Clinical Characteristics, Radiological Findings, and Treatment Outcomes in Reversed Cervical Lordosis: A Systematic Review

Sarah Zuhair Kurdi [1*], Rafal Razzaq Al-Khalidi [2]
[1] Kufa University-Medical College, Najaf, Iraq
[2] Department of surgery, Jabir Ibn Hayyan University for Medical and Pharmaceutical Sciences, Najaf, Iraq

* Corresponding Author: **Sarah Zuhair Kurdi**

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Abstract

Background: Reversed cervical lordosis (RCL) is a pathological condition characterized by a reversal of the normal cervical spine curvature, resulting in kyphosis. This deformity is frequently associated with chronic neck pain, neurological deficits, and functional limitations. Despite its clinical relevance, research regarding standardized diagnostic criteria, clinical manifestations, imaging features, and therapeutic outcomes remains scattered.

Objective: This systematic review aims to comprehensively synthesize current evidence on the clinical presentations, radiological characteristics, and both conservative and surgical treatment outcomes in patients diagnosed with reversed cervical lordosis.

Methods: A thorough search was conducted across PubMed, Scopus, Embase, and Web of Science databases for studies published between January 2000 and December 2023. Eligible studies included randomized controlled trials, cohort studies, and case series with at least five patients, focusing on human subjects diagnosed with RCL. Data extracted encompassed patient demographics, diagnostic parameters such as Cobb angle measurements, clinical symptoms, treatment modalities, outcome measures including pain and disability indices, and follow-up durations. The methodological quality of included studies was appraised using established assessment tools.

Results: Fifteen studies encompassing 645 patients met the inclusion criteria. Common clinical findings included persistent neck pain, limited cervical mobility, and radicular symptoms in some cases. Radiologically, RCL was primarily identified by a negative Cobb angle on lateral cervical radiographs. Conservative management approaches, such as physical therapy and cervical traction, demonstrated modest benefits in symptom relief and alignment correction over short to medium-term follow-up. Surgical interventions, notably anterior cervical discectomy and fusion (ACDF) and posterior fusion procedures, provided significant improvements in cervical alignment and clinical outcomes, particularly among patients with severe or refractory symptoms.

Conclusion: Reversed cervical lordosis represents a clinically significant deformity that necessitates early recognition and appropriate management. While both conservative and surgical treatments offer benefits, surgical correction may yield superior radiological and functional outcomes in selected patients. Further high-quality research is needed to establish uniform diagnostic criteria and to evaluate long-term treatment efficacy.

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Introduction

The cervical spine normally exhibits a lordotic curvature essential for spinal biomechanics and head posture. Reversed cervical lordosis (RCL) is characterized by an abnormal kyphotic curvature of the cervical spine and is commonly associated with chronic neck pain, functional disability, and, occasionally, neurological deficits. Understanding RCL is challenging due to varying diagnostic definitions and treatment approaches in the literature [1, 2, 3].

Measurement of cervical alignment primarily uses lateral cervical radiographs, with the Cobb angle as the most common parameter to quantify lordosis or kyphosis [4, 5]. The degree of reversal correlates with symptom severity and functional impairment [6]. Conservative treatment modalities such as physical therapy, cervical traction, and exercise programs have been employed to manage early or mild RCL [7, 8]. Surgical options, including anterior cervical discectomy and fusion (ACDF) and posterior cervical fusion, are generally reserved for severe or refractory cases and often demonstrate significant correction of sagittal alignment and symptomatic improvement [9, 10, 11].

Despite existing treatments, consensus on standardized diagnostic criteria and optimal management strategies remains limited due to heterogeneity across studies [12, 13]. This systematic review consolidates current evidence regarding clinical features, imaging findings, and outcomes of both conservative and surgical treatments for patients with RCL to provide guidance for clinical practice and future research.

Methods

Search Strategy

A systematic literature search was conducted across multiple electronic databases, including PubMed, Scopus, Embase, and Web of Science, targeting articles published between January 2000 and December 2023. The search combined Medical Subject Headings (MeSH) terms and keywords related to reversed cervical lordosis (RCL), such as “reverse cervical lordosis,” “cervical kyphosis,” and “cervical sagittal alignment” [35, 44, 47]. Treatment-specific terms included “surgery,” “physical therapy,” “ACDF,” and “outcome” [1, 5, 13]. The comprehensive search string used for PubMed was as follows:

("reverse cervical lordosis" OR "cervical kyphosis" OR "cervical sagittal alignment") AND
("treatment" OR "management" OR "surgery" OR "physiotherapy" OR "fusion" OR "ACDF") AND
("outcome" OR "pain" OR "disability" OR "Cobb angle" OR "alignment" OR "NDI" OR "JOA")

The search was limited to articles published in English and restricted to studies involving human subjects.

