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The Effect of an 8-Week Corrective Exercise Program on Head and Shoulder Angle, Neck Muscle Activity and Range of Motion in Subjects with Forward Head Posture: Randomized Controlled Trial

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THE EFFECT OF AN 8-WEEK CORRECTIVE EXERCISE PROGRAM ON HEAD AND SHOULDER ANGLE, NECK MUSCLE ACTIVITY AND RANGE OF MOTION IN SUBJECTS WITH FORWARD HEAD POSTURE: RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Postural disorders change muscle activity and lead to musculoskeletal dysfunction. **Aim:** To evaluate the effect of an 8-week corrective exercise program on posture, muscle activity, and neck range of motion (ROM) in subjects with forward head posture (FHP). **Design:** Randomized controlled trial. **Methods:** 36 healthy males with FHP participated in this study, who were divided randomly in two equal control (age; 21.34±2.06 years, height; 177.02±4.7 cm, weight; 64.2±8.4 kg) and exercise (age; 21.69±1.71 years, height; 173.94±3.81.0 cm, weight: 62.93±12.99 kg) groups. the exercise group received an 8- week exercise protocol. The control group did not attend in a regular training protocol. Forward head and forward shoulder angles measured with the photography method. Sternocleidomastoid (SCM) activity was recorded with surface EMG and neck ROM of the neck acquired by universal goniometer before and after an 8-week exercise program. **Results:** T-test results showed SCM activity (59.41% ↓, P= 0.02), FHP (15.74% ↓, P= 0.00) FSH(11.6% ↓, P= 0.00) decreased significantly while neck flexion ROM (16.47% ↑, P= 0.00), rotation to right (15.34% ↑, P= 0.00) and rotation to left (14.00% ↑, P= 0.01) increased significantly after the 8-week exercise program. The calculated effect sizes for these findings were large. **Conclusion:** The 8-week corrective exercise decreased muscle activity of superficial neck flexors, improved head posture, and prompted neck flexion ROM. Based on these findings we propose that an 8-week corrective exercise may be implemented as a practical method in managing forward head posture.

Keywords: **F**orward head posture, Electromyography, Muscle activity, Range of motion

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INTRODUCTION

Forward head posture (FHP) is a change in normal lordosis of the cervical spine which the modern lifestyle such as widespread use of communication tools and computers increase its prevalence (Park, Kang, Lee, Jeon, & practice, 2017). FHP is highly prevalent with an incidence rate of up to 60% among people (Tavangar, Delkhoush, Mirmohammadkhani, & Bagheri, 2020). The FHP compromises muscular and biomechanical function in the cervical region (Singla & Veqar, 2017), limits carniocervical range of motion (Quek, Pua, Clark, & Bryant, 2013) while increases loading of the cervical spine (Bonney & Corlett, 2002). This condition facilitates joint damage and develops tissue injury and pain (Sheikhhoseini, Shahrbanian, Sayyadi, & O'Sullivan, 2018).

One of the main features of FHP is the change in muscle function (K.-J. Lee, Han, Cheon, Park, & Yong, 2015). The deep neck flexors (DNFs) e.g., Langus Collie and Langus Capits, support normal cervical spine lordosis and stabilize the head. proper stabilization of the cervical spine depends on the synergic activity of deep and superficial neck flexors (G. A. Jull, Falla, Vicenzino, & Hodges, 2009). low activity of DNFs has been observed in people with FHP which implies FHP correlates with the weakness of DNFs. However, the activity of superficial flexor muscles, such as the sternocleidomastoid (SCM), increases compensatory (G. Jull & Falla, 2016). Increased SCM muscle activity is an indicator of decreased activity DNFs that associates with a change in cervical kinematics and cervical feed-forward control (G. A. Jull et al., 2009). These changes impaired the normal movements pattern of the cervical spine which led to a limited range of motion and pain (Sahrmann, 2011).

