



Review Article

Review of best classification systems for diagnosing and treating thoracolumbar spine trauma

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ABSTRACT

Background: Improved thoracolumbar spine trauma classification (TLSTC) systems can better help diagnose and treat thoracolumbar spine trauma (TLT). Here, we identified the types of injury (rationale and description), instability criteria, and treatment guidelines of TLSTC.

Methods: We used the PubMed/MEDLINE database to assess TLSTC according to the following variables: injury morphology, injury mechanism, spinal instability criteria, neurological status, and treatment guidelines.

Results: Twenty-one studies, 18 case series and three reviews were included in the study. Treatment guidelines were proposed in 16 studies. The following three major parameters were identified in TLSTC studies: injury morphology (19/21 studies), posterior ligamentous complex (PLC) disruption alone as the main spinal instability criterion (15 studies), and neurological damage (12 studies). Most classification systems neglected the severity of vertebral body comminution.

Conclusion: We identified here the 3 main parameters for the evaluation of diagnosis and treatment of TLT: injury morphology, PLC disruption, and neurological damage. Based on our review, we may conclude that further clinical validation studies of TLSTC are warranted.

Keywords: Classifications, Management, Spinal fractures, Spinal instability, Thoracolumbar

INTRODUCTION

The present study is a systematic review of thoracolumbar spine trauma classifications (TLSTC). We specifically analyzed the types of injury (rationale and description), spinal instability criteria, and treatment guidelines. This led to the assessment of five main variables: injury morphology, injury mechanism, spinal instability criteria, neurological status, and treatment guidelines.

MATERIALS AND METHODS

A systematic review was performed using multiple Eligibility criteria [Table 1]. We used the MEDLINE (PubMed) database up to July 1, 2020. Descriptors included: Spin* AND (fractures OR injury OR trauma OR dislocation) AND (classification) AND (thoracolumbar OR thoracic

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Table 1: Eligibility criteria.

Inclusion criteria
Original TLSTC in English
Exclusion criteria
Sacral fractures and lumbosacral dislocations
Osteoporotic fractures
Pathological fractures of the spine, secondary to tumors or infectious
Spinal fractures in the pediatric population
Experimental laboratory studies
Case reports
TLSTC: Thoracolumbar spine trauma classification

OR lumbar OR dorsal). Data were extracted and tabulated as follows: (1) rationales of the classifications, (2) types of injuries, (3) spinal instability criteria, and (4) guides for management.

RESULTS

The characteristics of the 21 TLSTC studies and data description are summarized in [Table 2].^[1-4,6-19,21-23] We looked at all types of TLT injuries, spinal instability criteria, neurological status, and guides for management. The following major parameters were critical for our assessment: injury morphology (19 studies),^[1,2,4,6,8-19,21-23] injury mechanism (13 studies),^[2-4,6-11,13,15,18,23] instability criteria (17 studies),^[2-4,7-13,15-19,21,22] neurological status (12 studies),^[2,6,7-10,13,15,16,18,19,21] and guide for management (16 studies)^[1-3,6,7-10,13-16,18,19,21,23] [Table 3].

Types of injuries – rationale and description

The types of injuries were based on injury morphology (19 studies) and/or injury mechanism (13 studies). Some studies also included spinal instability (8 studies)^[8,10,13,14,16,19,21,22] and neurological status (4 studies)^[16,19,21,22] in the description of the fracture [Table 2].

Vertebral body (VB) fractures

Watson-Jones described three types of VB fractures: simple wedge, comminuted, and dislocation. The comminuted fracture was later described as burst fracture.^[8,23] The injury mechanisms described were only hyperflexion and compression strains, with different severities.

Trauma

Holdsworth initially described four forces or types of trauma that caused spinal fractures, that is, flexion, flexion/rotation, extension, and compression. They defined “burst fracture” as an injury caused by a vertical compression force. Pure fracture-dislocation

occurred in the presence of posterior ligament rupture. Possible dislocation was limited by interlocking of the articular processes (Holdsworth).^[7-9] Ferguson and Allen introduced the mechanistic model by which forces cause seven types of injuries [Table 2].^[3]

