The Thoracolumbar AOSpine Injury Score

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Abstract

Study Design Survey of 100 worldwide spine surgeons.

Objective To develop a spine injury score for the AOSpine Thoracolumbar Spine Injury Classification System.

Methods Each respondent was asked to numerically grade the severity of each variable of the AOSpine Thoracolumbar Spine Injury Classification System. Using the results, as well as limited input from the AOSpine Trauma Knowledge Forum, the Thoracolumbar AOSpine Injury Score was developed.

Results Beginning with 1 point for A1, groups A, B, and C were consecutively awarded an additional point (A1, 1 point; A2, 2 points; A3, 3 points); however, because of a significant increase in the severity between A3 and A4 and because the severity of A4 and B1 was similar, both A4 and B1 were awarded 5 points. An uneven stepwise increase in severity moving from N0 to N4, with a substantial increase in severity between N2 (nerve root injury with radicular symptoms) and N3 (incomplete spinal cord injury) injuries, was identified. Hence, each grade of neurologic injury was progressively given an additional point starting with 0 points for N0, and the substantial difference in severity between N2 and N3 injuries was recognized by elevating N3 to 4 points. Finally, 1 point was awarded to the M1 modifier (indeterminate posterolateral ligamentous complex injury).

Keywords
- AOSpine
- thoracolumbar spine injury classification system
- TL AOSIS
- AOSpine injury score
- thoracolumbar trauma

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Conclusion The Thoracolumbar AOSpine Injury Score is an easy-to-use, data-driven metric that will allow for the development of a surgical algorithm to accompany the AOSpine Thoracolumbar Spine Injury Classification System.

Introduction

Numerous systems have been proposed to classify thoracolumbar injuries. Among the most influential were the ideas proposed by Denis, Magerl/AO, and the Thoracolumbar Injury Classification System (TLICS).[1–3] The Denis system was valuable in providing a modern concept of spinal stability and integrating the findings of computed tomography images to advance our understanding of injury morphology.[1] Although the Magerl/AO classification provided a comprehensive morphologic description of fracture subtypes, the multitude of injury subgroups and the lack of guidance for treatment decisions limited its clinical application and adoption.[3] The TLICS standardized a treatment protocol but has been criticized for its "one-size-fits-all" approach, which critics have accused of promoting the treatment biases of its creators.[3,4] Furthermore, the TLICS relies heavily on the evaluation of the posterolateral ligamentous complex (PLC), which is most commonly performed with magnetic resonance imaging, a modality that does not do so with sufficient specificity and is not widely available or used routinely in many parts of the world.

A classification system must provide sufficiently detailed morphologic descriptions to distinguish between clinically distinct injuries and guide treatment decisions; both of these purposes are essential but neither alone is sufficient. The universal adoption of a classification for both research and clinical purposes will likely occur only when a system is developed to classify morphology and guide treatment simultaneously. The recently described AOSpine Thoracolumbar Spine Injury Classification system combines the strengths of the Magerl/AO system and the TLICS with respect to morphologic injury classification.[5] Utilizing the same hierarchical approach of the AO classification scheme initially used to classify long bone fractures, this system classifies injury morphology into three main groups: type A—compression (subgroups A0 to A4); type B—tension band injury (subgroups B1 to B3); and type C—translation injuries. This system also includes the patient's neurologic status (N0 to N4 and Nx, unknown) and two clinical modifiers. This system was reliably applied to classify thoracolumbar injuries by a group of 100 surgeons uninitiated to the system from around the world.[6] The requisite next step in the development of guidelines is the creation of a scoring system to accompany the classification system. The scoring system should accurately reflect the relative injury severity with respect to the need for surgical stabilization and eventually will suggest appropriate surgical thresholds.

Complicating the standardization of treatment algorithms is the wide variation of preferred treatment methods currently seen among surgeons in different regions of the world. The variation in the treatment of thoracolumbar injuries is likely multifactorial, reflecting patient and surgeon biases and risk aversion, treatment cost, surgeon access, and tolerance of temporary disability during the postinjury recovery period.[6–11] Overcoming this clinical equipoise to establish uniform treatment algorithms is hindered by the paucity of data that provides indications for surgery and compares outcomes between different surgical and nonsurgical strategies. An important first step in establishing treatment algorithms is to be able to grade the severity of injury, considering the patient's injury morphology and neurologic status.