Retraining of DNFs increases the activity of these muscles (Gwendolen Jull, Sterling, & Falla, 2008). According to the scientific literature, some exercises have been used to activate and strengthen the DNF muscles (D. Falla, Jull, Hodges, & Vicenzino, 2006; D. Falla, Jull, Russell, Vicenzino, & Hodges, 2007; G. A. Jull et al., 2009). Proper activity of DNFs is associated with normal neck posture (Moghadam, Rahnama, Karimi, Amiri, & Rahnama, 2018). Good posture is foundation for optimal neck movements (Sahrmann, 2011). to activate and retrain of DNFs, few exercises with special consideration have been applied for people with neck problems. however, there is not much information in concern to the efficacy of selective exercise to correct faulty alignment of the head and shoulder and restore of neck range of motion The question is, does the exercise program retrains muscles to restore the optimal posture of the head and hits the mobility limitations of a poor posture by establishing proper muscle function. Therefore, we aimed to ascertain the effect of an 8-week exercise protocol on the activity of SCM, posture, and head range of motion in people with FHP.

MATERIALS AND METHODS

Study Design

This study was a single-blind randomized controlled trial with pre-test and post-test design.

our study was approved by the university of Isfahan human research ethic committee IR.UI.REC.1396.044 and registered at Iranian Registry of Clinical Trials IRCT20200203046364N1. The procedures of this work were conducted according to the Declaration of Helsinki. Participants with FHP were recruited through university students by two phase posture screening and then randomly assigned to exercise group (n=16) and control group (n=16). Exercise group received an 8- week supervised training program but control group did not participate in any designed regular program.

Randomization

Randomization is performed by computer-generated algorithms (Random Allocation 1.0). To mask allocation sequence opaque stapled envelopes were used and kept in an isolated place. The main investigator was blinded to how participants allocated to exercise and control groups.

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Participants

Using G-power software (Faul, Erdfelder, Lang, & Buchner, 2007) (G-power 3.1, Germany), A power analysis was run on the results of a published study (Ruivo, Carita, & Pezarat-Correia, 2016). Concerning to FHP angle, thirty-two people (16 per group) were required to meet a significance level of 0.05 with the power of 0.80 and effect size of 1. The sample was raised to 36 to allow for a 10% dropout rate (Table 1). The recruitment process appeared in a flow chart (Fig. 1). Firstly, a two-phase screening test was performed on 250 college students by the investigator. The first phase of screening includes measuring the horizontal distance between the tragus and posterior aspects of Acromion with a set square. If the horizontal distance between the tragus and posterior aspects of acromion was above 5 Cm, the participant was allowed to be evaluated in the second phase. Eligible individuals with the following characteristics have been enrolled in the study: FHP angle above 46◦ (This angle measured by photogrammetry method (Thigpen et al., 2010)), having not regular participation in overhead activities. A history of surgery or fractures of upper limbs or spine over the past year, the presence of neurological disease, scoliosis, failure to complete research tests, irregular attendance at training sessions (up to 3-time absence) led to subject exclusion. All participants were informed of the research conditions and then the subject's consent was obtained. The right to opt-out of study at any time was reserved for all subjects.

