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Prospective Case Study in Treatment of Cervical Rib at C4 Vertebra

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ABSTRACT

Background: Cervical rib is a rare congenital anomaly, usually from C7. Most are asymptomatic, but incomplete ribs can compress neurovascular structures, especially the brachial plexus, causing pain, paresthesia, and weakness. This case reports a 19-year-old male with a rare CR at C4, presenting with severe right-sided neck and shoulder pain, tingling, and functional limits after prolonged backpack use. Diagnosis was confirmed via X-ray.

Purpose: To evaluate whether a non-surgical, evidence-based physiotherapy program could reduce pain and improve function in a patient with a rare symptomatic cervical rib.

Method: A qualitative case study was conducted. Assessment included muscle strength, shoulder range of motion, nerve tension tests (ULTTs), and special tests (Adson's, Roos). The baseline Numeric Pain Rating Scale (NPRS) was 8/10; the Neck Disability Index (NDI) was 34 (severe). Intervention: Weeks 1–2: Neural mobilization (median, ulnar nerves) and ultrasound therapy (3 MHz, 2 W/cm², 4 days/week) → NPRS reduced to 6; NDI to 26. Weeks 3–4: Neural mobilization plus Muscle Energy Techniques (scalenes, upper trapezius) → NPRS 2; NDI 20. Weeks 5–6: Maintenance sessions (3 days/week) sustained improvements.

Results: Pain and functional scores improved steadily: NPRS from 8 to 2; NDI from 34 to 20 by Week 4, maintained through Week 6.

Conclusion: A non-surgical, phased physiotherapy program—combining neural mobilization, ultrasound therapy, and muscle energy techniques—effectively reduced symptoms and disability in a rare high-level cervical rib case.

1. Introduction

Cervical rib (CR), also known as a "supernumerary rib in the cervical region," is a congenital overdevelopment of the transverse process of a cervical vertebra (Fliegel & Menezes, 2023). Although CRs are most commonly attached to the seventh cervical vertebra, they may vary in size, shape, and attachment sites and can occur unilaterally or bilaterally. In 1869, Gruber proposed a classification of cervical ribs based on the amount of bone present and the thickness of the rib-like structure, which was later modified by Blanchard (Sanders *et al.*, 2013). This classification includes five types:

- Complete cervical rib attached to the sternum.
- Cartilage of the cervical rib is attached to cartilage of the first rib.
- Both extremities of the ribs are developed as bone structures, but the intermediate portion is a fibrous cord.
- Both extremities are developed but not united by a fibrous cord.
- The cervical rib is represented by a segment attached to the vertebra, with no anterior extremity present (Sanders *et al.*, 2013).

The presence of cervical ribs is usually asymptomatic in approximately 90% of patients and does not require removal (Roos, 1999; Sanders *et al.*, 2013). Trauma, overuse, poor posture, or large breasts may predispose an individual to symptoms, which are more common in incomplete cervical ribs. Symptoms occur in only 5–10% of individuals with cervical ribs, typically after middle age (Chang *et al.*, 2013). Incomplete ribs generally affect only the brachial plexus, whereas complete ribs may also compress the subclavian artery (Chang *et al.*, 2013). Cases have been reported at C6, C5, and even as high as C4 (Sanders *et al.*, 2013). In younger individuals, CR is often asymptomatic, but fewer than 1% may develop neurologic or vascular changes in the upper limb. Diagnosis is typically confirmed through radiographic imaging and becomes clinically relevant when symptoms arise from compression of the brachial plexus, subclavian artery, or subclavian vein (Fliegel & Menezes, 2019).

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In the present study, a 19-year-old student with CR at the C4 level and severe pain received a comprehensive, evidence-based physiotherapy program consisting of two approaches:

a) Butler's neural mobilization with ultrasound therapy and
b) Butler's neural mobilization with Muscle Energy Technique (MET) (Butler, 2000; Shacklock, 2005)

