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Dry Needling Effects of the Upper Trapezius Muscle on the Angles and Range of Motion of the Neck in Individuals with Forward Head Posture

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ABSTRACT

Introduction: Forward head posture (FHP) is one of the most common positional deviations. Frequent users often exhibit incorrect posture because of the rising popularity of media devices, such as smartphones and computers. This posture leads to changes in muscle activity in cervical flexion and extension. It is defined by hyperextension of the upper cervical vertebrae and forward translation of the cervical vertebrae. This study evaluates the effect of dry needles as a new method in the upper trapezius muscle on the neck's angles and range of motion (ROM) in individuals with FHP.

Materials and Methods: In this quasi-experimental interventional study, 18 women with FHP underwent a dry needle session. The photogrammetry of the cranio-vertebral angle measured the degree of FHP. Visual analog scale (VAS), pain pressure threshold (PPT), cranio-vertebral angle (CVA) and cranio-horizontal angles (CHA), ROM, scapular index (SI), and forward shoulder translation (FST) were assessed before and after the intervention.

Results: The results demonstrated that after the intervention, right and left PPT, flexion, and proper neck rotation, right and left SI, CVA, and CHA were significantly improved ($P<0.05$).

Conclusion: The results showed that one session of dry needling with stretching exercises intervention could improve PPT, ROM, SI, CVA, and CHA and consequently improve FHP.

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Introduction

Forward head posture (FHP) and rounded shoulder are the most common positional deviations [1] in the neck and shoulder area in adults [2, 3] and adolescents [4]. Frequent users often exhibit incorrect posture because of the rising popularity of media devices, such as smartphones and computers. FHP is an unrestricted forward deviation of the head (in standing or sitting situations) relative to the vertical line [5-7].

This posture might be caused by neck injuries, cervical muscle weakness, and improper postures [8], leading to changes in muscle activity in cervical flexion and extension [9, 10]. Shortened muscles include the upper trapezius, pectoralis, levator scapula, sternocleidomastoid [11, 12], and cervical extensors (sub-occipital, semispinalis of the neck and head, splenius) [13]. Meanwhile, weakened muscles include short, deep flexors of the cervical region [5, 14, 15], longus capitis and coli, serratus anterior, rhomboid, and lower trapezius [16].

This situation leads to forward deviation of the head, reduction in the range of motion (ROM) and the craniovertebral angle (CVA), an increase in the craniohorizontal angle (CHA), and chronic pain in the neck, shoulder, and upper and lower back [10].

The dry needle is an intramuscular inducement and invasive process that involves pushing a needle into the skin and muscle, especially to activate the myofascial trigger point to treat functional movement disorders and neuromuscular pain [17].

Dry needle causes inactivation of the trigger point, normalization of the chemical environment of the active trigger point, short muscle releasing, elimination of muscle stimulation source, normalization of peripheral nerve sensitivity, reduction of spontaneous muscle activity, and local and referral pain, and also restoration of ROM and muscle activity pattern. Stimulation of specific tissues or nerves by needle could increase the entry of afferents into the central mechanism, which could close the pain gate for the entry of afferents from particular areas of the body [18, 19].

Considering that the leading cause of FHP is muscle imbalance and that dry needling has some positive effects on muscle activities, this study evaluates the impact of dry needling of the upper trapezius muscle on the angles and ROM of the neck in individuals with FHP. Also, according to our previous knowledge, the effects of dry needle in individuals with FHP has not been studied yet.

Materials and Methods

Study design

This quasi-experimental study was conducted in the School of Rehabilitation, Tehran University of Medical Sciences, Iran.

Study participants

The study population consisted of 18 females with FHP who were enrolled according to the inclusion criteria and after obtaining signed informed consent from them. The study sample size was determined based on the pilot study data (cranio-horizontal angle) (Equation 1 and Equation 2):

1. $n=(Z_{1-\alpha/2}+Z_1-\beta)^2 (\sigma_1^2+\sigma_2^2)/(X_1-X_2)^2$

2. $n=10 ((2.75)^2+(4.25)^2)/(23.09–19.24)^2=17.28$

Inclusion criteria

The inclusion criteria were being 21 to 40 years old and having a CVA of <50 degrees [20].

Exclusion criteria

The exclusion criteria were having a history of central nervous system diseases, musculoskeletal disorders, fractures and surgery of the neck and shoulders, congenital neck problems, spondylosis, medical treatment or physiotherapy for the neck pain, any diagnosed mental disorders, such as anxiety and depression, tumors, and pregnancy [21-24]. Also, the exclusion criteria consisted of having conditions in which dry needles cannot be used, such as systemic disease, fever, high anxiety, feeling faint, bleeding problems, use of anticoagulants, and seizures or epilepsy [25].

