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CERVICAL SPINE INSTABILITY IN RHEUMATOID ARTHRITIS IN THE ERA OF MODERN ANTIRHEUMATIC THERAPY: PREDICTORS OF PROGRESSION AND TIMING OF NEUROSURGICAL REFERRAL

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ABSTRACT

Background and Objectives. To synthesize contemporary clinical evidence on rheumatoid cervical spine instability, identify predictors of structural progression, and distinguish the threshold for neurosurgical referral from the threshold for operative intervention.

Materials and Methods. A focused narrative clinical review was based on a PubMed/MEDLINE search updated through August 2026. Original clinical studies addressing cervical involvement, imaging, longitudinal progression, predictors, neurological consequences, and surgical outcomes were prioritized. Forty clinical publications formed the principal evidence base, no meta-analysis or formal risk-of-bias grading was performed.

Results. Modern disease-modifying antirheumatic therapy appears to reduce some de novo cervical lesions, but established instability may continue to progress. Pre-existing cervical abnormalities, destructive peripheral disease, longer rheumatoid arthritis duration, seropositivity, glucocorticoid exposure, osteoporosis, and previous joint surgery are associated with cervical involvement or progression. Serial imaging is particularly important because mechanical deterioration may precede overt neurological compromise.

Conclusions. Assessment should integrate rheumatological phenotype, established structural disease, longitudinal mechanical progression, and neural consequences. Neurologically intact patients with documented structural progression represent a clinically important intermediate group in whom earlier spine or neurosurgical assessment may be considered without implying prophylactic surgery.

KEYWORDS

Rheumatoid Arthritis, Cervical Spine, Atlantoaxial Instability, Cervical Instability, Disease Progression, Neurosurgical Referral

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Introduction

Rheumatoid arthritis (RA) is a chronic systemic inflammatory disease that may involve the cervical spine and, in advanced cases, lead to potentially life-threatening neurological complications. Persistent synovitis at the craniovertebral junction promotes pannus formation, ligamentous insufficiency, and progressive osseous erosion, resulting primarily in atlantoaxial instability (AAI), cranial settling, and subaxial subluxation (SAS). These abnormalities may occur independently, coexist, or develop sequentially and can ultimately cause spinal cord or cervicomedullary compression. Importantly, substantial radiographic instability may remain clinically silent until neurological compromise has developed [1, 2, 3, 4, 5].

The introduction of modern disease-modifying antirheumatic drugs (DMARDs), including biologic and targeted agents, has substantially changed the natural history of RA. Improved systemic disease control has been associated with less frequent development of new cervical lesions and a decline in RA-related cervical surgery in contemporary clinical cohorts [6, 7, 8, 9, 10]. However, this therapeutic progress has not eliminated the clinical significance of established cervical disease. Once structural instability has developed, progression may continue despite biologic therapy or otherwise improved systemic disease control [7, 8, 9, 11, 12, 13]. Consequently, control of peripheral RA and inflammatory markers should not necessarily be interpreted as evidence of cervical mechanical stability.

This distinction between inflammatory disease activity and mechanical instability represents a central challenge in the contemporary management of rheumatoid cervical disease. A clinically relevant question is therefore not only whether the cervical spine is involved, but which patients with established structural abnormalities remain at meaningful risk of further mechanical progression and subsequent neurological

deterioration. This issue is particularly important because neurological symptoms may develop relatively late, while radiographic progression can occur in patients who remain neurologically intact [1, 7, 11, 4, 13].

Accordingly, contemporary assessment requires integration of rheumatological risk factors, structural abnormalities, longitudinal imaging findings, and neurological status rather than reliance on symptoms, systemic inflammatory control, or a single radiographic measurement. Recognition of mechanically progressive disease before advanced spinal cord or cervicomedullary injury develops may provide an opportunity for specialist assessment while neurological function is still preserved [14, 6, 15, 11, 16, 13].

The aim of this narrative review is to synthesize current evidence regarding the pathophysiology, natural history, clinical presentation, imaging assessment, predictors of progression, and contemporary neurosurgical management of cervical spine instability in RA in the era of modern antirheumatic therapy. Particular emphasis is placed on the prognostic significance of longitudinal structural progression and on distinguishing the threshold for neurosurgical referral from the threshold for operative intervention. Based on the available evidence, we further propose a practical risk-based framework to address a clinically relevant question: which patients with rheumatoid cervical disease should be referred for neurosurgical assessment before irreversible neurological compromise develops.

