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Adult Cervical Spine Disorders: A Comprehensive Etiological, Imaging-Based, Biomechanical, Neurological, Surgical, and Host-Factor Classification System

Running Title: *The CERVICAL Classification*

Dr. Nishant

Assistant Professor, Department of Orthopedic Surgery, Netaji Subhash Chandra Bose Medical College and Hospital Amhara, Bihta--801106 Patna, India
Corresponding Author Email: *nishantspine[at]gmail.com*

Abstract: ***Background:*** ***Cervical spine pathology includes a broad spectrum of degenerative, ossified, deformity-related, traumatic, congenital, and postoperative conditions. Existing classification systems have improved communication and research within selected domains, including subaxial trauma, cervical deformity, degenerative cervical myelopathy (DCM), and ossification of the posterior longitudinal ligament (OPLL). However, no single clinically usable classification currently integrates the major variables that influence cervical decision-making: etiology, number of involved levels, compression phenotype, sagittal alignment, instability, neurological severity, approach-specific modifiers, and patient-related risk.*** ***Objective:*** ***To propose a modular cervical spine classification, the CERVICAL Classification, designed to standardize description, improve interdisciplinary communication, support surgical planning, and create a framework for future outcome validation across adult cervical compressive, deformity, OPLL, instability, and degenerative pathologies.*** ***Methods:*** ***A narrative synthesis of contemporary cervical spine classification systems and recent literature was performed. Key deficiencies in existing systems were identified, including disease-specific fragmentation, incomplete integration of dynamic instability, limited incorporation of compression direction and deformity, and inadequate representation of host-related modifiers. A modular classification was then developed using clinically measurable domains relevant to diagnosis, treatment selection, prognosis, and research standardization.*** ***Results:*** ***The proposed CERVICAL Classification includes eight domains: Cause, Extent, Radiological compression phenotype, Vertebral alignment, Instability, Cord/neural status, Approach modifiers, and Life/host factors. Each domain is coded independently, allowing concise case representation while preserving clinical nuance. OPLL-specific modifiers include K-line status, canal-occupying ratio, suspected dural ossification, and OPLL morphology. Neurological grading incorporates mJOA-based categories for mild, moderate, and severe myelopathy.*** ***Conclusion:*** ***The CERVICAL Classification is proposed as a comprehensive, modular, surgically actionable framework for adult cervical spine disease. It is not intended to replace validated trauma or deformity systems; rather, it integrates currently fragmented domains into a unified language. Prospective validation is required to determine interobserver reliability, predictive validity, and correlation with outcomes including mJOA recovery, Neck Disability Index, pain scores, complications, revision surgery, and patient-reported quality of life.***

Keywords: Adult cervical disorders; cervical spine; classification system; etiology; imaging; biomechanics; neurology; surgical approach; host factors; spine surgery.

1. Introduction

Cervical spine disease represents a complex intersection of neurological, mechanical, radiological, and patient-specific variables. Degenerative cervical myelopathy (DCM) is widely recognized as the most common cause of adult spinal cord dysfunction, and its pathophysiology involves both static compression and dynamic repetitive injury related to altered spinal mobility. Structural contributors include disc degeneration, uncovertebral and facet arthrosis, osteophytes, ligamentum flavum hypertrophy, and ossification of the posterior longitudinal ligament (OPLL). [1,5]

Despite advances in imaging, surgical technique, neuromonitoring, and outcome assessment, cervical spine decision-making remains heterogeneous. DCM diagnosis is based on clinical symptoms, neurological signs, and imaging evidence of cord compression; however, recent AO Spine RECODE-DCM work has emphasized that diagnostic criteria and research terminology still require standardization. Mild DCM and asymptomatic degenerative cervical cord compression remain particularly variable in management. [3,6,7]

Existing classification systems have made important contributions. The Subaxial Injury Classification and Severity Scale (SLICS) incorporates injury morphology, discoligamentous complex integrity, and neurological status. The AO Spine Subaxial Cervical Spine Injury Classification groups traumatic injuries by morphology and adds facet, neurological, and modifier categories. Cervical deformity classifications standardize sagittal and global alignment. OPLL decision-making uses K-line status, canal-occupying ratio, OPLL morphology, and cervical alignment. These systems are valuable, but they are generally disease-specific. [9-16,18,19]