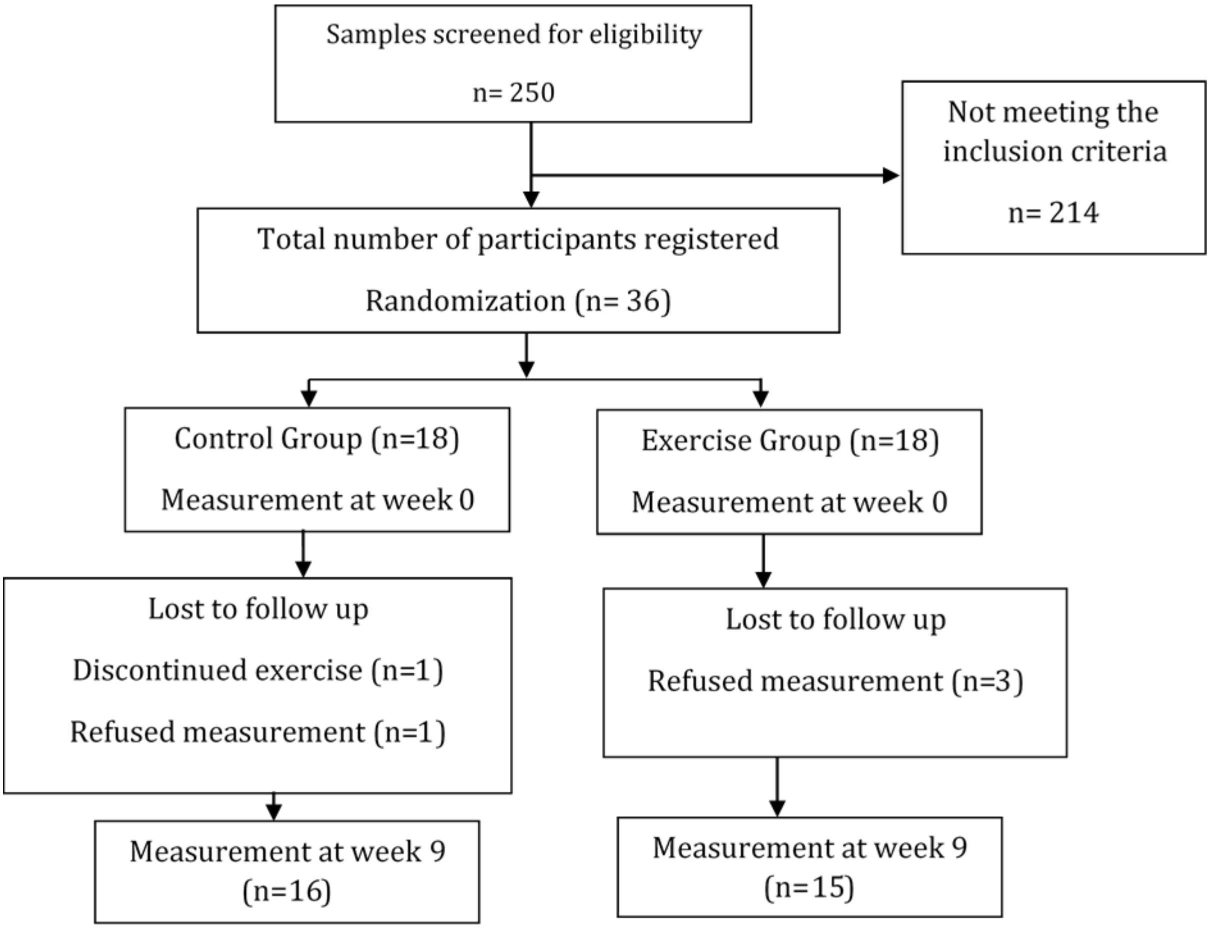

Figure 1. Follow chart of the study

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Procedures

Forward Head and Shoulder Angle

The subject's right tragus, acromion, and C7 vertebrae were marked with light-reflecting sticky labels. Subject stood on a marked spot 40 cm apart from a wall. A digital camera (Sony 14 megapixel, Japan) attached to a 1-meter height tripod, placed at 3 meters away from the subject. Following three trunk flexion, the subject took an upright position and was photographed laterally (Thigpen et al., 2010). All photos were transferred to a laptop and the angle of the head and shoulder calculated by Auto CAD software (v.11, Autodesk, Inc).

Neck Range of Motion

Neck range of motion in sagittal plane assessed by Universal goniometer (Clarkson, 2012) (baseline, USA) as illustrated below; Subjects sited on a comfortable bench. The goniometer axis was placed over the lobule of the ear, the stationary arm was perpendicular to the floor and the movable arm has lied parallel to the base of the nares, so in the start position, the goniometer showed 90°. This is recorded as 0°. Participants asked to flex his neck. At the limit of neck flexion, the goniometer was realigned. The number of degrees the movable arm lies away from the 90° position was recorded as the neck flexion. In order to measure neck extension ROM the same method was applied in the opposite direction. the subject extended back his neck and the goniometer was realigned at the limit of neck extension. The number of degrees the movable arm lies away from the 90° position was recorded as the neck extension. To approach neck rotation goniometer axis lay over the midpoint of the top of the head and the stationary arm paralleled a line joining the two acromion processes. The movable arm of the goniometer was aligned with the nose. In the start position, the goniometer showed 90° this was recorded as 0°. Subjects rotated his head to the right and when reaching the limit of neck rotation, the goniometer was realigned. The number of degrees the movable arm lies away from the 90 ° position was recorded as the neck right rotation ROM. This procedure repeated for left side.

