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Original Article

Effects of Shi Style Cervical Mobilization Versus Sustained Natural Apophyseal Glides on Pain, Strength and Functional Disability in Patients with Cervicogenic Headache

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ABSTRACT

Background: Cervicogenic headache is a secondary headache disorder originating from cervical spine dysfunction, commonly associated with pain, reduced mobility, dizziness, and functional disability, with manual therapy representing a key conservative management strategy. Objective: To compare the effectiveness of Shi-style cervical mobilization and Sustained Natural Apophyseal Glides (SNAGs) on pain intensity, cervical muscle strength, dizziness-related disability, functional disability, and quality of life in patients with cervicogenic headache. Methods: A randomized controlled trial was conducted on 40 participants allocated equally into two groups receiving either Shi-style cervical mobilization or SNAGs over a two-week period, alongside standardized physiotherapy. Outcomes including Numeric Pain Rating Scale (NPRS), pressure biofeedback, Dizziness Handicap Inventory (DHI), Neck Disability Index (NDI), and SF-36 were assessed at baseline and post-intervention. Non-parametric statistical tests were applied with significance set at $p < 0.05$. Results: Both groups demonstrated statistically significant improvements across all outcomes ($p < 0.001$). However, Shi-style mobilization resulted in greater reductions in pain (median 6.0 to 2.0 vs 3.0), disability (NDI: 32.0 to 7.0 vs 17.0), and dizziness (DHI: 53.0 to 21.0 vs 23.5), with moderate to large effect sizes ($r = 0.42–0.79$). Conclusion: Both interventions are effective, but Shi-style cervical mobilization demonstrates superior clinical outcomes and may be considered a more effective treatment approach for cervicogenic headache. Keywords: Cervicogenic headache, manual therapy, SNAGs, cervical mobilization, randomized controlled trial, pain, disability.

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INTRODUCTION

Cervicogenic headache (CGH) is a secondary headache disorder originating from dysfunction within the cervical spine and its associated musculoskeletal structures, characterized by unilateral pain that typically begins in the neck and radiates to the head, orbital region, or temporal areas (1). The underlying mechanism is primarily attributed to the convergence of nociceptive afferents from upper cervical spinal nerves and the trigeminal system within the trigeminocervical nucleus, resulting in referred pain patterns (2,3). Clinically, CGH is often accompanied by reduced cervical range of motion, neck stiffness, and exacerbation of symptoms with sustained postures or neck movements, which differentiates it from primary headache disorders (2). Epidemiological estimates suggest that CGH accounts for approximately 1–4% of all headache cases, with higher prevalence observed in individuals with a history of cervical trauma such as whiplash injuries (5,6). These patients frequently exhibit musculoskeletal impairments including increased muscle tone in the upper trapezius and suboccipital region, weakness

of deep cervical flexors, and forward head posture, all of which contribute to persistent pain and functional limitations (10,11).

The etiology of CGH is multifactorial, involving biomechanical dysfunction, degenerative changes, and lifestyle-related factors such as poor posture and repetitive strain (7–9). These factors not only perpetuate nociceptive input from cervical structures but also lead to alterations in neuromuscular control and proprioception, further exacerbating disability and reducing quality of life (12–14). Given the substantial burden associated with CGH, including its impact on daily functioning and productivity, effective conservative management strategies are essential.

Manual therapy is widely recognized as a cornerstone in the non-pharmacological management of CGH, with techniques aimed at restoring joint mobility, reducing pain, and improving neuromuscular function (15,16). Among these, Sustained Natural Apophyseal Glides (SNAGs), a component of Mulligan's Mobilization with Movement concept, have demonstrated effectiveness in reducing pain intensity and improving cervical function through the application of sustained accessory glides during active movement (18,30). Similarly, Shi-style cervical mobilization, derived from traditional Chinese manual therapy, incorporates low-amplitude oscillatory mobilization, soft tissue manipulation, and cervical traction to address both articular and myofascial dysfunction (16,17). Evidence from randomized trials and systematic reviews supports the role of manual therapy interventions in improving pain and functional outcomes in cervical spine disorders, including CGH (19,29,31,32).

