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IMMEDIATE EFFECT OF SUB-OCCIPITAL RELEASE ON PAIN, CRANIOVERTEBRAL ANGLE AND DEEP NECK FLEXOR ACTIVATION IN YOUNG ADULTS WITH FORWARD HEAD POSTURE - A PRE-POST EXPERIMENTAL DESIGN

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ABSTRACT

Background: Forward Head Posture(FHP) is a common postural issue associated with prolonged use of smartphones, particularly among young adults. Neck pain, muscular imbalances, and reduced deep neck flexor(DNF) function might arise from the head projecting forward from the ideal position. The sub-occipital muscles, which hold the head posture, have an affinity to become hyperactive in an FHP. The immediate effects of sub-occipital release on neck pain, Cranio-Vertebral Angle(CVA) and DNF activation among young adults with FHP was the purpose of this study.

Methodology: A pre-post experimental study was conducted with 25 young adults(ages 18–26) diagnosed with FHP(defined by a craniovertebral angle <50°). Participants received a standardized 5-minute sub-occipital release intervention. Key outcomes—pain(Numeric Pain Rating Scale), DNF activation(pressure biofeedback), and CVA(Kinovea software)—were assessed before and after the intervention.

Results: Non-parametric analysis supported the findings related to pain and muscle activation. Following the intervention, the participants reported a notable improvement in pain reduction (p=0.0001) and DNF activation(p=0.0001). However, there was no statistically significant change in CVA(p=0.285).

Conclusion: A single session of sub-occipital release significantly reduced neck pain and improved DNF activation in individuals with FHP. While the craniovertebral angle did not show immediate improvement, the technique shows promise as an early intervention for FHP management. Further research is needed to evaluate its long-term effects on posture correction.

Keywords: Forward head posture, Cervicovertebral angle, Deep neck flexor endurance, Sub-occipital release, Neck pain

INTRODUCTION

A postural asymmetry known as forward head posture (FHP) develops when the head tilts forward in front of the midline of the body, causing an inappropriate tension on the cervical spine and surrounding muscles1. When the external auditory meatus, or ear, aligns anterior to the vertical line of alignment, this condition becomes evident. Muscles most commonly affected include the sternocleidomastoid, pectoralis major, sub-occipital group, and posterior cervical muscles2.

FHP has become increasingly prevalent due to extended screen time, particularly among students and individuals working at computers3,4. This forward positioning of the head can disrupt muscle function and contribute to long-term postural dysfunction. Studies report that the annual occurrence of neck pain related to FHP ranges from 10.4% to 21.3%, with chronic discomfort in the surface of the neck being a frequent complaint5.

Biomechanically, FHP increases the flexion moment on the cervical spine, which leads to vertebral misalignment and heightened demand on the extensor muscles. These also negatively affect cervical proprioception5. The posture causes compression of the apophyseal joints, elongation of the anterior neck muscles (such as the short flexors and infrahyoid group), and shortening of the posterior muscles, including the sub-occipital region1,2. These imbalances commonly occur near the C7 vertebra and contribute to muscle strain and pain. The deep neck flexor (DNF) muscles are essential for cervical spine stability. Individuals with neck dysfunction often show delayed or reduced activation of these muscles, compromising their endurance capacity6.

The sub-occipital muscles connect the occiput with the first two cervical vertebrae (C1 and C2) in a triangular fashion adjacent to the base of the skull. These include the Rectus Capitis Posterior Minor, Rectus Capitis Posterior Major, and Obliquus Capitis muscles, which assist in precise head movements such as extension, rotation, and lateral tilt2. These muscles are innervated primarily by the sub-occipital nerve, with additional sensory input from the greater occipital nerve.

Sub-occipital trigger points may be attributed to faulty neck posture and can refer discomfort to the head. Myofascial release applies sustained pressure to the affected area to improve function and reduce discomfort[1]. A therapeutic technique known as sub-occipital release is frequently utilized in various contexts to relieve tension in this area. It targets sub-occipital muscle tightness and over-activity, particularly in individuals with FHP7,8. This technique is believed to reduce tissue sensitivity and improve mobility by relaxing the upper cervical fascia and musculature.

FHP is prevalent among young adults due to prolonged screen time and poor ergonomics. The forward head posture can occur in individuals who function by looking down, as in a desk job. The dynamics highlight that, to maintain the head in neutral, a sub-cranial backward bending will occur, which can cause shortening of soft tissue, including sub-occipital muscles, leading to pain and weakness of deep neck flexors, which can cause neck pain and functional limitations. Manual therapy techniques, such as sub-occipital release, may provide immediate improvements, but evidence is limited. Hence, the present study aims to determine the immediate impact of sub-occipital release on pain levels, CVA and DNF muscle activation in individuals presenting with FHP.

