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Original Article

Efficacy of ultrasound therapy with neck retraction exercises vs. ultrasound therapy with deep cervical flexor training for excessive screen time users: a pilot randomized controlled study

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Abstract. [Purpose] To compare the effectiveness of ultrasound therapy in combination with neck retraction exercises and deep cervical flexor training on pain, forward head posture, and deep cervical flexor muscle strength in excessive screen time users. [Participants and Methods] This 4-week intervention study included 36 participants with forward head posture, categorized into three groups: 1) ultrasound therapy with neck retraction exercises 2) ultrasound therapy with deep cervical flexor training, and 3) a control group. The outcomes were pain, forward head posture, and strength of the deep cervical flexor muscles. [Results] The strength of the deep cervical flexor muscles exhibited a notable increase, indicating a relatively higher mean value in the first intervention group. Upon follow-up, significant changes in all outcomes were observed between the first intervention group and the control group. Also, significant differences were revealed in the deep cervical flexor muscles between the second intervention group and the control group. [Conclusion] Ultrasound therapy with neck retraction exercises could have a more positive effect on pain, forward head posture, and strength of the deep cervical flexor muscles in comparison to ultrasound therapy with deep cervical flexor training for excessive screen time users.

Key words: Forward head posture, Neck pain, Ultrasound therapy

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INTRODUCTION

Neck pain is one of the most common musculoskeletal disorders worldwide. The 12-month reported prevalence of neck pain ranged between 42 to 67% in young adults, placing a substantial economic burden on healthcare systems[1–3)]. Neck pain is often the result of strained neck muscles that become irritated from everyday activities. Current evidence suggests that neck pain is negatively associated with health-related quality of life[4)].

We are living in an era of globalization. The smartphone is one of the most important technologies that helps people connect with others, providing an easy and fast way to communicate. With the growing use of smartphones, concerns about adverse health consequences associated with device overuse have also increased[5, 6)].

Forward head posture (FHP) is a postural disorder where the head is held forward to the body's center of gravity. It has also been associated with neck pain and disability[7, 8)]. The results of a study by Elserty et al. indicated a significant correlation between musculoskeletal discomfort and posture during smartphone use[9)]. According to previous studies, the most common pain areas among smartphone users were the neck, shoulders, and upper back, respectively[10–12)].

Research conducted on a training group which used a combination of ultrasound therapy and active chin tuck exercises showed statistically significant improvement and was found to be superior in improving neck function, whereas the training

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group employing ultrasound therapy with a suboccipital muscle release technique showed a statistically significant reduction in pain[13]. In another study, the researchers indicated that pain and FHP improved following conventional exercises in individuals with neck pain, while the mean improvement was more significant among those who received additional deep cervical flexor (DCF) muscle training using pressure biofeedback[14]. Recently, Swathi et al. found retraction exercises with ultrasound therapy to be more effective than the muscle energy technique in treating patients suffering mechanical neck pain with forward neck posture. However, both treatment techniques demonstrated a more significant improvement in reducing disability when compared to postural advice alone[15].

To the researchers' knowledge, limited studies are available on the use of the physical therapy technique for neck pain with FHP, which includes a follow-up test. Therefore, this study aims to compare the effectiveness of ultrasound therapy in combination with neck retraction exercises and deep cervical flexor training on pain, forward head posture, and deep cervical flexor muscle strength in excessive screen time users.

PARTICIPANTS AND METHODS

This randomized controlled trial study (RCT) consisted of 36 participants sampled from the University of Phayao, Phayao Province, Thailand, under the following inclusion criteria: 1) aged 18–25 years, 2) experienced non-specific neck pain or simple neck pain for more than three months, 3) had a neck pain score ≥4/10 on the numeric pain rating scale (NPRS), 4) had a craniovertebral angle (CVA) of less than 48 degrees, and 5) had at least six hours of screen time each day.

The study excluded volunteers who presented with 1) a cervical spine fracture, radiculopathy in the upper extremity, neck pain with headaches, serious pathology, malignancy, osteoporosis, and disc prolapses, 2) degenerative changes in the cervical spine, and 3) abnormal conditions associated with poor posture.

The sample size was calculated using G*Power 3.1.9.7 (University of Düsseldorf, Düsseldorf, Germany). A statistical significance level of 0.05, effect size 0.3 and power of 80% were used in the sample size calculation, yielding nine participants in each group. To mitigate participant dropout from the research, each group was comprised of 12 participants.