The central deficiency is therefore not the absence of classification, but fragmentation. Trauma, deformity, DCM, radiculopathy, OPLL, and postoperative disease are often described using separate vocabularies. A patient with multilevel OPLL, kyphosis, dynamic instability, moderate

myelopathy, and osteoporosis cannot be adequately represented by a single existing degenerative or deformity classification without losing information relevant to treatment. This manuscript proposes the CERVICAL Classification as a modular framework that integrates disease cause, anatomical extent, compression phenotype, alignment, instability, neurological severity, approach modifiers, and host factors.

2. Rationale and Current Deficiencies

Disease-specific fragmentation
Current systems often perform well within narrow indications but do not communicate across disease categories. Trauma classifications emphasize injury morphology and stability; DCM severity tools emphasize neurological impairment; cervical deformity systems emphasize alignment; and OPLL frameworks emphasize K-line, canal-occupying ratio, and ossification morphology. These variables commonly coexist in elderly patients, congenitally stenotic canals, postoperative adjacent segment disease, ankylosed spines, and multilevel degenerative disease.

Incomplete integration of neurological severity and imaging
The modified Japanese Orthopaedic Association (mJOA) score is widely used to grade DCM severity. Commonly used categories define mild myelopathy as mJOA 15-17, moderate myelopathy as 12-14, and severe myelopathy as 0-11. However, mJOA alone does not encode the compression direction, number of levels, sagittal alignment, dynamic instability, OPLL-specific risk factors, or patient-related surgical risk. [2]

Uncertainty in mild myelopathy and asymptomatic cord compression
Patients with mild DCM or asymptomatic cord compression are difficult to classify consistently. The radiological abnormality may be significant while neurological findings are subtle or absent. Conversely, clinically meaningful myelopathy may occur with less striking static imaging when dynamic compression, congenital stenosis, or cord vulnerability is present. [6,7]

Dynamic compression and instability are underrepresented
Cervical cord compromise may be static, dynamic, or mixed. Flexion-extension radiographs, dynamic MRI, CT, and clinical context can reveal translation, angular instability, ligamentum flavum buckling, or occult instability after trauma or previous surgery. These features directly influence whether decompression alone, decompression with fusion, or deformity correction is appropriate. [5]

OPLL requires specific approach modifiers
In OPLL, surgical strategy depends on cervical alignment, K-line status, canal-occupying ratio, lesion type, dural ossification, and feasibility of direct anterior decompression. Recent evidence supports evaluating K-line and canal-occupying ratio together rather than independently, because their combination influences neurological recovery and approach selection. [18,19]

Host factors are incompletely represented
Age, frailty, osteoporosis, diabetes, renal disease, smoking, malnutrition, ankylosed spine, previous cervical surgery, airway risk, and rehabilitation potential may substantially alter operative strategy and complication risk. Most classification systems describe the spine but not the patient.

Proposed Classification
The proposed system is called the CERVICAL Classification. It is primarily descriptive, modular, and intended to support communication, surgical planning, research stratification, and future prognostic modeling. It should not be used as a stand-alone treatment algorithm until validated.

Letter	Domain	Purpose
C	Cause	Defines primary pathology
E	Extent	Defines number and distribution of involved levels
R	Radiological compression phenotype	Defines severity, direction, and morphology of neural compression
V	Vertebral alignment	Defines lordosis, kyphosis, deformity, and junctional alignment
I	Instability	Defines static or dynamic instability
C	Cord / neural status	Defines neurological severity and radiculopathy/myelopathy state
A	Approach modifiers	Defines surgically relevant factors affecting anterior, posterior, combined, or motion-preserving strategies
L	Life / host factors	Defines patient-related risk modifiers

A full case code may be written as C-E-R-V-I-C-A-L. For example: C-O / E3 C3-C6 / R3-A-M / V2 / I1 / C3 / A4 / K- / COR >=60 / L3 describes multilevel cervical OPLL from C3 to C6 with severe anterior multilevel compression, flexible kyphosis, suspected instability, moderate myelopathy, high-risk OPLL approach modifiers, K-line negative status, high canal-occupying ratio, and osteoporosis.