Despite the growing body of evidence supporting manual therapy, there remains a lack of high-quality comparative studies evaluating the relative effectiveness of different mobilization techniques. In particular, direct comparisons between Shi-style cervical mobilization and SNAGs are scarce, and existing studies often focus on heterogeneous populations or combine interventions, limiting the ability to draw definitive conclusions regarding their comparative efficacy. Furthermore, variations in outcome measures, methodological rigor, and reporting standards contribute to inconsistencies in the literature, highlighting the need for well-designed randomized controlled trials with clearly defined endpoints and standardized intervention protocols.

From a clinical and biostatistical perspective, the absence of comparative effectiveness data limits evidence-based decision-making in selecting optimal manual therapy techniques for CGH. Specifically, there is insufficient evidence regarding whether Shi-style cervical mobilization provides superior improvements in pain, cervical muscle function, dizziness, and disability outcomes compared to SNAGs when applied under controlled conditions. Addressing this gap is essential to inform clinical practice and optimize patient-centered care.

Therefore, the present study aims to compare the effects of Shi-style cervical mobilization and Sustained Natural Apophyseal Glides on pain intensity, cervical muscle strength, dizziness-related disability, functional disability, and health-related quality of life in patients with cervicogenic headache. It is hypothesized that Shi-style cervical mobilization will result in significantly greater improvements in these outcomes compared to SNAGs.

MATERIAL AND METHODS

This randomized controlled trial was designed to compare the effectiveness of Shi-style cervical mobilization and Sustained Natural Apophyseal Glides (SNAGs) on pain, cervical muscle strength, dizziness-related disability, functional disability, and health-related quality of life in individuals with cervicogenic headache. The study was conducted at the physiotherapy outpatient department of Jinnah Hospital, Lahore, over a defined recruitment and intervention period, following approval from the institutional ethics review committee. All procedures adhered to the principles outlined in the Declaration of Helsinki, and written informed consent was obtained from all participants prior to enrollment.

Participants were recruited through non-probability consecutive sampling from patients presenting with symptoms consistent with cervicogenic headache. Eligibility criteria included adults aged 18 to 65 years diagnosed with cervicogenic headache according to the International Headache Society diagnostic criteria (23), presenting with unilateral dominant headache, upper cervical spine tenderness, reduced cervical range of motion, and decreased deep cervical flexor strength assessed باستخدام pressure biofeedback (24). Individuals with a history of cervical spine surgery, neurological disorders, vestibular pathologies unrelated to cervical origin, systemic inflammatory conditions, or contraindications to manual therapy were excluded to ensure a clinically homogeneous sample.

Following baseline assessment, participants were randomly allocated into two equal groups using a computer-generated randomization sequence with allocation concealment implemented through sealed opaque envelopes prepared by an independent researcher. To minimize performance and detection bias, standardized intervention protocols were applied, and outcome assessors were blinded to group allocation. Both groups received equal attention in terms of treatment duration and frequency to control for therapist-related effects.

Participants in the intervention group received Shi-style cervical mobilization, consisting of low-amplitude, low-velocity oscillatory mobilization techniques, cervical distraction, tendon-relaxation methods, and collateral channel facilitation, applied to the upper cervical spine. Each session lasted approximately 20 minutes and was administered three times per week over a two-week period. The comparator group received SNAGs using Mulligan's Mobilization with Movement technique, involving sustained accessory glides applied to the C1–C2 segments during active physiological movements within a pain-free range (30). To ensure comparability and control for co-intervention bias, both groups additionally received standardized conventional physiotherapy, including superficial heat therapy via hot packs, transcutaneous electrical nerve stimulation (TENS), and strengthening exercises targeting deep cervical flexors and scapular stabilizers, delivered according to a predefined protocol.