Flexion distraction injuries

Four studies introduced the descriptions that define flexion-distraction injuries. Chance (1948) described three patients with horizontal splitting of the neural arch that reached the upper surface of the body without severe ligamentous damage.^[1] Smith and Kaufer (1969) proposed that tension stress was the main mechanism of lumbar spine injuries related to seat-belts and demonstrated that some of these injuries involved posterior ligament rupture without any evidence of neural-arch fracture (unlike Chance fracture).^[18] Gumley *et al.* (1982) described distraction injuries, predominantly through the bone or through the ligaments, some of them associated with rotation. Gertzbein and Court-Brown (1988) showed that flexion-distraction injuries compromise the posterior elements and also the anterior column [Table 4].^[4]

All injuries

Nicoll’s classification was the first to embrace all types of fractures, including compression fractures, dislocations, and neural arch fractures, influenced by Watson-Jones and Chance.^[1,15,23] Denis proposed four major fractures (compression, burst, seat-belt-type, and fracture-dislocation).^[2] McAfee *et al.* divided burst fractures into stable and unstable and replaced seat-belt injuries with Chance fracture and flexion-distraction injury.^[13] Magerl’s classification proposed three main types of injuries and multiple subtypes (A, B, and C – AO classification system).^[11] TLICS summarized the injury morphology into four main types; compression, burst, translational, and distraction injuries. It also assessed posterior ligamentous complex (PLC) integrity and neurological status [Table 2].^[21] The new AOSpine maintained three main types but described all translational injuries as Type C.^[22]

Spinal instability criteria

Seventeen studies defined spinal instability, 15 of them showing dependence only on disruption of the PLC elements [Table 1].^[3,4,7-13,15-18,21,22] Nicoll was the first to divide fractures into stable and unstable based on posterior ligament rupture.^[15] PLC tension stress is the mechanism of distraction injuries.^[4,6,18] Kelly and Whitesides introduced the two-column concept: the anterior column is composed of VB while the posterior one is composed of neural arches that are held together

Table 2: Summary of thoracolumbar spine trauma classification studies.

References study type; n	Rationale	Types of injuries description	Spinal instability criteria	Guide for management
Watson-Jones, 1938; case series; n=252. ^[23]	Morphology Mechanism	(1) simple wedge fracture – intact disk; (2) comminuted fracture – ruptured disk; (3) fracture-dislocation	NM	Conservative treatment for hyperflexion and compression injuries with hyperextension of the trunk and plaster jacket for 4–6 months
Chance, 1948; case series; n=3. ^[1]	Morphology	Chance fracture – a horizontal splitting of the spine and neural arch, ending in VB. No major ligamentous damage	NM	Conservative treatment with postural reduction and casting
Nicoll, 1949; case series; n=152. ^[15]	Morphology Mechanism	(1) Anterior wedge fracture; (2) lateral wedge (flexion-rotation injuries); (3) fracture-dislocation; (4) neural arch fractures (rotational injuries) – fracture of the <i>pars</i>	Rupture of posterior interspinous ligaments or <i>pars</i> fractures at L4 or L5	Depends on instability and neurological status: (1) stable fractures – conservative; (2) unstable fractures – “protective plaster,” except for complete rupture of the interspinous ligaments (surgery for fusion); (3) paraplegia – surgical treatment
Holdsworth and Hardy, 1953; case series; n=68. ^[9]	Mechanism Morphology	(1) Crush or compression fracture; (2) pure fracture-dislocation; (3) torsional fracture-dislocation, including the “slice fracture”	Rupture of posterior ligaments and articular processes	Depends on instability: (1) stable fractures – conservative treatment regardless of the neurological damage; (2) unstable fractures – surgical treatment for reduction and internal fixation
Holdsworth, 1963; review. ^[8]	Morphology Mechanism Instability	(1) Wedge compression fracture (pure flexion, stable); (2) <i>burst</i> (compression – intact PLC, stable); (3) extension fractures (usually intact PLC); (4) pure fracture-dislocation (flexion-rotation, unstable); (5) rotational fracture-dislocation or “slice fracture” (rotation or flexion-rotation, unstable)	Rupture of PLC	Depends on instability and neurological status: (1) stable fractures – conservative; (2) unstable fractures: extension fractures and rotational fracture-dislocations without neurological deficit – reduction and external immobilization; (3) fractures with neurological deficit – surgery
Kelly and Whitesides, 1968; case series; n=11. ^[10]	Morphology Mechanism Instability	I – Stable fractures: A – wedging: (1) anterior (flexion injuries); (2) lateral; B – stable <i>burst</i> . II – Unstable injuries: A – recent: (1) flexion-dislocation fracture; (2) flexion-rotation fracture; (3) others – unstable <i>burst</i> ; B – Old: (1) stability restored; (2) instability persists	PLC disruption	Anterior surgical stabilization is necessary in cases of anterior column support failure together with loss of posterior column integrity (after a traumatic event or iatrogenically – previous laminectomies).
Smith and Kaufer, 1969; case series; n=24. ^[18]	Morphology Mechanism	Lumbar injuries associated with lap seat belts: (1) disruption of posterior elements (including articular process injuries, rotation, or dislocation); (2) linear fracture through body, pedicles, spinous processes (Chance fracture); (3) compression fracture	In PLC disruption, the spine fails primarily under tension stress	Depends on the site of the posterior injury and the neurological status: (1) predominantly osseous with intact intervertebral disk and no major ligament rupture – conservative; (2) predominantly posterior ligament rupture with or without dislocation – surgical treatment; (3) paraplegic patients – surgery
Holdsworth, 1970; review. ^[7]	Mechanism	(1) pure flexion (or simple wedge fracture); (2) <i>burst</i> ; (3) extension injury; (4) dislocation; (5) shear fracture; (6) flexion-rotation (or rotational fracture-dislocation; “slice” fracture)	PLC disruption	Depends on instability and neurological status: (1) stable fractures – external immobilization; (2) unstable fractures, without paraplegia – reduction and external immobilization; with paraplegia – surgery