Domain 1: C - Cause / Etiology

Code	Etiology
C-D	Degenerative disc-osteophyte complex / cervical spondylosis
C-O	OPLL / OLF / ossified ligamentous disease
C-H	Soft disc herniation
C-C	Congenital stenosis / congenital anomaly
C-P	Postoperative / adjacent segment / iatrogenic
C-T	Trauma or trauma-superimposed degenerative disease
C-I	Infective / inflammatory
C-N	Neoplastic
C-M	Mixed pathology

For the first validation phase, the recommended target population should be adult non-neoplastic, non-infective cervical compressive pathology, including degenerative spondylosis, disc herniation, OPLL, deformity-associated compression, postoperative disease, and trauma-superimposed stenosis.

Domain 2: E - Extent of Disease

Code	Definition
E0	No structural cervical compression
E1	Single-level disease
E2	Two-level contiguous disease
E3	Three or more contiguous levels
E4	Skip / noncontiguous lesions
E5	Junctional extension: craniovertebral junction or cervicothoracic junction
E6	Whole cervical / pan-cervical disease

Extent should be recorded using the principal pathological levels, for example E3 C3-C6 or E4 C3-C4 + C6-C7.

Domain 3: R - Radiological Compression Phenotype

This domain describes the severity, direction, and morphology of neural compression. MRI is the principal modality for cord compression and intramedullary signal change; CT is particularly important for OPLL, osteophytes, congenital anomalies, and surgical planning.

Code	Compression severity
R0	No cord or root compression
R1	Stenosis without cord deformation
R2	Cord deformation without intramedullary signal change
R3	Cord deformation with T2 hyperintensity
R4	Severe cord compromise with T1 hypointensity, multilevel signal change, or marked circumferential compression

Modifier	Meaning
A	Anterior / ventral compression
P	Posterior / dorsal compression
C	Circumferential compression
L	Lateral recess / foraminal compression
DYN	Dynamic compression demonstrated on flexion-extension MRI, CT, or radiographs
F	Foraminal-dominant radiculopathy
M	Multilevel cord compression
K	OPLL related to K-line status

Domain 4: V - Vertebral Alignment

Code	Alignment
V0	Preserved cervical lordosis / balanced cervical spine
V1	Straightened cervical spine / loss of lordosis
V2	Flexible segmental kyphosis
V3	Fixed cervical kyphosis
V4	Global cervical deformity / abnormal C2-C7 SVA or CBVA
V5	Cervicothoracic junctional deformity
V6	Craniovertebral junctional deformity
V7	Coronal cervical deformity

Alignment is important because it influences posterior cord drift, surgical approach selection, need for fusion, osteotomy planning, and risk of postoperative deformity progression.

Domain 5: I - Instability

Code	Instability status
I0	No instability
I1	Suspected instability / hypermobility
I2	Definite dynamic instability
I3	Fixed translation, listhesis, locked facet, or traumatic instability
I4	Instability requiring fusion consideration
I5	Junctional instability: craniovertebral or cervicothoracic

Instability should be assessed by flexion-extension radiographs, CT, MRI, and clinical context. It is particularly relevant in DCM, trauma-superimposed stenosis, postoperative adjacent segment disease, inflammatory conditions, and ankylosed spines.

