Delta University Scientific Journal
Journal home page: https://dusj.journals.ekb.eg

Influence of Various Cervical Positions on Hand Grip Strength in Neck Pain

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ABSTRACT
Background: Neck pain is a prevalent musculoskeletal issue and a major contributor to global disability. The one-year prevalence of neck pain is estimated to be around 45.5% among office workers, with a range of 45.8% to 54.7% among healthcare professionals. This study aimed to investigate the effect of neck pain, with varying neck positions (neutral, rotated left or right), on hand grip strength in teenagers. Methods: This double-blind, randomized, pre-test post-test control group experimental study involved 60 patients aged 16 to 18 years with neck pain . The participants were randomly assigned to three equal groups. Group A received traditional neck pain treatment with the neck in a neutral position. Group B received traditional neck pain treatment with the neck rotated 45° to the left. Group C received traditional neck pain treatment with the neck rotated 45° to the right. All groups underwent treatment twice a week for 4 consecutive weeks. Pain levels were assessed using the McGill Pain Questionnaire, hand grip strength was measured with a digital hand-held dynamometer, and upper extremity function was evaluated using the Quick DASH questionnaire. Results: After treatment, groups A, B, and C showed significant improvements in mean pain levels, hand grip strength, and upper limb function compared to their pre-treatment values. However, group B did not demonstrate any statistically significant differences in these outcomes when compared to groups A and C post-treatment. Conclusions: Variations in head-neck positions among patients with neck pain did not significantly affect pain levels, hand grip strength, or upper limb function. Nevertheless, hand grip strength was found to be greatest in the head-neck right rotation position, followed by the neutral position and then the head-neck left rotation. Further studies are recommended to examine factors such as age, sex, and body mass index, which may impact hand grip strength.
Keywords: *Neck Pain, Hand Grip Strength, Head-Neck Positions*

1. Introduction

It is essential to measure hand grip strength (HGS) in order to assess upper-extremity deficiencies and create efficient exercise regimens. (Zaccagni et al., 2020, Moncada-Jiménez et al., 2023). The hand is essential for interacting with and managing our environment. (Celik et al., 2023).

Hand grip strength assessments may be impacted by the location of the upper extremities and body, according to research (Xu et al., 2021, Fadavi-Ghaffari et al., 2021).According to Keshner et al. (2023), the tonic neck reflex (TNR) is a reflexive reaction in which head postures affect the tone of limb muscles. All four limbs may be impacted, however the upper extremities are more severely affected than the lower extremities (Celik et al., 2023).

The symmetrical tonic neck reflex (STNR) and the asymmetrical tonic neck reflex (ATNR) are the two components that make up the tonic neck reflex (TNR). According to Ralli et al., head-neck rotations should be included in upper-limb muscle strengthening exercises in order to produce ATNR (Nam and Kim, 2020).

Diffuse, nonspecific discomfort, especially during neck movements, is a typical characteristic of neck pain (Alizadeh et al., 2020).. When no discernible underlying pathology is present yet neck motions or prolonged neck positions cause or exacerbate neck pain, it is categorized as "non-specific" (McGrath et al., 2021).

Activity-related neck pain is a common and financially burdensome musculoskeletal condition, with an estimated prevalence of roughly 23% in the general population (Paolucci et al., 2021). It is more common in women than men, especially in middle age (Kazeminasab et al., 2022). Neck pain can be caused by a variety of factors, including depression, anxiety, poor posture, muscle strain from sports activities, and occupational factors. Neck

pain frequently manifests gradually and can cause symptoms in both the neck and upper extremities (Mueller et al., 2023).
The aim of this work was to detect the impact of different head neck positions (neutral, rotation to the left 45 °, rotation to the right 45°) on pain, hand grip strength and upper extremity function in patients neck pain.

2. Material and methods

This research employed a randomized controlled trial design that included an experimental double-blind design in addition to a pre- and post-test design. The ELRASHED school in Belqas City served as the study's site. Before the study began, the Research Ethical Committee of Delta University's Physical Therapy faculty in Egypt gave its approval (F.P.T 2507 031). The patients were adequately informed and their written consent was obtained.

2.1. Sample size calculations

It was done using digital hand grip strength as reported in (Zafar et al, 2018) with 90% power at $\alpha = 0.05$ level and effect size = 0.45, using F-test repeated measures MANOVA, for 3 groups. Total sample size is 60 subjects, 20 subjects in each group. The sample size was estimated utilizing the G*Power software (version 3.0.10) (Figure 1).