MATERIALS & METHODS:

After obtaining approval from the Institutional Scientific/Ethical Research Committee (ISC/SOAHS-PT/2025/065), a pre-post experimental trial was conducted. The sample size was confined to 25, based on alpha error(0.05), power(0.95), and effect size(0.8). Aforementioned criteria were considered to choose participants: Males and females with FHP(CVA < 50°), those between the ages of 18 and 26, complaints of upper cervical distress, and exclusion criteria: cervical radiculopathy, recent neck trauma, neck surgeries, vestibular disorders, and muscle relaxants. The objective of the study and the process were described, and signed informed consent was acquired. Baseline measurements, including CVA, neck pain(NPRS), and DNF endurance, were recorded. Participants then received a single session of the sub-occipital release technique. Post-intervention measurements were taken using the same tools and procedures. The collected data were compiled and analyzed to assess the immediate effect of the intervention on FHP among young adults.

Procedure:

Cranio-Vertebral Angle:

The software Kinovea was utilized.Initially, the subjects were informed about the procedure. They requested to stand sideways near a wall to capture their sagittal plane view in front of the camera. The participants were instructed to flex and extend their necks a few times to attain a natural resting posture, while keeping their gaze forward and arms relaxed by their sides. A photograph was captured, and the CVA was measured by drawing an imaginary line from the C7 spinous process to the ear tragus, intersecting with a horizontal line. The angle formed by these lines represented the CVA. A CVA of less than 50 degrees is considered significant and indicative of forward head posture9.

Figure 1 - Cranio-Vertebral angle Measurement

Deep Neck Flexor Endurance:

A pressure biofeedback component is used to measure deep neck flexor endurance. The subjects was in a crooked lying position with the neck horizontally aligned with the body. To bridge the gap left by the cervical lordosis, the stabiliser Pressure Biofeedback Unit(PBU) was positioned beneath the suboccipital area and inflated to 20 mmHg.

The subjects were taught to keep their lips together, teeth slightly apart, and tongue on the roof of their mouth to minimize jaw muscle activity and maintain a neutral neck. The subject was then asked to perform a chin tuck, and the ability to maintain the pressure was assessed using a stopwatch.

This process was repeated multiple times, at each 2.5 mmHg increment. The holding capacity was recorded using the stopwatch. If the subject was unable to maintain the pressure within ±2.5 mmHg of the target, it was considered a failure. Substitution by superficial neck flexors, such as the sternocleidomastoid or anterior scalene, was also regarded as a failure. The last successfully held target pressure without compensation was considered for analysis10.

Figure 2 - Deep neck flexor endurance

Pain Intensity(NPRS):

The Numeric Pain Rating Scale(NPRS) was used to assess neck pain by having participants rate their pain on a scale from 0(no pain) to 10(excruciating pain). It provides a simple and reliable measure of pain intensity, with a reported reliability of 0.90.

Intervention:

The sub-occipital release: a myofascial release technique, used to reduce tension in the deep upper cervical tissues. The subject was lying supine on the couch. The therapist has to position themselves behind the subject's head. The therapist's finger pads should be placed over the sub-occipital muscles of the neck bilaterally, just inferior to the superior nuchal line down to approximately the level of C2.

It was mandatory to keep the patient's head elevated. Head weight was supported on the pad of the fingers, causing stretch and distraction for 30 seconds until tissue relaxation is achieved, followed by ischemic compression on the trigger for another 30 seconds. After ischemic compression, for five minutes, transverse and circular friction on the trigger were treated at 15-second intervals. A passive distraction was applied for 10-15 seconds, followed by the release11.

Figure 3 - Sub-occipital release

Statistical Analysis:

Version 20.0 of SPSS, a software, was installed for the statistical analysis. We computed the mean and standard deviation of the acquired baseline data. We used the Shapiro-Wilk test to verify the data for a normal distribution. Using parametric or non-parametric tests, the data was tested to ascertain the significance(p<0.05) of the desired outcome.

RESULTS:

Table 1: The descriptive analysis of baseline data - mean pain score(5.48), DNF activation(22.22), and CVA(47.87). Shapiro-Wilk normality analysis of the baseline data suggests that the CVA(0.3309) is non-significant, while the NPRS(0.004) and DNF(0.0017) are significant. Thus, NPRS and DNF were examined using a parametric test(paired t-test) and a non-parametric test(Wilcoxon test) for a CVA.Table 01 - descriptive analysis and normal distribution of baseline Characteristics

Variable	N	Mean	SD	Shapiro Wilk p-value*
Pain-NPRS	25	5.48	0.98	0.004*
DNF activation	25	22.22	1.6	0.0017*
CVA	25	47.87	2.49	0.3309

N-Sample size; SD-Standard Deviation; NPRS-Numerical Pain Rating Scale; DNF-Deep Neck Flexor; CVA-CranioVertebral Angle;