Study procedure

The participants were evaluated for the inclusion criteria and CVA. Participants with a reduced CVA (less than 50 degrees) were invited to participate in the study. First, individuals were given a brief description of the session's duration and the assessment type. Afterward, the demographic questionnaire was completed, which included age, height, weight, and body mass index (BMI).

At first, the initial assessments, such as pain intensity, pain pressure threshold (PPT), CVA, CHA, ROM, scapular index (SI), and forward shoulder translation (FST) were performed. Then, the participants received a dry needle intervention with

stretching exercises. Reassessment was conducted immediately after the intervention to evaluate the immediate effects.

Study assessments

Visual analog scale (VAS)

A 100-mm ruler with a 0-100 mm scale was used for the visual analog scale (VAS) assessment. The participants marked the amount of pain on the chart [26].

Pain pressure threshold

The participants were seated, and the algometer (SF500-Taiwan) was placed vertically on the motor point (applying pressure with a relative increase of 1 kg/s). The participants had reported the onset of pain. This method was repeated thrice with specified intervals (60 s), and their average was reported [27]. The results of the study indicated that the intra-rater reliability (Cronbach α=0.94-0.98) of the pressure algometer was very high for the upper trapezius muscles tested (right=0.939 and left=0.980) [28].

Cranio-vertebral angle

In sitting, the participants were asked to look ahead, bend their heads three times, and straighten again. When the participant was completely relaxed, the angle was measured from the lateral view (left) with a digital camera (Samsung Galaxy J7, 13-megapixel, 2016) [29-31]. According to the landmarks of the seventh cervical vertebrae and tragus of the ear, the CVA was determined by connecting a line from the spinous process of the seventh cervical vertebra to the tragus of the ear and the horizontal line passing through the spinous process of the seventh cervical spine [32]. The results of the study indicate a good inter-rater reliability (ICC=0.76; CI=0.65-0.84) as well as intra-rater reliability (ICC=0.87; CI=0.82-0.91) between three successive CVA measurements [33] (Figure 1).

Cranio-horizontal angle

The initial steps and adjustment of the camera were similar to the CVA measurement. According to the landmarks of the ear's tragus and the external angle of the eye, the CHA was determined by connecting a line from the ear's tragus to the external eye angle and the horizontal line passing through the ear's tragus [32]. The study results indicate the head tilt angle (CHA) may not detect the subject with moderate-severe and non-FHP as efficiently as CVA. Meanwhile, CVA and CHA have excellent inter-rater and intra-rater reliability to measure FHP in healthy females. Also, the photogrammetric method had excellent inter and intra-rater reliability to assess the head and cervical posture [34] (Figure 1).

A protractor application (good to excellent Intra-rater and inter-rater reliability, 2017) was used to calculate the CVA and CHA. The reliability of this application is similar to that of AutoCAD [29].

Range of motion

In the sitting position, while the soles of the feet were on the ground, goniometer was placed at the proper position and forward head flexion (goniometer axis: Above the ear, fixed arm: Perpendicular to the ground,

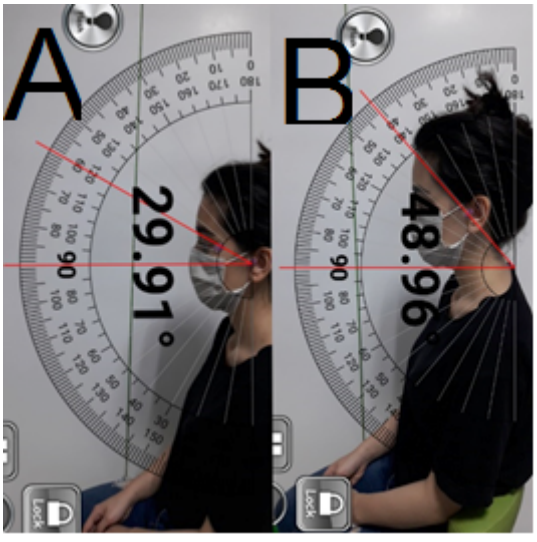

Figure 1. Cranio-horizontal angle (A) and cranio-vertebral angle (B) with on-protractor application

movable arm: Parallel to the ground), right and left rotation (goniometer axis: On the head, fixed arm: Similar to the horizon line, movable arm: Parallel to the horizontal center axis of the head), right and left lateral flexion (goniometer axis: Back of the head on the hypothetical midline of the head, fixed arm: Perpendicular to the ground, movable arm: Parallel to the hypothetical vertical line of the head) were measured. Each test was conducted thrice, and the mean value was reported for the final analysis [35, 36].