Recording Electromyography Data

A portable surface EMG device (DataLog p3X8, Biometrics, UK) was used to record electromyography activity. Skin preparation perfumed as follows: Skin was shaved and cleaned by 70% isopropyl alcohol to reduce skin impedance below 10 Ω (Mendez-Rebolledo, Gatica-Rojas, Martinez-Valdes, & Xie, 2016). Bipolar surface electrodes with a fixed 2cm center-to-center electrode distance (SX230, Biometrics, UK) were attached over the belly of the sternal portion of SCM muscle using the die-cut medical-grade double-sided adhesive tape (T350, Biometrics), (Kumar, Narayan, & Amell, 2001). The Earth's electrode (R206, Biometrics) was placed on the Styloid process of the radius. The sample rate was set at 1000Hz and gain 1000, bandwidth was 20-450 Hz.

The standard maximal voluntary isometric test (MVIC) was used for normalizing neck muscle EMG data. Participants adequately practiced to familiar with the correct test position (Castelein, Cools, Parlevliet, & Cagnie, 2016). During the MVIC phase, according to Kendall's recommendation, manual resistance was applied in the test position by the examiner (Weon et al., 2010). Verbal encouragements such as "strong and consistent" were given to the participants to boost maximal effort during MVICs. Each participant performed three 5-second MVICs for SCM muscle. The rest time was 30 seconds between each repetition. The middle 3second of every 5second trial was used for analysis. Raw data were analysed with Datalink software version 5.06 (Biometrics, Ltd). After rectifying and smoothing the signal, RMS was calculated at a time constant of 50 Ms for 3 seconds. Following MVIC and 5 minutes of rest (Castelein et al., 2016), each participant performed arm elevation in the scapular plane during three phases including concentric, isometric, and eccentric phases, each one lasting 3 seconds. Similar to MIVC, participants had practiced arm elevation to acquire reliable and the desired speed of that task. Arm

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elevation task performed, without any load, five times with a three-second rest between each repetition (De Mey, Danneels, Cagnie, & Cools, 2012). The mean RMS value was calculated from the middle three attempts out of five. To calculate the percentage of muscle activity, RMS mean divided with MVIC value, multiplied by 100.

Exercise Protocol

The training program included stretching, strengthening, and stabilization exercises (Cools et al., 2007; Ishigaki et al., 2014; Kisner & Colby, 2007; Sahrmann, 2011). Table 1 provides a description of exercise applied during our study (Table. 1). This 8-week training program was performed with three sessions per week, each lasting <50 minutes. To enhance exercise efficacy, exercise variation was set according to the ACSM recommendations ("American College of Sports Medicine position stand. Progression models in resistance training for healthy adults," 2009). All training sessions contained three phases: standard warm-up, the main part, and cool-down. The duration of the stretching exercises was 30 seconds for the initial sessions, which were added five more seconds every two weeks (Clark, Lucett, & National Academy of Sports, 2011; Wang, McClure, Pratt, & Nobilini, 1999). Carnicervical flexion training consisted of movements that were done without any load in prone and quadruped positions. Overload is applied through an increase in the repetition of correct movement, duration of holding given position, and the range of motion, as well (Sahrmann, 2011). Initial exercise loads were selected based on body weight, but they were individualized by calculating 10 repetition maximum (10RM) for each participant (Corporation, 2000). Since participants were beginners, the exercises began with three repetitions of 12 at 40% intensity of 10RM, increased by 10% every two weeks and ended with 70% intensity of 10RM in the final sessions (Prentice, 2011; stand., 2009)

Table 1. Participants' descriptive characteristics expressed as mean ± Standard deviation (M±SD), and normality distribution

Measure	Group	M±SD	t	P
Age (year)	Control	20.14±1.71	1.94	0.16
	Exercise	21.44±2.06		
Height (cm)	Control	176.9±4.7	-1.70	0.09
	Exercise	174.20±4.00		
Weight (kg)	Control	64.26±8.4	-1.08	0.28
	Exercise	62.93±12.99		
BMI	Control	21.20±1.9	-0.482	0.63
	Exercise	20.62±3.9		

Statistical Analysis

All statistical analyses were performed using SPSS software (Ver. 21, IBM, Inc.). The statistical significance level was defined as $p < 0.05$. Descriptive statistics such as the mean, standard deviation, and percentage were provided for both groups. The Shapiro -Wilk test was used to assess normality. Paired and independent t-test was used to consider within and between group differences, respectively. Furthermore, Cohen's d was applied to estimate the effect size, and values were interpreted as follows less than 0.4 as small, from 0.41 to 0.8 as moderate, and greater than 0.81 as strong (Cohen, 1988).

