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Developmental Cervical Canal Stenosis in Combat Sport Athletes: Recognizing subclinical Cord Dysfunction and Informing Return-To-Play decisions – A Narrative Review

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Abstract

Background. Cervical canal narrowing in a combat athlete does not establish cord dysfunction, yet its significance must be considered before return to contact.

Aim. To examine how subclinical cord dysfunction can be recognized in combat athletes with developmental stenosis and what the evidence contributes to return-to-play decisions.

Materials and Methods. Twenty-eight PubMed-indexed publications were purposefully selected for narrative synthesis. Diagnostic findings and participation outcomes were examined, distinguishing combat-sport evidence from studies of other athletes and non-athletic patients. No meta-analysis was performed.

Results. Most diagnostic evidence concerned degenerative cord compression, whereas combat-sport reports mainly described return after surgery. Electrophysiology detected abnormalities in some patients without clinical myelopathy. Dynamic MRI revealed compression missed in neutral positioning; quantitative MRI investigated tissue changes. Whether these findings predict injury during combat remains unresolved.

Conclusions. Available studies help distinguish anatomical narrowing from cord impairment but provide limited grounds for estimating risk during combat. The reviewed literature identified no single diagnostic parameter validated for combat-sport clearance.

Key words: cervical stenosis, combat sports, spinal cord dysfunction, myelopathy, return to play.

1. Introduction

1.1. Cervical spine vulnerability in combat sports

Combat disciplines impose different demands on the neck. Boxing and kickboxing involve forces transmitted through blows to the head, whereas wrestling and judo expose athletes to throws, falls, traction, and movement imposed by an opponent. Compression may occur together with rotation or forced flexion and extension (Bakirtzis et al. 2024; Sanchis-Gimeno et al. 2026). Understanding the circumstances of an episode is therefore an important part of neurological assessment, rather than merely background information about the sport.

Reported cervical injuries include strains, disc lesions, root or plexus injury, and cord involvement (Bakirtzis et al. 2024). An athlete with a developmentally narrow canal presents an additional anatomical consideration: less space surrounds the cord before an impact or acquired lesion is taken into account. The relevance of this finding varies with associated pathology and the actual exposure (Sanchis-Gimeno et al. 2026). A neurological complaint after grappling and an incidental abnormal scan in a symptom-free boxer pose different questions, even if their canal measurements are similar.

1.2. Clinical uncertainty and the rationale for this review

The difficult presentation is often neither an obvious acute cord injury nor an entirely normal assessment. An athlete may have compression on MRI, an uncertain sensory complaint, or an abnormal neurophysiological response without a convincing myelopathic syndrome. Literature on degenerative compression describes substantial clinical–radiological discordance, and terminology for these intermediate presentations is inconsistent (Horak et al. 2024; Agrawal et al. 2025).

Previous reviews have discussed cervical spine anatomy in athletes and return to martial arts after cervical surgery (Di Monaco et al. 2022; Sanchis-Gimeno et al. 2026). This review focuses on determining whether developmental canal stenosis affects spinal cord function and how this finding may influence participation in combat sports. Because few studies directly address this question in combat athletes, evidence from other sports and non-athletic populations is also considered, with attention to how well it applies to this group.

1.3. Aim and scope

This review examines the distinction between developmental canal narrowing and subclinical cord dysfunction, the diagnostic errors that complicate recognition, and the relevance of available findings to return-to-play (RTP) decisions. Combat athletes are the population of interest. Studies from other sports and non-athletic cervical compression populations are included to address gaps in direct evidence; postoperative findings are considered separately from untreated stenosis.

2. Materials and Methods

2.1. Review design and source identification

The manuscript is a narrative synthesis of a purposively selected bibliography. Twenty-eight PubMed-indexed publications with freely accessible full texts were identified through iterative topic-based searches and retrieval of PubMed, PubMed Central, and publisher records. The publication window was 13 October 2021 to 13 October 2026, including eligible online publication dates.

