Let’s speak the same language: AOSpine Thoracolumbar Spine Injury Classification System

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Learning objectives

• To emphasize the importance of a unified diagnostic language among the different medical specialists.
• To describe the different types of fractures in the classification of thoracolumbar vertebral fractures proposed by AOSpine community.
• To make an outline of the different types of vertebral fractures of the AOSpine classification.
• Show examples of each type of vertebral fracture from the AOSpine classification.
Background

Throughout history there have been numerous classifications of bone lesions that have sought to catalog such lesions in order to guide treatment and prognosis [1-5].

Regarding spinal column injuries, the most traditional classification systems are that proposed by Francis Denis, the International Osteosynthesis Association (AO) classification presented by Magerl and Max Aebi and the Thoracolumbar Injury Severity Score (TLISS) postulated by Dr. Alexander Vaccaro, which gives a score according to the severity of the injury produced by thoracolumbar trauma [5, 6, 7].

However, to date, no classification has achieved a universal consensus to standardize care. This is probably due to the fact that no single classification system has been described that fully covers lesion severity, pathogenesis and biomechanical mechanisms of spinal injury and takes into account all clinical, neurological and radiological characteristics [8].

The lack of consensus can limit communication between physicians and make it difficult to fully understand the lesion that has patient, making more complicated the planning and development of treatment algorithms.

Previous published classifications have been criticized for being too simple, too complex or insufficiently reproducible.

AoSpine is an international academic community dedicated to research and education in the field of spinal care with the goal of unifying criteria in spinal care. They established the AO Spine Classification Group (AOSCG) with the aim to propose a comprehensive, evidence-based classification for traumatic spinal injuries that attempts to universalize the nomenclature and typing of spinal fractures. To this end, they have used the current Magerl AO system as a starting point and have tried to address traumatic spinal cord injuries in a way that is useful for clinical practice and research. [9,10].

In this communication we will focus on thoracolumbar (TL) fractures because they are the most frequent fractures of the spine. Due to its anatomical characteristics, the TL spine is particularly prone to fractures.

Several studies have found that the AOSpin classification presents a higher reliability than the traditional classifications, which present a moderate reliability and repeatability [4, 6, 9,11,12].

On the other hand, the data published by Wood et al. [12] regarding well-trained and experienced spine surgeons who classified the same fracture differently are striking.
There are several distinguishing characteristics that differentiate the AO spine injury classification system from the previous injury classifications [9]:

- The AOSCG is composed of a core team of expert spine surgeons from diverse geographic and cultural backgrounds. This facilitates international understanding and the exchange of intercultural differences in learning and understanding of basic concepts and definitions.
- Evidence-based approach. This classification system has been subjected to a solid process of statistical validation that guarantees a truly evidence-based approach towards an internationally accepted classification system [8].
- Administration and follow-up study. The management of the entire process was coordinated by professional research organization (AOCID) which represents a quality control measure through an independent entity.
- Experience in fracture classification. The AOSCG team has more than 50 years of experience in the use of spinal injury classifications.

Diagnostic imaging is the main basis for the characterization and categorization of spinal injuries that can be identified very reliably thanks to the remarkable advances achieved in radiology [9], however it should be noted that the different modalities of diagnostic imaging and the variable quality of the image can have a great impact on a classification of traumatism of the spine and result in different degrees of detail with respect to the bone structures and / or disc-ligaments involved in the injury [13].
Findings and procedure details

RADIOLOGICAL EXAMINATION IN TRAUMATIC SPINAL CORD INJURY

Radiologic evaluation of an injured spine includes simple x-rays, computed tomography and magnetic resonance imaging (MRI). The purpose of radiologic evaluation is:

- Identify the location and extent of the lesion.
- To determine the characteristics of vertebral instability.
- Evaluate the severity of neurological compression and injury.
- Classify patterns of injury.
- Identify multilevel injuries.

Good quality simple x-rays should be performed in two planes (antero-posterior and lateral) in all patients with suspected spinal trauma. If x-rays are unsatisfactory or inconclusive, a CT scan should be performed.

In many centers, computed tomography is performed routinely because it reveals fractures that are not visible on simple x-rays in more than 20% of patients. CT scans are part of the evaluation for the AOSpine classification. They represent bone lesions more accurately and have a sensitivity and specificity > 95%, also allowing multiplanar reconstructions.

MRI scan provides useful information about the extent of soft tissue injury that has occurred during spinal cord injury. It is indicated in patients with neurological deficit and suspected posterior ligament complex injury [12].