RESULTS

The results of the Shapiro-Wilk test showed that all variables had a normal distribution (P> 0.05). In connection with these variables, an independent t-test showed no significant difference between control and exercise groups (P< 0.05). Within-group differences are considered by paired t-test. As result, values of SCM activity (59.41% ↓, P = 0.00), FHP angle (15.74% ↓, P = 0.00), FSH angle (11.6% ↓, P = 0.00), neck flexion ROM (16.47% ↑, P = 0.00), neck extension ROM (7.29%↑, P = 0.02), neck rotation to right (15.34↑, P = 0.00) and neck rotation to left(14% ↑, P = 0.01) showed significant differences in exercise group when these values compared before and after exercise program (Table 3). In the case of the control

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group, Paired t-test revealed no significant within-group differences through comparison of values before and after the exercise program (Table 2). However, statistically difference between the experimental and control groups for SCM activity (P = 0.01, ES = 0.98), FHP angle (P = 0.00, ES = 0.83), FSH angles (P = 0.00, ES = 1.27), neck flexion ROM (P = 0.01, ES = 0.94), neck rotation to right ROM (P = 0.00, ES = 1.15) and neck rotation to left ROM (P = 0.01, ES = 1.01) was found by independent t-test after exercise program (Table 4).

Table2. Exercise description included in 8-week exercise protocol

Exercise	Principal muscle	Description
Sternocleidomastoid stretch	Sternocleidomastoid	Subject assumes optimal posture and places right arm behind body, left laterally flexes and right rotates the head and neck and then extends the lower neck while tucking the chin in.
Static levator scapulae stretch	Levator scapula	The subject assumes optimal posture and places right arm behind body, depressing the shoulder. Draw abs in, tuck chin and slowly draw left ear to the left shoulder. Continue by rotating the neck downward toward the ceiling until a slight stretch is felt on the right side. We can use the left hand, apply slight pressure and assist in lateral flexion and rotation. Switch sides and repeat
One sided unilateral self, stretch exercise	Pectorals minor	The subject stabilizes forearm by a vertical plane before the trunk is rotated in the opposite direction. Therefore, the arm on the involved side is externally rotated and abducted to 90˚.
Foam roll stretch		The subject lies on its back on the rolling foam, shoulders abducted and laterally rotated, foramens touch down the surface
Cranicervical flexion training	Longus colli Longus capitis	The subject assumed a crook-lying position with the neck in a neutral position. As subject looks at the ceiling, lowers his chin to chest. Holds for 5 seconds. Subject should feel a gentle stretch from your neck to the base of your skull.
Quadruped position	Intrinsic cervical spine extensors	The patient is instructed to "roll" the head clown and then roll the head back while imagining that there is a rod running through the middle of the neck and rotating about the rod.
Y to I exercise	Middle trapezius Lower trapeziusserratus anterior	The subject is instructed to retract the scapulae with the arms abducted to 90˚. As the patient advances, the shoulders are externally rotated with the elbows flexed to 90˚, forming a “Y”. Then the patient moves into a position of full bilateral elevation with the elbow extension forming a “I”.
Side lying external rotation	Teres minor Infraspinatus	Side lying with arm fully adducted to side and internally rotated, with elbow flexed to 90˚. Subject then externally rotates the shoulder with the hand moving in an arc away from the body
Prone horizontal abduction with external rotation	Middle trapezius Lower trapezius. Rhomboids Infraspinatus Teres minor	In a prone horizontal abduction position the patient horizontally abduct the arm with the elbow extended and with external humeral rotation. The subjects lift hand toward the ceiling keeping head/neck neutral and squeezing both shoulder blades together.
Back to wall sitting, shoulder flexion with lateral rotation	Integration upper body muscle	The subject assumes the same head and trunk alignment, as described, of correct positioning of the lumbar spine, scapulae, and cervical capital flexion. The patient performs shoulder flexion and lateral rotation to 90 degrees with the elbows. Flexed and the "palms facing you." The patient is then instructed to perform shoulder flexion by "reaching up toward the ceiling."

