

Detailed Report on Research Completion and Publication Status

Motor Control Assessment & Training of Deep Neck Extensor Muscles in Cervicogenic Headache Individuals

1. Introduction

This report provides a comprehensive overview of the research work titled “*Motor Control Assessment & Training of Deep Neck Extensor Muscles in Cervicogenic Headache Individuals*,” conducted under a secondary research grant.

The primary aim of the research was to explore the role of the deep neck extensor muscles in individuals with cervicogenic headache (CGH), with a specific focus on identifying motor control impairments and evaluating the effectiveness of targeted rehabilitation strategies.

Cervicogenic headache is a musculoskeletal condition often associated with dysfunction of cervical musculature. While significant attention has been paid to the deep neck flexors, the contribution of the deep neck extensors remains relatively underexplored. This study was therefore conceptualised to address this gap using both assessment and intervention-based approaches.

2. Status of Research Completion: The research has been fully completed, encompassing all stages from conceptualisation to final defence. The progression of the study included:

- Development of research protocol and ethical approval
- Recruitment and assessment of participants
- Execution of both observational and experimental phases
- Data analysis using appropriate statistical methods
- Compilation and submission of the doctoral thesis

All planned objectives under the grant have been successfully achieved, and the study has been formally concluded.

3. Research Design and Methodological Framework: The study followed a two-phase mixed-method design, ensuring both exploratory and interventional insights.

Phase 1: Comparative Motor Control Assessment

The first phase was designed as a cross-sectional comparative study to evaluate differences between individuals with cervicogenic headache and asymptomatic controls.

Participants were assessed for:

- Motor control and activation patterns of deep neck extensor muscles
- Maximum voluntary isometric contraction (MVIC)
- Muscle endurance capacity

A key component of this phase was the validation of a Pneumatic Pressure Biofeedback (PPB) device, developed in collaboration with IIT Delhi. This device was evaluated against a standard Handheld Dynamometer (HHD) to establish its concurrent validity for clinical use.

Phase 2: Intervention and Training Study

The second phase was an experimental, multi-arm intervention study to evaluate the effectiveness of different rehabilitation strategies.

Participants with cervicogenic headache were allocated to different intervention groups, each receiving:

- Specific motor control training protocols targeting deep neck extensors
- Joint mobilisation as a common baseline intervention

The study compared the outcomes of various training approaches to determine the most effective strategy for improving muscle function and reducing symptoms.

4. Key Findings and Interpretation

4.1 Impairment in Deep Neck Extensor Function

The results clearly demonstrated that individuals with cervicogenic headache exhibit:

- Reduced neuromuscular control of deep neck extensors
- Decreased endurance and strength capacity
- Altered muscle activation patterns

These findings highlight that dysfunction is not limited to flexor muscles but also significantly involves the extensor subsystem, suggesting a more comprehensive approach to cervical rehabilitation.

4.2 Validation of Assessment Tool (PPB Device)

The Pneumatic Pressure Biofeedback device showed:

- Strong correlation with HHD measurements (based on Spearman's rank correlation)
- Acceptable agreement in Bland–Altman analysis
- Good potential as a clinically feasible and cost-effective assessment tool

This innovation is particularly relevant for settings where advanced equipment may not be easily available.

4.3 Effectiveness of Motor Control Training

The intervention phase revealed that targeted motor control training resulted in:

- Significant improvements in muscle activation and coordination
- Increased endurance of deep neck extensors
- Reduction in headache intensity and functional disability

Importantly, groups receiving combined interventions (motor control training + joint mobilisation) demonstrated superior outcomes compared to isolated approaches, reinforcing the importance of multimodal rehabilitation.

5. Statistical Analysis

The analysis was conducted using IBM SPSS Version 29, ensuring methodological rigor.

- Data normality was assessed using the Shapiro–Wilk test
- Correlation between devices was evaluated using Spearman’s rank correlation coefficient (ρ)
- Agreement between measurement tools was analysed through Bland–Altman plots
- Appropriate inferential statistics were applied for between-group and within-group comparisons

The statistical results supported the reliability of the findings and strengthened the validity of the conclusions drawn from the study.

6. Publication and Dissemination Status

Efforts have been made to disseminate the research findings through peer-reviewed publications.

Published Work

One manuscript derived from the research has been successfully published in:

- *Journal of Orthopaedic Reports (Scopus indexed)*, 2025

This publication primarily focused on one core aspect of the research, contributing to the existing body of literature in musculoskeletal physiotherapy.

Ongoing and Planned Submissions

Additional manuscripts based on:

- Device validation (PPB vs HHD)
- Comparative motor control findings

are in preparation and will be submitted to peer-reviewed journals.

7. Overall Conclusion

The research project has been successfully completed under the secondary research grant, achieving all its intended objectives.

The study provides important contributions in the following areas:

- Establishing the role of deep neck extensor dysfunction in cervicogenic headache
- Demonstrating the effectiveness of targeted motor control training interventions
- Introducing and validating an innovative, clinically feasible assessment tool

These findings have direct implications for clinical physiotherapy practice, rehabilitation strategies, and future research in cervical spine disorders.

8. Current Status Summary

| Component | Status |
|----------------------------|----------------------------|
| Research Project | Completed |
| Data Collection & Analysis | Completed |
| Manuscript Preparation | Completed |
| First Publication | Published (Scopus Indexed) |
| Additional Manuscripts | In Preparation |

Paper published: Piyush Singh and Chitra Kataria. Motor control assessment of the deep neck extensors (Semispinalis Cervicis) in cervicogenic headache: A Comparative analysis of endurance, EMG activity, and muscle structure. J Orthop Rep 2026;5:100703. doi.org/10.1016/j.jorep.2025.100703.