The pilot study was approved by the University of Phayao Human Ethics Committee (UP-HEC 1.3/030/66). All participants provided written informed consent prior to testing. The participants were randomly assigned into three different groups by a researcher: the first intervention group, the second intervention group, and the control group.

The outcomes were pain, forward head posture, and strength of the deep cervical flexor muscles, measured using the visual analog scale (VAS), craniovertebral angle (CVA), and craniocervical flexion test (CCFT), respectively. The CVA and CCFT were used in accordance with established protocols. All outcome parameters were measured at the beginning of the study, after four weeks of exercise, and a two-week follow-up.

The first intervention group was subjected to ultrasound therapy with neck retraction exercises three days a week for four weeks, while the second intervention group received ultrasound therapy with deep cervical flexor training three days a week for four weeks. All three groups received a single session of postural advice for good posture. All assessments and interventions were conducted in a laboratory setting at the Department of Physical Therapy, School of Allied Health Sciences, University of Phayao.

Participants were in the prone position when receiving ultrasound therapy on their pain area in a continuous mode, 1 MHz frequency, intensity 0.8w/ cm^2 for 10 minutes[15].

In this study, the level of pain was measured using the VAS. Scores were based on self-reported symptoms, recorded with a single handwritten mark placed at one point along the length of a 10-cm line, representing a continuum between the two ends of the scale—"no pain" on the left end (0 cm) of the scale and "worst pain" on the right end of the scale (10 cm). Measurements from the starting point (left end) of the scale to the participants' marks were recorded in centimeters and interpreted as their pain levels[16].

The CVA was measured using lateral photographs of the head and neck. In this study, the heads and necks of the participants were photographed from the lateral side. Photographs were obtained using a digital video camera (Canon EOS M200 (EF-M15-45mm f/3.5-6.3 IS STM) 24.1 megapixels). The distance between the camera lens and the participant was 150 cm. The height of the camera lens was adjusted to align with the tragus level in each participant's ear, ensuring the lateral tragus was captured at the center of the image. Participants were asked to stand with their head and trunk in the upright position, gazing forward. The same camera was used throughout the study, with the lens always set parallel to the participant and perpendicular to the floor, with the photographs taken using the same settings. Reflective adhesive dots, 8 mm in diameter, were posted on the C7 spinous processes and the tragus of the ear. The CVA was calculated by measuring the angle formed by the line connecting C7 with the tragus of the ear and the horizontal line[17].

In this study, participants were required to attempt 10 repetitions of a 10-s upper cervical flexion hold in the supine position while the pressure generated between the cervical spine and treatment bench was monitored by an inflatable air-filled pressure biofeedback unit. The performance index of the CCFT was calculated by multiplying the pressure increase achieved from a baseline of 20 mmHg (defined as the activation score) and the number of successful holds[18].

Statistical analysis was performed using SPSS statistical package version 26 (SPSS Inc, Chicago, IL, USA). The Shapiro–Wilk test was used to assess the normality of data distribution for each variable. The non-parametric Kruskal–Wallis test, Mann–Whitney U test, Friedman test, and Wilcoxon were performed at a significance level of 0.05. Bonferroni correction was also used to compare the differences between groups at the time of assessment, with α adjusted to 0.016.

RESULTS

At the conclusion of both the training and follow-up periods, no participants dropped out. The baseline characteristics of the participants and all outcome parameters at the baseline assessment are presented in Table 1. There was no statistically significant difference between the three groups for all outcome parameters at the baseline assessment.

According to the Kruskal–Wallis test (Table 2), the CCFT shows statistically significant differences between the three groups after four weeks of intervention (p=0.006). The pairwise comparison approach using the Mann–Whitney U test shows a significant difference in CCFT between the first intervention group and the control group (p=0.039).

At the follow-up assessment, the Kruskal–Wallis test (Table 2) revealed statistically significant differences among the three groups for VAS, CVA, and CCFT (p=0.009, p=0.017, p=0.001, respectively). For pairwise comparison, the results show significant differences in the VAS, CVA, and CCFT between the first intervention group and the control group (p=0.004, p=0.008, p=0.006). In addition, a significant difference in CCFT exists between the second intervention group and the control group (p=0.006).

DISCUSSION

The main findings of this study indicate that ultrasound therapy with neck retraction exercises was more effective than ultrasound therapy with deep cervical flexor training in treating patients with mechanical neck pain and forward neck posture at the end of the study. However, both treatment techniques showed a more significant improvement at follow-up in terms of pain, forward head posture, and strength of the deep cervical flexor muscles when compared to the baseline assessment.