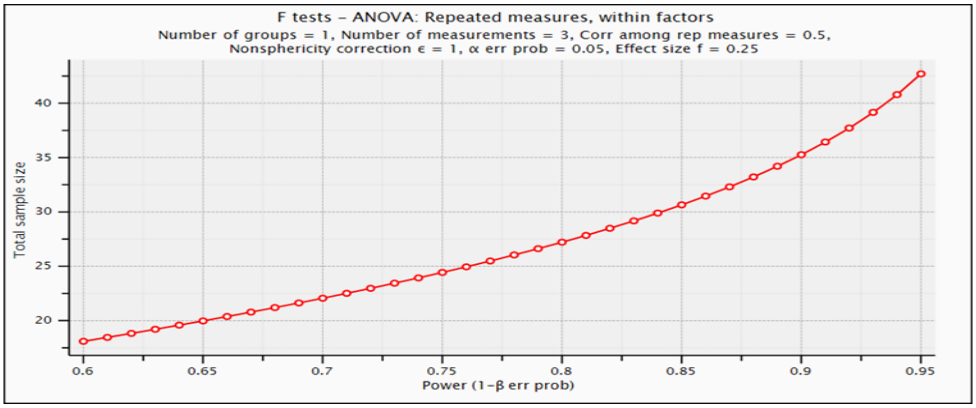

Figure 1: Sample Size calculation

2.2. Randomization

Using the envelope approach and simple randomization, sixty people were divided into three equal groups, designated as Groups A, B, and C. This allocation method was completed by an impartial individual who was not involved in participant recruitment or treatment, and they chose one envelope. Participants were placed in the appropriate group according to the cards they chose. Before their first session, each eligible person's envelope was unsealed.. Subjects: The study participants were 60 patients from both genders diagnosed with neck pain recruited from ELRASHED School. They were aged from 16 to 18 years old. They were randomized into three equivalent groups. Group A: 20 patients were given traditional treatment for neck pain from neutral head-neck position. Group B: 20 patients were given traditional treatment for neck pain from rotation 45 ° to the left. Group C: 20 patients were given traditional treatment for neck pain from rotation 45 ° to the right. The same standard physical treatment regimen was given to patients in each group. For four weeks in a row, laser therapy and hot packs were used, and then twice a week, isometric strengthening exercises were performed. Patients with a neck pain diagnosis for at least two months who were referred by an orthopedist met the inclusion criteria. For the past two months, patients have not received any physical therapy treatments.

2.3. Evaluation Tools

McGill pain questionnaireA multifaceted pain assessment tool is used to gauge the degree of pain as well as its sensory, emotional, and evaluative components. A 5-point pain intensity scale and four subscales measuring the sensory, emotional and evaluative, and other components of pain are included in the scale. The answers to these subscales make up the Pain Rating Index. Pain in the Present (Burckhardt CS., 2002)

Digital hand-held dynamometer: During the evaluation, hand grip strength was measured in three different head-neck positions: neutral, left- and right-rotation. According to Incel et al. (2002), the dynamometer is the gold standard for measuring hand grip strength and is considered the most dependable and popular commercial tool for doing so. It is also considered the reference standard in muscle testing and has excellent validity and reliability in both clinical and research settings. (Figure.3).

Figure 3: Digital hand-held dynamometer

Quick DASH questionnaire:

Clinical research on musculoskeletal problems of the upper extremities is increasingly using the 30-item Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. From the original, a shortened variant known as the 11-item Quick DASH was created. In contrast to the complete DASH, nothing is known about how well the Quick DASH can identify score changes (Beaton et al., 2005).

2.4. Treatment procedure

Before beginning the study, all participants completed an informed consent form after being briefed on its purpose and methods. The individuals' pre- and post-treatment statuses were assessed using a digital portable dynamometer, the McGill pain questionnaire, and the Quick DASH questionnaire in three distinct head-neck positions.

Exercises for neck isometry: The patient is seated in a chair. Position of the physiotherapist: stand behind the patient in a stride, place one hand at the lateral aspect of the occiput to provide rotational resistance for each side's isometric contraction, and ask the patient to spin against the greatest amount of resistance. Patients are asked to contract against their maximum resistance during three sets of ten repetitions, with one to three minutes of rest in between. The physiotherapist places the hand anteriorly to provide resistance to neck flexion for isometric contraction and at the posterior aspect of the occiput to provide resistance to neck extension for isometric contraction (Alatawi, S. F. 2024).

Conventional treatment

1- LASER Therapy: The patients were sitting on a chair with head resting on a plinth supported by pillows and the patients received an application of an infrared laser (diode gaal as) continuous with a wavelength of 970–980 nm for the duration of 3–4 min (the scan mode was used for 2 min, then acupuncture mode for 1 min of each trigger point) (Hosoda et al,.2010)

2-Hot packs: The patient was requested to lie prone with exposed cervical and upper trapezius region, then hot packs (a standard size that had been maintained in a hydrocollator tank at 74.5–80°C for 30 minutes) were applied on the cervical spine for 20 minutes. (Hosoda et al,.2010)

2.5. Statistical analysis

Statistical analysis was conducted using SPSS v20 (IBM Inc., Chicago, IL, USA). The quantitative parameters were reported as mean and standard deviation. Repeated measures MANOVA will be used to compare measured variables between and within groups. A two-tailed P value of less than 0.05 was accepted as significant.

