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TLICS-R and Comprehensive Spine Injury Classification: A Literature-Derived Framework for Modern Spine Trauma Decision-Making

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Abstract: ***Spine trauma classification systems are essential for communication, treatment planning, prognostication, audit, and research. The Thoracolumbar Injury Classification and Severity Score (TLICS), Subaxial Cervical Spine Injury Classification (SLIC), AO Spine classifications, and ASIA neurological grading remain widely used, but each has limitations. Conventional TLICS is clinically practical but incompletely captures quantitative radiographic instability, host biology, posterior ligamentous complex uncertainty, osteoporotic failure risk, ankylosed-spine behavior, frailty, and dynamic reassessment. This narrative review proposes an integrated model in which TLICS-R functions as a thoracolumbar module within a broader Comprehensive Spine Injury Classification System (CSICS). The framework preserves established systems while adding radiographic risk, host modifiers, posterior ligamentous complex confidence grading, neurological MRI severity using the BASIC score, surgical-risk tiering, damage-control considerations, outcome profiling, and an artificial intelligence-ready quantification layer. Existing literature permits construct-level and component-level validation: published studies support the clinical relevance of kyphosis, sagittal index, vertebral height loss, canal compromise, interpedicular widening, osteoporosis, ankylosed spine, MRI-based ligamentous assessment, cord signal severity, frailty, and conservative-treatment failure in grey-zone thoracolumbar injuries. However, the combined scoring weights, cutoffs, and treatment thresholds require patient-level retrospective derivation, interobserver reliability testing, external validation, and prospective multicenter assessment. TLICS-R/CSICS should therefore be regarded as a literature-supported classification proposal and validation roadmap rather than a validated replacement for existing systems.***

Keywords: spine trauma; thoracolumbar fracture; TLICS; classification; posterior ligamentous complex

Key Points
1) TLICS-R is proposed as a thoracolumbar module that preserves conventional TLICS while adding radiographic and host-risk modifiers.
2) CSICS extends this modular approach across the whole spine using region, morphology, neurology, stability, modifiers, surgical risk, and outcome profile.
3) Existing literature supports component-level validation of key modifiers including kyphosis, height loss, canal compromise, interpedicular widening, osteoporosis, ankylosed spine, MRI cord signal, and frailty.
4) The framework is not a validated replacement for TLICS, SLIC, AO Spine, or ASIA; patient-level validation is required before clinical adoption.

1. Introduction

Spine trauma classification systems are used to describe injury morphology, communicate instability, guide treatment, estimate prognosis, and support research. An ideal system should be reproducible, simple enough for emergency use, sufficiently detailed for surgical planning, and predictive of clinically meaningful outcomes. Existing systems each solve part of this problem, but none fully integrates current imaging, patient-specific risk, dynamic reassessment, and operative feasibility. [1-7]

The Thoracolumbar Injury Classification and Severity Score (TLICS) remains one of the most clinically useful treatment-linked systems. It combines injury morphology, posterior ligamentous complex (PLC) integrity, and neurological status. Its enduring strength is bedside practicality: low scores generally support nonoperative management, high scores support surgery, and intermediate scores require judgment. However, modern CT and MRI have made several TLICS limitations more visible. A simple burst fracture and a severely comminuted burst fracture may receive similar TLICS morphology points despite different kyphosis, canal compromise, vertebral height loss, interpedicular widening, and collapse risk. Similarly, PLC assessment is frequently uncertain because MRI edema, partial injury, and frank ligamentous discontinuity may be interpreted differently.

The problem is not limited to the thoracolumbar region. SLIC provides a subaxial cervical framework, AO Spine classifications improve morphology, ASIA remains fundamental for neurological examination, and upper-cervical and sacral injuries use separate descriptors. The result is clinically familiar but fragmented. This review proposes a modular solution: TLICS-R as a refined thoracolumbar module embedded within a broader Comprehensive Spine Injury Classification System (CSICS).

Methods: Literature-Derived Component Validation

This manuscript is a narrative review and classification proposal, not a completed patient-level validation study. The literature was reviewed around five questions: whether current classifications leave clinically important gaps; whether quantitative radiographic variables predict instability or failure; whether host modifiers influence treatment success and surgical strategy; whether neurological imaging adds prognostic information beyond functional examination; and whether dynamic reassessment is justified in grey-zone injuries.

