Review

Relationships between the Arbeitsgemeinschaft für Osteosynthesefragen Spine System and the Thoracolumbar Injury Classification System: An analysis of the literature

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Context: The Thoracolumbar Injury Classification System (TLICS) has been recently described to help surgeons in the decision-making process of thoracolumbar spinal trauma.

Objective: To analyze the potential relationships between the TLICS scores with the Arbeitsgemeinschaft für Osteosynthesefragen (AO) Spine System and patient's neurological status.

Methods: Literature analysis of the potential scored injuries in the TLICS system, based on its individual scores, its total score, and its suggested proposed treatment, correlating these with the AO system and neurological status.

Results: Findings are presented according to the TLICS score. Patients with a TLICS 1–3 points, receiving conservative treatment, are AO type A injuries, generally neurologically intact. TLICS 4 group also included AO type A fractures, neurologically ranging from intact to complete spinal cord injury. TLICS 5–10 points includes AO type B and C injuries, regarding their neurological status, and burst fractures (AO type A) with concomitant neurological injury and most of the patients with incomplete deficits and cauda equina syndrome.

Conclusions: As a general overview, according to the TLICS, patients without neurological deficit and with AO type A injuries are conservatively treated. AO type B and C injuries are managed surgically, with regard to neurological status. Patients with cauda equina or incomplete injuries also received a higher severity score. Controversies still exist regarding the management of unstable burst fractures without neurological status. The role of the posterior ligamentous complex status and the magnetic resonance imaging in the decision-making process require more clinical evidence.

Keywords: Thoracolumbar Injury Classification System, AO Spine System, Spinal cord injuries, Spinal fracture

Introduction

The Thoracolumbar Injury Classification System (TLICS) has been described by the Spinal Trauma Study Group to help surgeons in the decision-making process.¹ Three major descriptive categories were assessed to guide the decision for conservative versus surgical treatment of the thoracolumbar injuries: (1) injury morphology, (2) integrity of the posterior ligamentous complex (PLC), and (3) neurological status.¹ The severity score is calculated by summation of the individual scores: three or less points suggest conservative treatment, five or more points suggest surgical

treatment, and with four points suggest either surgical or conservative treatment can be chosen¹ (Table 1).

Another widely utilized system to classify the thoracolumbar injuries was proposed by Magerl *et al.*,² in 1994, also known as the AO Spine System, used primarily for describing injuries rather than as a basis for treatment decisions. Although widely used, this system is criticized as it does not adequately guide surgical decision-making and has been shown to have a low inter- and intra-observer agreement.³ The AO System is also criticized, as it does not account for the patients' neurological status, possibly one of the most critical determinants in surgical decision-making. The three main injury patterns are defined: type A (vertebral body compression), type B (anterior and posterior elements injuries with

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Table 1 Assignment of point values – TLICS

Variable	Points
Injury morphology	
Compression	1
Burst	+1
Translation/rotation	3
Distraction	4
Neurological status	
Intact	0
Nerve injury	2
Cord, conus medullaris	
Incomplete	3
Complete	2
Cauda equina	3
PLC integrity	
Intact	0
Indeterminate*	2
Injured	3

*Indeterminate status is attributed to patients with suggested ligamentous injury at the Short Tau Inversion Recovery (STIR) or T2 MRI sequence.

distraction), and type C (anterior and posterior elements injuries with rotation). The system has more than 50 classification subtypes, adding significant complexity, reducing reliability, and limiting its clinical utility.

Given the uncertainties around thoracolumbar spine injury classifications, the purpose of this study was to investigate the potential relationships between the TLICS scores, the AO system, and the patient's neurological status. In this context, we performed an analysis of the scored injuries in the TLICS system, based on its individual scores, its total score, and its suggested proposed treatment, correlating these with the AO system and the neurological status.