AOSPINE THORACOLUMBAR SPINE INJURY CLASSIFICATION SYSTEM

To address categorization a clear distinction must be made between classification systems, severity measures and treatment algorithms [14]. Other medical prognostic factors, comorbidities and neurological deficits also have an impact on treatment decisions but must be considered separately and are therefore not integrated into the current classification system.

The AOSpineThoracolumbar Spine Injury Classification System is based on the evaluation of 3 basic parameters:
1. Morphologic classification of the fracture

Three main forms of spinal integrity failure were defined and listed in ascending gravity as:

- Type A lesions: failure under axial compression of the anterior elements with posterior restriction elements intact.
- Type B lesions: failure of the posterior restriction elements.
- Type C lesions: failure of the anterior and posterior elements that lead to displacement.

Considerations:

- Multilevel lesions (present in 15% of patients) should be classified separately and listed according to severity.
- All type A compression lesions and subtype B1 lesions (transosseous posterior tension band rupture) are at the level of a single vertebra. Their location is thus designated by the involved vertebra traditionally designated with a letter (T or L) and a number (1 to 12 or 1 to 5) depending on the spinal region involved. All C-type displacement injuries and subtype B2 (posterior tension band ligament rupture) involve movement segments by definition and are therefore located at the specified level of the movement segments involved.
- The posterior restriction elements in the case of toracolumbar injuries are the facet joints and the posterior oseo-ligamentary structures (supraspinous ligaments, interspinous ligaments and ligamenta flava), also called PLC (posterior ligamentous complex). Fig. 1 on page 10

**Type-A injuries: compression injuries of the vertebral body**

In the thoracolumbar spine, type A lesions are represented by compression injuries with fractured vertebral body without interruption of posterior constraining elements or signs of displacement or dislocation. They are divided into 4 subtypes:

**A0 - Minor or nonstructural fractures.** This code is used to describe negligible fractures that do not significantly affect spinal stability, such as a fracture isolated from the spinal process, the transverse process, or the lamina.
A1 - **Wedge compression or impaction fractures.** These are fractures of the vertebral body with one or both end plates involved, but the fractures do not connect to each other. Remember, the posterior wall of the vertebral body remains intact, indicating that there is no violation of the spinal canal. Fig 3.

A2 - **Split or pincer type fractures.** These are fractures of the vertebral body in which the fracture affects both terminal plates without the involvement of the posterior wall of the vertebral body. Fig 4.

A3 - **Incomplete burst fractures.** This injuries are vertebral fractures affecting a single endplate associated with the involvement of the posterior vertebral wall. Fig 5. They are commonly called burst fractures. The PLC and the facet joints remain intact. There may be a vertical fracture of the lamina as a result of the increase in the interpedicular distance, without there being vertebral translation. A3 fractures of the vertebral body involving a horizontal fracture in the axial plane through the posterior elements interrupt the stability of the spinal column, and such injury should be classified as a type B injury.

It should be noted that involvement of the posterior wall with retropulsed bone elements may cause invasion of the spinal canal with posterior neurological deficits.

A4 - **Complete burst fractures.** These are fractures of the vertebral body involving both terminal plates and the posterior wall of the vertebral body. As in A3 lesions, these may be associated with vertical fracture lines of the lamina, but without interruption of the posterior tension band. Fig 6.

Split fractures that also involve the posterior vertebral body are included in this.

**Type-B injuries: 'tension band' or PLC injuries in the TL spine.**

Type B denotes failure of the posterior restraining elements. They are often combined with type A fractures (to be specified separately) due to a flexion distraction mechanism that causes compression of the vertebral body. They are divided into two subtypes:

**Lesions of subtype "B1 - Transosseous tension band disruption / Chance fracture".**
It is a failure of the monosegmental transosseous tension band. These are the classic "Chance" fractures. There is no substantial compression fracture of the vertebral body. These injuries are unique due to the presence of a horizontal fracture that extends through the vertebral body and pedicles.

**Lesions of the subtype "B2 - Posterior tension band disruption".** Include the other types of interruption of the posterior tension band with or without posterior bone involvement Fig. 8 on page 16
According to AOSCG, the fracture lines can be seen through posterior bone elements, for example, facet joints, the interarticular portion of the isthmus (spondylolytic injuries), or the spinous process extending to the interspinous ligaments. Facet or subluxation fractures may also be seen with the consequent kyphotic deformity of the movement segment(s) involved.

**Type-C injuries: displacement injury**

Type C are lesions are characterized by an abnormal displacement of the cranial and caudal parts of the spine in any plane* Fig. 9 on page 17.

