Case Based Approach on the Revised AO Spine Classification and Literature Review for Thoracolumbar Spine Trauma.

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Learning objectives

1. Discuss the revised AO Thoraco-lumbar (TL) spine injury classification system.

2. Illustrate the added value of using "The Thoracolumbar injury classification and severity score-TLISC".

3. Highlight the different classification systems proposed to evaluate dorsolumbar fractures injuries.
Background

Injuries' classifications are proposed to create a common language among the members of the healthcare team which is crucial for sound clinical management of injured patients. Trials to classify traumatic vertebral injuries were based on either mechanism of injury e.g. Böhler, different mechanistic descriptors of vertebral column e.g. Denis three column theory or a combination of both main mechanism of injury, pathomorphological uniformity e.g. Magerl's AO system. Using Magerl's AO system, the AO spine classification group (AOSCG) sat for a revised classification system to address the criticism given to Magerl’s system that it has too many details reducing both inter-observer and intra-observer reliability. Clinical application of this classification will be illustrated later on in a case based approach. Furthermore, a survey was given to Spine Trauma Study Group to identify similarities in treatment algorithms for common thoracolumbar injuries as well as to identify characteristics of injury that played a key role in the decision-making process. This survey named, the thoracolumbar injury classification and severity score (TLICS), was based on three major categories: the morphology of the injury; the integrity of the posterior ligamentous complex; and the neurologic status of the patient. This aims for a more simple and straightforward approach in classifying patients.
Imaging findings OR Procedure Details

The timeline for major spine classification systems is summarized below:

**Böhler** proposed the earliest classification system for TL spine fractures. Based on both anatomic appearance and mechanisms of injury, TL injuries were divided into compression fractures, flexion-distraction injuries, extension fractures, shear fractures, and rotational injuries. Yet, he did not attempt to define instability patterns.

Later on **Watson-Jones & Nicoll** recognized the importance of recognizing unstable fractures in order to avoid long-term neurological sequel as well as skeletal deformities. **Watson-Jones** described fractures according to their anatomic appearance with emphasis on ligamentous integrity as one of the key determinants of stability in various injury subtypes. **Nicoll** afterwards identified four anatomical structures (vertebral bodies, facet joints, posterior ligaments, discs) involved in any injury pattern and divided fractures into stable fractures and unstable fractures based on posterior ligamentous injury.

**Holdsworth** was the first to introduce the concept of column classification into TL fractures. He divided the spine into anterior column consisting of vertebral bodies and inter-vertebral discs and posterior column consisting of facet joints and the posterior ligamentous complex. Fractures categories include anterior compression fractures, fracture-dislocation, rotation fracture-dislocation, extension injuries, burst fractures, and shear injuries. The main drawback of this classification system is that it oversimplified the biomechanics of injury in TL fractures e.g. unstable burst fractures based on their natural history were falsely categorized as "stable".

To overcome this, **Denis** later on came with the concept of three columns, anterior column including anterior longitudinal ligament to the anterior two-thirds of the vertebral body, middle column including the posterior one-third of the vertebral body and posterior longitudinal ligament, and posterior column, which includes all structures posterior to the posterior longitudinal ligament. Four types of fractures emerged: compression fractures, burst fractures, fracture-dislocations, and seatbelt injuries. Denis's original concept of instability has been oversimplified to designate any fracture with two columns' disruption as unstable ones. This contradicts with Denis' original emphasis on distinction of mechanical and neurologic instability.

In contrast to Denis's mechanical based classification, **Mergel et al** classified injuries based on the direction of injury force into three types; compression, distraction and rotational. As mentioned earlier, this proposed system was criticized for its detail.
To address the drawbacks of the aforementioned classification schemes, the revised AO classification for TL injuries was proposed. It is divided into three categories:

- **Type-A injuries**: failure under axial compression of the anterior elements with intact posterior constraining elements (Fig. 1,2,3,4&5).