The validation approach is deliberately conservative. Existing literature can support construct validity and component validity, meaning that the proposed variables are biologically plausible, clinically relevant, and associated with outcomes or decision-making in published studies. However, literature alone cannot validate the final integrated scoring weights, cutoffs, or treatment thresholds. Those require patient-level derivation, calibration, discrimination testing, interobserver reliability analysis, and prospective external validation.

Current Classification Gaps

TLICS is limited mainly by three issues: the grey-zone score, PLC uncertainty, and inadequate quantification of bony instability. AO Spine adds morphological detail, especially for distinguishing incomplete and complete burst fractures and identifying tension-band or translational injuries, but treatment decisions still vary according to patient factors and institutional practice. SLIC is useful for subaxial cervical trauma but cannot serve as a whole-spine system. ASIA describes neurological function but does not quantify intramedullary edema or hemorrhage on MRI. [1,5-8,21-25]

Modern trauma care also requires variables that traditional systems do not consistently encode. Osteoporosis changes both collapse risk and fixation strategy. Ankylosing spondylitis and diffuse idiopathic skeletal hyperostosis convert even low-energy injuries into long-lever-arm fractures with high instability risk. Frailty and comorbidity influence whether definitive reconstruction, minimally invasive fixation, staged surgery, or nonoperative care is safest. Polytrauma physiology may require damage-control stabilization rather than immediate definitive surgery. These factors are often considered by surgeons, but they are not consistently captured in a structured classification string.

TLICS-R: Thoracolumbar Module

TLICS-R preserves the conventional TLICS score as the base and adds three domains: radiographic risk, host modifiers, and dynamic reassessment. The proposed formula is: TLICS-R total = conventional TLICS base score + radiographic risk score + host modifier score + dynamic modifiers. [8-12,16-20]

Radiographic risk variables include kyphosis or sagittal index above accepted thresholds, progressive kyphosis on standing or follow-up radiographs, vertebral body height loss greater than 50%, canal compromise greater than 50%, severe retropulsion or free canal fragment, interpedicular widening, laminar fracture, severe comminution, load-sharing concern, multilevel contiguous fractures, and adjacent segment instability. These variables do not automatically mandate surgery in neurologically intact patients, but they move the patient from a simple low-risk category into a structured grey-zone pathway.

Host modifiers include osteoporosis or poor bone quality, ankylosed spine, polytrauma requiring early mobilization, morbid obesity, poor brace tolerance, high functional demand, and severe surgical contraindication. A surgical contraindication should be recorded as a feasibility flag rather than as a subtraction from injury severity. TLICS-R also records PLC confidence using a suffix from PLC-C0 to PLC-C4, ranging from intact PLC to gross posterior tension-band failure. This suffix separates edema or indirect signs from definite structural disruption.

CSICS: Whole-Spine Modular Framework

CSICS extends the same logic across the whole spine using seven axes: region, morphology, neurology, stability, modifiers, surgical risk, and outcome. Region codes identify occipitocervical, subaxial cervical, cervicothoracic, thoracic, thoracolumbar, lumbar, lumbosacral, and sacral injuries. Morphology uses AO-style categories: compression, tension-band, translation, distraction, penetrating injury, transverse fracture through ankylosed spine, and isolated posterior element injury. [5-7, 21-32]

Neurology is coded using ASIA functional status with an MRI-based BASIC add-on when cord imaging is available. BASIC grade 0 indicates a normal cord, grade 1 short-segment edema, grade 2 longer edema without hemorrhage, grade 3 edema with small hemorrhage, and grade 4 frank intramedullary hemorrhage. The stability axis uses measurable height loss, local kyphosis, and canal compromise. The modifier axis records PLC injury, poor bone quality, ankylosed spine, pathology, polytrauma, comorbidity burden, chronicity, mechanism, vascular injury, pediatric status, frailty, dural tear, and soft-tissue compromise.