The purpose of this study was to derive a data-driven Thoracolumbar AOSpine Injury Score (TL AOSIS) to accompany the AOSpine Thoracolumbar Spine Injury Classification. This process relies on data obtained from a survey of surgeons on their perception of the relative severity of different types of thoracolumbar injury and neurologic deficits in determining the need for surgical stabilization. The surgical thresholds to accompany this scoring system will be established later and may reflect cultural differences that play an important role in surgical indications.

Methods

The AOSpine Thoracolumbar Spine Injury Classification System was developed under the oversight of a group of surgeons with interest in spinal trauma through a consensus-forming process, which has been previously described.[5,12] Although the classification system included input from surgeons with a relatively diverse approach to the treatment of spinal injuries, the consensus process was completed by a relatively small number of surgeons. An instrument that will drive clinical decision making must accurately represent the practice patterns from a wider group of well-informed surgeons from around the world. Because of the need for wider input, the spine injury score described in this article was derived from the results of a worldwide survey of 100 surgeons instead of determined by the consensus of a small group.

A survey was sent to 100 AOSpine members from all regions of the world including representatives in North America, South America, Europe, Africa, Asia Pacific, and the Middle East who were not part of the initial classification efforts. Each respondent was asked to numerically grade the severity of each variable of the AOSpine Thoracolumbar Spine Injury Classification System including injury morphology, neurologic injury, and patient-specific modifiers. A grade of 0 was considered not severe at all, and a grade of 100 represented the most severe injury possible. The complete results of this survey have been previously described.[13]

Analysis of the results of this survey was used to place the classification system components into a relative hierarchy using point values to represent relative injury severity, keeping in mind that a system that uses noninteger point values for various components would be cumbersome and limit practical usage. Furthermore, the M2 modifier (representing patient-specific variables) of the classification system cannot be easily assigned a point value as it is incompletely defined by nature, describing a comorbidity that affects surgical decision making and may influence a surgeon either toward or away from surgical intervention.

Following the initial interpretation of the survey results, the original classification group provided limited input to ensure that certain aspects of clinical practice would be captured in the scoring system. All alterations made in this manner to the scoring system from what would be dictated by strict interpretation of the survey results are specifically described below.

Results

Of the 100 surgeons around the world who were invited to complete the injury severity survey, complete responses were received and analyzed from 74 surgeons (►**Table 1**). Although more detailed analysis of this data has been previously published, the AOSpine TLICS morphology subgroups demonstrated a stepwise progression in terms of perception of injury severity through the A, B, and C groups (i.e., A0 → A1 → A2 → A3 → A4 and B1 → B2 → B3) with nearly even spacing between progressive morphologic subgroups (►**Table 2**).[13] A4 and B1 injuries scored within 5 points on a 100-point scale of one another, suggesting these injuries are perceived as relatively similar in severity despite the difference in morphology group (A versus B). Based on this input, the groups were consecutively given an additional point starting with 1 point assigned to A1 injury morphology. Importantly, no points were awarded to the A0 group. The point scheme for morphology is presented in ►**Table 3**. Because the A4 morphology was graded as slightly more severe than the B1 morphology and closer to the B2 morphology than the A3 morphology, A4 was determined to receive 5 points rather than downgrading B1 to receive 4 points.

With respect to neurologic injury, the survey suggested the perception of an uneven stepwise increase in injury severity moving from N0 to N4 with a large gap separating N2 (nerve root injury with radicular symptoms) and N3 (incomplete spinal cord injury). Because of this pattern of perceived severity, each grade of neurologic injury was progressively given an additional point starting with 0 points for N0 because it does not represent an injured state. The substantial difference in perceived severity between N2 and N3 injuries was recognized by elevating N3 to 4 points, an action endorsed by the classification group to recognize the urgency for surgical stabilization and decompression of patients with incomplete spinal cord injuries. Additionally, both the results of the injury severity survey and the members of the classification group felt that without the ability rule out a neurologic injury, a cautious approach must be taken, and so 3 points were awarded to Nx. The point scheme for neurologic status components and the M1 modifier is presented in ►**Table 4**.