Search topics covered congenital or developmental cervical stenosis, asymptomatic cord compression, subclinical dysfunction, cervical myelopathy, neurological examination, MRI, electrophysiology, combat and contact sports, and return to play. Diagnostic literature was retrieved separately from sport-specific publications because requiring athletic terminology in every search would omit relevant non-athlete studies.

2.2. Selection and synthesis

Publications were retained for relevance to anatomical definitions, recognition of cord dysfunction, participation decisions, or surveillance. The bibliography includes primary studies, systematic and scoping reviews, narrative reviews, and a survey of clinical practice. Study design, population, assessment methods, and outcomes were considered when organizing the discussion.

Evidence was grouped by direct applicability: combat-sport studies, studies of other athletes, and non-athlete cervical compression research. No meta-analysis or formal risk-of-bias assessment was performed. The five-year window and free-full-text restriction constrain coverage, and multiple reviews may discuss the same underlying studies. The bibliography is a basis for clinical interpretation rather than an exhaustive inventory of evidence.

3. Developmental Cervical Canal Stenosis: Anatomical and Functional Significance

3.1. Definitions and radiological characterization

Developmental cervical stenosis, also referred to as congenital cervical stenosis, describes an anatomically narrow spinal canal. Acquired changes, such as disc protrusion or ligamentous thickening, may further narrow the canal and should be distinguished from the underlying developmental stenosis (Goodwin and Hsu 2023).

Historical definitions include an anteroposterior canal diameter below 12–13 mm on lateral radiographs, while some MRI studies use a threshold below 10 mm. The Torg–Pavlov ratio is calculated by dividing the anteroposterior diameter of the spinal canal by that of the corresponding vertebral body on a lateral cervical radiograph. A relatively large vertebral body may therefore produce a low ratio even when the spinal canal is not

markedly narrowed (Goodwin and Hsu 2023). Measurements should consequently be reported with their modality and level, rather than treated as interchangeable cut-offs.

MRI adds the cord and soft tissues to the assessment. Cord deformation, surrounding cerebrospinal fluid space, and signal abnormalities provide information that plain radiographic dimensions cannot supply (Martin et al. 2022). The spinal cord occupation ratio expresses the relationship between cord size and available space; proposed thresholds differ across studies (Goodwin and Hsu 2023). For athletic assessment, functional stenosis concerns the effective reserve around the cord, including the consequences of compression, rather than bony width alone (Sanchis-Gimeno et al. 2026).

3.2. Reduced canal reserve and mechanisms of cord compromise

When little reserve surrounds the cord, an additional lesion may become consequential at a smaller degree of acquired narrowing. Disc changes, osteophytes, and ligamentous pathology can produce sustained encroachment, while movement changes their relationship to the neural tissue (Nouri et al. 2022; Goodwin and Hsu 2023). Flexion and extension may expose compression that is less apparent in neutral imaging (Nouri et al. 2022; Baram et al. 2025).

Mechanical deformation is accompanied by biological processes. Reviews of degenerative myelopathy describe impaired perfusion and secondary cellular injury, including ischemia-related apoptosis (Kim et al. 2023). These mechanisms explain how prolonged compression can contribute to dysfunction, although they do not quantify the risk from a particular training exposure. The broader literature also distinguishes static pathology from repeated movement-dependent compression (Thompson et al. 2024).

Throws or opponent-applied forces introduce external loading into this changing anatomical environment (Sanchis-Gimeno et al. 2026). A cumulative effect in athletes with reduced reserve is plausible, but has not been established as a pathway from repeated combat exposure to subclinical injury. The mechanism should be distinguished from its unmeasured frequency and clinical consequences.

3.3. Relevance to young adults and combat sport exposure

A retrospective case series identified seven men younger than 30 with non-herniated degenerative cervical myelopathy among hospitalized patients. All had radiographic congenital stenosis and dynamic narrowing at the responsible segment. Six participated in sport, including two judokas; the seventh had work requiring frequent neck extension (Terashima et al. 2023). The series documents a presentation in which developmental anatomy and acquired pathology coexist early in adulthood.

It does not estimate the prevalence of this condition in young athletes. Participants already had symptomatic disease, there was no control group, and the sample was small. The authors' proposed contribution of accumulated neck stress remains a mechanistic interpretation of selected cases (Terashima et al. 2023).