Materials and Methods

A focused literature search was conducted in PubMed/MEDLINE and updated in August 2026. Search concepts combined “rheumatoid arthritis” with terms related to “cervical spine”, “atlantoaxial instability” or “atlantoaxial subluxation”, “cranial settling” or “basilar invagination”, “subaxial subluxation”, “cervical myelopathy”, imaging, structural progression, and cervical or neurosurgical treatment. The search was designed to identify clinical evidence relevant to contemporary risk assessment rather than to perform an exhaustive systematic review.

Original clinical studies involving patients with rheumatoid arthritis and reporting data relevant to the objectives of this review constituted the primary evidentiary basis. Longitudinal and observational cohorts were prioritized for natural history and progression. Diagnostic and imaging studies were used for structural and neural risk assessment, and surgical cohorts were used for neurological, functional, and perioperative outcomes. Contemporary studies reflecting modern disease-modifying antirheumatic therapy were prioritized when available, while older clinical studies were retained when they addressed prognostic or surgical questions not adequately represented in modern cohorts.

Studies were synthesized narratively across prespecified clinical domains: patterns of cervical involvement, effects of modern antirheumatic therapy, predictors of structural progression, clinical presentation, imaging and surveillance, neurosurgical referral, and surgical management. The final evidence base comprised 40 clinical publications reporting original clinical data relevant to at least one of these domains. Reference lists of eligible clinical articles were also checked to identify additional primary studies relevant to longitudinal progression, imaging, and surgical outcomes. No meta-analysis, formal risk-of-bias assessment, or quantitative evidence grading was performed. Accordingly, this article should be interpreted as a focused narrative review and the proposed referral framework as an evidence-informed conceptual synthesis rather than a validated guideline.

Results

Pathophysiology and patterns of cervical involvement

Rheumatoid involvement of the cervical spine predominantly affects the highly mobile synovial articulations of the craniovertebral junction. Persistent synovial inflammation may lead to hypertrophic pannus formation, progressive erosion of the odontoid and adjacent articular structures, and weakening of the transverse, alar, and other stabilizing ligaments. As structural damage accumulates, the disease may transition from a predominantly inflammatory process to persistent mechanical instability. At this stage, suppression of systemic inflammation does not reverse established ligamentous or osseous damage, providing a plausible explanation for continued structural progression despite satisfactory control of peripheral rheumatoid arthritis [7, 11, 12, 13].

Three major patterns are clinically relevant: atlantoaxial instability (AAI), cranial settling, and subaxial subluxation (SAS). They may coexist or develop sequentially, and established upper-cervical instability can precede more complex deformity [11, 13].

Atlantoaxial Instability

Importantly, AAI may also represent an early structural stage within a broader process of cervical deterioration. Longitudinal observations indicate that pre-existing atlantoaxial abnormalities are associated with subsequent progression of rheumatoid cervical instability, emphasizing that an established lesion may carry prognostic significance beyond its baseline radiographic severity [11, 13].

Atlantoaxial instability is a characteristic manifestation of rheumatoid cervical disease. Progressive ligamentous insufficiency and erosive destruction of the C1-C2 articulations permit abnormal translation of the atlas relative to the axis, most commonly in the anterior direction. Instability may initially be dynamic and therefore become apparent primarily on flexion-extension radiographs. From a clinical perspective, the neurological significance of AAI depends not only on the magnitude of displacement but also on the residual space available for the spinal cord and the presence of additional soft-tissue compression, particularly periodontoid pannus [17, 15, 18, 19, 20].

Cranial Settling

Long-term clinical observations support the concept that cranial settling may develop as part of progressive rheumatoid cervical disease rather than exclusively as an isolated structural abnormality. Pre-existing upper cervical instability has been associated with subsequent deterioration and development of more advanced cervical abnormalities during longitudinal follow-up [11, 13].

Progressive destruction of the lateral masses and the occipitoatlantal and atlantoaxial articulations may result in superior migration of the odontoid relative to the skull base, producing cranial settling. This pattern is clinically important because progressive deformity at the craniovertebral junction may compromise the cervicomedullary junction and ultimately result in neurological dysfunction [17, 19, 20, 21].

Subaxial Subluxation

Longitudinal clinical studies demonstrate that subaxial instability may increase over time and may develop in patients with pre-existing cervical abnormalities. Its occurrence therefore further supports viewing rheumatoid cervical involvement as a potentially progressive structural process in susceptible patients rather than as a static radiographic finding [11, 13].

Rheumatoid structural disease may also involve the cervical spine below C2, producing subaxial subluxation. Multilevel involvement can result in progressive translation and characteristic stepwise deformity, with potential narrowing of the spinal canal and subsequent cervical myelopathy [22, 23, 24].

