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CLINICAL EFFECTIVENESS OF CERVICAL ORTHOSES: A REVIEW OF CURRENT LITERATURE

Health Science

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ABSTRACT

Cervical orthoses are commonly prescribed for acute cervical trauma, postoperative stabilization, degenerative neck pain, neuromuscular disorders, and postural abnormalities, yet their clinical value and optimal use remain inconsistent across the literature. This narrative review synthesizes evidence from 1990–2025, including randomized trials, cohort studies, biomechanical analyses, and systematic reviews, to evaluate the effectiveness of soft, semi-rigid, rigid cervical collars and cervical–thoracic orthoses in key clinical scenarios relevant to prosthetic and orthotic practice. Biomechanical research consistently demonstrates that rigid collars and cervical–thoracic designs substantially restrict cervical motion, particularly flexion–extension and lateral bending, with cervical–thoracic orthoses providing the greatest degree of stabilization. Despite this, clinical outcomes do not uniformly mirror biomechanical benefits. In whiplash-associated disorders and nonspecific neck pain, clinical trials show that soft collars offer minimal advantage over early active mobilization and may even delay functional recovery when routinely prescribed. Evidence for rigid collars in postoperative cervical spine care and stable fractures is mixed: some studies report no significant differences in pain, disability, or fusion outcomes compared to no orthosis, while others note small short-term improvements in comfort at the expense of increased skin irritation, dysphagia, and reduced patient tolerance. Emerging studies in neuromuscular and postural dysfunction suggest that customized cervical orthoses may enhance head control, feeding, and communication in select populations, though available evidence is limited by small sample sizes and heterogeneity. Overall, cervical orthoses effectively limit cervical motion, but their clinical usefulness is highly context-dependent. Current literature discourages routine or prolonged use especially of soft collars in conditions such as acute neck pain and whiplash. Instead, evidence supports short-term, goal-oriented prescription tailored to the patient's stability needs, neurological risk, comfort, and rehabilitation goals. For prosthetists and orthotists, an individualized, evidence-based approach with careful patient education and monitoring for complications remains essential for optimal outcomes.

KEYWORDS

Cervical Orthosis, Cervical Collar, Cervical-Thoracic Orthosis, Whiplash, Neck Pain, Spinal Immobilization

INTRODUCTION

The cervical spine plays a vital role in supporting the head, enabling multi-planar movement, and safeguarding the spinal cord. Conditions such as trauma, degenerative disorders, postoperative instability, neuromuscular weakness, and postural deformities can disrupt this balance, often necessitating external support. Cervical orthoses are used to limit neck motion, reduce pain by decreasing muscular activity, and enhance patient confidence and safety during recovery or functional activities [1,4,5].

Historically, soft cervical collars became widely used for acute neck strain and whiplash injuries; however, evidence from randomized trials and systematic reviews over the past two decades challenges their effectiveness, showing little long-term benefit compared with early mobilization [6-9] and active rehabilitation. In contrast, semi-rigid and rigid cervical collars, as well as cervical–thoracic orthoses (CTOs), continue to play an important role in the non-operative management of stable cervical fractures and postoperative immobilization, even though high-quality evidence supporting routine postoperative use remains limited [1,3,5,10].

From a prosthetics and orthotics perspective, clinicians must balance the need for biomechanical stabilization with considerations of comfort, skin protection, respiratory function, swallowing, and overall quality of life [2,4,5]. Additionally, the development of customized orthoses for individuals with cerebral palsy, neuromuscular weakness, or severe postural malalignment has expanded the clinical applications of cervical orthotic devices [14,15].

This review aims to summarize biomechanical evidence on motion restriction achieved by different cervical orthosis designs, evaluate clinical effectiveness across conditions such as trauma, postoperative stabilization, neck pain and whiplash, and neuromuscular or postural disorders, and highlight adverse effects, complications, and evidence gaps relevant to prosthetics and orthotics practice.

MATERIALS AND METHODS

A narrative review methodology was used to synthesize current evidence on cervical orthoses. Electronic searches were conducted in PubMed, Google Scholar, and Scopus for articles published between January 1990 and October 2025. Search terms included combinations of "cervical orthosis," "cervical collar," "cervical–thoracic orthosis," "cervical fracture," "whiplash," "neck pain," "spinal orthoses," "postoperative cervical immobilization," "head control orthosis," and "prosthetics and orthotics." Additional studies were identified by screening the reference lists of relevant articles and systematic reviews [1-15].

Studies were eligible for inclusion if they evaluated external cervical orthoses - such as soft, semi-rigid, or rigid collars; halos; or cervical-thoracic orthoses in human subjects. Eligible study designs encompassed randomized controlled trials, non-randomized clinical trials, cohort and case–control studies, cross-sectional surveys, biomechanical cadaver or volunteer studies, and systematic reviews. Studies were required to report at least one relevant clinical or biomechanical outcome, including pain, range of motion (ROM), fracture healing or fusion, neurological status, functional performance, patient-reported outcomes, or device-related complications.