To the researchers' knowledge, this is the first study to compare ultrasound therapy involving neck retraction exercises versus ultrasound therapy with deep cervical flexor training. Shaju et al.[13] reported that the training group receiving a combination of ultrasound therapy with active chin tuck exercise showed statistically significant improvement, and this method was also found to be superior in improving neck function, whereas the training group receiving ultrasound therapy with the suboccipital muscle release technique demonstrated a statistically significant reduction in pain. Alghadir et al.[14] indicated that pain and FHP improved following conventional exercises in individuals with neck pain, and mean improvement was more significant among those who received additional DCF muscle training using pressure biofeedback. Swathi et al.[15]

Table 1. Participants' characteristics at analysis (n=12 per group)

Characteristics	1st intervention group	2nd intervention group	Control group
Gender: Male/Female	5/7	5/7	4/8
Age (years)	21.4 ± 1.1	20.8 ± 0.9	21.1 ± 1.1
BMI (kg/m^2)	24.6 ± 6.9	23.6 ± 2.9	24.2 ± 5.1
VAS (scores)	5.3 ± 1.1	5.5 ± 0.8	5.6 ± 0.9
CVA (degrees)	44.0 ± 2.2	43.5 ± 3.3	45.1 ± 3.1
CCFT (mmHg)	28.5 ± 3.1	28.2 ± 2.8	27.7 ± 2.2

Mean ± SD, VAS: visual analog scale; CVA: craniovertebral angle; CCFT: craniocervical flexion test; SD: standard deviation.

Table 2. Comparison of the data in the three groups (n=12 per group)

Variables	Time	1st intervention group	2nd intervention group	Control group
VAS (scores)	Baseline	5.3 ± 1.1	5.5 ± 0.8	5.6 ± 0.9
	4 weeks	1.8 ± 1.3	1.4 ± 1.3	3.2 ± 2.5
	Follow up	0.8 ± 0.9**	1.5 ± 1.3	3.1 ± 2.3
CVA (degrees)	Baseline	44.0 ± 2.2	43.5 ± 3.3	45.1 ± 3.1
	4 weeks	50.1 ± 3.8	47.2 ± 3.6	46.3 ± 3.1
	Follow up	50.7 ± 3.3**	48.2 ± 3.0	46.3 ± 3.4
CCFT (mmHg)	Baseline	28.5 ± 3.1	28.2 ± 2.8	27.7 ± 2.2
	4 weeks	30.0 ± 0.0**	29.8 ± 0.6	28.2 ± 2.3
	Follow up	30.0 ± 0.0**	30.0 ± 0.0**	27.5 ± 3.5

Mean ± SD.
**p<0.01: comparison with the control group.
VAS: visual analog scale; CVA: craniovertebral angle; CCFT: craniocervical flexion test; SD: standard deviation.

revealed that retraction exercises with ultrasound therapy were more effective than the muscle energy technique in treating patients with mechanical neck pain and forward neck posture. However, both treatment techniques showed a more significant improvement in reducing disability when compared to postural advice alone.

In line with previous studies, our findings show that combining ultrasound therapy and neck retraction exercises is superior to a combination of ultrasound therapy and deep cervical flexor training. This may be because, in the present study, the neck retraction exercise is likely to result in cervical traction, which is good for stretching or loosening the muscles at the back of the neck. This exercise was performed in a supine position. It is possible that trunk stabilization may also significantly enhance traction. The neck retraction exercise may result in biomechanical changes around the neck region as well as posture adjustment in the activities of daily life. As far as we can ascertain, no previous research has performed a follow-up test. One possible reason for the results in the present study is that the combination of postural education and interventions may influence the long-term outcome parameters.

Some limitations were found in this study. Firstly, the study's results cannot be generalized to all age groups since it was conducted on volunteers aged 18–25 years. Further research is required to provide evidence to clarify this point. Secondly, the study only examined the short-term effects of the intervention. Thus, it is suggested that future studies be conducted using a longer intervention period. Lastly, the present study does not consider objective pain assessment. For added benefit, future studies should include pressure pain threshold (PPT).

In conclusion, this study shows that ultrasound therapy with neck retraction exercises could have a more positive effect on pain, forward head posture, and strength of the deep cervical flexor muscles in comparison to ultrasound therapy with deep cervical flexor training. Clinically, the results of the current study may provide implications for physiotherapists in managing pain and the forward head posture of individuals affected by excessive screen time.

Conflict of interest

The authors report no conflicts of interest.

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