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Research Article

Reliability of Selective Neck Muscle Size in Migraine Patients and Healthy Controls Using Ultrasonography

Tahere Rezaeian[1], Mehdi Ahmadi[2], Zahra Mosallanezhad[3*], Ladan Hemmati[4]

1. Department of Physical Therapy, Faculty of Allied Medicine, Kerman University of Medical Sciences, Kerman, Iran.
2. Department of Physical Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
3. Department of Physical Therapy, Research Center on Aging, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
4. Department of Physiotherapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.

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ABSTRACT

Introduction: In migraine headaches, motor control of muscles is impaired. In this research, thickness measurement of bilateral muscle thickness of upper trapezius (UT) and sternocleidomastoid (SCM) muscles was conducted and intra-rater reliability of the thickness measurement of these muscles was assessed in migraine headache and healthy subjects.

Materials and Methods: This study was a cross-sectional study to measure bilateral ultrasound images of UT and SCM muscles in 15 patients with migraine headaches and 15 healthy controls. A linear array probe with a 50-mm footprint and frequency range of 7.5 MHz measured the thickness of UT and SCM, parallel to the orientation of the muscle fibers. Intra-class correlation coefficients (ICC) and standard error of measurement (SEM) were used for data analysis.

Results: The ICC and SEM for thickness measurement of left UT were 0.88 and 0.06 (excellent) and it was 0.87 and 0.07 (excellent) for right UT thickness. The ICC and SEM for left SCM muscle thickness were 0.88 and 0.06 (excellent) and it was 0.85 and 0.08 (excellent) for right SCM thickness. Muscle thickness of the right UT muscle was 13.38±0.92 mm and 11.12±1.00 mm, in migraine and healthy groups, respectively. Also, muscle thickness of the right SCM muscle was 7.24±0.70 mm and 9.16±0.67 mm in migraine and healthy groups, respectively.

Conclusion: The present study showed that ultrasonography can be a reliable tool to measure cervical muscle thickness in migraine patients. Additionally, the ultrasonography protocol of the current study, the position, and the measurement level can be used with high reliability in future studies.

*** Corresponding Author:**
Zahra Mosallanezhad, PhD.
Address: *Department of Physical Therapy, Research Center on Aging, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.*
Tel: *+98 (21) 22180039*
E-mail: *zmosallanezhad@yahoo.com*

1. Introduction

In the 21st century, at least 46% of adults have suffered from headaches [1]. The International Headaches Society (IHS) determines that chronic migraine headache is a primary headache with an unknown source of pain. The vascular system, central/peripheral mechanism [2, 3], and myofascial trigger points (MTrPs) are vital in migraine pathogenesis [4]. The myofascial trigger points are very sensitive in tight bundles of the skeletal muscle and contribute to pain and motor limitation and ultimately cause functional impairment. The local twitch response (muscle fibers contraction because of the taut band) shows the presence of a trigger point as a critical clinical symptom [5]. Simons et al. stated that different MTrPs of head and neck muscles may trigger headache symptoms in migraine patients [6]. An increased MTrPs in ipsilateral cervical muscles, including Sub-Occipital, Sternocleidomastoid (SCM), Upper Trapezius (UT), and temporalis muscles has been shown in migraine subjects [7, 8]. Impairment in cervical muscles following neck pain or migraine headache causes impairment in motor control, including changes in the function, structure, and size of the muscles. For example, the atrophy of flexor muscles consisting of SCM muscle is crucial in cervical segmental stability [9-11]. Furthermore, it is well described that the presence of trigger points (TrPs) has been associated with motor disturbances, such as fatigue, altered coordination, and an altered pattern of muscular activity [12-15]. Hence, the size of a muscle may be a good indicator of the muscle's strength and ability to perform its normal function [16, 17]. Ultrasonography can be a reliable and valid tool in physical therapy centers for the initial assessment of muscle size and evaluation of therapeutic interventions [18, 19]. It seems that ultrasound images can be useful to evaluate the function and thickness of involved muscles in subjects with migraine headaches. However, no study was found that investigated the thickness of the cervical flexor and extensor muscle of the neck region and its measurement reliability, in migraine patients by ultrasonography. Hence, this study aimed to introduce a suitable method and position for UT and SCM muscles ultrasonography. Also, we evaluated the intraday and interday reliability of these muscle thickness measurements for diagnostic aims in migraine patients.