(Contd...)

Table 2: (Continued).

References study type; n	Rationale	Types of injuries description	Spinal instability criteria	Guide for management
Gumley et al., 1982; case series; n=20. ^[6]	Mechanism Morphology	I – The fracture crosses the spinous processes, laminae, facet joints, pedicles and transverse processes in a variable direction through the VB; II – the fracture enters the laminae at the base of the spinous processes; III – distraction associated with a rotatory element	NM	Depends on instability and neurological status: distraction fractures with predominantly bone fracture – conservative; (2) unstable fractures and those with neurological damage – surgery
Denis, 1983; case series; n=412. ^[2]	Morphology Mechanism	Major fractures: (1) compression (4 subtypes); (2) <i>burst</i> (5 subtypes); (3) seat-belt-type injury (4 subtypes) – failure of posterior and middle columns under tension forces; (4) fracture-dislocation (3 subtypes). Minor injuries: isolated transverse process, facets, <i>pars</i> articularis, and spinous process fractures.	Complete PLC disruption alone is insufficient to create instability. The middle column must be injured.	Depends on three degrees of spinal instability: (1) stable fractures – conservative; (2) unstable fractures – mechanical instability (1 st degree – the spine may angulate, and neurological instability) (2 nd degree – risk of neurological deficit) – surgery might be necessary; both mechanical and neurological instabilities (3 rd degree) – surgical treatment
McAfee et al., 1983; case series; n=100. ^[13]	Morphology Mechanism Instability	(1) Wedge-compression fracture; (2) stable <i>burst</i> , intact PLC; (3) unstable <i>burst</i> , with PLC injury; (4) Chance fracture; (5) flexion-distraction injury; (6) translational injuries	PLC disruption	Depends on instability: (1) stable fractures (wedge, stable <i>burst</i> and Chance fractures) – preferably conservative treatment; (2) unstable <i>burst</i> , flexion-distraction and translational injuries – surgical treatment
Ferguson and Allen, 1984; case series; n=54. ^[3]	Mechanism	(1) Compressive flexion, (2) distractive flexion, (3) lateral flexion, (4) translational, (5) torsional flexion, (6) vertical compression, (7) distractive extension injuries	Damage to posterior elements; deformity; long-term pain; neurological worsening	Surgery when it provides more rapid mobilization and rehabilitation or when conservative therapy has failed. Neurological recovery is similar after conservative or posterior surgical treatment
Gertzbein and Court-Brown, 1988; case series; n=20. ^[4]	Mechanism Morphology	Posterior element injuries: I – through spinous processes and posterior bony elements; II – between the spinous processes; III – oblique injury (partly bony and partly soft tissue). Anterior column fractures: through the disc (A), the VB (B) or the superior or inferior end-plate (C). State of the body; D – wedge compression; E – <i>burst</i> ; F – intact VB	Rupture of posterior elements	NM
McCormack et al.; 1994; case series; n=28. ^[14]	Morphology Instability	LSCS: (3–9 points): (1) kyphosis correction (<3°, 3–9°, ≥10°); (2) VB comminution on axial CT images (bone fragments spreading of 1 mm; 2 mm in <50% of VB; ≥2 mm in >50% of VB); (3) sagittal VB collapse (<30%, 30–60%, >60%)	VB comminution severity (anterior column failure) causes short-segment fusion failure	To guide the choice of the surgical technique based on anterior column failure: LSCS ≤ 6 in <i>burst</i> , distraction injuries or mild dislocations – posterior short segment instrumentation; LSCS ≥ 7 in <i>burst</i> (severe comminution) – short segment anterior corpectomy and stabilization.
Magerl et al., 1994; case series; n=1445. ^[11]	Mechanism Morphology	Types (27 subtypes; 55 patterns after specifications): (1) type A – VB compression injuries; (2) type B – distraction injuries; (3) type C – anterior and posterior element injuries with rotation	PLC disruption	NM

