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Original Article

Effects of Sub-Occipital Muscle Inhibition with and Without Hold Relax Agonist Contraction of Hamstrings on Pain, Disability and Craniovertebral Angle in Neck Pain Patients with Hamstring Tightness

Sumaiya[1]*, Saima Riaz[2], Asnia Javed[3], Rabia Liaqat[4], Faiza Mohsin[4], Adnan Hashim[5]

[1]Al Mahmood Welfare Foundation Sahiwal Pakistan.

[2]Ayesha Bakht Institute of Medical Sciences Lahore, Pakistan.

[3]Hafiz Ijaz Physiotherapy Centre Okara, Pakistan.

[4]The University of Faisalabad-Faisalabad, Pakistan.

[5]University Institute of Physical Therapy, The University of Lahore-Lahore, Pakistan.

Corresponding Author: Sumaiya; Email: sumaiyanaeem93@gmail.com

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ABSTRACT

Background: Neck pain is a prevalent musculoskeletal disorder with significant impacts on individuals' daily functioning and quality of life. The Superficial Backline (SBL) concept suggests that muscles and fascial structures are interconnected, implying that addressing muscle tightness in one area can influence distant regions. This study explored the effects of sub-occipital muscle inhibition (SMI) with and without hold-relax agonist contraction (HR-AC) of the hamstrings on pain, disability, and craniovertebral angle in patients with neck pain and hamstring tightness.

Objective: To determine the efficacy of SMI with and without HR-AC on pain relief, neck disability, and craniovertebral angle in patients suffering from neck pain and hamstring tightness.

Methods: This randomized controlled trial included 34 participants aged 20-40 years with neck pain (NPRS ≥ 5) and hamstring tightness (≥ 30° extension lag). Participants were randomly assigned to two groups: Group A (SMI without HR-AC) and Group B (SMI with HR-AC). Interventions were administered three times per week for two weeks. Pain, craniovertebral angle, and neck disability were assessed using the Numeric Pain Rating Scale (NPRS), Bubble Inclinometer, Image J software, and Neck Disability Index (NDI). Data were collected at baseline and post-treatment. Statistical analysis was performed using SPSS version 25, with paired and independent t-tests used to compare outcomes within and between groups.

Results: Significant reductions in NPRS scores were observed in both groups: Group A (mean pre-treatment: 6.25 ± 0.85, post-treatment: 3.18 ± 0.98) and Group B (mean pre-treatment: 6.40 ± 0.986, post-treatment: 2.133 ± 0.743). Craniovertebral angle improved significantly in both groups: Group A (mean pre-treatment: 41.25° ± 3.51, post-treatment: 45.48° ± 2.94) and Group B (mean pre-treatment: 40.99° ± 2.70, post-treatment: 49.02° ± 2.868). NDI scores also showed marked improvement: Group A (mean pre-treatment: 32.96 ± 3.04, post-treatment: 15.38 ± 3.39) and Group B (mean pre-treatment: 33.03 ± 2.89, post-treatment: 11.25 ± 3.27). Group B demonstrated more significant improvements in all measured outcomes compared to Group A ($p < 0.05$).

Conclusion: Both interventions, SMI without HR-AC and SMI with HR-AC, significantly reduced pain, improved craniovertebral angle, and decreased neck disability. However, the combination of SMI with HR-AC was more effective, highlighting the importance of addressing both ends of the myofascial chain in managing neck pain and hamstring tightness.

Keywords: neck pain, sub-occipital muscle inhibition, hamstring tightness, hold-relax agonist contraction, randomized controlled trial.