The risk tier separates injury severity from operative tolerance. It combines patient frailty, comorbidity, physiological status, and the planned invasiveness of surgery. The outcome profile is intended for counseling and research rather than deterministic decision-making. A representative code may be written as R5-M(A4)-N3(BASIC-2)-S2-Mod(M1+M2+M8HE)-Risk-T2-Outcome-P3.

Literature-Derived Validation

The strongest support for the proposed framework comes from evidence that conventional low or intermediate scores may still fail conservative care when additional risk factors are present. Published thoracolumbar burst-fracture cohorts demonstrate that a subset of neurologically intact or low-TLICS patients develop persistent pain, deformity progression, delayed neurological deficit, or delayed surgery. Interpedicular widening, kyphosis, sagittal index, canal compromise, vertebral height loss, osteoporosis, and pain/mobilization response have all been associated with treatment inadequacy or conservative failure. [8-12, 17-21, 23-25]

Modified TLICS studies further support adding measurable radiographic variables and more detailed PLC interpretation. These studies do not validate TLICS-R exactly, but they support the principle that conventional TLICS can be refined without discarding its structure. AO Spine and TL AOSIS literature supports morphology granularity and score-based treatment algorithms. BASIC scoring supports MRI-based neurological prognostication beyond functional ASIA grade. Frailty literature supports recording surgical tolerance separately from fracture severity. Together, these findings justify component-level validation.

The claim should remain limited. Literature-derived validation supports the inclusion of the domains and variables, not the final numerical weights. No published dataset has yet rescored patients using the full TLICS-R/CSICS framework. Therefore, superiority over TLICS,

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SLIC, AO Spine, TL AOSIS, or ASIA cannot be claimed at this stage.

Clinical Workflow

At admission, every patient should receive an established classification appropriate to the region. Thoracolumbar injuries receive conventional TLICS and AO morphology, followed by TLICS-R modifiers when relevant. CT is used to define morphology, height loss, kyphosis, canal compromise, comminution, interpedicular widening, ankylosis, and bone quality. MRI is used when neurological deficit is present, PLC status is uncertain, cord signal is relevant, or treatment depends on posterior tension-band integrity. [1, 5-7, 10, 17-20, 22]

Stable low-risk injuries may proceed to analgesia, mobilization, and brace according to local protocol. Intermediate injuries undergo a grey-zone pathway: MRI if needed, supervised mobilization, standing radiographs when safe, repeat neurological examination, and early follow-up imaging. Surgery is generally favored for progressive neurological deficit, cauda equina syndrome, persistent neural compression with incomplete deficit, translational injury, gross PLC disruption, displaced ankylosed-spine fracture, open injury with instability or CSF leak, mobilization failure due to mechanical pain, or progressive deformity.

The surgical strategy can be communicated with suffixes such as decompression, short-segment fixation, long-segment fixation, anterior reconstruction, cement augmentation, minimally invasive stabilization, fusion, or nonfusion temporary stabilization.

Validation Roadmap

The next step should be a retrospective derivation study followed by external validation. A thoracolumbar-first cohort is most feasible because TLICS-R is the most developed module and conservative-treatment failure in burst fractures is a measurable endpoint. Inclusion should require CT for all patients and MRI when available or clinically indicated. Variables should include conventional TLICS, AO Spine type, PLC confidence, kyphosis, sagittal index, vertebral height loss, canal compromise, interpedicular distance, comminution, bone quality, ankylosis, frailty, polytrauma, treatment, complications, and follow-up.

The primary endpoint should be failure of initial nonoperative management, defined by delayed surgery, neurological deterioration, progressive deformity, inability to mobilize because of pain, or unplanned procedure. Secondary endpoints should include pain, ODI or NDI, EQ-5D, return to work, final kyphosis, neurological recovery, complications, implant failure, length of stay, readmission, and cost.

Statistical analysis should compare TLICS-R/CSICS with conventional TLICS, AO Spine/TL AOSIS, SLIC for cervical injuries, and modified TLICS. Metrics should include area under the receiver operating characteristic curve, calibration, decision-curve analysis, sensitivity, specificity, net reclassification improvement, and interobserver reliability using kappa or intraclass correlation coefficients.