Materials and methods

We performed a literature analysis of the potential injuries scored by the TLICS. Using the TLICS score, the summation of three critical components (fracture pattern, neurological status, and PLC status), injuries can receive 1–10 points. The 10 possibilities were analyzed in isolation, correlating the possible injuries with one of the three main injuries (A, B, or C) proposed by the AO System and the patient's neurological status.

All the injuries scored were classified in one of the three AO spine injury patterns. AO type A injuries received one (compression) or two (burst fractures) points. Type B (distraction) received four points and type C (rotation) three, as proposed by the TLICS.

The possibilities for neurological status were defined such that neurologically intact patients received no points; complete cord/conus injury or nerve root injury received two points each and incomplete spinal cord/conus or cauda equina syndrome received the highest, three points.

The third variable used to score the TLICS system, the status of the PLC, was analyzed based on the following assumptions: AO type B and C, by strict definition, have concomitant injury of the PLC, receiving an additional three points for PLC disruption. These injury patterns (distraction, rotation) are defined by displacement of the vertebrae and PLC disruption; AO type A fractures present some controversy with regard to the PLC status. Magerl *et al.* stated that the ligamentous structures in AO type A fractures, compression and burst fractures, are intact. However, the literature widely defines burst fractures wherein the posterior ligamentous structures are thought to be injured (i.e. unstable burst fractures).⁴ For our study, we assume that type A injuries can have an intact PLC, thus receiving no points, have a suspected PLC injury at the magnetic resonance imaging (MRI) (two extra points) or a total disruption, with three extra points.

Results

Results are categorized according to the suggested treatment based on TLICS total score and summarized in non-surgical treatment (1–3 points – Table 2), surgical or non-surgical treatment (4 points – Table 3), and surgical treatment (5–10 points – Table 4).

Non-surgical treatment – TLICS 1–3 points (Table 2)

All potential injuries in this group, receiving 1–3 points, are AO type A injuries. No patients with an incomplete

Table 2 Classification of the patients with a TLICS score from 1 to 3 points according to the AO classification system and neurological status

TLICS score	AO type	Neurological status	Injury description (with the partial TLICS punctuation)
1	A	Intact	Compression fractures (1) + no neurological deficits (0) + intact PLC (0)
2	A	Intact	Burst fractures (2) + no neurological deficits (0) + intact PLC (0)
3	3.1	A	Intact
	3.2	A	Complete
	3.3	A	Nerve root injury
			Compression fractures (1) + no neurological deficits (0) + indeterminate PLC (2)
			Compression fractures (1) + complete neurological deficit (2) + intact PLC (0)
			Compression fractures (1) + nerve root injury (2) + intact PLC (0)

Table 3 Classification of the patients with a TLICS score of 4 points according to the AO classification system and neurological status

TLICS score	AO type	Neurological status	Injury description (with the partial TLICS punctuation)
4	4.1 A	Intact	Burst fractures (2) + no neurological deficits (0) + indeterminate PLC (2)
	4.2 A	Nerve root injury	Burst fractures (2) + nerve root injury (2) + intact PLC (0)
	4.3 A	Complete	Burst fractures (2) + complete neurological deficit (2) + intact PLC (0)
	4.4 A	Incomplete or cauda equina syndrome	Compression fractures (1) + incomplete neurological deficits or cauda equina syndrome (3) + intact PLC (0)

neurological deficit or cauda equina syndrome are included in this group.

Surgical or non-surgical treatment – TLICS 4 points (Table 3)

All potential injuries in this category were AO type A fractures. The neurological status can range from intact to complete spinal cord injury.

Surgical treatment – TLICS 5–10 points (Table 4)

In this group, all the three AO fracture patterns are possible. All the type B and C injuries belong to the surgical group of the TLICS system, regardless of neurological status (6.4; 7.3, 8.2; 8.3; 9 and 10).