INTRODUCTION

Neck pain is a prevalent musculoskeletal disorder in the adult population, with global prevalence rates ranging from 16.7% to 75% (1). Characterized primarily by discomfort in the cervical region, neck pain often results in a restricted range of motion and functional impairments (2). The etiology of neck pain is multifactorial, involving ergonomic, individual, and psychosocial factors (3). Among these, inadequate posture, particularly forward head posture, plays a significant role. This posture is defined as any alignment in which the plumb line is positioned posterior to the external auditory meatus, passing through the shoulder joint (4). Mechanical neck pain is generally associated with generalized neck and shoulder discomfort, worsened by maintaining certain neck positions, moving the neck, or palpating the cervical musculature (5). Impaired cervical spine proprioception, often linked to disruptions in sensorimotor control over the cervical spine, is a common mechanical factor contributing to neck pain (6). The stability of the cervical spine is largely dependent on the deep neck flexor and extensor muscles, including the sub-occipital muscles (7). These muscles, located in the sub-occipital region, contain the highest concentration of muscle spindles in the human body and function as proprioceptive monitors for effective head posture regulation (8). Their primary actions include head extension on the C1 vertebrae and head rotation on the C1 and C2 vertebrae (9). In individuals with neck pain and poor posture, activation of the deep neck flexors is often delayed or inhibited (10).

Fascia, a connective tissue sheet that encloses every nerve and blood vessel, surrounds each muscle fiber and separates muscles and other structures in the human body (11). This structural organization explains why hamstring shortening or increased tension can induce neck and shoulder discomfort. The superficial backline, one of the 12 myofascial meridians, connects the neck and lower extremity, while the soft tissue of the cervical spine links the dura mater and fascia of the sub-occipital muscles (12). Hamstring flexibility is crucial for physical fitness and biomechanical function, providing a functional mechanical advantage. It is defined as the ability of a muscle to lengthen to its normal range (13). Flexibility in the hamstrings is essential for the effectiveness and efficiency of movements such as walking, running, jumping, and various postural control actions (14). A tight hamstring disrupts the lumbopelvic rhythm and alters normal spinal and pelvic posture (15). Therefore, regaining adequate hamstring length is vital for reestablishing normal upright spinal posture (16). Various techniques are employed to restore normal hamstring flexibility, with proprioceptive neuromuscular facilitation (PNF) stretching being one of the considerations (17).

This study aims to determine the efficacy of sub-occipital muscle inhibition (SMI) with and without hold-relax agonist contraction (HR-AC) of the hamstrings on pain, disability, and craniovertebral angle in neck pain patients with hamstring tightness. By comparing these interventions, the study seeks to identify the better treatment option, thereby supporting the necessity and effectiveness of specific interventions for neck pain patients with hamstring tightness.

MATERIAL AND METHODS

The study, designed as a randomized controlled trial and registered under Trial Registration No: NCT05353075, was conducted at the Physical Therapy Center of Al-Mahmood Welfare Foundation, Sahiwal, over a period of 10 months following synopsis approval. The sample size, determined to be 34 participants, was based on a comprehensive physical examination, history, and assessment of neck pain in individuals with hamstring tightness. Participants were divided into two groups: Group A received sub-occipital muscle inhibition (SMI) without hold-relax agonist contraction (HR-AC) of the hamstrings, while Group B received SMI with HR-AC. A consecutive sampling technique was utilized for data collection, ensuring participant selection based on the inclusion and exclusion criteria.

Inclusion criteria encompassed individuals aged 20 to 40 years, of both genders, with neck pain scores of ≥ 5 on the Numeric Pain Rating Scale (NPRS), moderate neck disability with a Neck Disability Index (NDI) score of ≥ 14, and a ≥ 30° extension lag indicating tight hamstrings. Exclusion criteria included the presence of conditions such as cervical radiculopathy, recent cervical spine surgery, systemic inflammatory diseases, severe cardiovascular conditions, neurological deficits, or other significant medical or surgical histories that could interfere with participation.

Randomization of participants into the two groups was conducted after the fulfillment of inclusion and exclusion criteria. Written informed consent was obtained from all participants prior to their inclusion in the study. Random assignment to groups was performed by drawing cards from a box, with 17 cards marked "1" for Group A and 17 cards marked "2" for Group B. Data collection tools included the Numeric Pain Rating Scale (NPRS) for pain assessment, a Bubble Inclinometer for measuring the popliteal angle, Image J software for assessing the craniovertebral angle (CVA), and the Neck Disability Index Questionnaire for evaluating neck disability.