2. Methodology

2.1. Case Presentation

A 19-year-old student presented to the physiotherapy clinic with excruciating right-sided shoulder and neck pain, accompanied by an inability to raise the right arm overhead during activities of daily living. He reported severe pain while writing or taking notes during classes. The symptoms began two weeks earlier, following a bus journey in which he carried a heavy backpack on his shoulder. Since that time, the patient had experienced persistent pain and subsequently developed paresthesia throughout the entire right upper limb. He also reported multiple daily episodes of dizziness. On physical examination, a slight delay was noted in distal upper extremity pulses at rest when comparing the right and left limbs. Adson's and Roos's tests yielded positive results. No skin color changes or muscle atrophy were observed. Upper limb tension tests (ULTTs) for the median and ulnar nerves were provocative. The patient experienced dizziness in the clinic when his neck was repositioned while supine. Muscle strength testing of the right upper limb revealed marked weakness: shoulder flexors 2/5, shoulder abductors 2+/5, elbow flexors 3/5, shoulder extensors 2+/5, wrist flexors 3/5, and wrist extensors 3/5. No significant difference in tissue temperature was noted between the upper limbs.

Shoulder range of motion (ROM) assessment revealed active flexion limited to 60° and abduction to approximately 40°. Passive external rotation was full, but active internal and external rotations were painful. Radiographic imaging demonstrated elongation of the transverse processes of the C4–C5 vertebrae (Figure 1). The patient described pain in both the right shoulder and neck as deep and intermittent, with the primary pain site more severe than the secondary site. Palpation during central, left, and right unilateral passive accessory intervertebral motion (PAIVM) testing identified the C5–C6 level as the most painful, with tenderness also noted at C4 and C7. Passive physiological intervertebral motion (PPIVM) testing revealed restricted movement in left lateral flexion.

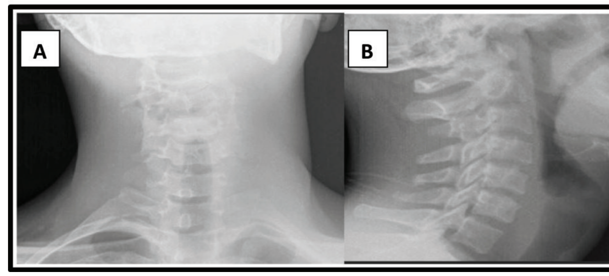

Figure 1: X-Ray Image of Cervical Spine at P*A(A) and Lat (B) Positions*

2.2. Outcome Measures

The patient was evaluated using two standardized outcome measures: (a) the Numeric Pain Rating Scale (NPRS) and (b) the Neck Disability Index (NDI).

2.2.1. Numeric Pain Rating Scale (NPRS) and Neck Disability Index (NDI)

The NPRS was used to assess the patient's pain intensity (Table 1), while the NDI (Table 2), a validated self-reported questionnaire, was employed to evaluate the degree of disability associated with neck pain (Vernon & Mior, 1991). At the initial assessment, the patient's NPRS score was 8/10, and the NDI score was 34/50, both indicating severe disability.

Table 1: Interpretation of NPRS

Score	Description
0	No pain
1–3	Mild pain
4–6	Moderate pain
7–10	Severe pain

2.2.2. NDI (Neck disability Index)

The Neck Disability Index (NDI) is a 10-item questionnaire designed to measure a patient's self-rated disability due to neck pain. It evaluates how neck pain affects the ability to manage daily activities (Vernon & Mior, 1991). The structure of the NDI includes 10 sections: pain intensity, personal care (e.g., washing, dressing), lifting, reading, headaches, concentration, work, driving, sleeping, and recreation. Each section has 6 response options, scored from 0 to 5, wherein 0 = No disability and 5 = Complete disability.

Table 2: Interpretation of NDI

NDI Score (%)	Disability Level
0–8%	No disability

10–28%	Mild disability
30–48%	Moderate disability
50–68%	Severe disability
70–100%	Complete disability

3. Physiotherapeutic Intervention

At the initial phase of the treatment, the patient received Butler's neural mobilization, particularly for the median nerve and ulnar nerve, along with ultrasound therapy (3 MHz at 2 watts/cm² for four days) over the suprascapular area for the initial two weeks. After a week of treatment, the NPRS score was gradually reduced to 7, and the NDI score was 28. The scores were 6 (for NPRS) and 26 (for NDI) after two weeks of treatment. After two weeks, the patient was treated with Butler's neural mobilization, particularly for the median nerve and ulnar nerve, along with Muscle Energy Technique (MET) for shoulder flexors, extensors, abductors, wrist flexors and extensors with 10 repetitions of 3 sets in a single session for four days/week for the next two weeks. After a week of treatment, the NPRS score was gradually reduced to 4, and the NDI score was improved to 22. After the fourth week, NPRS and NDI scores were 2 and 20, respectively. Improvements in the signs and symptoms led to a reduced treatment plan of thrice a week for another 2 weeks. A thorough assessment is done after every week of the given treatment protocol (Figure 2 to Figure 10). After four weeks of a reduced treatment plan, which is 3 days/week, NPRS and NDI gradually reduced to 2 and 20, respectively. The physical examination revealed the following scores:

Table 3: Evaluation of Outcomes Measure

Scoring System	**Scores**						
	Day 0	**Butler's neural mobilization + ultrasound therapy (4 days/week)**		**Butler's neural mobilization along with Muscle Energy technique (4 days/week)**		**Butler's neural mobilization along with Muscle Energy technique (3 days/week)**	
		Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
NPRS	8	7	6	4	2	2	2
NDI	34	28	26	22	20	20	20

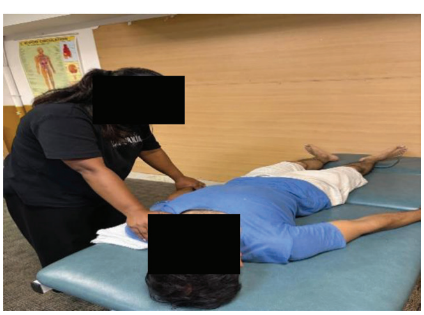

Figure 2: Median Nerve Mobilization -Starting Position

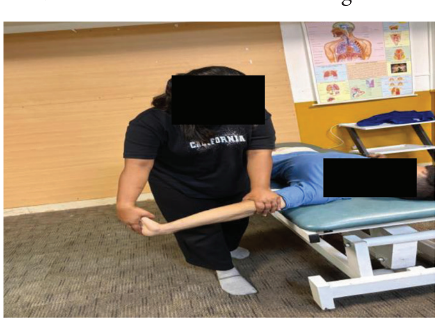

Figure 3: Median Nerve Mobilization-Ending Position

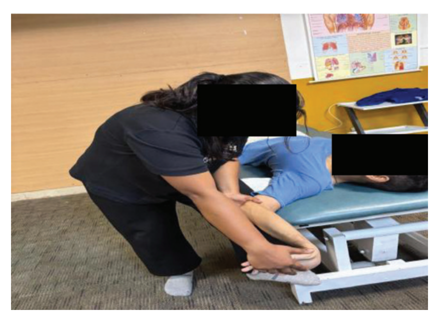

Figure 4: Ulnar Nerve Mobilization

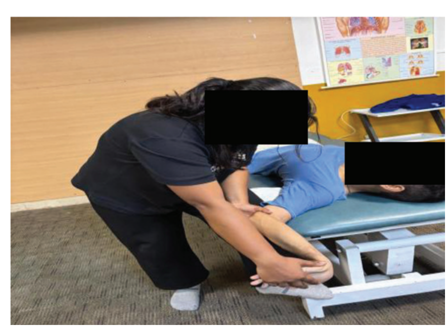

Figure 5: Ultrasound Therapy

Figure 6: Met-Wrist Flexion

Figure 7: Met-Wrist Extension

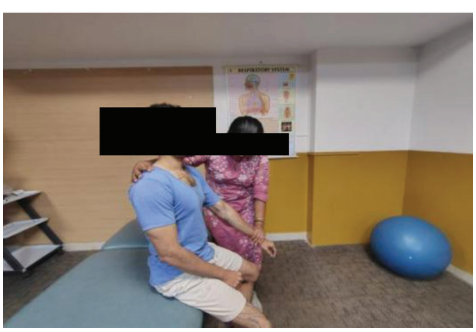

Figure 8: Met-Shoulder Flexion

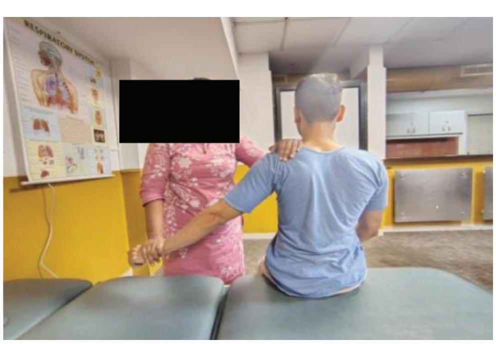

Figure 9: Met- Shoulder Abduction

Figure 10: Met- Elbow Flexion

4. Discussion

Cervical ribs are rare congenital anomalies arising from the costal processes of cervical vertebrae, most frequently from C7. However, their occurrence at higher cervical levels such as C6, C5, or C4—as observed in this case—is exceedingly uncommon, making this report a valuable addition to the existing clinical literature (Fliegel & Menezes, 2023; Sanders *et al.*, 2013). While most cervical ribs are asymptomatic, approximately 5–10% rib originated at the level of C4–C5, which is notably rare and, according to available literature, associated of individuals may develop symptoms related to compression of the neurovascular structures in the thoracic outlet, especially the brachial plexus and subclavian vessels (Chang *et al.*, 2013). In the present case, the cervical with a higher likelihood of neurogenic thoracic outlet syndrome (nTOS) due to anatomical proximity and the mechanical strain exerted on the brachial plexus (Bishaw, 2024; Roos, 1999). The patient's presentation of right-sided upper limb paresthesia, weakness, and positive Adson's and Roos tests is consistent with nTOS, further substantiated by provocative upper limb tension tests (ULTTs) for the median and ulnar nerves. This case suggests a high degree of neural mechanosensitivity and functional compression (Coppieters & Butler, 2008).