Cervical disease in the modern DMARD era

Impact of Modern Antirheumatic Therapy

Modern DMARD therapy has reduced some de novo cervical lesions, but its effect differs between patients with an initially unaffected cervical spine and those with established instability [7, 8, 25].

Population-level clinical data also support a changing epidemiological pattern. Morita et al. [25] compared 1,333 patients assessed in 2015 with an earlier 1999 survey and reported substantially lower frequencies of atlantoaxial and vertical subluxation in the later cohort. Importantly, cervical lesion progression remained associated with deterioration in myelopathy-specific quality of life, indicating that reduced incidence does not eliminate the clinical consequences of established disease.

This distinction was demonstrated by Kaito et al. [7], who evaluated 38 patients with RA receiving continuous biologic therapy. Radiographic progression occurred in 1 of 12 patients without a baseline cervical lesion, compared with 12 of 15 patients with baseline AAS and 9 of 11 patients with baseline vertical subluxation. These findings suggest that biologic therapy may be more effective at limiting de novo cervical involvement than at preventing progression once structural instability is established [7, 8, 26, 9].

These findings support a clinically important distinction: systemic inflammatory control does not necessarily restore ligamentous or osseous integrity once structural damage is established [7, 11].

Long-Term Structural Progression

Longitudinal clinical studies demonstrate that rheumatoid cervical instability may continue to evolve over several years. In a five-year prospective cohort study, Yurube et al. [13] observed progression of cervical spine instability during follow-up, with baseline cervical abnormalities providing important information regarding subsequent structural deterioration.

More recently, Kanda et al. [11] reported findings from a prospective multicenter cohort followed for more than ten years. The study demonstrated continued aggravation of cervical spine instability during long-term follow-up and identified pre-existing cervical abnormalities as important predictors of subsequent deterioration. These observations provide contemporary evidence that established rheumatoid cervical disease should not necessarily be regarded as a static structural consequence of previous inflammatory activity.

Together, these cohorts support a structural continuum in which established mechanical damage may continue to evolve despite improved systemic disease control [11, 13].

Predictors of Structural Progression

Identification of patients at increased risk of progression is essential for determining the intensity of cervical surveillance. Longitudinal clinical evidence indicates that pre-existing cervical abnormalities are among the most clinically relevant predictors of subsequent structural deterioration [11, 13]. In particular, established atlantoaxial or vertical abnormalities may identify patients in whom cervical mechanical disease has already entered a progressive phase.

Additional clinical characteristics associated with cervical instability or progression have been reported, including longer RA duration, destructive peripheral joint disease, previous joint surgery, greater cumulative inflammatory burden, and other markers of severe rheumatoid disease [27, 26, 11, 4, 12]. These factors may help identify a destructive RA phenotype in which the threshold for cervical assessment should be lower. In patients receiving biologic agents, Kaito et al. [26] found that baseline disease activity predicted AAS progression, whereas pre-existing AAS was the strongest predictor of subsequent vertical subluxation.

However, rheumatological characteristics should be interpreted primarily as risk modifiers rather than as independent indicators of neurological risk or surgical treatment. Their presence does not establish that a cervical lesion is mechanically unstable or progressing. Direct evidence of structural disease and, particularly, documented longitudinal deterioration therefore remains more relevant to cervical risk stratification than any isolated systemic characteristic.

Rheumatological characteristics therefore identify susceptibility, whereas established structural abnormalities and documented progression provide more direct evidence of mechanically active cervical disease [11, 13].

Clinical presentation and clinical-radiological dissociation

The clinical presentation of rheumatoid cervical spine disease is heterogeneous and does not necessarily reflect the severity of underlying structural abnormalities. Symptoms may range from neck or suboccipital pain and occipital neuralgia to manifestations of cervical myelopathy or cervicomedullary compromise. Neurological abnormalities may include paresthesia, weakness, impaired hand dexterity, gait disturbance, hyperreflexia, and other long-tract signs. In advanced craniovertebral disease, dysphagia, lower cranial nerve dysfunction, respiratory abnormalities, and brainstem-related manifestations may occur [3, 19, 20].

A clinically important feature of rheumatoid cervical disease is the potential dissociation between symptoms and structural severity. Significant radiographic abnormalities may occur in patients with limited cervical symptoms, while manifestations of early myelopathy may be difficult to recognize in the presence of peripheral joint deformity, muscle weakness, pain, or peripheral neuropathy [1, 3, 4, 20]. Consequently, symptom severity alone should not be used to estimate the degree of cervical mechanical instability.

Subtle neurological changes should therefore receive particular attention in patients with known cervical involvement [6, 15]. New deterioration in gait, impaired fine hand function, unexplained falls, progressive weakness, or the emergence of upper motor neuron signs may indicate developing spinal cord or cervicomedullary compromise and should prompt further neurological and imaging assessment [15, 19, 20].