2. Limitations

This proposal has important limitations. It is a conceptual framework and should not replace validated classifications in current documentation or operative decision-making. The thresholds for kyphosis, height loss, canal compromise, interpedicular widening, CT Hounsfield units, and PLC injury require calibration. Added variables may reduce simplicity and interobserver agreement unless digital templates or calculators are used. MRI access varies, and MRI may overestimate clinically meaningful PLC injury when edema is interpreted as disruption. Frailty, brace tolerance, functional demand, and surgical contraindications require standardized definitions.

The AI layer is aspirational unless local models are validated against expert human measurement. Outcome profiles may create false precision and should be presented as probability ranges rather than deterministic labels. Finally, the literature supporting the components is heterogeneous, with retrospective designs, treatment-selection bias, and incorporation bias in some studies.

3. Conclusions

TLICS-R/CSICS is a literature-supported, modular, and AI-ready framework for modern spine trauma decision support. TLICS-R refines conventional TLICS by adding radiographic risk, host modifiers, PLC confidence grading, and dynamic reassessment for thoracolumbar grey-zone injuries. CSICS extends the same philosophy across the whole spine using region, morphology, neurology, stability, modifiers, surgical risk, and outcome profile.

Existing literature supports the clinical relevance of the proposed components, including quantitative radiographic instability, osteoporosis, ankylosed-spine behavior, MRI cord signal severity, frailty, and conservative-treatment failure. However, definitive validation of the integrated score requires patient-level derivation, external validation, reliability testing, and prospective multicenter assessment. Until then, the framework should be presented as an evidence-supported classification proposal and validation roadmap, not as a validated replacement for TLICS, SLIC, AO Spine, or ASIA.

References

[1] Vaccaro AR, Lehman RA Jr, Hurlbert RJ, et al. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. Spine. 2005; 30: 2325-2333.

[2] Lee JY, Vaccaro AR, Lim MR, et al. Thoracolumbar injury classification and severity score: a new paradigm for the treatment of thoracolumbar spine trauma. J Orthop Sci. 2005; 10: 671-675.

[3] Patel AA, Dailey A, Brodke DS, et al. Thoracolumbar spine trauma classification: the Thoracolumbar Injury Classification and Severity Score system and case examples. J Neurosurg Spine. 2009; 10: 201-206.

[4] Koh YD, Kim DJ, Koh YW. Reliability and validity of Thoracolumbar Injury Classification and Severity Score. Asian Spine J. 2010; 4: 109-117.