Results

The mean values ± SD values of age of groups A, B and C were 17.1 ± 1.4, 17.6 ± 1.4 and 17.46 ± 1.3 years respectively. The number (%) of females of groups A, B, and C were 12 (63%), 9 (47%) and 7 (37%) and the number (%) of males 8 (37%), 11 (53%) and 13 (63%), respectively. also no significant difference was detected among three groups in the mean values of age (p = 0.268), also no significant difference was detected in gender distribution, among the three groups (p =0.263) (table 1).

Table 1. General characteristics of subjects of three groups.

Variables	**Group A** (n=20)	**Group B** (n=20)	**Group C** (n=20)	**f- value**	**p-value**
Age (years)	17.1 ± 1.4	17.6 ± 1.4	17.46 ± 1.3	1.35	0.268
Sex Females Males	12 (63%) 8(37%)	9 (47%) 11 (53%)	7 (37%) 13 (63%)	χ^2 = 2.67	0.263

Data was expressed as mean ± standard deviation or number (%), $\chi2$: chi square

Regarding effect of treatment on pain: The mean value ± SD of pain pre-study of the group A was 7.7 ± 1.5 and post study was 5.2 ± 1.2 . A statistically significant decline was noted in mean value of pain post study compared with pre study (p = 0.001), it was decreased by 32%. The mean value ± SD of pain pre-study of the group B and C was 6.8 ± 1.4, 7.3 ± 1.5 and post study was 5.5 ± 1.3 point and 5.6 ± 1.3 A statistically significant decline was observed in mean value of pain post study compared with pre study (p = 0.001), it was decreased by 19% and 22% respectively. There was no significant difference in the mean values of pain pre study between the three groups (p = 0.168), also there was no significant difference post study between the three groups (p = 0.655).

Regarding effect of treatment on hand grip strength the mean value ± SD of hand grip strength pre-study of the group A, B and C was 23 ± 11.2, 26.5 ± 7.4 and 26.6 ± 10.3 and post study was 27.9 ± 10.5 kg, 29.2 ± 6.6kg 35 ± 12.5kg respectively. A significant improvement was noted in mean value of hand grip strength post study compared with pre study (p = 0.001), it was increased by 21%, 10% and 31.5% respectively. No significant difference was noted in the mean values of hand grip strength pre study among the three groups (p = 0.060), no significant difference was observed post study among the three groups (p = 0.370).

Concerning effect of treatment on upper extremity function: The mean value ± SD of upper extremity function score pre-study of the group A, B and C was 57.1 ± 11.7, 49.1 ± 7 and 53.4 ± 10.8 and post study was 50.2 ± 10.1, 46.4 ± 6.3 and 47.4 ± 9 respectively. There was a significant decline in mean value of upper extremity function score post study compared with pre study (p = 0.001), it was decreased by 12%, 5.5% and 11% respectively. No significant difference was noted in the mean values of upper extremity function score pre study between the three groups (p = 0.433), also there was no statistical significant difference post study among the three groups (p = 0.082) (table 2).

Table (2): Comparison between pre- and post-study mean values of pain, hand grip strength and function between and within groups

Measured variables	Group A	Group B	Group C	f-value	P value
Pain (score)					
Pre-study	7.7 ± 1.5	6.8 ± 1.4	7.3 ± 1.5	1.7	0.186
Post-study	5.2 ± 1.2	5.5 ± 1.3	5.6 ± 1.3	0.42	0.655
% of change	32%	19%	22%		
(P-value)	0.001*	0.001*	0.001*		
Hand grip strength (kg)					
Pre-study	23 ± 11.2	26.5 ± 7.4	26.6 ± 10.3	2.9	0.060
Post-study	27.9 ± 10.5	29.2 ± 6.6	35 ± 12.5	1	0.370
% of change	21%	10%	31.5%		
(P-value)	0.001*	0.001*	0.001*		
Function (Quick DASH score)					
Pre-study	57.1 ± 11.7	49.1 ± 7	53.4 ± 10.8	0.85	0.433
Post-study	50.2 ± 10.1	46.4 ± 6.3	47.4 ± 9	2.6	0.082
% of change	12%	5.5%	11%		
(P-value)	0.001*	0.001*	0.001*		

p-value: probability value *: significant

Discussion

Hand grip strength (HGS) refers to the force generated by the muscles of the forearm and hand when gripping an object. It is considered a key indicator of overall fitness and upper-body strength (Alatawi, 2024). Factors influencing HGS include age, sex, general muscle strength, and physical health. Additionally, physical activity levels, food, and pre-existing health issues can also effect HGS (Quattrocchi et al., 2024).