The prognostic importance of neurological status is supported by clinical surgical outcome studies. Casey et al. [14] demonstrated substantially better neurological and functional outcomes in ambulatory than in non-ambulatory patients undergoing surgery for rheumatoid cervical myelopathy. Similarly, van Asselt et al. [16] reported neurological improvement after cervical surgery in a substantial proportion of surviving patients, while patients with advanced neurological impairment had particularly poor outcomes. These findings indicate that advanced myelopathy represents a clinically important stage of neural compromise and that the potential for neurological recovery becomes more limited once severe functional deterioration has developed.

Neurological examination and structural assessment are complementary: absence of neurological deficit does not exclude continuing radiographic progression [11, 13].

From a clinical perspective, myelopathy should be regarded as evidence of established neural compromise rather than as a prerequisite for clinically significant cervical mechanical disease. Patients with documented structural instability or radiographic progression may require continued surveillance and, in selected cases, specialist assessment even while neurological function remains preserved [11, 13].

Imaging and risk stratification

Imaging should define the lesion, determine whether neural structures are threatened, and establish whether the abnormality is stable or progressing [11, 13, 15, 18-20].

Dynamic Radiography and Atlantoaxial Instability

Dynamic flexion-extension radiography is particularly useful for detecting abnormal motion at the atlantoaxial articulation that may be underestimated on neutral images. Atlantoaxial instability can be characterized using the anterior atlantodental interval (AADI) and posterior atlantodental interval (PADI), although these measurements provide different types of clinical information.

The AADI reflects anterior translation of C1 relative to C2 and is useful for identifying and characterizing atlantoaxial instability. However, the magnitude of anterior displacement should not be interpreted as an isolated indicator of neurological risk or as an automatic threshold for surgical intervention [15, 18, 19, 20].

The PADI provides an indirect estimate of the residual osseous space available for the spinal cord. In clinical imaging studies, reduction in the space available for neural structures and MRI evidence of atlantoaxial compression or impingement have been associated with neurological dysfunction and subsequent deterioration [15, 19, 20]. PADI should therefore be interpreted together with neurological findings and cross-sectional imaging rather than as an isolated operative trigger.

Assessment of Cranial Settling

Assessment of cranial settling is more challenging because rheumatoid destruction of the craniovertebral junction may distort the anatomical landmarks used for individual radiographic measurements. Several radiographic criteria have therefore been developed, including the Ranawat criterion, Redlund-Johnell measurement, and Clark station [21].

Riew et al. [21] directly evaluated the reliability of radiographic criteria for diagnosing basilar invagination in patients with RA. The combined use of the Clark station, Redlund-Johnell criterion, and Ranawat criterion achieved a sensitivity of 94% and a negative predictive value of 91%. These findings support the use of complementary radiographic measurements rather than reliance on a single criterion when cranial settling is suspected.

Importantly, abnormal or equivocal measurements on plain radiographs identify patients requiring more detailed anatomical assessment rather than providing a complete characterization of neural compromise. Cross-sectional imaging becomes particularly important when cranial settling is suspected or when the relationship between osseous deformity and neural structures cannot be adequately determined radiographically [19, 20, 21].

Role of CT and MRI

Computed tomography (CT) provides detailed characterization of osseous anatomy at the craniovertebral junction and is particularly useful for evaluating erosive destruction, complex deformity, and anatomical relationships relevant to operative planning [3, 28].

Magnetic resonance imaging (MRI) provides complementary information by directly demonstrating the spinal cord, cervicomedullary junction, periodontoid soft-tissue abnormalities, and neural compression. This becomes particularly relevant when neurological abnormalities are present or when radiographic instability raises concern for compromised neural reserve [17, 29, 15, 18, 19, 20].

MRI complements radiography and CT by showing soft-tissue disease, pannus, cord or cervicomedullary deformation, and neural compression. Patients with similar osseous measurements may therefore have different neural reserve [17-20, 28].

Longitudinal Imaging as a Marker of Mechanical Progression

A single imaging examination characterizes cervical anatomy at one point in time but cannot determine whether an established lesion remains mechanically stable. Serial imaging provides an additional dimension by demonstrating the longitudinal behavior of cervical structural disease [11, 13].

Prospective clinical studies provide evidence that rheumatoid cervical abnormalities may progress over time. Yurube et al. [13] demonstrated progression of cervical instability during five years of follow-up, while Kanda et al. [11] subsequently confirmed continued aggravation of cervical instability in a prospective multicenter cohort followed for more than ten years. Pre-existing cervical abnormalities were associated with subsequent deterioration, supporting the prognostic relevance of baseline structural disease [11, 13].

