Analysis of the Classification Systems for Thoracolumbar Fractures

Subjects: Orthopedics

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Spinal fractures represent a category of traumatic lesions with a significant impact both medical and social aspects of life. Within this category, thoracolumbar fractures (TLF) form a particular subcategory due to their location with specific biomechanics—the transition from thoracic physiologic kyphosis (fixed) to lumbar lordosis (mobile). Lesions at this level may have severe consequences such as complete/partial motor deficit, local pain or kyphosis.

thoracolumbar fractures classification

1. Introduction

Spinal fractures represent a category of traumatic lesions with a significant impact both medical and social aspects of life. Within this category, thoracolumbar fractures (TLF) form a particular subcategory due to their location with specific biomechanics—the transition from thoracic physiologic kyphosis (fixed) to lumbar lordosis (mobile) [1]. Lesions at this level may have severe consequences such as complete/partial motor deficit, local pain or kyphosis [2].

The incidence of thoracolumbar traumatic lesions is variable dependent on the region and country and the number of cases ranges between 6.4 and 11.7/million/year in the United States [3] and 2.4/million/year in China [4], with a global incidence of 3/million/year, including osteoporotic fractures [5]. Within spinal fractures, thoracolumbar localization is present in more than half of the cases (58%) [6]. The most common localization is L1, followed by T12 and L2 [7]. Neurologic deficit (AIS A–AIS D) affects between 25–45% of the cases and 54% [6][7]. More importantly, the treatment of these fractures is still the subject of much controversy. There are three issues that have not yet found a definitive solution which are as follows: 1—a reliable classification/scale, 2—the best surgical approach [8].

In 2002, Mirza et al. defined the ideal criteria that have to be fulfilled in the classification of traumatic spinal lesions [9]. According to them, the terminology has to be clear, comprehensive, concise and descriptive, so as to clearly define each category; the lesion has to be described in terms of pathogeny and biomechanics (mechanism), to precisely indicate the severity and to guide the treatment; lesion characteristics have to defined both in terms of clinical and radiologic elements; the neurology has to be defined in terms of etiology, severity and manifestations; lesion morphology scaling has to take into account the severity of bony and ligamentous lesions, prognostic predictors, including natural history, treatment type and results, deformity risk and additional neurological deficits, to provide useful elements for future research.

Historically, multiple classifications and scales have been devised in order to optimally define the lesions as well as the treatment options. These systems evolved over time, considering not only the morphology of the lesion and mechanisms but also stability, neurology and PLC integrity.

In 2010, van Middendorp et.al. describe the ideal characteristics of a classification system for spinal traumatic lesions [10]. Ideal properties of spinal injury classification categories are, according to them, as follows: (1) clear definitions without ambiguity or freedom of interpretation; (2) all-inclusive and mutually exclusive; (3) clearly distinguishable representative graphic illustrations; (4) straightforward and practicable for daily use; (5) limited number of categories; (6) characterized by increasing grades of severity; (7) each (sub)category alphanumerically coded; (8) injury characteristics easily discernable on diagnostic images [10].

2. Bohler Classification

The first classification of thoracolumbar traumatic lesions belongs to Bohler in 1930 [11]. In his classification he introduced lesion mechanism and morphology, describing 5 categories: compression fracture, flexion distraction injury (compression injury to the vertebral body and distraction injury to the posterior element), extension injury, shear fracture, and rotational injuries. He made no attempt to define spinal instability based on lesion morphology [12].

Sethi et.al., 2009, when looking at the existent classifications analyses, studied the Boehler classification and concluded that it is simple, easily usable, yet very descriptive, outdated, unvalidated, and cannot be predictive of outcome [13]. The same paper also evaluates other less used classifications, such as the Watson–Jones classification and the Nicoll, McAffee, Ferguson and Allen classifications [14][15][16][17]. Although these are considered simple and easy to use in practice, they are as a general rule not validated, they do not predict the outcome and as a result are not commonly used.

3. The Load Sharing Classification (LSC) of Spine Fractures

A classification based on a quantitative point system, The Load Sharing Classification (LSC) of Spine Fractures was published by McCormack and Gaines in 1994 [18]. This classification appeared as a result of the increasingly extensive use of pedicular screws, a technique described and used by Roy Camille, initially in spine fractures, then in other types of spinal pathologies [19][20][21][22][23]. The authors documented in certain cases the failure of short segment pedicular screws SSPS instrumentation systems—of one level above, or one level below—used for the treatment of three-columns fractures and fractures–dislocations in the thoracic and thoracolumbar areas, leading to kyphosis. This classification evaluates, based on a quantitative point system, the following elements: (1) the degree of kyphosis correction on lateral view, (2) degree of vertebral body comminution, (3) the apposition of the fracture fragment. Each element can be evaluated with 1 to 3 points, leading to an overall score of 3 to 9. As the score increases, the anterior support is more severely affected. SPSS is indicated for a score of 6 or lower. For a score greater or equal to 7, without dislocation (severe burst fractures) short-segment anterior corpectomy, strut-graft