Although compression fractures can theoretically reach this severity score leading to surgical treatment (5.3; 5.4), we believe that these clinical scenarios are rare. Unstable burst fractures (5.1; 7.1; 7.2 and 8.1)

regardless of the neurological status are proposed to be treated surgically. Stable burst fractures with incomplete neurological deficit may be surgically treated (5.2), as well as some burst fractures with indeterminate PLC injury and with either nerve root injury (6.2) or complete spinal cord injury (6.3).

Discussion

The TLICS score has a strong association with the neurological status and the three main types of the Magerl classification system. In a previous study, Joaquim *et al.*⁵ found a statistically significant association between the neurological status (normal or changed) and the AO type fracture ($P = 0.0041$) or the TLICS score ($P < 0.0001$).⁵ They also found an association between the AO type fracture and the TLICS score ($P = 0.0088$).

Table 4 Classification of the patients with a TLICS score from 5 to 10 points according to the AO classification system and neurological status

TLICS score	AO type	Neurological status	Injury description (with the partial TLICS punctuation)
5	5.1 A	Intact	Burst fractures (2) + no neurological deficits (0) + PLC disruption (3)
	5.2 A	Incomplete or cauda equina	Burst fractures (2) + incomplete neurological deficits or cauda equina syndrome (3) + intact PLC (0)
	5.3 A	Complete	Compression fractures (1) + complete neurological deficits (2) + indeterminate PLC (2)
	5.4 A	Nerve root	Compression fractures (1) + nerve root injury (2) + indeterminate PLC (2)
6	6.1 A	Incomplete or cauda equina syndrome	Compression fractures (1) + incomplete neurological deficits or cauda equina syndrome (3) + indeterminate PLC (2)
	6.2 A	Nerve root	Burst fractures (2) + nerve root injury (2) + indeterminate PLC (2)
	6.3 A	Complete	Burst fractures (2) + complete neurological deficits (2) + indeterminate PLC (2)
	6.4 C	Intact	Rotational injury (3) + no neurological deficits (0) + PLC disruption (3)
7	7.1 A	Complete	Burst fractures (2) + complete neurological deficits (2) + PLC disruption (3)
	7.2 A	Nerve root	Burst fractures (2) + nerve root injury (2) + PLC disruption (3)
	7.3 B	Intact	Distraction injury (4) + no neurological deficits (0) + PLC disruption (3)
8	8.1 A	Incomplete or cauda equina syndrome	Burst fractures (2) + incomplete neurological deficits or cauda equina syndrome (3) + PLC disruption (3)
	8.2 C	Complete	Rotational injury (3) + complete neurological deficits (2) + PLC disruption (3)
	8.3 C	Nerve root	Rotational injury (3) + nerve root injury (2) + PLC disruption (3)
9	9.1 B	Complete	Distraction injury (4) + complete neurological deficits (2) + PLC disruption (3)
	9.2 B	Nerve root	Distraction injury (4) + nerve root injury (2) + PLC disruption (3)
	9.2 C	Incomplete or cauda equina syndrome	Rotational injury (3) + incomplete neurological deficits or cauda equina syndrome (3) + PLC disruption (3)
10	B	Incomplete or cauda equina syndrome	Distraction injury (4) + incomplete neurological deficits or cauda equina syndrome (3) + PLC disruption (3)

Non-surgical group – TLICS ≤ 3

In the non-surgical treatment group, all the patients have type A injuries. With an exception of patients with the TLICS of two points (burst fractures – neurologically intact – PLC intact), all the other have compression injuries. Of note, patients in the 3.2 and 3.3 groups have complete neurological deficit and nerve root injuries with compression morphology fractures. Although possible, these latter two clinical scenarios are quite rare in the literature and in our experience. In summary, conservative treatment according to the TLICS was proposed for neurologically intact patients without PLC injury and with AO type A fractures.