Domain 6: C - Cord / Neural Status

Code	Neurological status
C0	Asymptomatic radiological compression
C1	Radiculopathy only
C2	Mild myelopathy, mJOA 15-17
C3	Moderate myelopathy, mJOA 12-14
C4	Severe myelopathy, mJOA 0-11
C5	Rapid neurological deterioration
C6	Acute traumatic cord syndrome
C7	Myeloradiculopathy with dominant root deficit

This domain deliberately separates neurological status from imaging severity, because patients may have marked radiological compression with minimal symptoms or clinically meaningful myelopathy with less severe static compression. mJOA-based severity thresholds provide a reproducible clinical anchor for DCM stratification. [2]

Domain 7: A - Approach Modifiers

Code	Approach modifier
A0	No specific approach modifier
A1	Anterior-dominant focal pathology
A2	Posterior-suitable multilevel pathology with preserved lordosis
A3	Combined anterior-posterior consideration
A4	High-risk anterior pathology: large OPLL, dural ossification, revision anterior surgery
A5	High-risk posterior strategy: fixed kyphosis, poor posterior cord drift potential
A6	Anatomical risk: vertebral artery anomaly, narrow pedicles, congenital anomaly
A7	Revision surgery modifier
A8	Motion-preservation consideration: focal soft disc, preserved facets, no instability

OPLL-specific modifiers

Modifier	Definition
K+	K-line positive
K-	K-line negative
COR <50	Canal-occupying ratio below 50%
COR >=50	Canal-occupying ratio 50% or higher
COR >=60	High canal-occupying ratio
DO+	Suspected dural ossification
SEG	Segmental-type OPLL
CONT	Continuous-type OPLL
MIX	Mixed-type OPLL

The K-line is defined as a line connecting the midpoints of the spinal canal at C2 and C7 on lateral radiography. OPLL crossing this line is conventionally considered K-line negative. OPLL modifiers should be recorded when CT confirms OPLL, because these factors influence anterior, posterior, or combined strategy selection. [17,18]

Domain 8: L - Life / Host Factors

Code	Host factor
L0	Low-risk surgical candidate
L1	Elderly but physiologically fit
L2	Frailty / high anesthesia risk
L3	Osteoporosis / poor bone quality
L4	Diabetes, renal disease, smoking, malnutrition, immunosuppression
L5	Ankylosed spine / DISH / inflammatory spondyloarthropathy
L6	Previous cervical surgery
L7	High dysphagia / airway / anterior approach risk
L8	Poor rehabilitation potential / severe systemic disease

This domain is intentionally separated from spinal morphology because two patients with identical imaging may require different strategies depending on bone quality, frailty, previous surgery, systemic illness, and rehabilitation capacity.

Provisional Severity and Complexity Index

The CERVICAL Classification is primarily descriptive. However, a provisional complexity index may be useful for research. This score is hypothesis-generating and should not be used for treatment decisions until reliability and predictive validity are confirmed.

Domain	Suggested score
R: Compression severity	0-4
V: Alignment deformity	0-4
I: Instability	0-4
C: Neurological status	0-5
A: Approach complexity	0-4
L: Host risk	0-4

Total provisional score	Suggested category
0-5	Low complexity
6-10	Moderate complexity
11-15	High complexity
16-25	Very high complexity

Clinical Application Examples

Example 1: Multilevel OPLL with kyphosis

A 62-year-old patient presents with gait imbalance, hand clumsiness, and mJOA 13. MRI shows severe C3-C6 ventral compression with T2 cord signal. CT shows mixed-type OPLL with canal-occupying ratio 65%. Lateral radiograph shows flexible kyphosis and K-line negative status.

Classification: C-O / E3 C3-C6 / R3-A-M / V2 / I1 / C3 / A4 / K- / COR >=60 / MIX / L1

This represents multilevel OPLL with moderate myelopathy, severe anterior compression, flexible kyphosis, high canal-occupying ratio, and K-line negative status. Posterior-only decompression may be less predictable because posterior cord drift may be limited.

Example 2: Multilevel cervical spondylotic myelopathy with lordosis

A 58-year-old patient has progressive hand numbness and gait imbalance. mJOA is 15. MRI shows C3-C6 multilevel stenosis with cord deformation but no T2 signal change. Cervical lordosis is preserved. No dynamic instability is present.

Classification: C-D / E3 C3-C6 / R2-C-M / V0 / I0 / C2 / A2 / L0

This describes multilevel degenerative cervical myelopathy with preserved lordosis and mild myelopathy. Posterior decompression may be surgically suitable depending on symptom progression, patient preference, and surgeon judgment.