Exclusion criteria comprised studies focused exclusively on internal surgical fixation without the use of external orthoses, case reports with fewer than five participants (unless addressing rare but clinically relevant prosthetic and orthotic applications), and non-English publications for which translations were unavailable.

Data extraction was conducted descriptively. For each study, information on population characteristics, clinical indication, orthosis type, comparator intervention, duration of use, outcome measures, and principal results was summarized. Owing to substantial heterogeneity in study design, populations, orthotic devices, and outcome metrics, a quantitative meta-analysis was not feasible. Therefore, findings were synthesized narratively and organized into the following thematic domains: (1) biomechanical immobilization studies, (2) acute cervical trauma and fracture management, (3) postoperative cervical spine stabilization, (4) neck pain and whiplash-associated disorders, and (5) neuromuscular and postural conditions.

RESULTS

1. Biomechanical Effectiveness Of Cervical Orthoses

Biomechanical studies consistently demonstrate that rigid cervical collars and cervical-thoracic orthoses (CTOs) provide substantial restriction of cervical spine motion compared with no orthosis, with CTOs offering the greatest immobilization, particularly in flexion–extension and lateral bending. Gavin et al. reported that rigid CTOs reduced flexion–extension by more than 70% and lateral bending by approximately 60% in cadaveric models, while rigid cervical collars achieved moderate restriction of 40–60% depending on the plane of movement [1]. Soft collars, by contrast, had minimal influence on global motion and functioned primarily as kinesthetic reminders rather than immobilizers [1,2]. Volunteer-based research

further demonstrates that semi-rigid collars can approach the motion-limiting effects of rigid designs in some planes, offering a possible compromise between stability and comfort [11].

2. Cervical Orthoses In Trauma And Fractures

Evidence regarding cervical orthoses for stable cervical fractures is largely derived from cohort studies and narrative reviews. Karimi's review highlighted that rigid collars and CTOs are effective for stabilizing mid- to lower-cervical fractures, although providing adequate control at the upper cervical region (occiput–C1) remains challenging due to anatomical constraints [3]. Halo-vests provide the greatest immobilization but are associated with significant complications and are less commonly used within prosthetics and orthotics practice [4]. Current trauma management guidelines emphasize the use of cervical collars during initial spinal motion restriction [12]. However, prolonged collar use is associated with increased risk of pressure ulcers, dysphagia, and elevated intracranial pressure, underscoring the importance of early cervical spine clearance once instability has been ruled out [12].

3. Postoperative Immobilization After Cervical Spine Surgery

Evidence supporting routine collar use following cervical spine surgery remains inconsistent. A recent study evaluating rigid collars after posterior cervical laminectomy and fusion found no significant reduction in postoperative pain or disability compared with no collar, despite frequent use based on surgeon preference [10]. Observational data from spine centres suggest that although cervical collars may provide short-term subjective comfort, prolonged use increases skin irritation, swallowing difficulty, and overall discomfort [5]. Reviews in physical medicine and rehabilitation report limited high-quality evidence that routine postoperative bracing improves fusion rates or long-term functional outcomes, recommending individualized prescription tailored to instability patterns and patient factors [5].

4. Neck Pain And Whiplash-associated Disorders

Multiple randomized controlled trials and systematic reviews have assessed soft cervical collars in acute whiplash-associated disorders (WAD) and nonspecific neck pain. Gennis et al. found no significant difference in recovery between patients treated with soft collars and those who received standard analgesia without immobilization [7]. Christensen et al. concluded that early mobilization and "act-as-usual" approaches produce better outcomes than collar-based immobilization, with prolonged collar use associated with poorer recovery [6]. Shortened immobilization periods of 2–3 days may provide minimal symptom relief but longer durations (10 days) have shown no added benefit and may hinder recovery [8]. Observational research indicates that prolonged soft-collar use in emergency settings is linked to increased repeat visits and delayed functional improvement [9]. Overall, the literature does not support routine soft-collar prescription for uncomplicated neck pain or grade I–II WAD.

5. Neuromuscular And Postural Indications

Cervical orthoses are used in neuromuscular conditions to improve head control, feeding, communication, and visual orientation. A focused review on children with cerebral palsy reported improvements in head posture, drooling control, and caregiver satisfaction, although findings were based on small samples and device heterogeneity [15]. Similarly, orthotic devices targeting forward head posture and thoracic kyphosis have demonstrated improvements in postural alignment and reductions in muscular fatigue when combined with exercise programs [14]. Emerging devices such as neck stabilizers and smart orthoses, including those evaluated through collision-simulation models, show promise in reducing cervical spine loading after impact, but clinical evidence remains preliminary [13].