Scapular index

In the standing situation with hanging arms, the distance between the coracoid process to the sternal notch and between the posterior edge of the acromion and the thoracic vertebra was measured with a measuring tape. The SI was calculated as a percentage according to the formula (the distance between two anterior landmarks was divided by the distance between the two posterior landmarks) [37].

Forward shoulder translation

In the upright position, the distance from the posterior outer part of the acromion to the rear view was determined with a tape to calculate FST [38].

Study interventions

Dry needling for upper trapezius muscle

The participants were placed in a sitting position with support [39]. The hygienic protocols were performed, and the exact motor point area of the upper trapezius muscle on both sides (the midpoint of the connecting line between the acromion and the spinous process of the seventh cervical vertebra) was determined [40]. The needle (40×3.0 mm, Tony, China) was inserted perpendicular to the motor point. It rotated 360 degrees counterclockwise for 15 s to make one rotation per second, and then the needle remained in the tissue for 20 min [41] (Figure 2).

Stretching exercises

Sternocleidomastoid muscle

In a standing position, while having one hand behind the body, the head and neck were bent so that the ear would be close to the opposite shoulder, and the head was turned upward to feel the stretch. Stretching was performed for both sides [42-46].

Pectoralis muscle

The participants were placed on a foam roll in the supine position, with their legs slightly bent and the shoulders and elbows in a 90-degree position so that the palms would be close together. Then, the scapula was retracted, and the palms were apart [47-50].

Cervical extensor muscle

The participants were lying supine, trying to push their chin toward the bed [47-51]. Each stretch was conducted during two sets, repeated ten times, and held for 30 s [52].

Statistical analysis

All the statistical tests were conducted using the SPSS software, version 23. Descriptive statistics were used for anthropometric data (Table 1). Normal distribution of the data was determined using the Kolmogorov-Smirnov test. The test showed that data had a normal distribution ($P>0.05$); therefore, the paired t test was used to evaluate the intra-group effects ($\alpha=0.05$).

Results

Figure 2. Dry needling application on the upper trapezius muscle

Table 1. The information of paired t test (n=18)

Variables	Mean±SD				Mean Difference		CI		P	
	Pre		Post				Lower	Upper		
VAS (mm)	1.94±6.11		1.65±5.55		0.55		-0.11	1.22	0.09	
CVA (degree)	5.90±38.01		6.47±41.20		-3.17		-4.80	-1.54	0.00*	
CHA (degree)	4.91±30.20		5.56±28.09		2.11		0.92	3.30	0.00*	
Flex (degree)	6.02±39.57		7.00±44.33		-4.75		-8.20	-1.33	0.00*	
	Right	Left	Right	Left	Right	Left	Right Left	Right Left	Right	Left
Lat.flex (degree)	8.20±36.60	7.53±36.33	6.90±39.51	7.75±38.44	-2.90	-2.11	-5.82 -5.15	0.00 0.93	0.05	0.16
Rot (degree)	11.90±57.20	10.36±62.70	11.20±62.81	11.50±65.34	-5.61	-2.64	-10.63 -5.42	-0.59 0.13	0.03*	0.06
SI (%)	20.14±75.24	21.36±79.50	20.75±79.89	21.56±84.02	-4.65	-4.51	-6.77 -7.60	-2.53 -1.42	0.00*	0.00*
FST (cm)	1.01±12.14	1.40±12.50	0.94±11.94	1.57±12.41	0.19	0.05	-0.19 -0.27	0.58 0.38	0.31	0.72
PPT (kg/cm^2)	1.68±4.45	1.47±4.52	1.23±3.72	1.35±3.85	0.73	0.66	0.08 0.24	1.38 1.09	0.03*	0.00*

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Abbreviations: VAS: Visual analog scale; PPT: Pain pressure threshold; Lat. flex: Lateral flexion; Rot: Rotation; SI: Scapular index; FST: Forward shoulder translation; CVA: Cranio-vertebral angle; CHA: Cranio-horizontal angle.

*The values are according to Mean±SD.

The data was collected from 18 female participants with FHP, and their demographic data in terms of Mean±SD were as follows:

Age=35.17±5.80 years; height=160.80±7.30 cm; weight=67.75±10.14 kg; and body mass index=26.15±3.30 kg/m^2.

The paired t-test results showed that the variables of right and left PPT, cervical flexion, and proper rotation, right and left SI, CVA, and CHA had significantly improved after the intervention ($P<0.05$).

Discussion

This study showed that dry needles with stretching exercises could improve the right and left PPT, cervical flexion, proper rotation, right and left SI, CVA, and CHA.