[5] Vaccaro AR, Oner C, Kepler CK, et al. AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers. Spine. 2013; 38: 2028-2037.
[6] Kepler CK, Vaccaro AR, Schroeder GD, et al. The Thoracolumbar AOSpine Injury Score. Global Spine J. 2016; 6: 329-334.
[7] Vaccaro AR, Schroeder GD, Kepler CK, et al. The surgical algorithm for the AOSpine thoracolumbar spine injury classification system. Eur Spine J. 2016; 25: 1087-1094.
[8] Park HJ, Lee SY, Park NH, Shin HG, Chung EC, Rho MH, et al. Modified thoracolumbar injury classification and severity score and its clinical usefulness. Acta Radiol. 2016; 57: 74-81.
[9] Shen J, Xu L, Zhang B, Hu Z. Risk factors for the failure of spinal burst fractures treated conservatively according to the Thoracolumbar Injury Classification and Severity Score: a retrospective cohort trial. PLoS One. 2015; 10: e0135735.
[10] Khil EK, Choi I, Lee KY, Kim YW. Can conservative treatment be effective for thoracolumbar injuries patients with TLICS scores of 4 or 5? BMC Musculoskelet Disord. 2024; 25: 431.
[11] Li T, Yan J, Liu X, Hu J, Wang F. Efficacy and safety of conservative treatment compared with surgical treatment for thoracolumbar fracture with score 4 TLICS: a systematic review and meta-analysis. Clin Spine Surg. 2024; 37: 230-241.
[12] Withrow J, Trimble D, Narro A, et al. Validation and comparison of common thoracolumbar injury classification treatment algorithms and a novel modification. Neurosurgery. 2025; 96: 172-182.
[13] Dao QA, et al. Diagnostic accuracy and clinical utility of mTLICS versus TLICS and TL AOSIS in stratifying three-tier treatment for thoracolumbar injuries. BMC Musculoskelet Disord. 2025.
[14] Kweh BTS, et al. The AO Spine Thoracolumbar Injury Classification System and Treatment Algorithm in decision making for thoracolumbar burst fractures without neurologic deficit. Global Spine J. 2024.
[15] Canseco JA, et al. Interobserver reliability in the classification of thoracolumbar fractures using the AO Spine Thoracolumbar Injury Classification System among clinical experts in spine trauma care. Global Spine J. 2024.
[16] Bizdikian AJ, et al. Posterior ligamentous complex injuries of the thoracolumbar spine: importance and surgical implications. 2021.
[17] Bailey CS, Urquhart JC, Dvorak MF, et al. Orthosis versus no orthosis for treatment of thoracolumbar burst fractures without neurologic injury: a multicenter randomized equivalence trial. Spine J. 2014; 14: 2557-2564.
[18] Wood KB, Buttermann GR, Phukan R, et al. Operative compared with nonoperative treatment of thoracolumbar burst fracture without neurological deficit: follow-up at 16 to 22 years. J Bone Joint Surg Am. 2015; 97: 3-9.
[19] Siebenga J, Leferink VJ, Segers MJ, et al. Treatment of traumatic thoracolumbar spine fractures: multicenter prospective randomized study of operative versus nonsurgical treatment. Spine. 2006; 31: 2881-2890.
[20] Rabb CH, et al. Congress of Neurological Surgeons systematic review and evidence-based guidelines on the evaluation and treatment of patients with thoracolumbar spine trauma. Neurosurgery. 2019; 84: E1-E2.
[21] Talbott JF, Whetstone WD, Readdy WJ, et al. The Brain and Spinal Injury Center score: a novel, simple, and reproducible method for assessing acute cervical spinal cord injury severity with axial T2-weighted MRI. J Neurosurg Spine. 2015; 23: 495-504.
[22] Fehlings MG, Vaccaro A, Wilson JR, et al. Early versus delayed decompression for traumatic cervical spinal cord injury: results of the STASCIS study. PLoS One. 2012; 7: e32037.
[23] Mirza SK, Deyo RA, Heagerty PJ, et al. Development of an index to characterize the invasiveness of spine surgery. Spine. 2008; 33: 2651-2661.
[24] Subramaniam S, Aalberg JJ, Soriano RP, Divino CM. New 5-factor modified frailty index using American College of Surgeons NSQIP data. J Am Coll Surg. 2018; 226: 173-181.
[25] Fisher CG, DiPaola CP, Ryken TC, et al. A novel classification system for spinal instability in neoplastic disease: an evidence-based approach and expert consensus from the Spine Oncology Study Group. Spine. 2010; 35: E1221-E1229.
[26] Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine. 1983; 8: 817-831.
[27] Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S. A comprehensive classification of thoracic and lumbar injuries. Eur Spine J. 1994; 3: 184-201.
[28] Anderson LD, D'Alonzo RT. Fractures of the odontoid process of the axis. J Bone Joint Surg Am. 1974; 56: 1663-1674.
[29] Anderson PA, Montesano PX. Morphology and treatment of occipital condyle fractures. Spine. 1988; 13: 731-736.
[30] Levine AM, Edwards CC. The management of traumatic spondylolisthesis of the axis. J Bone Joint Surg Am. 1985; 67: 217- 226.
[31] Spence KF Jr, Decker S, Sell KW. Bursting atlantal fracture associated with rupture of the transverse ligament. J Bone Joint Surg Am. 1970; 52: 543-549.
[32] Schroeder GD, Kepler CK, Kurd MF, et al. The development of a universally accepted sacral fracture classification: a survey of AOSpine and pelvic trauma surgeons. J Orthop Trauma. 2016; 30: 650-656.