Sport-specific loading gives this finding clinical context. Striking and grappling differ in their balance of impact, traction, throws, and externally imposed movement (Bakirtzis et al. 2024; Sanchis-Gimeno et al. 2026). These exposures are relevant to an individual history, but no incidence estimate for subclinical dysfunction in combat athletes can be derived from either a general injury review or the young-adult series.

4. Recognizing Subclinical Spinal Cord Dysfunction

4.1. Distinguishing stenosis, asymptomatic compression, and myelopathy

Stenosis describes canal narrowing; compression describes its effect on the cord. Neither establishes clinical myelopathy. In the degenerative literature, “asymptomatic compression” usually means absence of myelopathic manifestations, even if neck pain or radiculopathy is present (Horak et al. 2024). A systematic review found inconsistent terminology across 96 studies, making apparently similar populations difficult to compare (Agrawal et al. 2025).

Here, *subclinical cord dysfunction* denotes objectively detected functional impairment attributable to the cervical cord without unequivocal clinical myelopathy. This is a working definition. An evidence-based commentary proposed a broader category incorporating functional, microstructural, and metabolic abnormalities (Horak et al. 2024); this review keeps tissue markers distinct from demonstrated functional impairment. Clinically attributable symptoms and findings may already constitute mild myelopathy despite limited disability (Hilton et al. 2022). Table 1 summarizes these distinctions without implying inevitable progression.

Table 1. Working distinctions used in this review.

Finding	What is established	What remains to be determined
Developmental stenosis	Anatomical canal narrowing	Whether the cord is compressed or impaired
Compression without clinical myelopathy	Radiological effect on the cord	Whether additional testing demonstrates dysfunction
Subclinical cord dysfunction	Objective functional abnormality attributed to the cord	Prognosis and relevance to sporting exposure
Clinical myelopathy	Clinically attributable cord syndrome supported by assessment	Severity, course, and treatment requirements

Author synthesis based on (Hilton et al. 2022; Horak et al. 2024; Agrawal et al. 2025). These categories are descriptive, not validated RTP classes.

4.2. Subtle symptoms and neurological findings

History-taking should ask about hand dexterity, sensory disturbance, walking, and balance rather than neck pain alone (Tetreault et al. 2022a; Sharma et al. 2025). Difficulty with buttons or keys may communicate the functional

problem more clearly than a general question about weakness (Balmaceno-Criss et al. 2024). In athletes, establishing change from usual ability can be useful, although sporting performance itself is not a specific diagnostic measure.

Reflexes and pathological responses add evidence, but their value differs. A systematic review and meta-analysis identified Trömner responses and hyperreflexia among the more sensitive findings, while Babinski responses and clonus were among the more specific (Jiang et al. 2024). These results come from heterogeneous degenerative myelopathy studies. They support using the examination as a pattern of findings, including limb function and gait, rather than choosing one sign as decisive (Jiang et al. 2024; Sharma et al. 2025).

Symptoms attributed to training still require localization. Hand pain after contact may be peripheral, whereas upper-limb complaints accompanied by leg findings raise a different concern. When manifestations are convincingly clinical, calling them subclinical simply because disability is modest misrepresents the condition.

4.3. Electrophysiological evidence of dysfunction

Motor evoked potentials (MEPs) assess motor conduction, and somatosensory evoked potentials (SEPs) examine sensory pathways. Electromyography (EMG) and nerve conduction studies help identify root or peripheral nerve involvement; EMG abnormalities may also arise from anterior horn pathology (Yu et al. 2022; Martin et al. 2022). An abnormal test result in an athlete with cervical stenosis may reflect nerve root or peripheral nerve injury rather than spinal cord dysfunction, so the site of impairment must be established.