Example 3: Single-level disc herniation with radiculomyelopathy

A 45-year-old patient has a C5-C6 soft disc herniation, radicular pain, hyperreflexia, and mJOA 16. MRI shows anterior compression and mild cord deformation without signal change.

Classification: C-H / E1 C5-C6 / R2-A-F / V0 / I0 / C2+C7 / A1 or A8 / L0

This describes focal anterior compression with radiculomyelopathy. Depending on disc morphology, facet status, instability, age, and motion-preservation suitability, anterior decompression with fusion or arthroplasty may be considered.

Example 4: Asymptomatic radiological cord compression

A 70-year-old patient undergoing lumbar stenosis evaluation is found to have C4-C5 and C5-C6 cervical cord compression on MRI. There is no gait disturbance, no hand dysfunction, and no objective myelopathic signs.

Classification: C-D / E2 C4-C6 / R2-M / V1 / I0 / C0 / A0 / L1

This separates radiological compression from neurological disease and may be useful for surveillance cohorts, counseling, and future natural-history studies.

Proposed Decision-Support Use

The classification is not intended to dictate treatment. Instead, it may support structured case discussion, multidisciplinary review, registry design, and research stratification. Representative interpretive patterns are shown below.

Pattern	General implication
R3-R4 with C3-C5	High neurological concern; decompression commonly considered if clinically appropriate
A1, E1-E2, V0-V1, I0	Anterior approach may be suitable
A2, E3-E4, V0, I0	Posterior decompression may be suitable
V3-V4 or K-/COR>=50	Posterior-only decompression may be less predictable
I2-I4	Fusion should be considered
L2-L4	Host optimization and risk-adjusted planning required
C0 or C2 with R1-R2	Observation versus surgery requires individualized shared decision-making

3. Discussion

The CERVICAL Classification attempts to solve a practical problem: cervical spine pathology is multidimensional, but existing classification systems are usually disease-specific. A patient's treatment is rarely determined by a single variable. Surgical approach depends on compression direction, number of involved levels, sagittal alignment, instability, neurological severity, OPLL morphology, bone quality, previous surgery, systemic risk, and surgeon-specific feasibility. [1,5,6,9-19]

The proposed system is modular. The full CERVICAL code can be used for complex cases, while a shortened code may be sufficient in routine documentation. For example, C-D / E3 / R2 / V0 / I0 / C2 may communicate the essentials of mild multilevel DCM with preserved alignment, whereas the A and L modifiers become essential when planning revision surgery, OPLL surgery, deformity correction, or fixation in osteoporotic bone.

A key strength is separation of radiological compression from neurological severity. This is important because asymptomatic degenerative cervical cord compression is common, and patients with similar MRI findings may have different clinical states. Conversely, dynamic compression or congenital stenosis may produce clinically significant myelopathy despite less dramatic static imaging. The CERVICAL Classification is therefore intended to support phenotyping rather than replace clinical examination. [6,7]

Another strength is incorporation of deformity and OPLL concepts into a unified cervical framework. Cervical deformity classification has matured through descriptor-modifier systems, but these systems primarily serve deformity description rather than comprehensive compressive pathology classification. Similarly, K-line and canal-occupying ratio are highly relevant in OPLL, but they are not routinely included when classifying broader cervical myelopathy. The proposed framework brings these factors into a single language. [15-19]

Validation Plan

Phase 1: Expert Delphi consensus
A modified Delphi process should include orthopedic spine surgeons, neurosurgeons, musculoskeletal radiologists, neurologists, rehabilitation physicians, physiotherapists, and methodologists. Goals should include finalizing domain definitions, removing redundant variables, agreeing on minimum imaging requirements, refining OPLL and deformity modifiers, and defining simplified versus advanced versions.