The effects of dry needles in individuals with FHP have not been studied yet. Most studies have examined the impact of dry hands on myofascial pain syndrome (in the neck and shoulder areas). These studies have shown contradictory results. Accordingly, a review study found that a dry needle did not affect the ROM of the neck in comparison with a placebo dry needle [53]. On the other hand, another review study stated moderate evidence about the effectiveness of dry needles in improving the neck's ROM (lateral flexion) and weak evidence about its efficacy on functionality and quality of life of the participants [54]. However, others have considered dry needling more effective than placebo dry needling in reducing pain and improving the participants' quality of life [55]. Therefore, it was necessary to investigate the effects of dry needling on pain, range of motion, and postural parameters in individuals with FHP. If dry needling effectively improves the head position, this intervention could be a new treatment for these individuals.

Dry needling could improve the ROM and muscle shortening and change muscle activity. However, the exact mechanism of how dry needles work is not fully understood, and mechanical and neurophysiological theories are proposed. Neurophysiological effects include reduced metabolic mediators, increased microcirculation, decreased peripheral pain afferents, and activation of descending inhibition control systems. Dry needle causes micro-trauma (which destroys the axon motor end plate) and denervation. This destruction causes hyper-stimulation, which stops the pain cycle created by the positive feedback chain [8, 55-57]. Since motor points are specific points in the muscle with the most concentration of the motor end plates and thick nerve fibers [58], in the present study, dry needling was performed precisely at the motor point of the upper trapezius muscle. Accordingly, the mentioned mechanisms might be the reason for improving the PPT in this study.

The proposed mechanical effects of dry needles on the shortened muscles include destroying contractile nodes and local stretching of contracted cytoskeletal structures. This reduces the overlap of actin and myosin filaments to sarcomere return to resting length. In addition, flexibility means the muscle's ability to increase its length and allow the joint to move along the range of motion [59]. Hence, the possible mechanisms of dry needle effect, which cause short muscle flexibility and subsequent improvement of ROM, might be muscle relaxation following neurological factors caused by dry needle effect on the muscle that stimulates sensory fibers and its transfer to higher centers [19, 60, 61], sarcomere returning to rest length with disruption of cytoskeletal structures and decreasing actin and myosin overlap (mechanical theory) and increasing blood flow and oxygen delivery that counteract muscle contraction (neurophysiological theory) [62-64].

Therefore, by increasing the flexibility of the upper trapezius muscle, dry needling could play an effective role in managing the trapezius muscle shortness and improving FHP by improving the CVA and CHA. Then, in the present study, a dry needle increased the neck's ROM by modifying the pattern of muscle activity and increasing the flexibility of the upper trapezius muscle.

Additionally, FHP increases neck lordosis, thoracic kyphosis, and FST [5, 14, 15]. Therefore, due to the role of the dry needle in improving FHP, the FST (SI) improvement has also occurred following the head position improvement.

On the other hand, studies have shown muscle stretching improved postural parameters, including CVA flexion ROM in females with FHP [65]. The proposed mechanical effects of stretching exercise on the shortened muscles include improved flexibility, blood circulation, and stretching of contracted cytoskeletal structures, reducing the overlap of actin and myosin filaments [66-68]. Hence, in the present study, maybe part of the effects is related to stretching exercise.

As mentioned, dry needling with stretching exercises improved the variables by increasing blood flow, pain gate, muscle flexibility, and muscle spindle re-adjustment.

This study only examined the immediate effects and did not examine the short-term, medium-term, and long-term outcomes and complications. It is recommended that future studies extend the follow-up time to examine them, too. In addition, the design of clinical trial studies is essential to select the most effective intervention. It is also suggested that in subsequent studies, patients would be selected from both sexes to obtain more comprehensive results.

Conclusion

The results showed that one session of dry needle therapy with stretching exercises could improve PPT, ROM (flexion and rotation), SI, CVA, and CHA, which improved FHP. Therefore, a dry needle could be used as a new approach to enhance FHP.

Ethical Considerations

Compliance with ethical guidelines

All procedures performed in the present study were following the ethical standards. This project was approved by the Ethics Committee of the Tehran University of Medical Sciences (Code: IR. TUMS. MEDICINE.REC.1400.884), and it was registered at Iranian Registry of Clinical Trials (IRCT) (Code: IRCT20211017052787N1).

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Authors' contributions

Conceptualizations, study design, data analysis and data interpretation: Sara Golzareh, Azadeh Shadmehr and Sara Fereydounnia; Methodology: Azadeh Shadmehr, Khadijeh Otadi and Sara Fereydounnia; Data collection: Sara Golzareh; Draft manuscript preparation and final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

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