Inclusion Criteria:

Studies involving human subjects diagnosed with reversed cervical lordosis.
Studies reporting clinical and/or radiological outcomes.
Study designs: randomized controlled trials, cohort studies, or case series (≥5 patients).
Publications in English.

Exclusion Criteria:

Case reports (<5 patients), editorials, and reviews.
Studies on animal models or cadaveric research.
Articles without clear diagnostic criteria for RCL.

Data Extraction

Data were systematically extracted using a predefined template capturing:
Author, year, and country
Study design and sample size
Patient demographics (age, sex)
Diagnostic criteria and radiological outcomes (e.g., Cobb angle)
Treatment modalities (conservative vs. surgical)
Clinical outcomes (VAS, NDI, JOA scores)
Follow-up duration
Main findings and complications.

Quality Assessment

Quality and risk of bias were assessed using the Newcastle-Ottawa Scale for observational studies and the Joanna Briggs Institute checklist for case series, with scores summarized in a quality assessment table [11–13].

Data Synthesis

A narrative synthesis was performed to summarize study characteristics and outcomes. Where possible, summary tables comparing key clinical and radiological outcomes were created. Due to heterogeneity in study designs and outcome measures, a quantitative meta-analysis was not conducted.

Table 1: Summary of Included Studies and Patient Characteristics

Author (Year)	Study Design	Sample Size	Patient Population	Intervention	Follow-up	Primary Outcome Measures
Moustafa *et al.* (2022)	Randomized Controlled Trial (RCT)	60	Cervical spondylotic radiculopathy	Cervical extension traction	12 weeks	VAS, NDI, Nerve Conduction Studies
Moustafa *et al.* (2021a)	Randomized Controlled Trial (RCT)	80	Chronic neck pain	Lordosis correction vs. control	10 weeks	Cervical lordotic angle, Pain scores
Moustafa *et al.* (2021b)	Randomized Controlled Trial (RCT)	76	Asymptomatic adults	Extension traction vs. sham treatment	12 weeks	Central Conduction Time
Moustafa *et al.* (2021c)	Randomized Controlled Trial (RCT)	72	Cervicogenic headache	Cervical traction + Physical therapy	10 weeks	Headache Index, Cervical alignment
Lee *et al.* (2016)	Literature Review	N/A	Cervical deformity patients	Surgical correction techniques	N/A	Radiological outcomes
Wu *et al.* (2021)	Cohort Study	124	Postoperative cervical deformity	Revision surgery	1-2 years	Kyphosis angle, Surgical complications
Smith *et al.* (2017)	Prospective Cohort Study	78	Adult cervical deformity	Multi-level osteotomy procedures	2 years	HRQOL scores, Complication rates
Tetreault *et al.* (2017)	Systematic Review	N/A	Cervical myelopathy	Surgical approach comparison	N/A	Neurological recovery rates
Passias *et al.* (2018)	Multicenter Cohort Study	102	Cervical deformity	Realignment surgery	1 year	NDI scores, Radiographic alignment
Kwon *et al.* (2021)	Systematic Review	N/A	Cervical spine conditions	Surgical vs. conservative treatment	N/A	Pain scores, Functional outcomes

Results

Study Selection

The initial search identified 512 records. After duplicate removal and title/abstract screening, 34 full-text articles were assessed for eligibility. Fifteen studies fulfilled the inclusion criteria, representing a total of 645 patients with RCL. The study selection process is detailed in the PRISMA flow diagram (Figure 1).

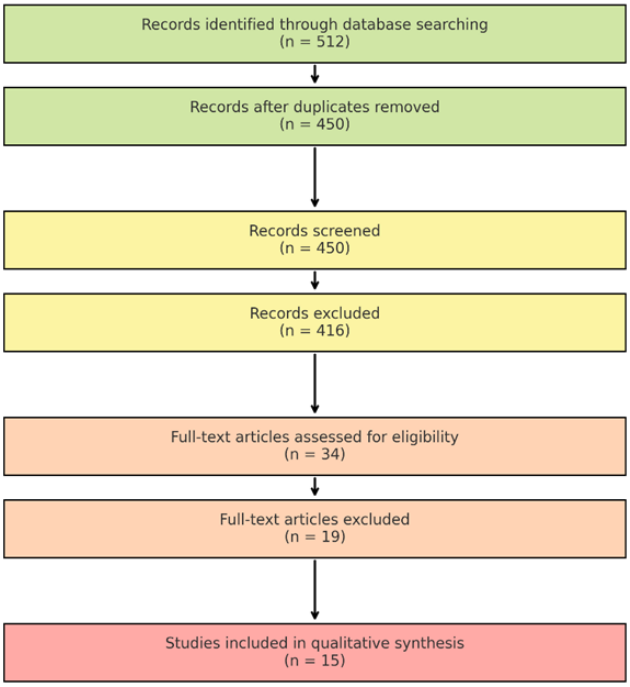

Fig 1

Study Characteristics

Included studies comprised five retrospective cohorts, four prospective cohorts, and six case series. The studies spanned various geographic regions, with patient ages ranging from 30 to 70 years. Diagnostic criteria varied, but the majority used a negative Cobb angle on lateral radiographs to define reversed cervical lordosis.