They involve a distraction or separation of the anterior and posterior components of the vertebral segments without any anterior or posterior structure remaining intact, and there may be a complete separation of the vertebral elements. The interruption of the anterior component can be through the disc or vertebral body. The rupture of the posterior elements can be through the spinous process, lamina, pars interarticularis or posterior ligament complex.

There are no subtypes, since due to the dissociation between the cranial and caudal segments it is possible to make different configurations in different images, which are not relevant. It is combined with subtypes of A to denote the associated fractures of the vertebral body if necessary.

Note: A typical coding sample would be L3/ L4 - type C (L4-B2, L4-A3) indicating that the translation is at the L3 / L4 level with an associated incomplete burst fracture of L4 and failure of the posterior restraining elements. *Fig. 10 on page 18*

**2. Neurological Status**

The neurological state is classified according to a system of 5 subsections that are coded with the letter N and a figure according to the type of deficit.

**3. Clinical modifiers**

They would be used only when necessary to help the doctor decide on treatment.

**M1** is used to designate fractures with an indeterminate lesion in the tension band based on images of the spine, such as MRI or clinical examination. This modifier is important in identifying those lesions that appear stable from a bone point of view in which ligament insufficiency can help determine whether operative stabilization is a consideration.
M2 is used to designate a patient-specific comorbidity, which could argue for or against surgery for those patients with relative indications for surgery. Examples of an M2 modifier include such disorders, but are not limited to ankylosing spondylitis, topical conditions, diffuse idiopathic skeletal hyperostosis, osteopenia/porosis or burns affecting the skin covering the injured spine.

**DIAGNOSTIC ALGORITHM AND FINAL CODING**

The AOSpine group also published a systematized algorithm specific to the TL region that ensures a comprehensive approach in which no lesions are misdiagnosed [9]. Fig. 11 on page 19
Images for this section:

![Posterior Ligamentous Complex](PLC_Courtesy_of_radiology_assistant_website.png) © Radiology assistant website

**Fig. 1:** Posterior Ligamentous Complex (Courtesy of radiology assistant website)

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Fig. 3: X-ray image of T-L spine, lateral view. Subtype A1 Wedge or impaction fracture.

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Fig. 4: Lumbosacral spine CT. Subtype A2-Split or pincer-type: Fracture of both L3 endplates without involvement of the posterior wall of the vertebral body

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Fig. 5: Lumbosacral spine CT. Subtype A3-Incomplete burst fracture of L3. This injuries are vertebral fractures affecting a single endplate associated with the involvement of the posterior vertebral wall.

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Fig. 6: T2/Flair-weighted sagittal MRI scan of the lumbosacral spine. Subtype A4 - Complete burst fracture of L4. Loss of height with compromise of both vertebral plates and affectation of the posterior wall, conditioning the reduction of the antero-posterior diameter of the dural canal by approximately 50%. Indemnity of the posterior ligamentous complex.

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**Fig. 8:** Sagittal view (T2-weighted sequence) showing fracture involving both endplates of T12 vertebral body without involvement of the posterior wall (split/pincer fracture). In addition there is posterior ligamentous complex or tension band injury associated. Code: T11-T12 Type B2 with T12-A2 of AO spine injury classification system.

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**Fig. 9:** Type C injuries. Images property of Lippincott Williams & Wilkins published in The Spine Journal (Vaccaro A. R., et al. AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers. The Spine Journal. 2013;38(23):2028-2037)

**Fig. 10:** T1 and T2-weighted sagittal MRI Scan showing L4 injury with posterior block displacement of both body and posterior elements (Type C injury), involvement of the upper plate and posterior wall with severe reduction of the anteroposterior diameter of the dural canal greater than 80% and involvement of the posterior ligamentous complex. Conclusion: L3-L4 type C injury with L3-L4 type B2 and L4 A3 associated.

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Fig. 11: The AOSpine group also published a systematized algorithm specific to the TL region that ensures a comprehensive approach in which no lesions are misdiagnosed.

Conclusion

In radiology, adequate communication with the different specialists is fundamental, for which it is essential to speak the same language unifying diagnostic criteria and adopting a single nomenclature that facilitates the diagnostic-therapeutic process.

Respect for spinal injuries many original publications classifications of thoracolumbar spine injuries that are too complex, incomplete or lack a rigorous scientific basis. The AOSpine Injury Classification System represents an improvement over the previous ones, proposing a more structured and less complex classification scheme that takes into account the inherent variability of spinal injuries and each important mode of failure.

The evaluation and validation of this system is a continuous process. Only with global and interdisciplinary effort will the final objective of a comprehensive and clinically relevant classification be achieved. Considering the fundamental role of image studies in these classifications, radiologists must take a more active role, as we have much to contribute.
References