In order to ascertain the maximum force applied during a static grip, the hand grip strength was usually assessed using a hand dynamometer. The dynamometer is held firmly by the person. The device measures force in kilos or pounds. HGS is essential for rehabilitation, occupational health, and sports performance. According to Yoo et al. (2017), it was frequently used as a gauge of overall strength and functional ability.

Healthcare practitioners have a knowledge gap on this issue because there aren't enough studies on how different head and neck positions affect HGS in patients with neck pain (Lupton-Smith et al., 2022). The objective of this study was to examine the impact of neck pain in various neck postures [neutral, left rotation, right rotation] on HGS among young adults.

Pain levels decreased, hand grip strength improved, and upper extremity function scores showed enhancement post-treatment compared to pre-treatment within each group; however, there were no significant differences in these metrics before or after treatment when comparing the three groups. The study found that treatment significantly improved outcomes within all groups (A, B, and C) but did not show significant differences between groups.

The effectiveness of the conventional therapy itself is responsible for the improvement seen in all groups; it most likely included a combination of electrotherapy, hydrotherapy, and strengthening exercises, which are known to help reduce pain, relieve muscle tension, improve flexibility, and promote healing in conditions involving chronic neck pain, as well as improving overall mobility (Chen et al., 2023). Furthermore, the improvement in upper extremity function and hand grip strength indicates that the therapy not only relieved the neck pain but also enhanced the strength and functionality of the surrounding muscles, which probably helped to improve general comfort and body mechanics (Elsayed et al., 2019).

Interestingly, the position in which the treatment was administered did not significantly impact the outcomes. Whether the neck was in a neutral position or rotated to the right or left, the improvements in pain levels and function were similar across all groups. Thus, the therapeutic effects of conventional treatment may not be sensitive to head-neck positioning. Rather, the therapy itself regardless of starting position seems to be the key factor driving improvement (Wollesen et al., 2020).

The findings align with previous studies (Lytras et al., 2019, Mata et al., 2024).on CMNP, which have consistently demonstrated that traditional physical therapy, including manual therapy and exercise, can significantly reduce pain and improve physical function in patients suffering from CNP. These therapies typically target the musculoskeletal system, aiming to restore range of motion, alleviate discomfort, and enhance muscle strength.

In agreement with our investigations, (Tutar et al., 2024) as they found that treatment significantly enhanced outcomes in the patient group compared to the control group, specifically in hand grip strength. There was a statistically significant increase in the right-hand grip strength (from 45.21 ± 11.47 lb-f to 56.50 ± 4.59 lb-f) and left-HGS (from 42.62 ± 12.34 lb-f to 53.83 ± 7.36 lb-f) for both women and men in the patient group in comparison with the control group ($p < 0.05$). Additionally, a statistically significant difference was found in the right hand finger lateral grip strength for women (from 13.56 ± 2.07 lb-f to 14.90 ± 1.86 lb-f) in comparison with the control group ($p < 0.05$). However, no significant differences were found for the left hand finger lateral grip strength in women or for both hands in men ($p > 0.05$).

Consistent with our findings, Alatawi's study [27] determined that HGS was maximal in the neutral head as well as neck position (HNP) and minimal in extension (30°) across both dominant and non-dominant sides. After testing both dominant as well as non-dominant hands in neutral, flexion (40°), along with extension (30°) positions, researchers found no statistically significant difference in HGS ($p > 0.05$). On the other hand, when comparing dominant HGS in neutral with non-dominant HGS in extension, a statistically significant difference was seen ($p = 0.021$; $p = 0.018$).

On the other hand, (Kumar et al., 2012) found that the left side of the head-neck rotation had the strongest grip. This difference may be attributed to that they involved healthy young volunteers, whose responses to head-neck movements are likely more typical and predictable, which may explain why left head-neck rotation resulted in superior grip strength in their study.

Conversely, Lee et al. (2010) discovered that the head-neck rotation posture produced somewhat better results than the head-neck neutral position when assessing grip strength in healthy individuals. The placement of kinesio tape on the hand's flexor muscle during the grip strength test could account for the discrepancy. According to the company that makes Kinesio tape, it improves muscle function by fortifying weak muscles. By improving blood and lymph circulation in the taped area, kinesio tape may cause physiological changes in muscle and myofascial actions (Sarhan, 2024).

Conclusion

Different head-neck positions did not significantly affect upper extremity function, hand grip strength, or pain in patients with neck pain. Future studies on HGS should take factors like sex, age, and BMI into account.

Financial support and sponsorship: Nil

Conflict of Interest: Ni

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