Phase 2: Reliability study
A multicenter image bank of 150-250 cervical cases should be created, including degenerative cervical myelopathy, radiculopathy, OPLL, cervical deformity, postoperative adjacent segment disease, trauma-superimposed stenosis, and asymptomatic cord compression. Raters should classify cases twice, 4-6 weeks apart. Interobserver and intraobserver reliability should be measured using weighted kappa for categorical domains and intraclass correlation for continuous measurements.

Phase 3: Predictive validity
The classification should be correlated with treatment selected, mJOA improvement, Neck Disability Index, VAS neck and arm pain, complications, C5 palsy, dysphagia, revision surgery, fusion failure, return to work, and patient-reported quality of life. A minimum 1-year and ideally 2-year follow-up should be used, particularly for OPLL and deformity cases.

Phase 4: AI-assisted automation
Once validated, the classification may be suitable for AI-assisted extraction from radiographs, CT, and MRI. Automated tasks could include level identification, stenosis grading, cord signal detection, sagittal alignment measurement, OPLL segmentation, canal-occupying ratio calculation, and automated generation of a preliminary CERVICAL code for surgeon verification.

4. Limitations

This manuscript proposes a classification but does not validate it. The system may be too detailed for routine outpatient use unless a simplified version is created. Some domains, especially compression severity and approach modifiers, may be subject to interobserver variability. The classification includes several pathology categories, but first-phase validation should focus on adult degenerative compressive disease, OPLL, deformity-associated compression, and postoperative disease rather than infection, tumor, or pediatric pathology. Surgical decision-making is also influenced by patient preference, surgeon expertise, resource availability, and regional practice patterns, none of which can be fully captured by a classification code.

5. Conclusion

The CERVICAL Classification is a proposed modular framework for adult cervical spine pathology that integrates etiology, disease extent, compression phenotype, alignment, instability, neurological status, approach modifiers, and host factors. It addresses current deficiencies in cervical classification by unifying variables that are currently distributed across trauma, deformity, DCM, and OPLL systems. The classification may improve communication, documentation, research standardization, and surgical planning. Formal Delphi refinement and multicenter validation are required before clinical adoption.

Declarations

Ethics approval: Not applicable for a classification proposal manuscript without patient data.

Consent: Not applicable.

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References

[1] Fehlings MG, Tetreault LA, Riew KD, et al. A Clinical Practice Guideline for the Management of Patients With Degenerative Cervical Myelopathy: Recommendations for Patients With Mild, Moderate, and Severe Disease and Nonmyelopathic Patients With Evidence of Cord Compression. Global Spine J. 2017;7(3 Suppl):70S-83S. doi:10.1177/2192568217701914.

[2] Tetreault L, Kopjar B, Nouri A, et al. The modified Japanese Orthopaedic Association scale: establishing criteria for mild, moderate and severe impairment in patients with degenerative cervical myelopathy. Eur Spine J. 2017;26(1):78-84. doi:10.1007/s00586-016-4660-8.

[3] Hilton B, Tempest-Mitchell J, Davies BM, et al. Establishing Diagnostic Criteria for Degenerative Cervical Myelopathy [AO Spine RECODE-DCM Research Priority Number 3]. Global Spine J. 2022;12(1 Suppl):55S-63S. doi:10.1177/21925682211030871.

[4] Davies BM, Mowforth OD, Smith EK, Kotter MRN. AO Spine RECODE-DCM: Why Prioritize Research in Degenerative Cervical Myelopathy? Global Spine J. 2022;12(1 Suppl):5S-7S. doi:10.1177/21925682211058363.

[5] Kim MW, Kang CN, Choi SH. Update of the Natural History, Pathophysiology, and Treatment Strategies of Degenerative Cervical Myelopathy: A Narrative Review. Asian Spine J. 2023;17(1):213-221. doi:10.31616/asj.2022.0440.

[6] Brannigan JFM, Davies BM, Mowforth OD, et al. Management of mild degenerative cervical myelopathy and asymptomatic spinal cord compression: an international survey. Spinal Cord. 2024;62(2):51-58. doi:10.1038/s41393-023-00945-8.