2. Materials and Methods

Subjects

In this cross-sectional study, 30 subjects, including 15 migraine patients and 15 healthy subjects (without previous history of headaches, as a control group) participated. All participants were women. The sampling method was a convenience sampling method and 30 subjects were determined according to a similar study [20]. It was conducted at the physical therapy research center of the University of Social Welfare and Rehabilitation Sciences. The participants who were referred to a neurology clinic in Tehran City, Iran, were recruited. The inclusion criteria in the patients' group included ages between 25-55 years with active trigger points in their UT and SCM muscles and having a chronic migraine based on the international headaches society (IHS) criteria by a neurologist. The active trigger points were defined as focal muscle tenderness by palpation [21]. Patients were excluded if they had other types of headaches, or a history of cervical disc herniation. At first, all participants signed an informed consent form approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Sciences (USWR) (Ethics code: IR.USWR.REC.1395.192) before entering this study.

Ultrasound measurement of muscle thicknesses

The thickness of UT and SCM muscles was measured using a B-Mode ultrasonography device (Honda 2100, Honda Corporation, Japan) by a linear array probe (frequency 7.5 MHz) with a 50 mm footprint, perpendicular to the muscle surface. In this study, the thickness of the muscles was identified as the maximal distance between the surrounding fasciae in the anterior-posterior direction. Tests were performed for all samples in the same sequence and were not random.

To obtain images of UT muscle thickness, each subject sat upright on a chair with the head and neck in a neutral position. The UT muscle thickness was measured in the shoulder resting position. In this position, each subject's arm was in 0 degree of flexion with elbow full extension and forearm neutral position [22, 23]. Then, a line was drawn from the seventh cervical spinous process to the acromion process. The midpoint of this line was considered a primary part of the UT muscle [24]. A linear array probe was adjusted so that muscle fibers were parallel and two ends of muscle were at their thickest state. Then, a longitudinal image of the UT muscle was recorded and the maximum thickness of the muscle was measured [18, 22]. Both sides were imaged separately (Figure 1).

Figure 1. Ultrasound image of the Upper Trapezius (UT) muscle

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To determine the thickness of the SCM muscle, subjects were placed in a supine position with both arms along the sides of the body and head and neck in a neutral state [25, 26]. To evaluate the size of the SCM muscle, a linear array probe was used and a transducer was targeted parallel to the orientation of SCM muscle fibers. A line was drawn from the sternoclavicular joint to the mastoid process. The middle point of this line was considered a primary part of the SCM muscle. The middle point of the probe was located longitudinally on the anterior neck. In this position, proper imaging of flexor muscles was seen [25]. Both sides were imaged separately (Figure 2).

Reliability of the ultrasound of upper trapezius (UT) and sternocleidomastoid (SCM) muscles

The muscle thickness was evaluated three times, twice a day with 30-minute intervals (intraday reliability), and once a week later (interday reliability) by the same physiotherapist. To avoid possible errors, the measurements were repeated three times each time and their average was recorded. An expert physiotherapist with 5 years of experience in musculoskeletal ultrasonography performed ultrasonography measurements.

Statistical analysis

Data were analyzed using SPSS software v. 23. Data normality was checked using the Shapiro-Wilk test (P>0.05). The reliability of measuring UT and SCM muscle thickness was performed by intra-class correlation coefficients (ICC) and standard error of measurement (SEM). The results were evaluated according to Rosner to identify the quality and reliability of variables. According to Rosner, the ICC <0.4 indicates poor reliability, 0.4-0.75 shows fair to good and>0.75 indicates