As described above, the nature of the M2 modifier makes assigning point values impossible, as it is inherently variable and dependent upon the specific details of the individual patient's comorbidity. Burns over the potential operative site, for example, may argue against surgery, and a fracture in a patient with ankylosing spondylitis is often a strong indication for surgery given the associated instability. With respect to the M1 modifier (an indeterminate injury to the PLC), the severity survey suggested that the respondents viewed ambiguous PLC compromise as intermediate between N2 and N3 but closer in severity to N2 injuries, which would indicate that the M1 modifier should receive 2 points. However, both in the classic literature and in a recent study performed by the

Table 1 Demographics of respondents

Region of reviewer	*n*
Europe	14
Asia Pacific	21
Latin America	18
Middle East	11
North America	9
Africa	1
Experience of reviewer (y)	
1–10	21
11–20	34
21+	19

Table 2 Average injury severity score for each variable in AOSpine Thoracolumbar Injury Classification System

Type	*n*	Mean	SD
A0	74	5.09	5.07
A1	74	14.78	7.74
A2	74	29.81	14.41
A3	74	44.68	16.99
A4	74	59.7	18.77
B1	74	54.88	18.41
B2	74	69.09	17.66
B3	74	71.49	15.94
C	74	94.8	10.18
N0	72	1.08	3.13
N1	72	19.19	17.14
N2	72	33.57	16.9
N3	72	79.79	19.07
N4	72	91.36	14.48
NX	72	66.96	28.42
M1	72	50	23.67
M2	72	62.4	24.18

Abbreviation: SD, standard deviation.

Table 3 Point allocation for morphologic groups

Subgroup	Points
Type A—compression fractures	
A0	0
A1	1
A2	2
A3	3
A4	5
Type B—tension band injuries	
B1	5
B2	6
B3	7
Type C—translational injuries	
C	8

AOSpine Trauma Knowledge Forum,[14] the interobserver reliability of indentifying an injury to the PLC is only slight to fair, and so the decision was made to lessen the points awarded to the M1 modifier. Although there is no doubt about the biomechanical importance of the PLC, it was determined that the inability of the surgeons to reliably determine the integrity of the PLC limits the clinical importance of the M1 modifier.

The summation of the score awarded to each variable (i.e., morphology, neurologic status, and patient-specific modifiers) represents the total TL AOSIS for a specific injury.

Discussion

Although the AOSpine TLICS describes a new scheme that was designed to overcome the shortcomings of previously described classification systems, the description of morphologic injury patterns and associated neurologic injury alone is likely to be insufficient to spur widespread adoption, particularly among clinicians. To provide greater benefit for patients and clinicians, a thoracolumbar injury classification system should provide robust guidance for physicians treating patients with these injuries. Past criticism of the scoring system and treatment algorithm associated with TLICS was centered on the perception that TLICS largely represents the treatment biases of its creators and does not accurately represent treatment algorithms commonly used in many parts of the world.[11,15,16] Despite this criticism, there is ample precedence for establishing widely used severity scales based on expert opinion and consensus; the Injury Severity Scale, its predecessor the Abbreviated Injury Scale, and the Glasgow Coma Scale were all developed through an expert consensus process.[17–19] Nevertheless, because of the amount of previous study of thoracolumbar trauma and the divergent attitudes toward management of these patients, we felt it was critical to use a largely data-driven approach with only gentle editing by the smaller group of surgeons to establish a scoring scheme to accompany the AOSpine TLICS. Instead of relying on consensus alone, the development of the spine injury score was driven by data and created in consideration of the perception of injury severity of a much larger group of surgeons across all regions of the world to reflect the various aspects of cultural diversity that likely play a role in the treatment algorithms.