For neurologically intact patients, serial imaging distinguishes a stable deformity from mechanically active disease and may reveal deterioration before overt neurological compromise [11, 13].

Longitudinal progression may include increasing atlantoaxial displacement, worsening cranial settling, development or progression of subaxial instability, or reduction of the residual space available for neural structures [11, 13]. Such changes provide direct evidence that an established cervical lesion remains mechanically active.

Integrating Imaging Findings into Risk Assessment

Imaging findings should therefore be interpreted according to three complementary questions:

1. What structural lesion is present?
2. Is the spinal cord or cervicomedullary junction threatened or compromised?
3. Is the structural lesion stable or progressing over time?

Thus, risk assessment should integrate structural severity, neural consequences, and longitudinal behavior rather than rely on a single measurement [11, 13].

Screening and surveillance

Surveillance should be risk-adapted, focusing on symptoms or neurological findings, destructive RA phenotype, established structural abnormalities, and evidence of longitudinal mechanical progression [4, 7, 11-13].

Identifying Patients Requiring Cervical Assessment

Patients presenting with neck or suboccipital pain, occipital neuralgia, new neurological symptoms, gait disturbance, impaired hand function, or signs suggestive of myelopathy warrant cervical assessment [1, 2, 3, 6, 4]. However, a purely symptom-driven strategy may fail to identify clinically important disease because structural cervical abnormalities can precede overt neurological deterioration [1, 2, 3, 4, 5].

Clinical characteristics associated with cervical involvement may help identify patients requiring greater vigilance [2, 27, 30, 4, 12, 5]. In a clinical cohort of 1,114 patients with RA, Baek et al. [27] identified cervical instability in 27.5% of patients and atlantoaxial subluxation in 17.9%. Rheumatoid factor (RF) positivity, anti-citrullinated protein antibody (ACPA) positivity, erosive peripheral disease, and osteoporosis were independently associated with cervical instability, with ACPA demonstrating the strongest association.

These clinical characteristics should lower the threshold for cervical assessment, but they are not independent indications for neurosurgical treatment [11].

Surveillance After Cervical Instability Is Identified

Serial imaging is therefore most informative in patients with established structural disease, particularly when prior studies have already shown change. Progressive atlantoaxial translation, worsening cranial settling, decreasing residual space for neural structures, or development of subaxial instability should be interpreted as evidence of mechanically active disease [11, 12, 13].

Preserved neurological function does not remove the need for structural follow-up because deterioration may precede clinically apparent neural compromise [11, 13, 15, 20].

Escalation of Imaging

The choice and escalation of imaging should reflect the clinical question being addressed. Dynamic radiography can characterize pathological motion and changes in cervical alignment, whereas cross-sectional imaging becomes particularly important when complex craniovertebral deformity, neurological compromise, or limitations of plain radiographic assessment are present [31, 18, 19, 20, 21].

CT and MRI should be added when osseous anatomy, craniovertebral complexity, or the relationship between structural abnormalities and neural structures cannot be adequately characterized by radiographs [3, 17-20, 28].

Surveillance Intervals

The included studies do not establish a universally validated interval for repeat cervical imaging. Longitudinal cohorts demonstrate structural progression over time [11, 13] but were not designed to define a single optimal surveillance schedule.

Because no validated universal interval exists, follow-up should be individualized according to baseline severity, previous progression, neurological status, and destructive RA phenotype [11, 13].

The absence of a validated interval represents an evidence gap rather than an argument against follow-up, particularly in neurologically intact patients with established instability.

Neurosurgical referral and operative decision-making

Referral for specialist assessment and operative treatment are separate thresholds. Consultation can clarify mechanical stability, neurological risk, anatomical complexity, and the consequences of continued observation before a decision about surgery is made.

Neurological Compromise and Prompt Referral

Objective neurological deterioration represents the clearest indication for prompt specialist assessment. Progressive myelopathy, loss of ambulation, or manifestations of cervicomedullary compromise indicate that cervical structural disease has already produced clinically significant neural consequences [14, 16].

Clinical outcome studies demonstrate the prognostic importance of neurological status at the time of surgical treatment. In a prospective study of 134 patients with rheumatoid cervical myelopathy, Casey et al. [14] demonstrated substantially better neurological and functional outcomes among ambulatory patients than among patients who had already become non-ambulatory. These findings suggest that delaying assessment until advanced neurological impairment has developed may substantially reduce the potential for functional recovery.