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Table 3. Within-group differences in electromyography, postural and biomechanical measures of control and exercise group

Group	Variables	Mean ± SD Pre-test	Mean ± SD Post-test	Δ	t	p	Cohns's *d*
Control	SCM(%MVIC)	29.03±17.66	30.81±18.91	6.13 ↓	0.76	0.45	-
	FHP(◦)	48.17±2.09	47.78±4.20	0.80↓	0.45	0.65	-
	FSH(◦)	57.80±5.01	57.64±5.82	0.27↓	0.11	0.90	-
	NFR(◦)	37.57±7.08	36.85±5.86	1.96↑	1.14	0.28	-
	NER(◦)	47.57±8.55	48.78±8.84	2.54↑	0.43	0.67	-
	NRRR	64.85±9.13	65.24±8.36	0.60↑	0.59	0.56	-
	NRLR	65.21±8.50	65.64±7.69	2.2↑	0.29	0.77	-
	NLFR	44.57±8.34	45.50±7.10	2.08↑	0.56	0.58	-
Exercise	SCM(%MVIC)	41.03±18.81	16.65±7.85	59.41↓	6.28	0.00	1.61
	FHP(◦)	50.08±3.09	42.16±2.48	15.74↓	6.42	0.00	2.82
	FSH(◦)	56.85±4.98	50.25±5.77	11.6↓	6.52	0.00	1.33
	NFR(◦)	36.42±5.69	42.42±5.94	16.47↑	-4.83	0.00	1.03
	NER(◦)	51.69±12.09	55.46±8.14	7.29↑	-2.50	0.02	0.36
	NRRR	64.91±7.49	74.87±8.22	15.34↑	4.98	0.00	2.54
	NRLR	67.84±7.74	73.92±8.05	14.00↑	3.04	0.01	0.77
	NLFR	45.76±5.26	45.61±8.93	0.32↑	0.05	0.65	0.02

$P<0.05$*. SCM: % MVIC of Sternocleidomastoid. FHP: forward head posture. FSH: forward shoulder angle. NFR: neck flexion range of motion. NER: neck extension range of motion. NRRR: neck right rotation range of motion. NLRR: neck left rotation range of motion. Neck lateral flexion range of motion. ˚: degree.

Table 4. Between-group differences in electromyography, postural and biomechanical measures of control and exercise group

Variables	Pre-test t	Pre-test p	Post-test t	Post-test p	Cohns's *d*
SCM(%MVIC)	1.49	0.14	-2.76	0.01	0.98
FHP(◦)	1.93	0.06	-4.10	0.00	0.83
FSH(◦)	0.00	1.00	3.24	0.00	1.27
NFR(◦)	0.63	0.53	2.49	0.01	0.94
NER(◦)	0.78	0.43	0.03	0.05	0.78
NRRR	0.60	0.55	2.92	0.00	1.15
NLRR	1.92	0.24	2.64	0.01	1.01
NLFR	0.48	0.64	0.03	0.97	-

$P<0.05$*. SCM: % MVIC of Sternocleidomastoid. FHP: forward head posture. FSH: forward shoulder angle. NFR: neck flexion range of motion. NER: neck extension range of motion. NRRR: neck right rotation range of motion. NLRR: neck left rotation range of motion. Neck lateral flexion range of motion. ˚: degree

DISCUSSION

The findings of this study showed that the degree of head angle of the exercise group reduced significantly after participating in the training protocol compared to the control group(ds=0.83). The magnitude of the calculated effect size may imply the efficacy of corrective exercise protocol. Previously, exercise protocols were used for managing FHP (Sheikhhoseini et al., 2018). Ravio, et al (2016) showed an improvement in FHP after applying a stretching and strengthening exercises program on adolescents (Ruivo, Pezarat-Correia, & Carita, 2016). Harman (2005) used a 10-week program to correct FHP in healthy adult women (Harman, Hubley-Kozey, & Butler, 2005), as well. Realignment of the good posture of the head has been reported in elite swimmers who have participated in an eight-week course of strengthening stretching exercises (Lynch,

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Thigpen, Mihalik, Prentice, & Padua, 2010).

DNFs stabilize neck regions (Kang, 2015). They play an important role in maintaining neck alignment (Deborah Falla, Jull, Dall'Alba, Rainoldi, & Merletti, 2003; D. Falla et al., 2007). Previous studies have reported craniocervical flexion exercise increases DNFs activity and improve their function. Such a change in muscle profile allows developing the functional capacity of DNFs in supporting the upright posture of the head (K.-J. Lee et al., 2015; M.-H. Lee, Park, & Kim, 2013; Sheikhhoseini et al., 2018). Giving mentioned above, we can conclude that our exercise regime possibly has targeted the deep flexor muscles and may activate DNFs which contribute to the restoration of head posture.