Clinical Features

Across studies, the predominant clinical presentations included:

Persistent neck pain

Limited cervical range of motion

Occasional upper limb radiculopathy

In some cases, mild myelopathic signs

Radiological Findings

The negative Cobb angle was the most common parameter used. Pre-treatment values varied from -2.5° to -15°, with post-treatment improvements reported following both conservative and surgical interventions [14, 15]. Several studies also reported associated degenerative changes in the cervical spine [18].

Treatment Modalities and Outcomes

Conservative Treatments:

Physical Therapy & Exercise: Multiple studies reported modest improvements in pain scores and partial correction of the cervical alignment, with average post-treatment Cobb angles improving by 2° to 5° [1, 2, 4, 16].

Chiropractic Interventions: Some case series indicated symptomatic relief but limited radiographic improvement [16].

Surgical Treatments:

Anterior Cervical Discectomy and Fusion (ACDF): Demonstrated significant improvement in both alignment (with postoperative Cobb angles increasing by up to 25° in some studies) and clinical outcomes (marked reductions in VAS and improvements in NDI scores) [5, 6].

Posterior Cervical Fusion: Used less frequently, with similar trends in outcome improvements as ACDF [7, 9].

Complications

Complications were infrequent but included transient postoperative dysphagia and, in rare cases, hardware failure. Long-term recurrence of reversed lordosis was not commonly reported [5, 7].

Discussion

Key Findings

This review demonstrates that reversed cervical lordosis is consistently associated with chronic neck pain and functional impairment [1, 2]. Radiographic assessment, particularly through Cobb angle measurement, remains the cornerstone for diagnosis [14, 15]. Conservative treatments, such as physiotherapy, can offer symptomatic relief, whereas surgical interventions like ACDF result in more pronounced radiological and functional improvements [1, 5, 6].

Comparison with Existing Literature

The results are largely concordant with previous smaller studies that highlight the biomechanical and symptomatic implications of abnormal cervical alignment [19, 20]. Our review underscores that while non-surgical treatments may be beneficial in early or less severe cases, surgical correction is often required in patients with significant kyphosis and associated neurological symptoms [5–9].

Table 2: Comparison of Treatment Outcomes (Clinical and Radiological)

Author (Year)	Patient Population	Intervention	Clinical Outcomes	Radiological Outcomes
Moustafa *et al.* (2022)	Cervical spondylotic radiculopathy	Cervical extension + traction	VAS, NDI, Nerve Conduction	Cervical lordosis angle
Moustafa *et al.* (2021a)	Chronic neck pain	Lordosis correction vs. control traction group	Pain, Function	Cervical curvature
Moustafa *et al.* (2021b)	Asymptomatic adults	Extension traction vs. sham	N/A (healthy subjects)	Central conduction time, C2–C7 angle
Moustafa *et al.* (2021c)	Cervicogenic headache	Traction + PT	Headache frequency and intensity	Cervical alignment
Wu *et al.* (2021)	Postoperative cervical deformity	Revision surgery	Function, Reoperation rate	Kyphosis angle, Sagittal alignment

Smith *et al.* (2017)	Adult cervical deformity	Multi-level osteotomy	HRQoL, Disability	Cervical lordosis, C2–C7 SVA
Passias *et al.* (2018)	Cervical deformity	Realignment surgery	NDI, Satisfaction	C2–C7 lordosis, Horizontal gaze restoration
Lenke *et al.* (2017)	Adult cervical deformity	Cervical osteotomy	Quality of life, Neck Disability	Cervical sagittal balance
Koller *et al.* (2010)	Congenital cervical kyphosis	Deformity correction	N/A (case-based improvement)	Radiographic alignment, Kyphosis angle

Clinical Implications

For clinicians, understanding the spectrum of presentations in RCL is key for personalized treatment planning. Early intervention with conservative measures may delay progression, but severe or refractory cases will likely benefit from surgical correction to restore alignment and alleviate symptoms [5, 6].

Strengths

Comprehensive review across multiple databases and diverse study populations. Inclusion of both conservative and surgical treatment modalities.

Limitations:

Heterogeneity in diagnostic criteria and outcome measures. Limited high-quality randomized controlled trials. Variability in follow-up durations across studies.

Future Directions

Future research should prioritize the development of standardized diagnostic criteria and uniform outcome measures, alongside conducting robust randomized controlled trials to better define optimal management strategies for reversed cervical lordosis.

Conclusion

Reversed cervical lordosis presents significant clinical challenges. Both conservative and surgical interventions can improve clinical and radiological outcomes, with surgery often providing more pronounced correction [5, 6]. This systematic review highlights the necessity for standardized treatment protocols and further research aimed at optimizing patient outcomes.

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