Diagnostic imaging revealed an elongated transverse process at C4–C5, supporting the clinical diagnosis. This case highlights how subtle anatomical variations—when subjected to biomechanical stress (e.g., carrying a heavy backpack)—can become symptomatic, particularly in the presence of predisposing postural factors (Roos, 1999). Two main outcome measures—Numeric Pain Rating Scale (NPRS) and Neck Disability Index (NDI)—were used to monitor patient progress. Baseline scores (NPRS = 8; NDI = 34) indicated severe pain and moderate-to-severe disability. By the end of treatment, NPRS was reduced to 2 and NDI to 20, indicating clinically meaningful improvement. Literature suggests that a change of ≥2 points in NPRS and ≥10% in NDI represents the minimal clinically important difference (MCID) (Vernon & Mior, 1991; Pool *et al.*, 2007). Treatment was delivered in two phases: initial Butler's neural mobilization combined with ultrasound therapy, followed by neural mobilization with Muscle Energy Techniques (MET). Neural mobilization aims to restore dynamic homeostasis in the peripheral nervous system by improving intraneural blood flow, reducing inflammation, and desensitizing nerve tissues (Butler, 2000). In neurogenic TOS, such interventions have been shown to reduce pain and improve function via mechanosensory modulation (Shacklock, 2005).

MET operates via post-isometric relaxation and reciprocal inhibition, addressing soft tissue imbalances and segmental dysfunction. These techniques may effectively reduce cervical muscle tightness and improve segmental mobility, alleviating secondary mechanical compression on the brachial plexus (Roos, 1999; Vernon & Mior, 1991). The transition from modality-assisted pain reduction (ultrasound) to mobility enhancement aligns with current evidence supporting a multimodal, phase-based physiotherapy approach for neurogenic TOS (Pool *et al.*, 2007). This staged, non-invasive approach proved cost-effective and beneficial, particularly for a young patient without vascular compromise. However, limitations include its single-case nature, absence of long-term follow-up, and lack of advanced imaging such as MRI or CT angiography to fully assess neural or vascular involvement.

5. Conclusion

In the present study, the use of the neural tension test was a major part of treatment. The mechanical and physiological events of the nervous system are interdependent; mechanical stresses are applied to evoke the physiological responses such as intraneural blood flow. MET decreases sympathetic tone through a post-isometric relaxation of the muscle. Met also induces a reciprocal agonist muscle inhibition. This phenomenon is a result of a physiological neuro-response involving Golgi tendon organs. Furthermore, when a therapist's force equals or surpasses a patient's effort, the patient can cause movement through an isotonic eccentric or concentric contraction. Application of Butler's neural mobilization along with ultrasound therapy, followed by Butler's neural mobilization along with the muscle energy technique, effectively ameliorated the signs and symptoms of cervical rib in the patient.