Contact heat-evoked potentials (CHEPs) extend assessment to temperature and pain pathways. A cross-sectional study examined 82 patients with asymptomatic degenerative compression and 10 with clinical myelopathy. Dermatomal CHEPs were abnormal in 50% of the former group and were the sole detected neurophysiological abnormality in 20.7%; conventional SEP and MEP abnormalities were less frequent (Joppekova et al. 2025). Thus, tests that appear reassuring in one pathway may leave another domain unexplored. The study was cross-sectional, with a mean age of 53.7 years in the asymptomatic compression group (Joppekova et al. 2025). Its result concerns detection, not subsequent injury during sport. Electrophysiology can characterize an otherwise uncertain presentation; prospective research must determine whether particular patterns predict deterioration.

5. Diagnostic Pitfalls and Multimodal Assessment

5.1. Confusing cord dysfunction with peripheral neurological injury

“Stingers” and “burners” commonly describe brief post-traumatic symptoms arising from the brachial plexus or cervical roots. A sports-neuropathy review distinguishes a unilateral upper-limb episode resolving within minutes to hours from central injury involving both arms or the legs (Farag et al. 2025). Grouping these presentations under the same label loses clinically important information.

Root-pattern weakness or altered sensation may coexist with cord disease. Therefore, examination needs to extend beyond the painful limb: lower motor neuron findings at the involved level can accompany upper motor neuron

findings below it (Tetreault et al. 2022a). Equally, a narrow canal should not distract from a peripheral lesion that better explains the presentation. Imaging and electrodiagnosis are complementary when localization remains uncertain (Tetreault et al. 2022a; Farag et al. 2025).

5.2. Overreliance on imaging or a single clinical sign

Two errors work in opposite directions: assigning every symptom to an abnormal MRI, and dismissing symptoms because one reflex is normal. Compression without clinical myelopathy is well described (Horak et al. 2024). Conversely, the absence of upper motor neuron signs does not exclude degenerative myelopathy, and individual signs show variable sensitivity and specificity (Jiang et al. 2024).

T2 hyperintensity can support concern about cord pathology, but is not present in every clinical case (Martin et al. 2022). A scan without signal change should be assessed against the history and examination, not used to close the investigation. The same applies to an isolated Hoffmann response, whose diagnostic contribution is limited (Jiang et al. 2024; Sharma et al. 2025). When findings disagree, the next question is which explanation accounts for the symptom pattern, including alternatives identified during the neurological assessment (Balmaceno-Criss et al. 2024).

5.3. Conventional, dynamic, and quantitative MRI

Conventional MRI defines the level and source of compression, cord shape, and associated pathology (Martin et al. 2022). Dynamic MRI asks whether this relationship changes with neck position. A systematic review found additional or more severe compression on positional imaging in selected degenerative disease cohorts (Baram et al. 2025). This can explain otherwise discordant findings, but controlled flexion or extension in a scanner does not reproduce an impact or opponent-applied force.

Quantitative MRI addresses tissue properties rather than positional anatomy. Diffusion tensor imaging (DTI), magnetization transfer imaging, and spectroscopy offer different measures related to microstructure or metabolism. A scoping review examined these approaches and highlighted small samples and short observation periods (He et al. 2022). Their contribution is best understood as potential phenotyping of early injury; technical promise has not yet translated into a validated athletic risk threshold.

5.4. Integrating clinical, imaging, and functional findings

Investigations should follow the unresolved clinical question. In a unilateral sensory episode, the first task may be peripheral localization. In a patient with gait change and hand clumsiness, assessment should address a possible cord syndrome (Tetreault et al. 2022a). MRI then tests the anatomical explanation; electrophysiology can explore functional involvement or a competing diagnosis (Martin et al. 2022).

Function deserves its own record. Dexterity, walking, and balance measures can capture domains incompletely represented by manual strength or a global score (Soufi et al. 2022). Repeating a documented measure supports comparison over time (Tetreault et al. 2022b), though sport-specific meaningful change remains undefined. Table 2 sets out the complementary questions these methods address.

Table 2. Diagnostic contributions and unresolved interpretation.