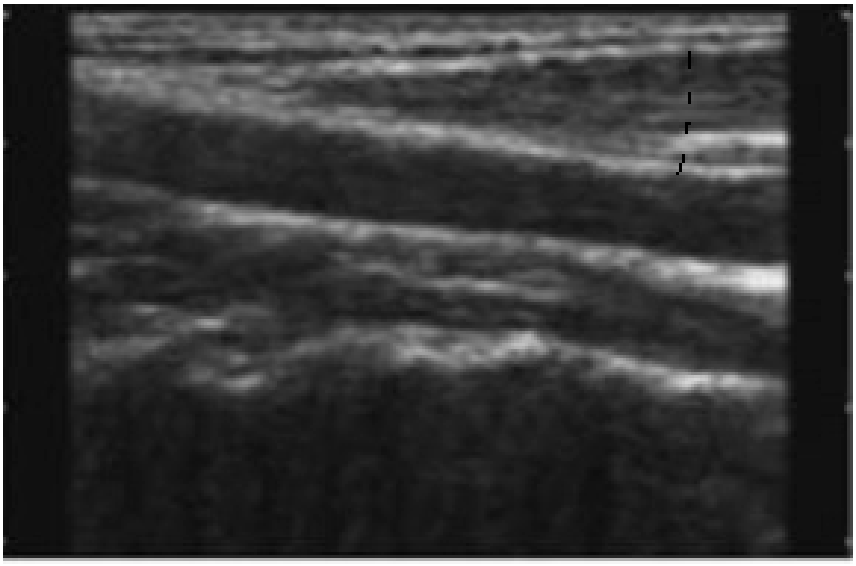

Figure 2. Ultrasound image of Sternocleidomastoid (SCM) muscle

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excellent reliability [27]. The differences between repeated measurements were presented by Bland and Altman's plotting. It was used to better express the reliability results, which describes the agreement between measurements in different sessions [28]. Independent samples t-test was used to compare any variation in muscle thickness between the two groups.

3. Results

Fifteen subjects with migraine headaches (Mean±SD age, 33.66±6.98 years) and 15 healthy matched controls (Mean±SD age, 35.00±7.12 years) were included in this study. No significant differences were found between the two groups in demographic variables (Table 1). All variables had a normal distribution in both groups, therefore the parametric tests were used for analysis.

Comparison of upper trapezius (UT) and sternocleidomastoid (SCM) muscle size between patient and healthy groups

Table 2 presents the muscle thickness of UT and SCM muscles in both groups. Using an independent sample t-test, the results showed that UT muscle thickness increased and SCM muscle thickness decreased in the migraine patients group compared to the healthy group (P <0.001).

Intraday and interday reliability in patients and control groups

ICCs related to intraday and interday reliability of muscle thickness of UT and SCM muscles on the left and right sides were excellent in both groups (Table 3) [27].

Table 1. Demographic characteristic, migraine patients and healthy subjects (n=15)

Variables	Mean±SD		P
	Migraine Patients	Healthy	
Age (y)	33.66±6.98	35.00±7.12	0.60
Weight (kg)	70.06±8.14	70.46±8.65	0.89
Height (cm)	1.68±0.11	1.69±0.09	0.66
Body mass index (BMI)	25.22±5.38	24.83±5.14	0.84

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Table 2. Comparison of muscle thickness between two groups

Variables		Mean±SD		P
		Patients	Healthy	
Muscle thickness of UT[1] (mm)	Left side	13.69±0.72	12.25±0.93	<0.001
	Right side	13.38±0.92	11.12±1.00	<0.001
Muscle thickness of SCM[2](mm)	Left side	7.97±0.85	9.50±0.88	<0.001
	Right side	7.24±0.70	9.16±0.67	<0.001

UT: Upper trapezius; SCM: Sternocleidomastoid

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Table 3. Intraday and interday reliability for muscles thickness

Group	Muscle Thickness (mm)	Mean±SD			
		ICC for UT[1] (SEM)		ICC for SCM[2] (SEM)	
		Left Side	Right Side	Left Side	Right Side
Patients group	Intraday	0.88±0.066	0.87±0.071	0.88±0.068	0.85±0.081
	Interday	0.85±0.084	0.90±0.058	0.84±0.086	0.84±0.089
Healthy group	Intraday	0.96±0.020	0.98±0.010	0.85±0.084	0.87±0.071
	Interday	0.97±0.015	0.99±0.008	0.84±0.087	0.85±0.084