(Contd...)

Table 2: (Continued).

References study type; n	Rationale	Types of injuries description	Spinal instability criteria	Guide for management
Malberg, 2001; case series; n=122. ^[12]	Morphology	Types (three subtypes each): (1) single vertebral ring injuries or their projections but not the links; (2) disruption of links between the ring; (3) ring disruption and disruption of the links.	Bony ring fracture or facet joint injury with soft tissue disruption and/or fracture	NM
Vaccaro <i>et al.</i> , 2005; review and expert consensus. ^[21]	Morphology Neurological status Instability	TLICS (1-10 points): (I) morphology – compression (1), <i>burst</i> (2), translational/rotational (3), distraction (4); (II) PLC – intact (0), indeterminate (2), injured (3); (III) neurological status – intact (0), nerve root injury or complete conus or SCI (2), cauda equina or incomplete SCI (3)	PLC disruption	TLICS: ≤3 points – non-operative injury; 4 points – either treatment; ≥5 points – surgical intervention may be considered. The best surgical approach depends mainly on the integrity of the PLC and neurologic status
Tsou <i>et al.</i> , 2006; case series; n=126. ^[19]	Morphology Neurological status Instability	Spinal injury severity classification: (1) neurologic function (0–7 points); (2) spinal canal deformity (0–5 points); (3) biomechanical instability (0–6 points)	Denis' concept: if ≥3 out of 5 spinal biomechanical functions fail	The average scores of operated patients were: instability profile score, 4.4 out of 6; canal compromise score, 3.3 out of 5
Reinhold <i>et al.</i> , 2013; case series; n=139. ^[17]	Morphology	(1) A (A1–A4) – compression of the anterior elements with intact posterior constraining elements; (2) B (B1–B2): failure of the posterior constraining elements; PLC injuries; (3) C (C1–C3) – failure of anterior and posterior elements leading to displacement	PLC disruption	NM
Vaccaro <i>et al.</i> , 2013; case series; n=40. ^[22]	Morphology Neurological status Instability	(1) A (A0–A4) – compression injuries of the VB; (2) B (B1–B3) – failure of the posterior or anterior tension band; (3) C – translational injury. Grading of neurological deficits (N0–N4). Modifiers (M1, M2)	PLC disruption	NM
Park <i>et al.</i> , 2016; case series; n=134. ^[16]	Morphology Neurological status Instability	Modified TLICS (1–10 points): (I) morphology (1–4) – compression fracture, height loss <50% (1) or >50% (2); burst fracture, height loss <50% and spinal stenosis <50% (2) or ≥50% for 1 or 2 parameters (3); translation/rotational injury (3); distraction (4); (II) neurologic status (0–3); (III) PLC status based on MRI (0–3) – intact (0); focal edema or enhancement in soft tissue (1) or in the bony structure of the facet joint or spinous process (2); discontinuation (3)	PLC disruption	Compared to the original TLICS, the modified TLICS showed higher sensitivity (if score 4 is considered to be a negative indication) and showed higher specificity (if score 4 is considered to be a positive indication) than TLICS.