fusion and instrumentation is indicated. If dislocation is also present then, for the same score of 7 or greater, SPSS followed by an anterior approach (circumferential, 360 degrees) is indicated. Alternatively, LSPS (8 screws) can be used with the downside of supplemental mobility impairment. The authors underline from the beginning a couple of disadvantages of their classification such as a lack of evaluation of the mechanism of injury, ligament integrity, which in turn makes this score unusable for surgical decision making (the evaluation of the ligamentous system is essential in therapeutical decision). In conclusion, this classification is useful in making the choice between SSPS or LSPS, as well as the anterior approach (**Figure 1**).

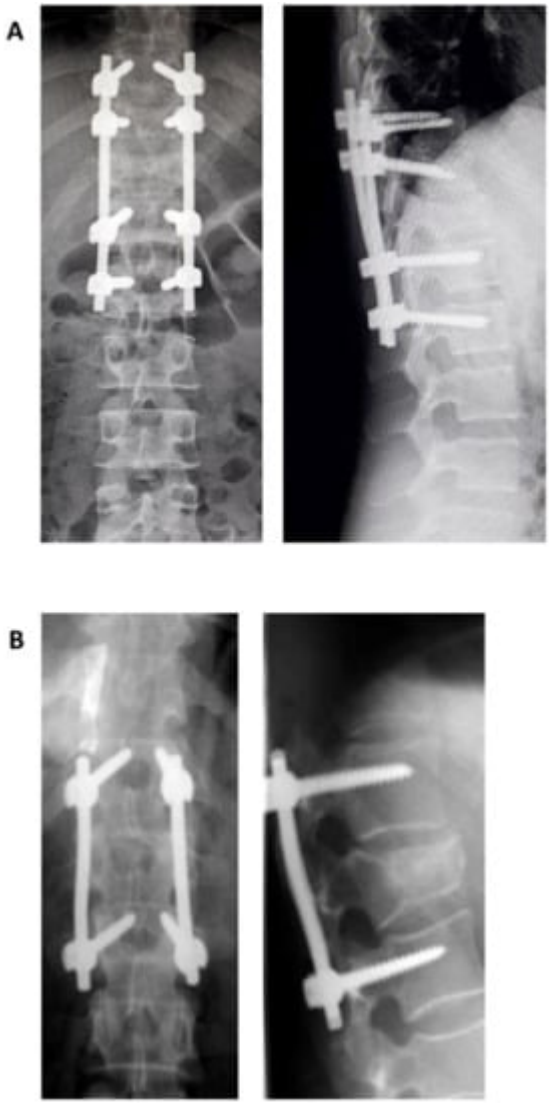


Figure 1. Postoperative X-ray showing a long segment pedicular screws (**A**) and short segment pedicular screws (**B**).

Sethi et.al. advance the opinion that the Load Sharing Classification method of McCormack is simple, predicts the outcome of short instrumentation, but is not validated, and does not evaluate neurology and stability [13]. Radcliff et.al. conclude that the Load Sharing Score (LSS) cannot be used alone for surgical decision making for thoracolumbar fractures in the absence of a significant correlation between the neurological status and ligament integrity [14]. This caveat can lead to an incorrect choice of treatment, a low interobserver reliability for the proposed

surgical treatment threshold score of 6, which may hinder communication and the continuity of care among providers, and surgical decision making at a score greater than 6 it is not reproducible, sensitive and specific.

Even more, both surgical techniques as well as instrumentation systems have evolved significantly in recent decades and, as a result, the LSS should be used carefully [15]. Stam et.al. in their systematic literature review published in 2020 conclude that, although an LSS equal or greater than 7 requires the reconstruction of anterior spinal support with or without SSPS, SSPS alone is sufficient and safe in these cases [16]. As a result, LSS loses its predictive value when faced with sagittal and posterior instrumentation failure.

In spite of all the above-mentioned disadvantages, LSS is valuable with regard to the issue of anterior vertebral support, taking into account the comminution and fragments apposition. These elements represent red flags for possible lesion progression towards chronic pain and segmental kyphosis, especially in cases treated conservatively.

4. Introduction of Columnar Concepts

A critical landmark in the evolution of thoracolumbar lesions classification was the introduction of the columnar concept. It was introduced in 1963 by Holdsworth as the “Two Column Concept” [17]. The author defined two parts for the spinal column, namely the anterior column consisting of the vertebral body, intervertebral disk and anterior and posterior ligaments, and the posterior column consisting of the pedicles, joint process, transverse apophysis, yellow ligament, spinous process and supra and interspinous ligaments. Column stability depends on the posterior column. This is the first instance that the role of PLC in column stability is noticed. Traumatic lesions are therefore split in stable—wedge compression fracture, burst fracture and unstable dislocations, i.e., extension fractures and dislocations rotational fracture-dislocation. The latter are produced through the following mechanisms: flexion, flexion-rotation, extension, extension-compression and translation. It is a classification that takes into account traumatic mechanisms and lesion morphology.