Table 1: Gaps in existing spine trauma classification systems and proposed solutions

Gap	Proposed CSICS/TLICS-R response
TLICS grey zone and limited bony granularity	Add radiographic risk modifiers: kyphosis, height loss, canal compromise, interpedicular widening, comminution.
Variable PLC interpretation	Add PLC confidence suffix from PLC-C0 to PLC-C4.
Region-specific fragmentation	Use whole-spine axes while retaining regional modules such as TLICS-R and SLIC.
Limited host adjustment	Add osteoporosis, ankylosed spine, frailty, comorbidity, polytrauma, and brace tolerance modifiers.
Neurology limited to function	Add BASIC MRI cord injury grade to ASIA status.
Static classification	Add dynamic reclassification after MRI, mobilization, discharge, and follow-up.
No operative tolerance estimate	Separate surgical-risk tier from injury severity.

Table 2: Proposed TLICS-R thoracolumbar radiographic and host modifiers

Domain	Variable	Score/flag	Clinical meaning
R1	Kyphosis/sagittal index above threshold or progressive kyphosis	+1	Mechanical collapse risk.
R2	Vertebral body height loss >50% or severe anterior column collapse	+1	Anterior column failure.
R3	Canal compromise >50%, severe retropulsion, or free canal fragment	+1	Neural/deformity concern.
R4	Interpedicular widening, laminar fracture, severe comminution, load-sharing concern	+1	Burst-fracture severity.
R5	Multilevel contiguous fractures or adjacent segment instability	+1	Higher mechanical demand.
H1	Osteoporosis, fragility bone, low CT HU, or low BMD	+1	Higher collapse and fixation-failure risk.
H2	Ankylosing spondylitis, DISH, or long-segment ankylosis	+2	Long-bone-type unstable fracture behavior.
H3	Polytrauma, poor brace tolerance, morbid obesity, or high functional demand	+1	May favor stabilization.
H4	Severe surgical contraindication	Flag	Treatment feasibility issue, not lower injury severity.

Table 3: CSICS seven-axis notation.

Axis	Definition	Examples
Region	Anatomical location from occipitocervical junction to sacrum	R1 occipitocervical; R5 thoracolumbar; R8 sacrum.
Morphology	AO-style injury pattern	A1 wedge, A4 complete burst, B tension-band, C translation, F ankylosed transverse fracture.
Neurology	ASIA functional grade with optional BASIC MRI add-on	N3(BASIC-2).
Stability	Quantitative height loss, kyphosis, canal compromise score	S0 stable to S3 grossly unstable.
Modifiers	Clinical and imaging variables that alter risk or strategy	M1 PLC injury, M2 poor bone, M3 ankylosis, M11 frailty.
Risk	Surgical risk tier based on patient and procedure factors	Risk-T1 to Risk-T4.
Outcome	Predicted recovery profile for counseling/research	P1 baseline recovery to P5 severe disability.

Table 4: Literature-derived validation domains

Proposed component	Literature-supported rationale	Validation status
TLICS base	Established morphology, PLC, neurology treatment framework.	Validated base system, not replaced.
Radiographic risk	Failure studies support kyphosis, sagittal index, canal compromise, height loss, interpedicular widening.	Component-level support.
PLC confidence	MRI assessment is important but variably interpreted.	Component-level support; reliability testing needed.
Osteoporosis	Associated with conservative-treatment failure and fixation strategy changes	Component-level support.
Ankylosed spine	Recognized unstable long-lever-arm behavior.	Strong construct support.
BASIC MRI grade	Anatomic cord injury severity adds prognostic information.	Component-level support.
Frailty/risk tier	Complication and tolerance prediction should be separated from injury severity.	Component-level support.
Final integrated score	No patient-level dataset has yet tested full TLICS-R/CSICS.	Not definitively validated.

Table 5: Proposed formal validation roadmap

Phase	Design	Primary goal
1	Retrospective thoracolumbar derivation cohort	Refine TLICS-R weights and thresholds.
2	External retrospective validation	Test discrimination, calibration, and decision-curve net benefit.
3	Prospective reliability study	Measure interobserver and intraobserver agreement.
4	Prospective multicenter outcome cohort	Correlate score with failure, surgery, neurological change, ODI/NDI, complications
5	AI-assisted measurement study	Compare AI-derived measurements with expert human measurements.
6	Pragmatic comparative study	Compare standard classification-guided care with TLICS-R/CSICS-assisted workflow.