Borderline injury severity score – the TLICS 4

In the group of patients that can be treated conservatively or surgically, all the patients have type A injuries. All patients have stable burst fractures and are neurologically intact, with an exception of patients in the 4.4 group, who have incomplete neurological deficit or cauda equina syndrome and a compression fracture. Again, although theoretically possible, these scenarios are rarely reported in the literature as well as in our experience. This group also includes patients with burst fractures and suspected PLC injury, nerve root injury (4.2) or with complete neurological deficit (4.3). While there is evidence to support surgical treatment of patients with neurological deficit (4.3) to maintain neurological stability, many reported indications for surgical treatment focus on deformity (height loss and kyphosis). The development of post-traumatic deformity is not accurately predicted by routine preoperative measurements. A classic paper by Roberts and Curtiss⁶ evaluated the progression of deformity in seven patients with paraplegia and burst fractures treated conservatively. The authors reported that none of these patients require surgical stabilization, once spontaneous inter-body fusion occurred, and none of them developed late deformity. The radiculopathy secondary to burst fractures, especially in the lower lumbar levels, can be caused by the retropulsion of the posterior wall into the lateral recess (injury 4.2). In a series of 44 patients with lumbar burst fractures (L3–5), 8 had unilateral radiculopathy.⁷ Seven were surgically treated, all of them with a good or excellent prognosis, just one of them with a fair evolution.⁷ It seems very reasonable that these injuries can be treated conservatively in cases with mild and temporary radiculopathy, or surgically treated in patients with more prominent symptoms.

Surgical group – TLICS ≥ 5

As presented in the Results section, all type B and C injuries lead towards surgical treatment, regardless of

the neurological status (6.4; 7.3, 8.2; 8.3; 9 and 10). These fracture patterns are probably the most important determinant for surgical treatment in the TLICS system, even more than the neurological status, given the defined disruption of the PLC status. Surgery for stabilization of these injuries is accepted based on the fact that they can develop severe post-traumatic deformities.⁸ These deformities can be consequence of a missed fracture or wrong indication for conservative therapy in unstable injuries, leading to pain, neurological worsening, and postural problems.⁹

Unstable burst fractures, an AO type A injury with concomitant PLC injury (5.1; 7.1; 7.2 and 8.1), are typically managed surgically according to the TLICS system. Although this topic has been extensively studied in many papers,^{10–15} there is no specific evaluation of the prognostic value of the PLC status in thoracolumbar spine injuries in the clinical setting. A major assumption of our review is that type A (burst) fractures classified within the AO system may or may not have a PLC injury (PLC intact, indeterminate, or disrupted). Although this assumption may be a confounding factor in our analysis, it also reflects an inherent weakness of the AO classification system and a potential advantage of the TLICS system.

Regarding the neurological status, incomplete deficits, at the spinal cord or in the conus, and cauda equina syndrome received the highest severity for neurological impairment. Most of these injuries are the critical factors for determining surgical treatment. Injury to the conus or cauda equina has an unpredictable natural history, especially when caused by trauma, with sudden neural dysfunction, generally having a poor prognosis.¹⁶ Although there is no level I or II evidence to clearly define the indication, surgery is often proposed in an attempt to improve neurological recovery and avoid deterioration or concomitant pain syndromes.¹⁷ Based on similar principles, in comparison with complete spinal cord injuries in which neurological improvement is unpredictable or less effectual, incomplete lesions should be referred for early decompression and surgery, as neurological improvement can be observed in up to 95.2% of the patients.¹⁸

Conclusions

The TLICS injured severity score is a promising system, helping surgeons to guide surgical treatment. As a general overview, patients without neurological deficit and with AO type A injuries are conservatively treated. AO type B and type C injuries are managed surgically, regarding the neurological status. Patients with cauda equina or incomplete injuries also received a

higher severity score, enforcing the importance of prompt decompression to improve neurological outcomes.

The great controversy about injuries treated based on the TLICS is the management of unstable burst fractures. The role of the status of the PLC and MRI findings in the decision-making process requires more clinical evidence to support widespread use.

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