6. Limitations

This study is limited by its single-subject design, which restricts generalizability to broader populations. The absence of long-term follow-up prevents assessment of sustained outcomes.

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Authorship Contribution

Conceptualization and methodology were carried out by Srijeeta Biswas. Formal analysis and investigation were conducted by Kusum Agarwal. Resources, data curation, and visualization were managed by Ritu Patwari. The original draft preparation was done by Kusum Agarwal, while review and editing were performed by Srijeeta Biswas. All authors have read and agreed to the published version of the manuscript.

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Declarations

The authors declare that they have followed all ethical standards in conducting this research. All data supporting the findings are available within the manuscript

Conflict of Interest

The authors declare no conflict of interest related to this study.

References

Abbott, J. H., & Mercer, S. R. (2002). The validity of manual assessment of spinal segmental motion. *Spine, 27*(11), 127–133. https://doi.org/10.1097/00007632-200206010-00012

Bishaw, S. (2024). A rare case of cervical rib at C4: Clinical presentation and management. *Journal of Clinical Images and Medical Case Reports, 5*(8), Article 3224. https://doi.org/10.52768/2766-7820/3224

Butler, D. S. (2000). *The sensitive nervous system*. NOI Group.

Chang, K. Z., Likes, K., Davis, K., *et al.* (2013). The significance of cervical ribs in thoracic outlet syndrome. *Journal of Vascular Surgery, 57*(3), 771–775. https://doi.org/10.1016/j.jvs.2012.08.110

Chang, K.-V., Chen, Y.-W., Wu, W.-T., & Özçakar, L. (2024). Muscle energy technique to reduce pain and disability in cases of non-specific neck pain: A systematic review and meta-analysis of randomized controlled trials. *Musculoskeletal Science and Practice, 68*, Article 102795. https://doi.org/10.1016/j.msksp.2024.102795

Coppieters, M. W., & Butler, D. S. (2008). Do 'sliders' slide and 'tensioners' tension? Analysis of neurodynamic techniques. *Manual Therapy, 13*(3), 213–221. https://doi.org/10.1016/j.math.2006.12.008

Fliegel, B. E., & Menezes, R. G. (2019). Cervical rib. In *StatPearls* [Internet]. StatPearls Publishing. Retrieved from https://europepmc.org/article/nbk/nbk541001

Fliegel, B. E., & Menezes, R. G. (2023). Cervical rib. In *StatPearls*. StatPearls Publishing. Retrieved from https://europepmc.org/article/nbk/nbk541001

Maitland, G. D., Hengeveld, E., Banks, K., & English, K. (2005). *Maitland's vertebral manipulation* (7th ed.). Butterworth-Heinemann.

Modarresi, S., Lukacs, M. J., Ghodrati, M., Salim, S., MacDermid, J. C., Walton, D. M., & CATWAD Consortium Group. (2021). A systematic review and synthesis of psychometric properties of the Numeric Pain Rating Scale and the Visual Analog Scale for use in people with neck pain. *Clinical Journal of Pain, 38*(2), 132–148. https://doi.org/10.1097/AJP.0000000000000999

Pool, J. J., Ostelo, R. W., Hoving, J. L., *et al.* (2007). Minimal clinically important change of the Neck Disability Index and the Numerical Rating Scale. *Spine, 32*(26), 3047–3051. https://doi.org/10.1097/BRS.0b013e31815cf75b

Roos, D. B. (1999). Thoracic outlet syndrome is underdiagnosed. *Muscle* & *Nerve, 22*(2), 126–129.

Sanders, R. J., Hammond, S. L., & Rao, N. M. (2013). Thoracic outlet syndrome: A review. *Neurologic Clinics, 31*(2), 523–537. https://doi.org/10.1097/nrl.0b013e318176b98d

Schleip, R. (2003). Fascial plasticity, a new neurobiological explanation—Part 2. *Journal of Bodywork and Movement Therapies, 7*(2), 104–116. https://doi.org/10.1016/S1360-8592(02)00076-1

Shacklock, M. (2005). *Clinical neurodynamics: A new system of musculoskeletal treatment*. Elsevier.

Vernon, H., & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. *Journal of Manipulative and Physiological Therapeutics, 14*(7), 409–415. https://doi.org/10.1016/S1360-8592(02)00076-1

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