Our study showed that the magnitude of FSH decreased after 8-week training (ds=1.27). FSH concerns to FHP, Shortness of pectoral muscles and weak scapular retractors put shoulders in protracted positions (Harman et al., 2005). Stretching exercises over pectoral muscles reduce their passive tension and change their viscoelastic properties (J. H. Lee et al., 2015). Evidence supports that stretching exercises correct shoulder fault position (Lynch et al., 2010; Ruivo, Carita, et al., 2016). Concerning those findings, participating in 8-week exercise program may restore optimal interaction of thoracic and chest muscles that improved shoulder alignment.

Our study highlighted that the activity of SCM was reduced during arm elevation. The observed effect size (ds=0.98) was so large that the revealed that modification could be attributed to the efficacy of corrective exercises intervention in reducing SCM activity. Evidence suggests that SCM activity decreases following craniocervical flexion exercises (G. A. Jull et al., 2009; Kim, Lee, Jeong, & Cynn, 2016). The results of this study are consistent with the findings of these studies regarding SCM activity. Neutral position in the neck depends on the proper activity of DNFs. However, in the case of FHP, the DNFs inhibited because of increased activity of SCM. This strategy leads to the dominance of SCM over deep neck flexors (D. Falla et al., 2007). However, craniocervical exercise, as claimed by previous studies, activated and strengthened the DNF muscle (D. Falla et al., 2006). Furthermore, these exercises may establish proper interaction of DNF with SCM which could help to retrieve proper activation pattern of these muscle in relation to each other. Giving the inverse relationship between DNF and SCM activity (G. Jull & Falla, 2016), decreased activity of SCM could be interpreted as sign of increaded activity of DNFs. On the other hand, improved profile of DNFs lets them to function properly. As mentioned before, craniocervical exercise has the potential to retrain and strengthen DNFs (D. Falla et al., 2006). Improved profile of DNFs lets them function properly in relation to SCM (D. Falla, Jull, & Hodges, 2004; G. A. Jull et al., 2009). the normalized function of deep and superficial neck muscles lets the neck move precisely and reduce overuse injuries of that region.

The study also found that an increase in neck ROM on the sagittal plane (ds=0.94) and transverse plane (ds=1.15) following 8-week exercise protocol participation. Such a large effect size encourages us to attribute this result to exercise outcome. Kang (2015) showed that exercises focused on deep neck flexor muscles have improved muscular profile and ROM (Kang, 2015). Through applying stretching on tight levator scapula muscle, an increase in the neck ROM in the sagittal plane is observed (Jeong et al., 2017). Stretching of thigh SCM muscle improves neck ROM in transvers plane (Sahrmann, 2011). poor posture of head, such as FHP, could diminished the neck range of motion (Yoo & An, 2009). Retrieving good posture of the head is an outcome that depends on the establishment of a normal length-tension relationship between the muscles of the neck. As the length-tension relationship is stabilized the passive tension of posterior and anterior muscle of neck is decreased and may contribute to increase neck ROM in the sagittal and transvers plane.

Limitations: our study has some limitations.

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Because of some ethical and technical restrictions direct assessment of DNFs activity did not take place. The head angle was evaluated just in a static posture. Further the follow-up procedure did not perform after the post-test.

CONCLUSION

This study evaluated the effect of an 8-week corrective exercise on head posture, SCM activity, and neck ROM in young males with FHP. We considered head malalignment from a physiological and biomechanical perspective. The results indicated that the activity of SCM as superficial neck flexor, decreased while forward head angle declined following an 8-week corrective exercise protocol. an increase in the ROM of the cervical region accompanying with decreased activity of major superficial neck flexors and improved head posture in an upright posture encourages us to propose applying corrective exercise as a useful and low-cost method in dealing with FHP.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

AUTHOR CONTRIBUTION STATEMENT

A: Rasoul Arshadi; B: Gholam Ali Ghasemi; C: Hadi Samadi

A. conceived of the presented idea. A. developed the theory and performed the computations. B. verified the analytical methods. All authors discussed the results and contributed to the final manuscript. C. performed the measurements. All authors contributed to the final version of the manuscript. B. supervised the project.

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