The data collection procedures involved a comprehensive initial visit during which physical examinations, history-taking, and subjective measurements were conducted. These included the NDI and NPRS for assessing neck disability and pain, respectively, as well as measurements of the popliteal angle and CVA. Following group allocation, treatment was administered according to the specific intervention protocols assigned to each group. Participants attended treatment sessions three times per week over the course of two weeks. Post-treatment data were collected at the end of the second week to assess changes in pain, disability, and craniovertebral angle.

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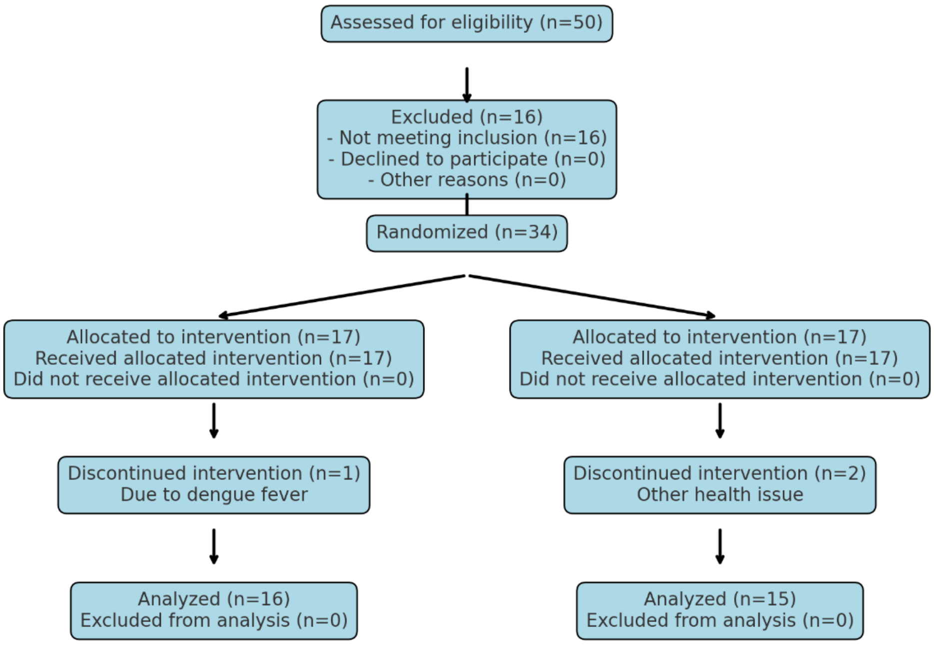

Figure 1 Study Participant Flow Diagram

The study adhered to ethical guidelines set forth by the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review board prior to the commencement of the study. Data analysis was performed using SPSS version 25. Descriptive statistics were used to summarize the baseline characteristics of the participants. Inferential statistics, including paired t-tests and independent t-tests, were employed to compare pre- and post-treatment outcomes within and between the two groups. Statistical significance was set at $p < 0.05$.

This study aimed to provide evidence on the efficacy of sub-occipital muscle inhibition with and without hold-relax agonist contraction of the hamstrings in reducing pain, disability, and improving craniovertebral angle in neck pain patients with hamstring tightness. The findings may support the development of more effective intervention methods for managing neck pain in this specific patient population.

RESULTS

The study evaluated the effects of sub-occipital muscle inhibition (SMI) with and without hold-relax agonist contraction (HR-AC) of the hamstrings on pain, disability, and craniovertebral angle in patients with neck pain and hamstring tightness. Participants were divided into two groups: Group A received SMI without HR-AC, while Group B received SMI with HR-AC. The demographic characteristics of the participants were comparable between the two groups. Group A had a mean age of 25.81 years (SD = 5.799), with minimum and maximum ages of 21 and 38 years, respectively. Group B had a mean age of 28.93 years (SD = 7.34), with ages ranging from 20 to 40 years. The mean height for Group A was 1.604 meters (SD = 0.078), while for Group B, it was 1.599 meters (SD = 0.082). The mean weight for Group A was 59.13 kilograms (SD = 11.57), and for Group B, it was 56.74 kilograms (SD = 14.3). The mean BMI for Group A was 22.87 (SD = 3.590), compared to 22.095 (SD = 4.94) for Group B, indicating similar physical profiles across both groups (Table 1).