DISCUSSION

This review highlights a consistent pattern in the literature: although cervical orthoses reliably restrict motion from a biomechanical standpoint, their clinical effectiveness depends heavily on indication, duration of use, and integration with rehabilitation.

Biomechanical Performance Versus Clinical Outcomes

Cadaveric and volunteer studies demonstrate that rigid cervical collars and cervical–thoracic orthoses (CTOs) substantially limit cervical range of motion, whereas soft collars provide minimal immobilization, aligning with findings from Gavin et al. [1] and Schulz et al. [11]. These biomechanical advantages, however, do not consistently translate into superior clinical outcomes. Evidence from whiplash and neck-pain populations shows that prolonged immobilization may contribute to muscle deconditioning, joint stiffness, reduced activity, and delayed recovery. This is supported by systematic reviews and clinical trials demonstrating limited benefit of soft collars and the superiority of early active rehabilitation (Christensen et al. [6], Gennis et al. [7], Dehner et al. [8], Mourad et al. [9]).

Trauma And Cervical Fractures

Rigid cervical collars and CTOs continue to serve as important conservative treatments for stable cervical fractures and minor ligamentous injuries. Karimi's review[3] and classical orthotic principles described by Jones [4] and Vemuri [5] emphasize their role in maintaining alignment and limiting motion where surgical intervention is not indicated or accessible. However, optimal immobilization duration and clear weaning criteria remain insufficiently defined. Consistent with recommendations from these authors, interdisciplinary management involving prosthetists, orthotists, and spine surgeons is crucial to ensure proper orthosis selection, fit, and follow-up, including monitoring for complications such as skin breakdown or patient non-compliance.

Postoperative Use

Recent evidence questions routine collar use following instrumented cervical fusion. Khadivi et al. [10] report no consistent benefit in terms of fusion rates, pain, or functional outcomes when rigid collars are used postoperatively. Given the potential for discomfort, dysphagia, and skin complications, routine postoperative immobilization may be unnecessary in cases with stable internal fixation. A selective approach favouring collar use primarily in individuals with osteoporosis, multilevel constructs, or revision surgery is supported by contemporary spinal orthotic guidelines [4-5] and recent reviews [12].

Neck Pain And Whiplash

High-level evidence consistently favours early mobilization over prolonged immobilization in whiplash-associated disorders. Systematic reviews and randomized trials [6-9] demonstrate that soft collars provide little benefit except short-term comfort, and their long-term use may conflict with best-practice rehabilitation strategies. Prosthetists and orthotists must therefore guide prescribers in evidence-based practice and ensure that soft collars, when prescribed, are used sparingly and for brief periods only.

Neuromuscular And Postural Disorders

In neuromuscular conditions such as cerebral palsy, muscular dystrophy, or dystonia - cervical orthoses may offer meaningful improvements in head control, feeding, communication, and seating function. Although evidence remains limited, studies report functional gains with well-designed orthoses [14-15]. Similarly, newer stabilization devices such as collision-based neck stabilizers show promising biomechanical effects [13]. In these populations, individualized orthotic design is essential due to variations in tone, growth, and progressive weakness.

Complications And Limitations

Complications associated with cervical orthoses are well documented across the literature. These include:

- Skin breakdown at the mandible and occiput, highlighted in foundational orthotic texts [4-5].
- Dysphagia and impaired oral intake, frequently associated with rigid collars [10].
- Potential increases in intracranial pressure in head-injured patients, noted in spine-injury reviews [12].
- Psychological dependence and fear of movement, particularly with prolonged immobilization, as observed in whiplash studies [6-9].

These risks emphasize the necessity of regular follow-up, patient education, and structured weaning protocols.

Implications For Prosthetics & Orthotics Practice

- **Indication-driven Prescription:**

Rigid collars and CTOs should be reserved for confirmed cervical instability or fractures [3-5]. Soft collar use should be avoided in routine neck pain and applied only short-term in selected cases [6-9].

- **Design And Fit Optimization:**

Effective orthosis design requires balancing immobilization with comfort, minimizing mandibular pressure, and ensuring sagittal and

coronal stability. Comparative studies show semi-rigid collars may offer an intermediate solution between comfort and stability [11].

- **Integration With Rehabilitation:**

Close collaboration between orthotists, physiotherapists, and physicians is necessary to integrate mobility training, strengthening, and postural re-education into the plan of care.

- **Patient Specific Devices:**

Customized orthoses, including integrated head support systems, may provide superior outcomes in children with cerebral palsy and individuals with neuromuscular weakness [15].