Assessment	Main contribution	Limitation relevant to this review
History and neurological examination	Clinical pattern and localization	Subtle findings may be absent or nonspecific (Tetreault et al. 2022a; Jiang et al. 2024)
Conventional MRI	Compression, cord morphology, associated lesions	Anatomy does not directly measure function (Martin et al. 2022)
Dynamic MRI	Position-dependent compression	Does not reproduce combat loading (Baram et al. 2025)
Quantitative MRI	Tissue-property markers	Prognostic validation remains limited (He et al. 2022)
Electrophysiology	Pathway function and peripheral localization	Abnormalities require localization; sporting prognosis is unresolved (Yu et al. 2022; Joppekova et al. 2025)
Functional measures	Documented performance in selected domains	Sensitivity to small athlete-specific changes is uncertain (Soufi et al. 2022; Tetreault et al. 2022b)

6. Return-to-Play Considerations in Combat Sport Athletes

6.1. Assessing evidence applicable to combat sports

A martial-arts review reported return in 21 of 24 martial arts practitioners drawn from published surgical cases and an additional judoka case (Di Monaco et al. 2022). That result describes selected postoperative athletes. It is a different evidence question from continued participation with untreated stenosis, and the small reports cannot reliably estimate uncommon or delayed neurological events.

Football literature offers broader experience with cervical injury and residual abnormalities (Miller and Dossett 2023). Anatomical reviews add comparisons across exposures (Sanchis-Gimeno et al. 2026). These sources inform assessment by analogy, rather than supplying a combat-sport outcome estimate. Endpoint definitions also matter: An arthroplasty review distinguished training from competition after arthroplasty (Reiter et al. 2023). An undifferentiated “return to sport” can conceal materially different levels of contact.

6.2. Clinical and imaging factors relevant to participation decisions

An incidental narrow canal and stenosis discovered after transient limb weakness require different interpretation. The latter assessment needs the distribution, duration, recurrence, and likely origin of the episode (Farag et al. 2025; Sanchis-Gimeno et al. 2026). Current examination establishes whether a deficit remains. Football reviews commonly describe normal neurological findings, full strength, and pain-free motion as prerequisites for return, while acknowledging that imaging can still change the decision (Miller and Dossett 2023).

The scan should identify residual compression, instability, cord abnormalities, and associated lesions (Martin et al. 2022; Sanchis-Gimeno et al. 2026). These observations become meaningful in relation to the clinical diagnosis and proposed activity. Technical practice, contact sparring, and competition should be specified rather than combined into one clearance decision. Table 3 shows the domains requiring documentation without proposing a scoring system.

Table 3. Domains informing a participation discussion.

Domain	Information to document	Relevant sources
Previous neurological events	Distribution, duration, recurrence, recovery, localization	(Farag et al. 2025; Sanchis-Gimeno et al. 2026)
Current status	Persistent deficits, clinical myelopathy, functional change	(Miller and Dossett 2023; Horak et al. 2024)
Structural findings	Compression, stability, associated disc or ligament pathology	(Martin et al. 2022; Sanchis-Gimeno et al. 2026)
Treatment	Treated lesion, postoperative healing, residual pathology	(Di Monaco et al. 2022; Miller and Dossett 2023; Brecount et al. 2023; Reiter et al. 2023)
Proposed exposure	Discipline, training activity, sparring or competition	(Di Monaco et al. 2022; Sanchis-Gimeno et al. 2026)

The table is an author synthesis of assessment domains, not a validated clearance checklist.

6.3. Return after cervical surgery

Postoperative assessment must account for both recovery and the remaining cervical anatomy. A focal decompression does not necessarily resolve multilevel developmental narrowing. Martial-arts reports principally concern anterior cervical discectomy and fusion, with heterogeneous follow-up (Di Monaco et al. 2022).

Arthroplasty preserves segmental movement, an attractive feature for demanding activity. Reviews describe favourable return outcomes in selected athletes (Brecount et al. 2023; Reiter et al. 2023), but preserved motion does not answer whether residual cord reserve is sufficient for unrestricted contact. These outcomes concern athletes who underwent treatment; they provide neither an indication for prophylactic surgery nor a direct estimate of risk in untreated stenosis.