Although the results of the severity survey were allowed to dictate the associated TL AOSIS point value in nearly all cases, the classification group intervened to increase the score assigned to A4 to give it the same point value as B1 injuries based on the almost identical severity scores of these two injury patterns. Rather than decreasing the B1 score, the A4 score was increased to reflect several considerations. First, the A4 score was closer to the B2 score (difference < 10 points) than it was to the A3 score (difference > 15 points). Second, neurologically intact patients with burst fractures are commonly treated with surgical intervention in many parts of the world, suggesting that surgeons feel patients with these injuries have worse outcome with nonoperative treatment. Although this article does not yet provide treatment guidelines, it is logical to promote such an injury to a higher score rather than demote an injury (B2) that is most commonly treated with surgery to a lower score. It is important to note that despite an increased score for C injuries compared with B3 injuries, both of these injuries are unstable and require surgical stabilization. Reports of nonoperative treatment of either thoracic extension-distraction injuries or translational injuries are rare, and every previous morphologic classification system has recognized the unstable nature of these injuries and the associated indication for surgery barring extenuating circumstances that absolute preclude decompression and stabilization.[1–3,5]

Significant debate was had by the classification group when attempting to determine the point value for a patient who is unable to be examined (Nx). It is likely that patients who sustain an injury severe enough to limit the ability of the surgeon to obtain a proper neurologic exam are polytrauma patients, and so even in a neurologically intact patient, immediate stability is particularly beneficial in these patients. Furthermore, the risk of catastrophic neurologic sequelae

Table 4 Point allocation for neurologic status and modifiers

Subgroup	Points
Neurologic status	
N0	0
N1	1
N2	2
N3	4
N4	4
Nx	3
Patient-specific modifiers	
M1	1
M2	0

from the failure to promptly stabilize a patient cannot be ignored.

There is very little variation in grading fracture morphology or in perception of injury severity on a geographic basis. Schroeder et al found no significant regional variation in perception of fracture severity in any of the morphologic or neurologic elements graded,[13] which is highly relevant to the present investigation as it strongly suggests that there is no need to consider a point system with regional variation. We expect the point system described previously to accurately reflect worldwide perceptions of injury severity, and we anticipate that there will be widespread adoption of the scoring system given the lack of variation in perception of injury severity.

Future efforts will establish surgical thresholds based on questionnaires designed to distinguish which morphologic injury patterns and neurologic deficits are thought to require stabilization/decompression and sent to a large group of surgeons with an interest and experience in spinal trauma. We expect this research strategy to capture the wide variation in practice patterns. An inclusive approach will increase the generalizability of the resulting recommendations and allow for surgical thresholds to be evaluated on a regional basis to capture culture differences among surgeons and patients that influence treatment. The ultimate goal is to use this classification and scoring system framework to perform randomized, controlled trials that would allow patient outcomes and not surgeon perception of patient outcomes to establish the surgical thresholds and algorithms.

This investigation has several shortcomings. Although we used the results of a survey sent to surgeons thought to have particular expertise and experience in treating patients with spinal trauma, there was no practical metric to verify whether this belief was true. This flaw is inherent to all studies that utilize "expert opinion," although our intent in including a large number of surgeons was to mitigate the influence any single surgeon would hold over the study results. The points assigned to each injury were arbitrary, as was the relative importance of morphology and neurologic injury. We used the largely uniform stepwise perception of injury severity in the ascending injury subgroups to assign single-point increases with the few exceptions as described previously, but the magnitude of the point scale and relatively severity implied is somewhat arbitrary. Prospective application to injured patients with follow-up outcome measures along with the investigations to identify surgical thresholds will provide feedback about the point system described herein, which can be modified if necessary.

Conclusion

In this article, we have provided face validity for the AOSpine Thoracolumbar Classification system in that the consensus scoring system that has been developed aligns with the ordered classification itself. Furthermore, the hierarchy of neurologic and other modifiers was consistently rated and scored by surgeons and confirms the increasing severity of injury expressed within this classification system. These results indicate that through utilizing the TL AOSIS, the AOSpine Thoracolumbar Classification system is an ideal system for the establishment of a globally accepted treatment algorithm for thoracolumbar trauma.

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