Table 1: Age, Height, Weight, and BMI of Patients

Variables	Group	Minimum	Maximum	Mean ± SD
Age	Group A	21.00	38.00	25.81 ± 5.799
Age	Group B	20.00	40.00	28.93 ± 7.34
Height	Group A	1.524	1.768	1.604 ± 0.078
Height	Group B	1.473	1.727	1.599 ± 0.082
Weight	Group A	42.0	80.0	59.13 ± 11.57
Weight	Group B	35.9	74.7	56.74 ± 14.3
BMI	Group A	18.08	28.37	22.87 ± 3.590
BMI	Group B	14.95	33.29	22.095 ± 4.94

Table 2: Within Group Pair-wise Comparison of the Numeric Pain Rating Scale, Craniovertebral Angle, and Neck Disability Index

Variables	Group	NPRS	CVA	NDI	P value
Pre-Treatment	Group A	6.25 ± 0.85	41.25 ± 3.51	32.96 ± 3.04	
Pre-Treatment	Group B	6.40 ± 0.986	40.99 ± 2.70	33.03 ± 2.89	
Post Treatment	Group A	3.18 ± 0.98	45.48 ± 2.94	15.38 ± 3.39	
Post Treatment	Group B	2.133 ± 0.743	49.02 ± 2.868	11.25 ± 3.27	
	Group A	3.06 ± 0.57	4.22 ± 1.87	17.58 ± 2.30	0.000
	Group B	4.266 ± 0.593	8.03 ± 2.35	21.78 ± 2.12	0.000

Table 3: Group Comparison of the Numeric Pain Rating Scale, Craniovertebral Angle, and Neck Disability Index

Variables	Measure	Mean Difference	P value
Pre-Treatment	NPRS	0.150	0.654
Pre-Treatment	CVA	0.258	0.820
Pre-Treatment	NDI	0.066	0.951
Post Treatment	NPRS	1.054	0.002
Post Treatment	CVA	3.540	0.002
Post Treatment	NDI	4.131	0.002

Before the intervention, both groups showed similar levels of pain, disability, and craniovertebral angle. Group A's mean pre-treatment NPRS score was 6.25 (SD = 0.85), while Group B's was 6.40 (SD = 0.986). The mean pre-treatment craniovertebral angle (CVA) for Group A was 41.25 degrees (SD = 3.51), compared to 40.99 degrees (SD = 2.70) for Group B. The pre-treatment Neck Disability Index (NDI) scores were also comparable, with Group A having a mean of 32.96 (SD = 3.04) and Group B a mean of 33.03 (SD = 2.89) (Table 2).

Post-treatment results showed significant improvements in all measured outcomes for both groups. Group A's mean post-treatment NPRS score decreased to 3.18 (SD = 0.98), while Group B's score dropped even further to 2.133 (SD = 0.743). This reduction in pain was statistically significant within each group (p = 0.000) and indicates the effectiveness of both interventions in managing pain (Table 2). The craniovertebral angle improved significantly post-treatment, with Group A's mean CVA increasing to 45.48 degrees (SD = 2.94) and Group B's mean CVA reaching 49.02 degrees (SD = 2.868), again showing statistically significant improvements (p = 0.000) (Table 2).

The NDI scores post-treatment also demonstrated substantial reductions, indicating a decrease in disability. Group A's mean NDI score dropped to 15.38 (SD = 3.39), and Group B's mean score fell to 11.25 (SD = 3.27), reflecting significant within-group improvements (p = 0.000) (Table 2).

When comparing the mean differences between pre- and post-treatment outcomes across the two groups, Group B showed a greater reduction in NPRS scores (mean difference = 4.266, SD = 0.593) compared to Group A (mean difference = 3.06, SD = 0.57), with a p-value of 0.002, indicating a significant difference between the groups in pain reduction (Table 3). Similarly, the improvement in the craniovertebral angle was more pronounced in Group B (mean difference = 8.03, SD = 2.35) compared to Group A (mean difference = 4.22, SD = 1.87), with a p-value of 0.002 (Table 3). The NDI score reduction was also greater in Group B (mean difference = 21.78, SD = 2.12) compared to Group A (mean difference = 17.58, SD = 2.30), further supporting the superior efficacy of SMI with HR-AC (p = 0.002) (Table 3).