Progressive neurological abnormalities should therefore prompt expedited specialist assessment rather than continued radiographic surveillance alone [14, 16].

Progressive Structural Disease Without Neurological Deficit

In neurologically intact patients, documented progression may reasonably lower the threshold for specialist consultation without implying prophylactic stabilization [11-13, 15, 20].

Increasing atlantoaxial displacement, worsening cranial settling, development or progression of subaxial instability, or reduction of the residual space available for neural structures may indicate ongoing mechanical deterioration [15, 11, 20, 12, 13]. Such findings may reasonably lower the threshold for specialist assessment even when neurological function remains preserved.

Anatomical Severity and Neural Risk

No single radiographic measurement should be treated as an automatic indication for surgery, longitudinal behavior, neurological status, reducibility, bone quality, and operative risk remain essential.

From Neurosurgical Referral to Operative Decision-Making

Once a patient has been referred, the decision to proceed with stabilization requires individualized assessment. Relevant considerations include neurological status, documented structural progression, severity and pattern of deformity, neural compression, reducibility, bone quality, systemic disease burden, and expected perioperative risk [14, 32, 33, 15, 19, 23, 20, 34, 16, 35].

The operative decision should therefore integrate neurological status, structural progression, deformity, neural compression, reducibility, bone quality, systemic disease burden, and perioperative risk [14-16, 19, 20, 23, 32-35].

Contemporary neurosurgical management and outcomes

The principal objectives of surgical treatment in rheumatoid cervical spine disease are to restore mechanical stability, prevent further neurological injury, relieve structurally mediated pain, and decompress neural structures when necessary [36, 14, 32, 22, 37, 38, 23, 16, 35]. The operative strategy depends on the location and extent of instability, reducibility of the deformity, pattern of neural compression, bone quality, and feasibility of achieving durable fixation.

Atlantoaxial and Occipitocervical Stabilization

Nagaria et al. [38] reported long-term outcomes following C1-C2 transarticular screw fixation for rheumatoid atlantoaxial instability. Bony fusion was achieved in 97% of patients, with substantial improvement in pain and neurological grading during follow-up. These findings demonstrate that durable segmental stabilization can achieve favorable structural and clinical outcomes in selected patients.

In patients with instability predominantly confined to C1-C2 and anatomy suitable for segmental fixation, atlantoaxial stabilization can provide durable mechanical control while preserving occipitoatlantal motion [36, 38]. Clinical outcome data support the effectiveness of this approach in appropriately selected patients with rheumatoid atlantoaxial instability.

More extensive occipitocervical stabilization may be required when rheumatoid destruction extends beyond the C1-C2 articulation or when the anatomy does not permit reliable isolated atlantoaxial fixation [36, 32, 35]. Bhatia et al. [36], in a surgical series of 224 patients, demonstrated an evolution toward greater use of segment-preserving C1-C2 fixation relative to occipitocervical fusion, although some patients subsequently required extension of their fusion construct.

The choice between limited and more extensive stabilization should reflect the anatomical distribution of disease. Subaxial involvement may require multilevel reconstruction [22-24, 32, 35, 36].

Neural Decompression and Periodontoid Pannus

Neural compression in rheumatoid cervical disease may result from a combination of pathological motion, osseous deformity, and periodontoid soft-tissue abnormalities. Importantly, direct removal of periodontoid pannus is not necessarily required in every patient, because regression after mechanical stabilization has been demonstrated on postoperative MRI [37].

In reducible disease, stabilization may provide indirect decompression, direct decompression can be reserved for persistent or irreducible clinically significant compression [22, 23, 37].

Bone Quality and Operative Planning

Operative planning in patients with RA is complicated by factors that may compromise fixation and fusion. Osteoporosis, chronic glucocorticoid exposure, erosive osseous disease, altered craniovertebral anatomy, and systemic comorbidity may influence both the technical feasibility and risk of cervical reconstruction [32, 23, 34].

Preoperative planning should therefore incorporate bone quality, medical status, and reconstructive complexity in addition to instability and neural compression [23, 32-34].

Neurological and Functional Outcomes

More contemporary data are broadly consistent with these historical observations. In a 2025 retrospective series of 17 surgically treated patients with rheumatoid cervical involvement, Combalia et al. reported that 10 patients improved in Ranawat neurological grade and seven remained stable during long-term follow-up. One postoperative death occurred. Although the cohort was small, it provides recent clinical evidence that surgery may stabilize or improve neurological status while retaining meaningful perioperative risk [39].