In 1983, Denis described the three columns system, which divides the Holdsworth anterior column in two, resulting a middle column which consists of the posterior half of the vertebral body, intervertebral disk and PCL (**Figure 2**). The middle column allows for a good differentiation between compression fractures that affect only the anterior column and burst fractures that involve both anterior and middle columns. Denis classifies thoracolumbar lesions as minor lesions—lesions of the transverse apophysis, spinous process, and isthmus (pars interarticularis) and major lesions—compression fracture, burst fracture, flexion-distraction injury (seat-belt injury), and fracture-dislocation [24]. Lesions are considered unstable if at least two columns are involved (e.g., a compression fracture with comminution is stable; a burst fracture with comminution produced by axial loading and compression of the vertebral body is unstable; the seat belt fracture that is the result of flexion and involves all three columns is unstable; a luxating fracture that involves all three columns and is a result of complex mechanisms of compression and rotation, is unstable). This classification has a series of disadvantages [25]. It does not evaluate the status of PCL that can lead over time at progressive instability, classifies all comminutive fractures as unstable (two columns involved), overlooks the neurology and provides no treatment guidelines.

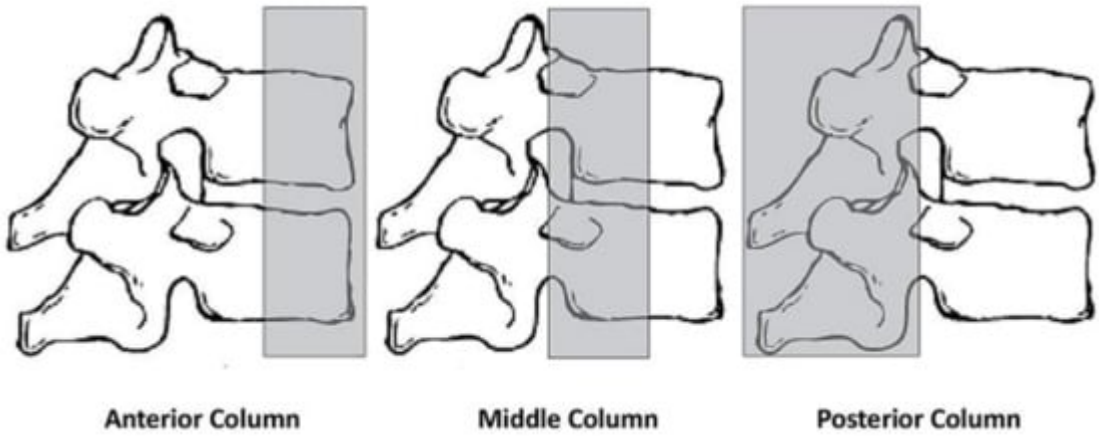


Figure 2. Schematic representation of Denis' three column concept.

5. Magerl Classification

Magerl et.al. described, in 1994, a new comprehensive classification for thoracolumbar fractures, the AO (Arbeitsgemeinschaft für Osteosynthesefragen) Classification or Magerl Classification, drawing on a study of 1445 fractures over a period of 10 years [26]. This is again a bi-columnar classification and is based on the radiographic morphology of the lesions (Rx and CT) as well as mechanism (compression, distraction, and axial torque). This classification uses a numeric system (3-3-3) and distinguishes three types of lesions referred to as A, B, and C. These are further divided, based on morphological criteria, into three groups which, in turn, have each a series of three sub-groups, adding supplementary specifications. Lesion severity and subsequently, the instability grow from A to C and from 1 to 3. Type A are compression fractures of the vertebral body without PLL involvement, which are stable or partially unstable. Type B are anterior and posterior element injuries with distraction. Comprising, as a rule, disk and ligamentous lesions, they have a surgical indication due to their poor healing potential. Type C anterior and posterior element injuries with rotation are unstable and require surgical treatment.

Sethi et al. consider the Magerl Classification method to be comprehensive. It is based on morphologic aspects, defining severity and instability, but is too complex, has moderate reliability and does not take into account the neurological deficit [13]. Furthermore, although it discusses instability, its definition is not clear, and almost all lesions have a degree of instability. Indeed, as a classification with 53 subtypes that is extremely detailed, with elements that are at times difficult to differentiate, makes its use in daily clinical practice quite difficult.

The reproducibility and reliability of Magerl Classification are not very high. If the lesions type and subtypes are considered, the interobserver agreement is fair (k = 0.32), also the intraobserver is also fair (k = 0.38) [27].

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