a reproducible and valid classification system that is easy to learn and that is readily applicable in clinical practice.

The findings from this study confirmed that the AOSTLIC system was generally reliable and valid with good inter- and intra-observer agreements for classifying patients with TL injuries. Although the AOSTLIC system showed promise, however since the study sample was small, thus the procedure will need to be repeated with larger, multicenter datasets to indicate its classification power convincingly.

Table 2: The characteristics of the study patients and their AOSTLIC system with 74 TL injuries (*n*=56)

	Number	Percentage
Age (year)		
Mean (SD)	32.3 (8.1)	
Range	14 to 61	
Gender		
Male	34	60.7
Female	22	39.3
AOSpine thoracolumbar spine injury classification type	**Observer 1**	**Observer 2**
Compression fractures (total)	32 (43.2)	30 (40.5)
Subtype A0	2 (2.7)	2 (2.7)
Subtype A1	7 (9.4)	7 (9.4)
Subtype A2	4 (5.4)	4 (5.4)
Subtype A3	9 (12.2)	8 (10.8)
Subtype A4	10 (13.5)	9 (12.2)
Tension band injuries (total)	19 (25.7)	23 (31.1)
Subtype B1	6 (8.1)	6 (8.1)
Subtype B2	11 (14.9)	13 (17.6)
Subtype B3	2 (2.7)	4 (5.4)
Translation injuries (total)	23 (31.1)	21 (28.3)
A total + B total + C total	74 (100)	74 (100)

SD – Standard deviation

Table 3: Inter- and Intra-observer AOSTSIC system (*n*=74 pairs of repeated evaluations)*

	Intra-observer	Inter-observer
TL injury type		
Type A	0.84 (0.82-0.0.91)	0.88 (0.80-0.94)
Type B	0.83 (0.81-0.88)	0.86 (0.83-0.93)
Type C	0.86 (0.83-0.92)	0.89 (0.84-0.94)

*All values are expressed as kappa value (95% CI=confidence interval). Interpretation of standard kappa: <0.20, poor agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, good agreement; 0.81-1.00, very good agreement, according to the interpretation of the kappa statistic by Landis and Koch

Table 4: The pretreatment ODI by AOSpine thoracolumbar spine injury classification system among the study sample (known groups comparison)

AOSpine thoracolumbar spine injury classification system	Mean ODI score*	SD
Type A	31.9	6.3
Type B	37.4	4.1
Type C	41.5	3.9
P**	< 0.001	

* Lower scores indicate better conditions. ** Derived from one-way analysis of variance (the Bonferroni correction was used as post-hoc analysis). ODI – Oswestry disability index; SD – Standard deviation

Vaccaro *et al*. demonstrated well to excellent inter-observer and intra-observer reliability with the AOSTLIC system (reference). They reported that κ (κ, agreement index) values for the inter-observer agreement were 0.72 for type A injuries, 0.58 for type B injuries, and 0.7 for type C injuries. They also reported that κ values for intra-observer had substantial to

excellent reproducibility results for the AOSTLIC system with an average κ value of 0.77 (ranging from 0.6 to 0.97), which is in line with our findings.

Various developed classification systems for spinal fractures or injuries have been used. However, no classification system has been able to satisfy the clear communication between clinicians and researchers. Recently, however, a unique cooperative effort among experts from the AOSpine created a uniform international classification system with the objective to develop a widely accepted, comprehensive yet simple classification system with proven intra- and inter- observer reliability that reflects the current understanding of the various forms of TL injuries.[7] Vaccaro *et al*. who led the effort, hope that the classification system will standardize definitions of different classes of TL injury and encourage uniform and reproducible reporting of cases among different medical centers.[7] For this aim, we encourage other researchers to validate the new AOSTLIC system in different countries and medical institutions.

The findings from the current study showed that patients who differed in the ODI were differed in the type of TL injury as expected. However, we only carried out a limited test to perform validity. In future, it might be necessary to perform other tests to establish stronger psychometric indexes for the AOSTLIC system.

There were some limitations in our study. First, since this was a retrospective study, there were some missing data. Second, the sample size was small and thus we were unable to perform those analyses that need bigger sample size (e.g., factor analysis).

Conclusion

The findings showed that AOSTLIC system is a useful and reliable tool in terms of intra-observer and inter-observer agreements for classification and evaluation of the TL fractures. Thus, the AOSTLIC system may be used in the decision-making process.

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