Overall, the results suggest that both interventions were effective in reducing pain, disability, and improving craniovertebral angle among neck pain patients with hamstring tightness. However, the inclusion of hold-relax agonist contraction with sub-occipital muscle inhibition yielded more significant improvements, demonstrating the potential benefits of this combined therapeutic approach.

DISCUSSION

The interlinking of muscles and fascial structures within the Superficial Backline (SBL) underscores the concept that muscles do not function as isolated units but rather as part of integrated chains. Tension or trigger points in one area can thus influence distant regions (18). This study observed a significant reduction in NPRS scores for both Group A (SMI without HR-AC) and Group B (SMI

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with HR-AC), indicating effective pain alleviation. Notably, Group B, which received SMI and hamstring relaxation, experienced a more substantial reduction in pain. This finding supports the hypothesis that addressing both ends of the myofascial chain (neck and hamstrings) can result in more effective pain relief. These results align with a previous study on tension headache patients, where hamstring relaxation reduced headache scores by alleviating neck muscle tension (19). This underscores the importance of myofascial connections and force transmission through the SBL in managing pain.

Forward head posture (FHP), characterized by a reduced craniovertebral angle (CVA), can impair the activation of deep neck flexors, leading to sub-occipital muscle shortening (10). Tight hamstrings can cause reduced lumbar lordosis and posterior pelvic tilt, contributing to swaying and a flat back posture (20). This study observed significant improvements in CVA for both groups, with Group B showing more pronounced improvement. This suggests that targeting both ends of the myofascial chain can lead to greater enhancements in CVA. These findings are consistent with recent studies that demonstrated marked improvements in CVA following hamstring stretching interventions in neck pain patients (21). While the study noted no significant difference between different stretching methods, both static and PNF stretching resulted in significant CVA improvements after a single treatment session.

The impact of SMI with and without hamstring relaxation on the Neck Disability Index (NDI) was also assessed. Both groups exhibited marked improvements in NDI scores, with Group B showing more substantial improvements. This aligns with previous research by Song et al. (2019), which found that myofascial release techniques improved NDI and forward head posture among college students (22). This parallels the current study's results, further validating the efficacy of interventions targeting myofascial structures in enhancing neck disability and posture.

Contrastingly, another study investigating remote effects along myofascial chains, specifically the SBL, found that a seven-week foam rolling and stretching intervention targeting the plantar foot sole did not significantly affect range of motion (ROM) and strength at the ankle region or triceps surae stiffness. The minor improvements in ROM observed in the intervention group were attributed to increased stretch tolerance rather than alterations in muscle structure (23). This highlights the complexity and variability in outcomes when addressing myofascial chains.

Given the interconnectedness of sub-occipital muscles and hamstrings via the posterior fascial chain and myodural connections, applying SMI at the cervical region can reduce sub-occipital muscle hypertonicity, subsequently inducing relaxation throughout the posterior fascial chain and improving hamstring flexibility. Conversely, relaxing the hamstring muscles can decrease upper cervical muscular tension, thereby enhancing cervical spine posture. This explains why the SMI with HR-AC group showed more significant improvements in all measured variables.

The study had several strengths, including the randomized controlled design, comprehensive assessments, and the use of validated measurement tools. However, it also had limitations, such as the relatively small sample size and short duration of the intervention, which may affect the generalizability of the findings. Future research should explore long-term effects and involve larger sample sizes to validate these results. Additionally, investigating other myofascial chains and their impacts on different musculoskeletal conditions could further elucidate the interconnectedness of fascial structures.

CONCLUSION

Both groups receiving either SMI without HR-AC or SMI with HR-AC showed significant within-group improvements in pain, craniovertebral angle, and neck disability index. However, the combination of SMI with HR-AC yielded more substantial improvements compared to SMI alone. These findings support the integrated approach of addressing both ends of the myofascial chain to enhance treatment outcomes for neck pain patients with hamstring tightness.

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