Descriptive statistics; Shapiro wilk test of normality; p-value*<0.05-Significant

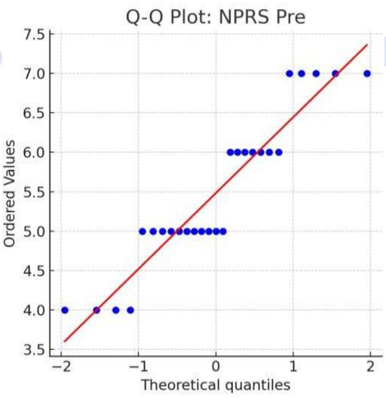
Table 2: The Wilcoxon signed-rank test - pain and DNF activation indicate statistically significant differences between pre- and post-intervention(p-values <0.001).

Table 2 - Pre-post Wilcoxon signed-rank analysis of selected variables

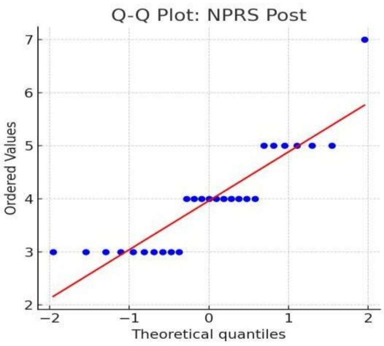
Variable	N	Mean	SD	Z-value	p-value*
Pain-NPRS	25	3.96	0.98	-1.56	0.0002*
DNF activation	25	24.0	1.47	1.11	0.0*

N-Sample size; SD-Standard Deviation; NPRS-Numerical Pain Rating Scale; DNF-Deep Neck Flexor;

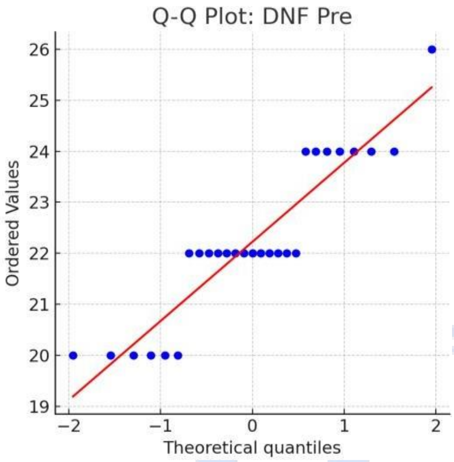
Wilcoxon signed-rank test; p-value*<0.05-Significant



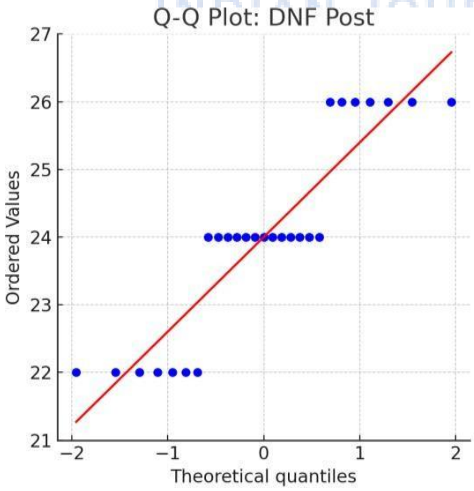
Graph 1.1 - Pre NPRS



Graph 1.2 - Post NPRS



Graph 2.1 - Pre DNF Activation



Graph 2.2 - Post DNF Activation

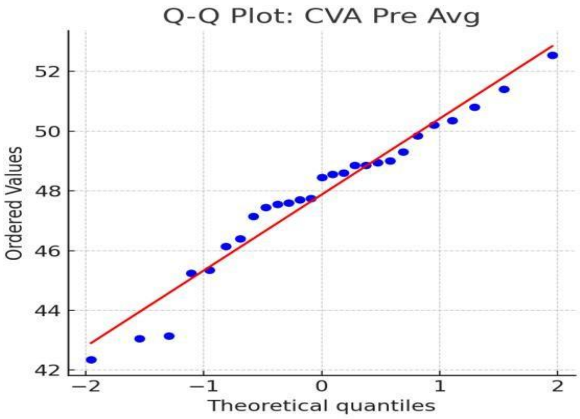
Table 3: paired t-test - CVA resulted in statistically insignificant(p-values >0.05), meaning there's no strong evidence of change or difference in CVA.