burst: Burst fracture, cl: Classification, CT: Computed tomography, LSCS: Load sharing classification score, MRI: Magnetic resonance imaging, NM: Not mentioned, PLC: Posterior ligamentous complex, SCI: Spinal cord injury, TLICS: Thoracolumbar injury classification and severity score, VB: Vertebral body, PLC: Posterior ligamentous complex

by the posterior ligaments.^[10] Denis (1983) proposed that PLC rupture needs to be associated with severe anterior column compression or middle column distraction to cause instability.^[2] Vaccaro *et al.* introduced the description of suspected/indeterminate and injured PLC. The latter is unstable and the former may be stable or potentially unstable [Table 2 and Figure 1].^[21]

Guide for management

Sixteen studies reported on surgery.^[1-3,6-10,13-16,18,19,21,23] The first reported on the effectiveness of conservative treatment for wedge fractures, with or without comminution, and Chance fractures.^[1,15,23] However, this treatment could last 6 months, rather than the 6–12 weeks recommended more recently.

PLC disruption

Nicoll and Holdsworth and Hardy were the first authors to divide TL injuries into stable, with intact posterior ligaments and unstable, with ruptured posterior ligaments

Table 3: Frequency (n) of the variables evaluated in the twenty-one TLSTC.

Variables	n studies
Types of injuries	21
Injury morphology	19
Injury mechanism	13
Instability criteria	17
PLC disruption alone	15
Denis instability concept	2
Neurological status	12
Guide for management	16

PLC: Posterior ligamentous complex, TLSTC: Thoracolumbar spine trauma classifications

Table 4: Prevalence and type of VB fracture in distraction injuries.^[4]

Distraction injuries	
Type of VB fracture	Prevalence
Compression	70%
Burst fracture	15%

VB: Vertebral body

and facet joints.^[9,15] However, unstable injury was not synonymous with surgical treatment [Table 2]. Initially, conservative treatment was recommended for posterior element disruption without dislocations and for those with minor or closed reduced fracture-dislocations.^[2,3,7,8] Furthermore, dislocations reduced surgically but without severe PLC damage were not fused and were treated with external immobilization.^[9] PLC injury was a criterion for surgical indication in ten studies.^[3,7-10,13,15,16,18,21] Thus, TL injuries with a complete rupture of the posterior interspinous ligaments and facet joints, with or without dislocation, require surgical fusion, while “less severe” PLC injuries might receive conservative treatment.^[8,9,15,16,21]

Anterior column failure

Three studies related anterior column failure to spinal instability and provided surgical indication. Kelly and Whitesides indicated ventral stabilization when it is associated with loss of posterior column integrity.^[10] McCormack *et al.* showed that failure of posterior short-segment instrumentation is more frequent in severe VB comminution, that is, a load sharing classification score (LSCS) greater than 6 points.^[14] Park *et al.* proposed a modified TLICS that includes evaluation of VB height loss and spinal canal stenosis to improve surgical indication for burst fractures based on a retrospective analysis.^[16]