- **Type-B injuries**: failure of the posterior constraining elements (tension band or PLC injuries in case of TLspine). Unfortunately, we didn't encounter fracture type B2 in our collection, so only a diagram is provided (Fig 6,7&8).

- **Type-C injuries**: failure of anterior and posterior elements leading to displacement (Fig. 9).

**N.B** More than one type of injury can be described together for instance Type-A1 and type-B2 according to fracture morphological description.

Figure 10 presents a suggested simplified approach for morphological classification of TL injuries.

Posterior ligamentous complex the integrity and neurologic status of the patient in addition to the previously described morphologic classification of TL injuries are combined together to give thoracolumbar injury classification and severity score. This allows a more objective approach in determining the management approach of a certain patient. This score is illustrated in figure 11.
Fig. 1: (1&2) CT scan of the TL spine -axial and coronal reconstruction shows D12 left transverse process fracture (3) Illustration of AO TL spine, A0 "Insignificant injury".

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Fig. 2: (1)Lateral radiograph & CT scan of the TL spine -axial and sag. reconstruction(2&3)- shows impacted L3 fracture involving the superior end plate with mild anterior wedging. No posterior wall involvement or subluxation. (4) Illustration of AO TL spine, A1.

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Fig. 3: (1)Lateral radiograph & CT scan of the TL spine -axial and sag. reconstruction(2&3)- shows splitL1 fracture involving both end plates. No posterior wall involvement or subluxation. (4) Illustration of AO TL spine, A2.

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Fig. 4: (1) Lateral radiograph & CT scan of the TL spine - axial and sag. reconstruction (2&3) shows impacted L3 fracture involving the superior end plate and posterior wall involvement with retro-pulsed bone fragment. (4) Illustration of AO TL spine, A3.

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**Fig. 5:** (1&2) CT scan of the TL spine -axial and sag. Reconstruction shows L1 fracture involving both end plates and posterior wall involvement with retro-pulsed bone fragment. (3) Sag STIR MRI redemonstrate the findings with bone marrow contusion & mild cord encroachment (4) Illustration of AO TL spine, A4.

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**Fig. 6:** (1&2) CT scan of the TL spine - sag. & coronal reconstruction shows D11 fracture mono-segmental trans-osseous tension band failures "classic chance fracture". (3) Focused recon. at fracture site. (4) Illustration of AO TL spine, B1.

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Fig. 7: 1) CT scan of the TL spine -sag reconstruction shows L1 fracture showing posterior tension band disruption evidenced by widened inter-spinous distance. (2 & 3) Sag. & coronal T2 MRI proves the previously suggested ligamentous injury. (4) Illustration of AO TL spine, B2 "osseoligamentous disruption".

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**Fig. 8:** Illustration of AO TL spine, B3: Anterior tension band injury "hyperextension". This injury has not yet been encountered in our institute.

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Fig. 9: (1) CT scan of the TL spine -sag reconstruction shows L1 fracture with anterior displacement of the D12 relative to L1. (2) VRT images showing again the fracture with associated translation. (3) Illustration of AO TL spine, C.

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Fig. 10: Scheme for morphological classification of TL injuries.

© AOSpine Traumatic Spine Injuries Classification System. Classification toolkit
<table>
<thead>
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<tbody>
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<td>Morphology</td>
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<tr>
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<tr>
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<td>Complete</td>
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<tr>
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<tr>
<td>Injured</td>
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**Fig. 11:** Thoracolumbar injury classification and severity score.

Conclusion

Many trials were proposed to classify TL injuries. A classification system that is simple, reliable and clinically relevant is always the ultimate goal of these classification systems. We recommend using the AO system for this purpose. The added value of *thoracolumbar injury classification and severity score* is clear in directing patient management and ensuring a favourable patient outcome.

AO TL spine classification creates a simple way of communication between radiologists and caring physicians.
References


AOSpine Thoracolumbar Classification System. www.aospine.org/TLclassification
Personal Information

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