Table 3 - Pre-post paired t-test analysis of selected variable

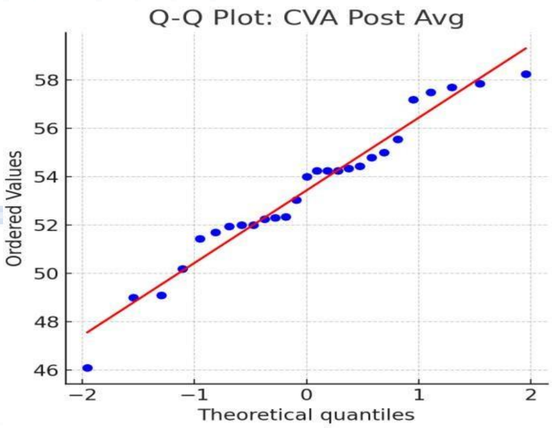
Variable	**N**	**Mean**	**SD**	**Z-value**	**p-value***
CVA	25	53.44	2.94	2.23	0.285

N-Sample size; SD-Standard Deviation; CVA-Cranio Vertebral Angle

Paired t-test; p-value*<0.05-Significant.



Graph 3.1 - Pre CVA



Graph 3.2 - Post CVA

DISCUSSION:

The primary aim of this study was to evaluate the immediate effects of sub-occipital release on pain, CVA, and DNF activation in individuals with FHP. The results showed statistically significant and clinically relevant improvements in pain levels and DNF activation, suggesting that sub-occipital release may serve as an effective therapeutic intervention for symptom relief and postural improvement in individuals with FHP.

Pain Reduction (NPRS):

A significant reduction in pain was noted, as indicated by the Numerical Pain Rating Scale(p=0.00028), reflecting a large effect size. These findings are consistent with those of Cristina

Perez-Martinez et al. and Ebrahim et al. (2020), who reported that both myofascial and sub-occipital release techniques significantly reduce pain by relieving tension in the sub-occipital region, improving fascial mobility, and reducing pressure on pain-sensitive structures. The pain reduction seen in this study also aligns with earlier reports of Visual Analog Scale(VAS) score improvements(from 7.35 to 4.15), supporting the analgesic effect of sub-occipital release. Furthermore, the results support the conclusions of Amita Agarwal et al., who found that sub-occipital release is more effective than conventional physiotherapy in reducing neck pain and improving posture.

Deep Neck Flexor(DNF) Activation:

The study also demonstrated a statistically significant increase in DNF activation($p<0.01$), emphasizing the importance of this technique for cervical spine stabilization and postural control. These results are comparable to studies that have employed cervical mobilization methods, such as Grade IV Maitland mobilization. For example, Ghan and Babu found that mobilization from C1 to T3 improved DNF strength by stimulating articular mechanoreceptors and enhancing neuromuscular control.

Although many previous studies have highlighted mobilization techniques, this study suggests that suboccipital release alone may produce similar neuromuscular benefits. The observed improvement in DNF activation may be attributed to the reduction in fascial tightness, increased proprioceptive feedback, and improved neuromuscular recruitment. This is further supported by the work of Karia Yuko Abe et al., who reported enhanced trunk extensor strength following mobilization techniques.

Craniovertebral Angle(CVA) Improvement:

Although there was a numerical improvement in CVA following the intervention, the change was not statistically significant($p=0.285$). This may be due to the short duration and single-session nature of the intervention, which may not be sufficient to induce measurable structural or postural adaptations. Long-term interventions that focus on postural correction exercises and strengthening may be necessary to achieve significant changes in CVA, as supported by the findings of Dae Hyun Kim et al. (2018).

Limitations:

Immediate vs. Sustained Effects: Long-term follow-ups are needed to assess durability. Sample Specificity: Focus on young adults may limit generalizability to other age groups. Mechanistic Clarity: Further EMG studies could clarify DNF activation changes post-intervention

The current study highlights the immediate benefits of sub-occipital release on reducing pain and enhancing DNF activation in individuals with FHP. While these findings are promising, the study paves the way for a broader scope of research to understand the long-term and comprehensive effects of this intervention. Future studies should aim to evaluate sustained outcomes of sub-occipital release over weeks or months to determine its efficacy in lasting postural correction and muscle re-education. Longitudinal studies can help establish whether repeated or maintenance sessions of the intervention result in permanent improvements in CVA and functional outcomes.

Another significant area for future research is to expand the population demographic. This study focused solely on young adults(ages 18–26); hence, further research could include older adults, adolescents, or working professionals with varying degrees of FHP severity. Such diversity can help establish age-specific or occupation-specific protocols for the use of sub-occipital release.

CONCLUSION:

The sub-occipital release technique was effective in reducing neck pain and enhancing DNF activation, although it did not produce a statistically significant improvement in head posture as measured by the CVA. These findings suggest that sub-occipital release can be a beneficial addition to clinical practice for individuals with FHP. When integrated into treatment plans, this manual therapy technique offers a non-invasive option for improving muscle function and potentially realigning the cervical spine. The results support existing evidence that emphasizes the value of targeted manual therapy, particularly for the upper cervical spine and suboccipital region, in managing postural syndromes.

Declaration by Authors:

Ethical Approval: Obtained from the institutional scientific/ethical research committee (ISC/SOAHS-PT/2025/065)

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