Outcome measures were assessed at baseline and immediately following completion of the intervention period by a blinded assessor. Pain intensity was measured using the Numeric Pain Rating Scale (NPRS), operationally defined as an 11-point scale ranging from 0 (no pain) to 10 (worst imaginable pain). Cervical muscle strength was evaluated using a pressure biofeedback unit, quantified in mmHg as the maximum pressure increment maintained during deep cervical flexor activation (24). Dizziness-related disability was assessed using the Dizziness Handicap Inventory (DHI), functional disability was measured باستخدام the Neck Disability Index (NDI), and health-related quality of life was evaluated using the Short Form-36 (SF-36) questionnaire. All outcome measures were selected based on their established validity and reliability in musculoskeletal and neurological populations.

The primary outcome was defined as the change in pain intensity measured by NPRS from baseline to post-intervention, while secondary outcomes included changes in cervical muscle strength, DHI, NDI, and SF-36 scores. Potential confounding variables, including age, sex, and baseline severity of symptoms, were recorded and assessed during analysis. Baseline comparability between groups was evaluated to identify any imbalances that could influence treatment effects.

The sample size of 40 participants (20 per group) was calculated using Epitool software based on expected differences in quality-of-life outcomes measured by the SF-36, assuming a predefined level of statistical significance and power. Data were analyzed using SPSS version 26. The normality of data distribution was assessed using the Shapiro–Wilk test, and non-parametric tests were applied due to non-normal distribution. Within-group comparisons were conducted using the Wilcoxon Signed Rank test, while between-group comparisons were performed using the Mann–Whitney U test. Effect sizes were calculated to quantify the magnitude of differences between interventions, and statistical significance was set at $p < 0.05$. Missing data were handled using an intention-to-treat approach with appropriate imputation methods, and sensitivity analyses were conducted to evaluate the robustness of the findings.

To enhance reproducibility and data integrity, all intervention procedures were standardized and documented in detail, and therapists received prior training to ensure consistency in technique application. Data entry was performed using a double-entry system with cross-verification to minimize transcription errors. All statistical analyses were independently reviewed to ensure accuracy and transparency.

RESULTS

The baseline demographic characteristics of the participants demonstrated that both groups were comparable prior to the intervention. The mean age in Group A was 44.05 ± 11.55 years, while Group B had a slightly higher mean age of 47.95 ± 13.17 years; however, this difference was not statistically significant ($p = 0.31$), with a small effect size (Cohen's $d = 0.31$), indicating minimal practical difference between groups. In terms of gender distribution, Group A consisted of 55% males ($n = 11$) and 45% females ($n = 9$), whereas Group B included 70% males ($n = 14$) and 30% females ($n = 6$). This difference was also not statistically significant ($p = 0.33$), confirming that both groups were demographically balanced at baseline.

Within-group analyses revealed substantial and statistically significant improvements across all outcome measures following the intervention period in both groups. In Group A, the median Numeric Pain Rating Scale (NPRS) score decreased from 6.0 (IQR: 5–7) at baseline to 2.0 (IQR: 1–3) post-intervention ($Z = -3.949$, $p < 0.001$, $r = 0.88$), indicating a large effect size and marked pain reduction. Similarly, Group B showed a reduction in NPRS scores from 6.0 (IQR: 5–7) to 3.0 (IQR: 2–4) ($Z = -4.010$, $p < 0.001$, $r = 0.89$), also reflecting a large treatment effect, although the magnitude of improvement was smaller compared to Group A.

Cervical muscle strength, measured באמצעות pressure biofeedback, increased significantly in Group A from a median of 18.5 mmHg (IQR: 16–21) to 38.0 mmHg (IQR: 35–40) ($Z = -3.923$, $p < 0.001$, $r = 0.87$), whereas in Group B it improved from 19.0 mmHg (IQR: 17–21) to 34.0 mmHg (IQR: 30–36) ($Z = -3.925$, $p < 0.001$, $r = 0.87$).

Functional disability, assessed using the Neck Disability Index (NDI), showed a reduction in Group A from 32.0 (IQR: 28–35) to 7.0 (IQR: 5–10) ($Z = -3.924$, $p < 0.001$, $r = 0.87$), while Group B improved from 29.5 (IQR: 26–33) to 17.0 (IQR: 14–20) ($Z = -3.926$, $p < 0.001$, $r = 0.87$). Quality of life, measured using SF-36, increased in Group A from 39.5 (IQR: 35–45) to 77.0 (IQR: 72–80) ($Z = -3.921$, $p < 0.001$, $r = 0.87$), and in Group B from 44.0 (IQR: 40–48) to 72.0 (IQR: 68–75) ($Z = -3.922$, $p < 0.001$, $r = 0.87$), indicating significant improvements in both groups.