[7] Horak T, Adamova B, Kerkovsky M, Kadanka Z, Bednarik J. Evidence-based commentary on the diagnosis, management, and follow-up of asymptomatic degenerative cervical cord compression. Front Neurol. 2024;15:1341371. doi:10.3389/fneur.2024.1341371.

[8] Fehlings MG, Tetreault LA, et al. AO Spine Clinical Practice Recommendations for Diagnosis, Natural History, and Nonoperative Management in Degenerative Cervical Myelopathy. Global Spine J. 2025. doi:10.1177/21925682251331050.

[9] Vaccaro AR, Hulbert RJ, Patel AA, et al. The Subaxial Cervical Spine Injury Classification System: a novel approach to recognize the importance of morphology, neurology, and integrity of the disco-ligamentous complex. Spine. 2007;32(21):2365-2374. doi:10.1097/BRS.0b013e3181557b92.

[10] Patel AA, Dailey A, Brodke DS, et al. Subaxial cervical spine trauma classification: the Subaxial Injury Classification system and case examples. Neurosurg Focus. 2008;25(5):E8. doi:10.3171/FOC.2008.25.11.E8.

[11] Vaccaro AR, Koerner JD, Radcliff KE, et al. AOSpine subaxial cervical spine injury classification system. Eur Spine J. 2016;25(7):2173-2184. doi:10.1007/s00586-015-3831-3.

[12] Canseco JA, Schroeder GD, Patel PD, et al. The Subaxial Cervical AO Spine Injury Score. Global Spine J. 2022;12(1):105-114. doi:10.1177/2192568220961199.

[13] Karamian BA, Schroeder GD, Lambrechts MJ, et al. An international validation of the AO Spine Subaxial Injury Classification System. Eur Spine J. 2023;32:1077-1086. doi:10.1007/s00586-022-07467-6.

[14] Ames CP, Blondel B, Scheer JK, et al. Cervical radiographical alignment: comprehensive assessment techniques and potential importance in cervical myelopathy. Spine. 2013;38(22 Suppl 1):S149-S160. doi:10.1097/BRS.0b013e3182a7f449.

[15] Passias PG, Oh C, Jalai CM, et al. Redefining cervical spine deformity classification through novel cutoffs: an assessment of the relationship between radiographic parameters and functional neurological outcomes. J Craniovertebr Junction Spine. 2021;12(2):117-124.

[16] Kaidi AC, Kim HJ, Lafage R, et al. Classification(s) of Cervical Deformity. Neurospine. 2022;19(4):862-871. doi:10.14245/ns.2244702.351.

[17] K-line concept: Fujiyoshi T, Yamazaki M, Kawabe J, et al. A new concept for making decisions regarding the surgical approach for cervical ossification of the posterior longitudinal ligament: the K-line. Spine. 2008;33(26):E990-E993. doi:10.1097/BRS.0b013e318188b300.

[18] Shin JJ, et al. The Role of K-Line and Canal-Occupying Ratio in Surgical Outcomes for Multilevel Cervical Ossification of the Posterior Longitudinal Ligament: A Retrospective Multicenter Study. Neurospine. 2025. PMID:40624997.

[19] Sun N, Jiang Y, Wang H, et al. Surgical options for ossification of the posterior longitudinal ligament of the cervical spine: a narrative review. J Orthop Surg Res. 2024;19:703. doi:10.1186/s13018-024-05215-8.

[20] Zhang J, Liang Q, Qin D, et al. The anterior versus posterior approach for the treatment of ossification of the posterior longitudinal ligament in the cervical spine: a systematic review and meta-analysis. J Spinal Cord Med. 2021;44(3):340-349. doi:10.1080/10790268.2019.1703424.

[21] Furuya T, et al. Conservative Treatment and Surgical Indication of Cervical Ossification of the Posterior Longitudinal Ligament. J Clin Med. 2023;12(17):5710. doi:10.3390/jcm12175710.

[22] Hirai T, et al. Postoperative Progression of Cervical Ossification of the Posterior Longitudinal Ligament: Decompression Alone versus Decompression with Fixation. Neurospine. 2025.