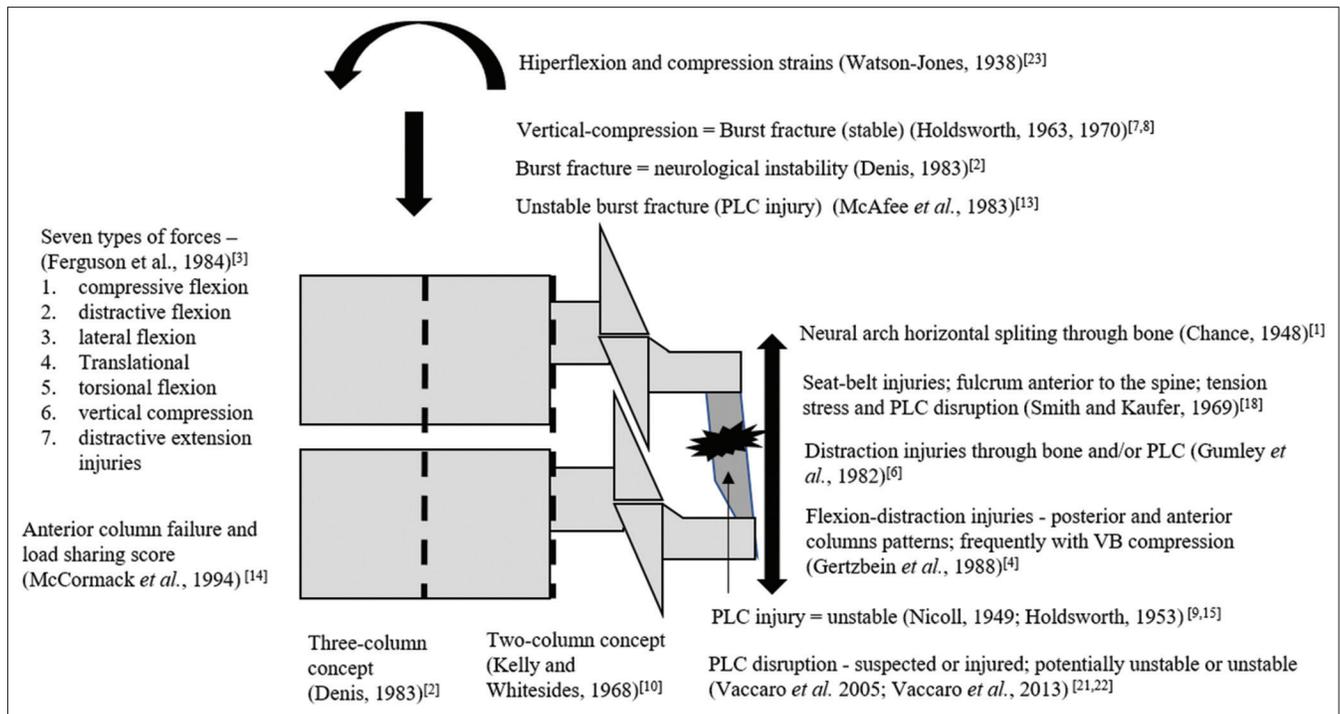


Figure 1: The main contributions of thoracolumbar spine trauma classifications to the understanding of the injury mechanisms and spinal instability.

Neurological status

Surgical treatment was initially indicated for fractures of paraplegic patients to allow early mobilization, better nursing care, and prevention of pressure sores but was later also indicated for incomplete neurological injuries.^[8,15] Spinal canal realignment decompresses neural structures and improves neurological recovery.^[9] Anterior and posterior decompressions, through corpectomy and laminectomy, are also recommended to enlarge the canal and remove bone fragments impinging the nerve roots and spinal cord.^[10,13] Twelve studies considered neurological damage as a parameter favoring surgical treatment.^[2,6-10,13,15,16,18,19,21] Neurological status was incorporated into the classification description by TLICS and later by three other classifications.^[16,19,21,22]

DISCUSSION

This review demonstrated the evolution of concepts in the diagnosis and treatment of thoracolumbar spine trauma.

Three major parameters were included in TLSTC studies: injury morphology, spinal instability (especially PLC disruption), and neurological damage.

Injury morphology

There have been significant achievements in the understanding of the cause-effect relationship of the traumatic event between the 1960s and 1980s, with the descriptions of the mechanisms of injury.^[3,7,8] Although Denis's three-column theory was not widely accepted, its four main types of injury are essentially the same as those of most recent classifications.^[2] In the new AO Spine classification, Magerl's AO classification of three main types, compression (A), distraction (B), and rotational (C) injuries, was replaced with compression (A), distraction (B – that does not include dislocations), and translational (C).^[11,22] Since TLICS, most classifications have relied on morphology alone, not associated with injury mechanism, since it results in greater reliability.

Spinal instability and PLC disruption

The fundamental role of posterior ligament rupture in spinal instability has been widely reported. Unstable injuries include (1) translational injury in the lateral, ventral, or dorsal directions, (2) torsional/rotational injury, with or without dislocation, which is often associated with proximal fracture of adjacent ribs, and (3) distraction injury. Holdsworth and Hardy stated that “displacements seen on radiological examinations were not necessarily an accurate indication of the actual displacement at the time of injury.”^[9] The radiological findings of PLC injury include:

(1) the dislocation itself; (2) increased interspinous distance or adjacent spinous process displacement, laterally or rotationally; (3) facet joint diastasis, subluxation, or luxation; and (4) hyperkyphosis.

Frequently, VB fractures occur together with distraction and rotational injuries. If these fractures are secondary to distractive or torsional flexions, VB height is preserved or even increased. However, compression or burst fractures may also occur when there are combined forces such as compressive flexion or vertical compression, respectively.^[4] Therefore, one should always look for signs of PLC injury when a VB fracture is identified.