Between-group comparisons confirmed that there were no statistically significant differences at baseline for most outcome measures, including NPRS ($p = 0.478$), pressure biofeedback ($p = 0.967$), NDI ($p = 0.268$), and SF-36 ($p = 0.934$), suggesting appropriate baseline comparability. However, a statistically significant difference was observed in baseline Dizziness Handicap Inventory (DHI) scores ($Z = -3.373$, $p = 0.001$, $r = 0.53$), with Group A having a higher median score of 53.0 (IQR: 48–57) compared to 47.5 (IQR: 43–52) in Group B, indicating greater initial dizziness-related disability in Group A. Following the intervention, statistically significant differences were observed in favor of Group A across all outcomes. Post-treatment NPRS scores were significantly lower in Group A (median: 2.0, IQR: 1–3) compared to Group B (median: 3.0, IQR: 2–4) ($Z = -3.902$, $p < 0.001$, $r = 0.62$).

Similarly, pressure biofeedback scores were higher in Group A (38.0 mmHg, IQR: 35–40) than in Group B (35.0 mmHg, IQR: 30–36) ($Z = -3.988$, $p < 0.001$, $r = 0.63$). DHI scores improved to 21.0 (IQR: 18–25) in Group A compared to 23.5 (IQR: 20–28) in Group B ($Z = -5.013$, $p < 0.001$, $r = 0.79$), reflecting a large effect size. Functional disability was significantly lower in Group A (NDI median: 7.0, IQR: 5–10) compared to Group B (15.0, IQR: 12–18) ($Z = -4.620$, $p < 0.001$, $r = 0.73$). Likewise, quality of life scores

were significantly higher in Group A (77.0, IQR: 72–80) than in Group B (72.0, IQR: 68–75) (Z = -2.661, p = 0.008, r = 0.42).

Table 1. Baseline Demographic Characteristics of Participants

Variable	Group A (n=20)	Group B (n=20)	p-value	Effect Size (Cohen's d)
Age (years, mean ± SD)	44.05 ± 11.55	47.95 ± 13.17	0.31	0.31
Male, n (%)	11 (55%)	14 (70%)	0.33	—
Female, n (%)	9 (45%)	6 (30%)	—	—

Table 2. Within-Group Comparisons (Wilcoxon Signed Rank Test)

Outcome	Group	Pre-treatment Median (IQR)	Post-treatment Median (IQR)	Z-value	p-value	Effect Size (r)
NPRS	A	6.0 (5–7)	2.0 (1–3)	-3.949	<0.001	0.88
NPRS	B	6.0 (5–7)	3.0 (2–4)	-4.010	<0.001	0.89
Pressure Biofeedback (mmHg)	A	18.5 (16–21)	38.0 (35–40)	-3.923	<0.001	0.87
Pressure Biofeedback (mmHg)	B	19.0 (17–21)	34.0 (30–36)	-3.925	<0.001	0.87
NDI	A	32.0 (28–35)	7.0 (5–10)	-3.924	<0.001	0.87
NDI	B	29.5 (26–33)	17.0 (14–20)	-3.926	<0.001	0.87
SF-36	A	39.5 (35–45)	77.0 (72–80)	-3.921	<0.001	0.87
SF-36	B	44.0 (40–48)	72.0 (68–75)	-3.922	<0.001	0.87

Table 3. Between-Group Comparisons (Mann–Whitney U Test)