6.4. Shared decision-making under uncertainty

The discussion should explain what the athlete has, what further investigation may clarify, and which risks cannot presently be quantified. Specialist input can address cord involvement, structural treatment needs, and rehabilitation (Sanchis-Gimeno et al. 2026). Practice variation in asymptomatic compression and mild myelopathy illustrates why recommendations may differ between clinicians (Brannigan et al. 2024). The reason for disagreement is more useful to the athlete than an unexplained second opinion.

Preferences and competitive goals help define the proposed activity and acceptable modifications. They do not settle an uncertain diagnosis. Documentation should record the clinical interpretation, activity considered, recommendation, and circumstances prompting reassessment. A new neurological episode may change the decision even when the original assessment was reassuring.

7. Management, Surveillance, and Research Gaps

7.1. Observation and reassessment

Follow-up addresses the initial problem: emergence of symptoms in anatomical stenosis, change in function with established compression, or the course of detected subclinical abnormalities (Horak et al. 2024). Baseline examination and selected functional measurements provide a reference. Serial differences need interpretation in light of test variability, injury, and other explanations (Soufi et al. 2022; Tetreault et al. 2022b).

Athletes should recognize changes in dexterity, sensation, strength, gait, or balance as reasons for review (Horak et al. 2024). Repeat MRI or electrophysiology should answer a specific question rather than follow an assumed universal schedule. The survey of current practice and commentary on asymptomatic compression show uncertainty about the extent of surveillance (Horak et al. 2024; Brannigan et al. 2024); neither establishes a combat-sport protocol.

7.2. Surgical intervention in the absence of overt myelopathy

A controlled pilot study enrolled patients with asymptomatic degenerative compression and at least one predictor of progression. Forty-one surgical and 68 non-surgical patients completed at least 36 months of follow-up. Myelopathy developed in one surgical patient and nine non-surgical patients; the whole-group comparison had $P = 0.054$, while comparison with a matched non-surgical subgroup had $P = 0.029$ (Kadanka et al. 2025). Allocation was not randomized, baseline characteristics differed, and four surgical patients had early complications.

The study supports a larger controlled investigation, but concerns progression in a selected degenerative population. It did not test injury during contact or return to combat. Earlier commentary found no supporting evidence for routine prophylactic surgery in asymptomatic patients without additional progression risk factors (Horak et al. 2024). Treatment should address the patient's neurological and structural condition; enabling competition is a separate objective.

7.3. Limitations of current evidence and priorities for future research

Three gaps recur across this literature. First, population mismatch: combat-sport evidence is mostly case-based or postoperative, whereas studies of subclinical dysfunction largely involve degenerative compression (Di Monaco et al. 2022; Joppekova et al. 2025; Sanchis-Gimeno et al. 2026). Second, definitions differ, including whether "asymptomatic" permits radicular complaints or abnormal functional tests (Agrawal et al. 2025). Third, detection is often mistaken for prognosis. Finding a CHEP or quantitative MRI abnormality does not establish how that athlete will respond to continued exposure (He et al. 2022; Joppekova et al. 2025).

Prospective cohorts should report developmental morphology, compression, clinical status, and objective dysfunction separately. Striking and grappling exposure, training volume, and neurological events need recording alongside clearly defined return endpoints. Longitudinal functional assessment can document change (Tetreault et al. 2022b), while diagnostic research should test added prognostic value rather than abnormality frequency alone (Martin et al. 2022; He et al. 2022). Preventive surgery requires controlled evidence, including benefits and harms (Kadanka et al. 2025).

8. Conclusions

Developmental stenosis becomes relevant to participation assessment when interpreted alongside the neurological history, current function, associated compression, and proposed exposure. A canal measurement cannot substitute for identifying the condition that prompted assessment.

Clinical evaluation and MRI remain the starting point. Electrophysiology may clarify dysfunction or localization, while dynamic and quantitative imaging address questions left unresolved by conventional assessment. The clinical meaning of additional abnormalities must be distinguished from their ability to predict injury during contact.

Direct evidence in combat athletes remains limited. Postoperative return reports and experience from other collision sports provide context, but do not resolve risk in untreated developmental stenosis. Carefully defined prospective studies are needed to connect diagnostic findings with outcomes during continued participation.

Disclosure

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