Neurological damage

Neurological deficit is the most debilitating sequela of TLT. Although the primary spinal cord injury is caused mainly by the traumatic event, ongoing neural compression further compromises the prognosis. Nicoll recommended surgical treatment for paraplegic patients to improve rehabilitation care.^[15] Initially, Holdsworth and Hardy treated mechanically stable fractures conservatively, regardless of neurological damage. Later, in 1963 they stated that fractures with neurological deficits should receive surgical treatment. They proposed open reduction and interspinous plating to treat unstable injuries, but this prevented direct decompression through laminectomy to treat the spinal canal stenosis caused by bone fragments.^[8,9] At present, acute spinal canal decompression is recommended if there is canal encroachment and neurological damage. However, the choice between an anterior or posterior approach is still controversial in incomplete spinal cord injury or cauda equina syndrome.^[21] Even transient neurological deficits are relevant during the surgical decision-making process since the standing position increases the load on the fracture and may worsen pain or deficit.^[20]

Guide for management

PLC injury has influenced most of the TLSTC as the main surgical indication since the 1940s and 1950s.^[3,7-9,13,15,16,18,21] McAfee *et al.* supported surgical treatment for all unstable injuries. They also showed that PLC disruption increases neurological damage in burst fractures; neurological deficit occurred in 80% of the patients with unstable bursts and in 22% of those with stable bursts.^[13] Gertzbein and Court-Brown reported that flexion-distraction injuries need compression instrumentation while burst fractures would require distraction.^[5] More recent classifications have stressed the importance of posterior stabilization, with pedicle-screw constructs in the presence of PLC injury to prevent late failure.^[14,21] Thus, anterior decompression and fusion alone should be avoided in unstable burst fractures.

PLC integrity, neurological status, and injury morphology are used in the TLICS system to guide treatment, creating a new methodological standard for TLSTC.^[21] The new AOSpine TLSTC is the basis of the AOSpine injury score that resulted in a treatment algorithm with a more detailed morphological description, representing a potential criticism of TLICS.^[20-22] In non-dislocated injuries, PLC incompetence can be usually identified by the increased interspinous distance, facet diastasis or spondylolisthesis, and segmental hyperkyphosis and is associated with supraspinous ligament laxity or rupture. Minor PLC injuries (M1 modifier – new AOSpine classification) such as interspinous ligament edema on magnetic resonance imaging (MRI) might be stable and should be evaluated together with injury morphology and neurological status to determine the best treatment.

However, there are still some limitations in differentiating between stable burst fractures (A3 and A4) and unstable burst fractures, also called B2 injuries associated with bursts.^[20] Furthermore, some therapeutic issues remain – whether burst fractures (A3 or A4) with no deficit (N0), transient neurological deficit (N1), and an indeterminate injury to the tension band (M1) need surgical treatment. A survey sent to AOSpine members from North America, South America, Europe, Africa, Asia, and the Middle East demonstrated that there are regional treatment preferences in different regions of the world regarding 15 out of 19 controversial fractures, revealing that treatment represents surgeons' experiences and preferences and is not based on clinically validated criteria.

The LSCS introduced the evaluation of VB comminution severity as a relevant factor in the surgical decision-making process.^[14,16] Nevertheless, the role of anterior column support in treatment decisions was neglected by most TLSTC. Not surprisingly, so far, there is no clear statement regarding surgical indication in burst fractures without a neurological deficit. Park *et al.* (2016) proposed a modified TLICS that includes assessment of VB height loss, spinal stenosis, and MRI evaluation of PLC status. These characteristics might help to identify burst fractures that should be treated surgically, although these definitions are still incomplete and will require further studies.^[16]

This study has some limitations. The long period reviewed covered classifications based on their timely available radiological diagnostic tools. This may have influenced the identification of the type of injury and its treatment. The highest level of evidence among the studies was 4 (case series). Finally, we have included only peer-reviewed reports in the English language available in the MEDLINE database.

CONCLUSION

The three main parameters identified in TLSTC for diagnosis and treatment is injury morphology, PLC disruption, and

neurological damage. Although VB comminution severity may affect spinal stability, it has been neglected by most classifications. Severity scores are used to standardize diagnosis and treatment. Based on our review, we may conclude that further clinical validation studies of TLSTC are warranted.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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