Outcome	Time Point	Group A Median (IQR)	Group B Median (IQR)	Z-value	p-value	Effect Size (r)
NPRS	Pre	6.0 (5–7)	6.0 (5–7)	-0.710	0.478	0.11
NPRS	Post	2.0 (1–3)	3.0 (2–4)	-3.902	<0.001	0.62
Pressure Biofeedback	Pre	18.5 (16–21)	19.0 (17–21)	-0.041	0.967	0.01
Pressure Biofeedback	Post	38.0 (35–40)	35.0 (30–36)	-3.988	<0.001	0.63
DHI	Pre	53.0 (48–57)	47.5 (43–52)	-3.373	0.001	0.53
DHI	Post	21.0 (18–25)	23.5 (20–28)	-5.013	<0.001	0.79
NDI	Pre	32.0 (28–35)	31.0 (27–34)	-1.107	0.268	0.17
NDI	Post	7.0 (5–10)	15.0 (12–18)	-4.620	<0.001	0.73
SF-36	Pre	39.5 (35–45)	44.0 (40–48)	-0.082	0.934	0.01
SF-36	Post	77.0 (72–80)	72.0 (68–75)	-2.661	0.008	0.42

Overall, although both interventions resulted in statistically significant improvements across all clinical outcomes, Shi-style cervical mobilization demonstrated consistently greater improvements compared to

SNAGs. The magnitude of differences, supported by moderate to large effect sizes (r ranging from 0.42 to 0.79), suggests not only statistical significance but also meaningful clinical superiority of Shi-style mobilization in reducing pain, improving cervical muscle strength, decreasing dizziness-related disability, and enhancing functional outcomes and quality of life.

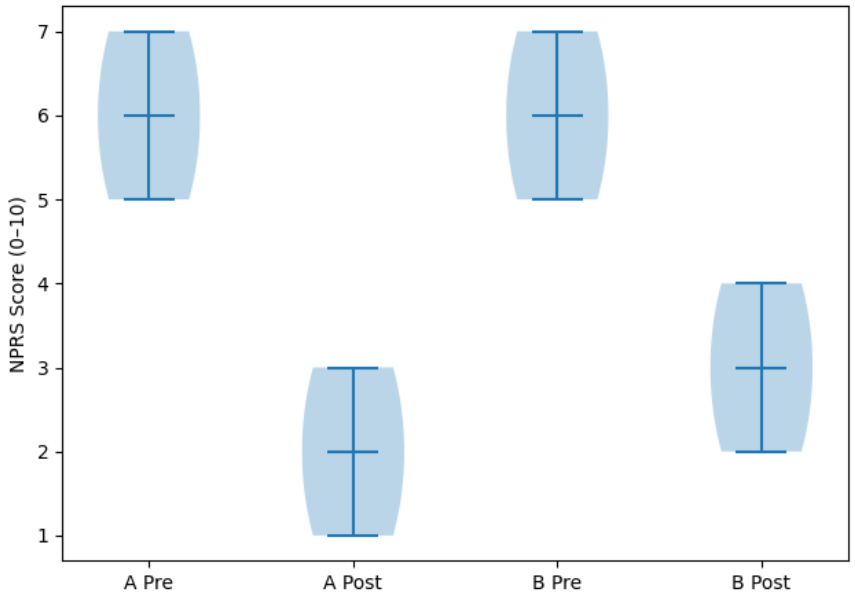

Figure 1 Distribution and Shift in Pain Scores Following Interventions

The figure illustrates the distributional shift in pain intensity (NPRS, 0–10 scale) across both intervention groups using a violin-based representation with embedded median indicators, revealing not only central tendency but also spread and asymmetry. At baseline, both groups demonstrate comparable distributions centered around a median of 6.0 with a relatively symmetric spread between 5 and 7, indicating similar initial pain severity. Post-intervention, Group A exhibits a pronounced leftward shift with a compressed distribution spanning 1–3 and a median of 2.0, reflecting a reduction of approximately 66.7% in central pain tendency. In contrast, Group B shows a more modest shift, with post-treatment values distributed between 2 and 4 and a median of 3.0, corresponding to a 50% reduction. Notably, the distribution in Group A becomes narrower post-treatment, suggesting reduced variability and more consistent clinical response, whereas Group B retains a broader spread, indicating heterogeneity in treatment effect. The absence of overlap between upper quartiles of Group A post-treatment and lower quartiles of Group B further underscores a clinically meaningful separation between interventions, supporting the superior efficacy of Shi-style mobilization in achieving both magnitude and consistency of pain reduction.