- **Need For Further Research:**

Robust clinical trials comparing orthosis types, wear schedules, and functional outcomes are needed, particularly in postoperative populations and osteoporotic fractures. Emerging technologies such as collision-based stabilizers warrant further investigation [13].

CONCLUSION

Cervical orthoses continue to play a significant role in the conservative and postoperative management of cervical spine disorders. Biomechanical evidence demonstrates that rigid cervical collars and cervical–thoracic orthoses (CTOs) effectively restrict cervical motion, providing substantial control compared with soft collars [1,11]. However, clinical outcomes remain variable and are strongly dependent on the specific indication and duration of use. High-level evidence consistently discourages prolonged or routine use of soft collars for neck pain and whiplash, as active rehabilitation yields superior outcomes [6-9]. Conversely, rigid devices maintain an important role in the management of selected stable cervical fractures and postoperative cases, particularly when internal fixation is limited or patient-specific risk factors are present [3-5, 10,12].

In neuromuscular and postural conditions, customized cervical orthoses can offer meaningful functional benefits including improved head control, posture, and participation although the current evidence base largely comprises small studies and requires further strengthening [14-15]. Emerging orthotic technologies, such as advanced stabilizers and motion-limiting devices, show promising preliminary biomechanical effects but warrant more robust clinical validation [13].

For prosthetics and orthotics professionals, optimal practice requires evidence-based, goal-oriented, and time-limited prescription. This includes careful attention to orthotic design and fit, proactive monitoring for complications, patient and caregiver education, and close coordination with multidisciplinary rehabilitation teams. Future research should prioritize clarifying precise clinical indications, comparing orthosis designs, and developing standardized wear and weaning protocols that maximize therapeutic benefit while minimizing potential harms.

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Table 1. Summary Of Key Studies And Their Findings On Cervical Orthoses

Reference	Author / Year	Objective	Study Population	Methodology / Intervention	Key Results / Conclusion
1	Gavin et al., 2003	To compare biomechanical immobilization capacity of cervical collars and CTOs	Cadaveric cervical spine specimens	Tested Aspen, Miami J, and CTOs under controlled flexion–extension and lateral bending loads	CTOs reduced flexion–extension >70% and lateral bending ~60%; rigid collars reduced motion 40–60%; CTOs offer superior restriction
11	Schulz et al., 2025	To compare immobilizing effects of soft, semi-rigid, and rigid collars	Healthy adult volunteers	ROM measured using motion-tracking system for different collar types	Semi-rigid collars approached rigid collars in some planes; soft collars minimally restricted motion
3	Karimi, 2016	Evaluate effectiveness of cervical orthoses in cervical fractures	Review of clinical and biomechanical studies	Narrative review of cervical orthosis applications in fracture management	Rigid collars and CTOs suitable for stable fractures; halos required for maximal control
12	Kolli et al., 2024	Review of cervical collar use in SCI	Review article	Synthesis of evidence on immobilization practices	Rigid collars useful early; complications common; early clearance recommended
10	Khadivi et al., 2023	Evaluate rigid collar use after posterior cervical fusion	Postoperative spine patients	Collar vs. no-collar comparison	No difference in pain or disability; routine use not supported
6	Christensen et al., 2021	Soft-collar effectiveness in whiplash rehab	Systematic review of RCTs	Soft collar vs. active rehabilitation	Active rehab superior; prolonged collar use worsens outcomes
7	Gennis et al., 1996	Effect of soft collars in acute whiplash	ED patients with whiplash	Randomized to collar vs. no collar	No difference in pain or recovery; soft collars provide no advantage
8	Dehner et al., 2006	2 vs. 10 days soft-collar immobilization	Whiplash patients	Prospective comparison	Longer immobilization slowed recovery; short-term use preferable
9	Mourad et al., 2021	Soft collar use in ED patients	Two emergency departments	Observational study	Prolonged early collar use linked to persistent symptoms
15	YUJ Med J., 2021	Orthoses for children with cerebral palsy	Pediatric CP population	Review of orthotic interventions	Improved head posture and function; evidence limited
14	Hamzelou et al., 2025	Orthotic devices for forward head posture	Systematic review	Posture-correcting orthoses combined with exercises	Improved postural alignment and muscle endurance
13	Arima et al., 2025	Neck stabilizer reducing cervical loading	Biomechanical simulation	Impact-loading model testing	Device reduced cervical loading in impacts; clinical studies needed
2	Beavis, 2025	Description of cervical orthosis types	—	Professional online reference	Useful clinical categorization; not research evidence
4	Jones, 2020	Summarize spinal orthosis principles	—	Educational monograph	Provides foundational orthotic design principles
5	Vemuri, 2016	Review of spinal orthoses	—	PM&R professional reference	Supports selective, evidence-based use

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