Preoperative neurological status remains an important determinant of postoperative recovery. Casey et al. [14] demonstrated substantially better outcomes among ambulatory than non-ambulatory patients with rheumatoid cervical myelopathy, while van Asselt et al. [16] reported neurological improvement in 67% of surviving surgically treated patients and particularly poor outcomes in those with advanced Ranawat IIIB neurological impairment.

These data reinforce the importance of timing: stabilization may prevent further deterioration, but recovery from established cord injury can remain incomplete [6, 14, 16].

Perioperative Complications and Risk

Sakuraba et al. [34] evaluated 139 patients with RA undergoing primary cervical spine surgery and reported perioperative complications in 20.1% of patients. Higher American Society of Anesthesiologists (ASA) physical status and longer fusion constructs were associated with increased perioperative risk.

At the population level, Fields et al. [33] analyzed 5,597 adults with RA undergoing cervical spinal fusion in a national database and reported a 90-day readmission rate of 12.3%. Infectious, respiratory, and implant-related complications contributed to postoperative morbidity. These findings emphasize that operative decision-making should incorporate systemic health and anticipated reconstructive complexity in addition to cervical anatomy and neurological status. Long-term mortality after cervical surgery in RA has also been reported [40].

The potential benefits of cervical stabilization must be balanced against meaningful perioperative morbidity in patients with RA [32, 33, 40, 34]. Contemporary clinical studies demonstrate that complications remain relevant despite advances in surgical techniques and perioperative management.

Perioperative risk is not an argument for delaying referral until advanced myelopathy. Earlier specialist assessment can clarify operative feasibility and patient-specific risk while neurological function is preserved.

Whether earlier referral reduces complications or reconstructive complexity remains unproven and requires prospective evaluation [36].

Evidence-informed risk-based referral framework

The proposed framework integrates four domains: rheumatological phenotype, established structural cervical disease, longitudinal mechanical progression, and neural consequences.

These domains are not a validated prediction score. They organize available evidence to guide the transition from rheumatological surveillance to specialist assessment.

Table 1. Key clinical studies informing the proposed risk-based referral framework

Study	Design / population	Clinical domain	Main finding	Framework relevance
Kaito et al. [7]	Retrospective cohort. 38 patients receiving biologic agents	Modern DMARD era	Progression: 1/12 without baseline lesions, 12/15 with AAS, and 9/11 with vertical subluxation.	Supports the distinction between systemic inflammatory control and mechanical behavior of established lesions.
Yurube et al. [13]	Prospective cohort. 5 years	Progression	Baseline abnormalities predicted later deterioration.	Supports longitudinal assessment of established cervical disease.
Kanda et al. [11]	Prospective multicenter cohort >10 years	Progression	Established abnormalities remained predictors of aggravation.	Supports long-term surveillance and the prognostic relevance of baseline structural abnormalities.
Baek et al. [27]	Clinical cohort 1,114 RA patients	Risk phenotype	RF, ACPA, erosive disease and osteoporosis associated with instability.	Identifies clinical characteristics associated with cervical instability and supports risk-adapted assessment.
Riew et al. [21]	Diagnostic clinical study	Cranial settling	Combined radiographic criteria improved sensitivity for basilar invagination.	Supports complementary radiographic assessment when cranial settling is suspected.
Reijnierse et al. [20]	Clinical MRI study	Neural consequences	MRI evidence of neural compromise correlated with neurological dysfunction.	Supports MRI assessment of neural compromise in addition to osseous measurements.
Casey et al. [14]	Prospective surgical cohort 134 patients	Neurological timing	Ambulatory patients had better outcomes than non-ambulatory patients.	Demonstrates the prognostic importance of neurological status at surgical treatment.
van Asselt et al. [16]	Surgical outcome study	Neurological outcome	Advanced Ranawat IIIB disease was associated with poor outcome.	Demonstrates poorer prognosis in advanced neurological impairment.

Study	Design / population	Clinical domain	Main finding	Framework relevance
Sakuraba et al. [34]	139 primary cervical operations	Perioperative risk	Complications occurred in 20.1%, ASA class and construct length increased risk.	Quantifies perioperative risk and supports individualized operative assessment.
Fields et al. [33]	National database, 5,597 fusions	Perioperative outcome	90-day readmission was 12.3%.	Quantifies contemporary postoperative morbidity and readmission burden.

Domain 1: Rheumatological Phenotype
Domain 2: Established Structural Cervical Disease
Domain 3: Longitudinal Mechanical Progression
Domain 4: Neural Consequences

Translating the Four Domains into Referral Decisions

The intermediate group is clinically important: stable abnormalities may remain under structured surveillance, whereas documented progression with preserved neurological function may justify earlier specialist consultation.