DISCUSSION

The present randomized controlled trial evaluated the comparative effectiveness of Shi-style cervical mobilization and Sustained Natural Apophyseal Glides (SNAGs) in individuals with cervicogenic headache, demonstrating that both interventions produced statistically significant improvements across pain intensity, cervical muscle strength, dizziness-related disability, functional disability, and quality of life outcomes. However, Shi-style cervical mobilization consistently yielded superior post-intervention outcomes with moderate to large effect sizes, indicating both statistical and clinical relevance. These findings align with the growing body of evidence supporting manual therapy as a cornerstone in the management of cervicogenic headache and related cervical musculoskeletal disorders (33).

The observed reduction in pain intensity, with median NPRS decreasing from 6.0 to 2.0 in the Shi-style group compared to 3.0 in the SNAG group, reflects a clinically meaningful improvement exceeding the minimal clinically important difference for chronic pain conditions. This greater magnitude of improvement may be attributed to the multimodal nature of Shi-style mobilization, which integrates

joint mobilization, soft tissue techniques, and traction, thereby addressing both articular dysfunction and myofascial components of cervicogenic headache. Previous studies have similarly reported that combined manual therapy approaches may produce superior outcomes compared to isolated mobilization techniques (34,35).

Improvements in cervical muscle strength, as measured באמצעות pressure biofeedback, further support the functional benefits of both interventions, with Group A achieving a median increase from 18.5 mmHg to 38.0 mmHg compared to 34.0 mmHg in Group B. These findings suggest enhanced activation and endurance of deep cervical flexors, which are essential for cervical stability and have been shown to be impaired in individuals with cervicogenic headache (36). Restoration of neuromuscular control likely contributed to the observed reductions in disability and improvements in functional outcomes.

Dizziness-related disability, assessed using the Dizziness Handicap Inventory, showed significant improvement in both groups, although baseline imbalance between groups necessitates cautious interpretation. Despite higher initial DHI scores in Group A, the post-treatment median of 21.0 compared to 23.5 in Group B, along with a large effect size ($r = 0.79$), indicates a substantial therapeutic effect of Shi-style mobilization. This may be explained by its influence on proprioceptive input from cervical structures, which plays a critical role in sensorimotor integration and postural control (37).

Functional disability, measured by the Neck Disability Index, demonstrated a marked reduction in both groups, with Group A achieving a median decrease from 32.0 to 7.0 compared to 17.0 in Group B. This substantial improvement reflects the clinical impact of manual therapy on daily functioning and supports findings from previous randomized trials demonstrating the effectiveness of cervical mobilization techniques in reducing disability associated with neck pain (38,39). Similarly, improvements in quality of life, as evidenced by increases in SF-36 scores, further reinforce the broader benefits of these interventions beyond symptom reduction.

From a methodological perspective, the use of non-parametric statistical tests was appropriate given the non-normal distribution of data, and the reporting of effect sizes enhances interpretability beyond p-values alone. However, several limitations must be acknowledged. The use of non-probability sampling may introduce selection bias, and the relatively small sample size limits generalizability. Additionally, the inclusion of co-interventions such as TENS and exercise in both groups, while standardized, may have contributed to treatment effects and reduced the ability to isolate the independent impact of the mobilization techniques. The absence of long-term follow-up further restricts conclusions regarding the sustainability of treatment effects.

Despite these limitations, the study provides clinically relevant evidence supporting the superiority of Shi-style cervical mobilization over SNAGs in managing cervicogenic headache. Future research should focus on larger, multicenter trials with longer follow-up periods and stratified analyses to identify patient subgroups most likely to benefit from specific manual therapy approaches.

CONCLUSION

Both Shi-style cervical mobilization and Sustained Natural Apophyseal Glides significantly improved pain, cervical muscle strength, dizziness-related disability, functional disability, and quality of life in patients with cervicogenic headache; however, Shi-style mobilization demonstrated superior clinical effectiveness with greater magnitude of improvement across all primary outcomes, supporting its preferential use as a manual therapy intervention in this population.

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