Table 2. Practical risk-stratification summary for rheumatoid cervical spine disease

Clinical state	Key findings	Suggested action	Rationale
No established instability	No structural lesion or neurological deficit, destructive RA phenotype may increase vigilance.	Risk-adapted surveillance, cervical imaging when clinically indicated.	Systemic phenotype indicates susceptibility, not mechanical instability [27, 11, 12].
Established but stable disease	AAI, cranial settling, or SAS without serial progression or neural compromise.	Continue structured clinical and imaging follow-up.	A single abnormal study does not prove continuing mechanical deterioration [11, 13].
Progressive disease, neurologically intact	Serial worsening of translation, cranial settling, neural reserve, or SAS.	Consider early spine and neurosurgical consultation within the proposed framework.	Serial progression may precede overt neurological deterioration. The referral threshold remains unvalidated [15, 11, 20, 12, 13].
Neural compromise and progressive deficit	Myelopathy, gait or motor decline, loss of ambulation, major cord or cervicomedullary compression.	Prompt specialist evaluation and individualized assessment for operative stabilization.	Advanced neurological impairment is associated with poorer recovery [14, 6, 16].

Referral Is Not Equivalent to Surgery

Referral clarifies mechanical risk, neural reserve, anatomy, and the consequences of continued observation. It does not mandate surgery.

The framework therefore places documented mechanical progression between baseline structural disease and overt neurological deterioration [11-13, 15, 20].

This pathway is an evidence-informed conceptual synthesis, not a validated prediction rule or treatment guideline.

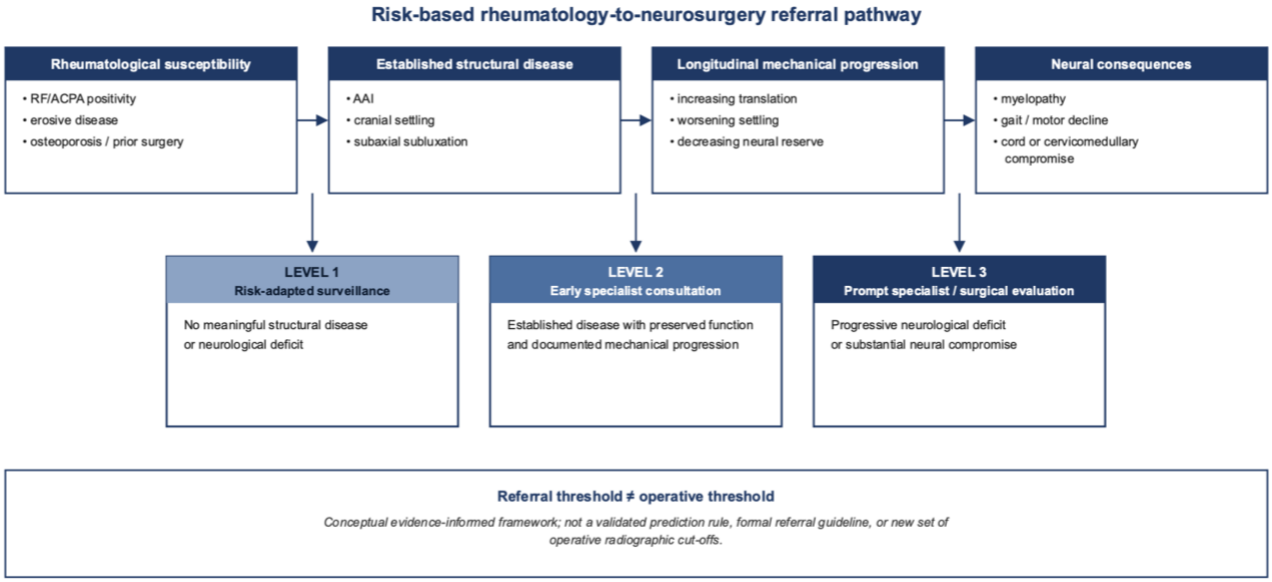

Fig. 1. *Proposed risk-based referral pathway for rheumatoid cervical spine disease.*

Conclusions

Modern antirheumatic therapy has changed the epidemiology of rheumatoid cervical disease but has not eliminated progression once mechanical instability is established [7, 11, 13].

Contemporary assessment should integrate rheumatological susceptibility, structural severity, longitudinal imaging, and neurological status. Mechanically progressive disease with preserved neurological function may represent a clinically relevant window for specialist assessment [11-13, 15, 20].

Referral and operative intervention should remain separate thresholds: consultation can define mechanical risk, neural reserve, anatomy, and the consequences of observation without implying prophylactic stabilization [14, 16].

The proposed framework is an evidence-informed conceptual model that requires prospective multicenter validation.

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