ICC: Intra-class correlation coefficients; UT: Upper trapezius; SCM: Sternocleidomastoid; SEM: Standard error of measurement

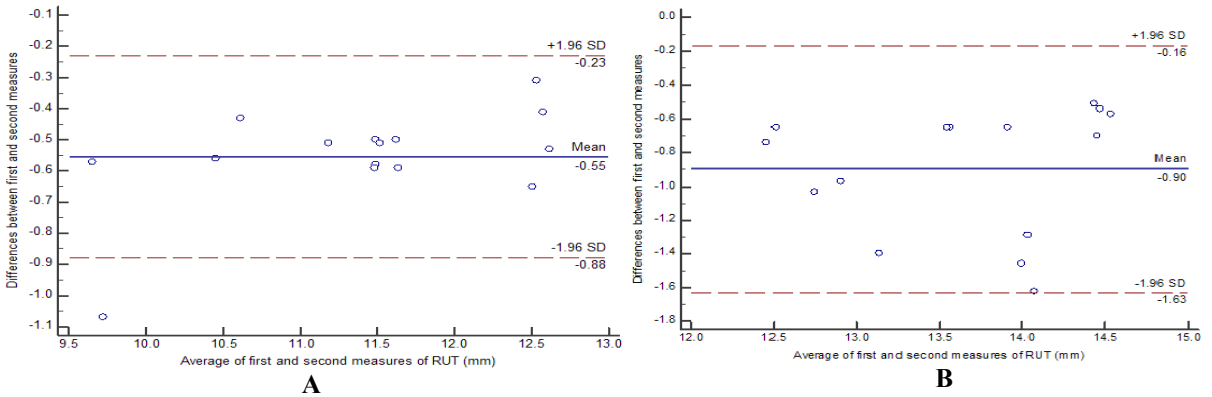

Figure 3. Average of the first and second measures for the right Upper Trapezius (UT)

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Overall, ICC values were higher for intraday reliability in comparison with interday reliability in the two groups.

Bland and Altman's plotting showed an agreement between the first and second measurements for muscle thickness of the right UT muscle in both groups. The limits of agreement (Bland and Altman method) were defined as the mean difference between the two Mean±SD, drawn on two lines. It is better if these two lines are closer together. It shows no significant difference between the two means. In the observations that are outside of these lines, the difference between the two observations is more than the amount that can be attributed to chance and these two observations are significantly different [28]. Figure 3 showed the comparison of muscle thickness of the right UT muscle between the first and second assessments in each group. The mean differences were -0.55 (95% CI of -0.88 to -0.23 mm) and -0.90 (95% CI of -1.63 to -0.16 mm) for the healthy group and migraine group, respectively (Figure 3). According to the results, a good agreement was shown between intraday assessments.

Furthermore, Figure 4 showed a comparison of muscle thickness of the right UT muscle (interday assessments) in both groups. The mean differences were -1.00 (95% CI of -1.28 to -0.71 mm) and -0.87 (95% CI of -1.54 to -0.20 mm) for healthy and patient groups (Figure 4), respectively, indicative of a good agreement between assessments [28].

Bland and Altman's plotting showed agreement between assessments for muscle thickness of SCM muscle in both groups. A comparison of muscle thickness of the right SCM muscle between intraday assessments in healthy and migraine groups was performed using Bland and Altman plotting. The mean differences were -0.09 (95% CI of -0.77 to 0.58 mm) and -0.41 (95% CI of -1.05 to 0.23 mm) for healthy and migraine groups, respectively (Figure 5). It indicated a good agreement between the two assessments [28].

Finally, a comparison of muscle thickness of the right SCM muscle (interday assessments) in healthy and migraine groups was performed using Bland and Altman plotting. The mean differences were -0.10 (95% CI of -0.87 to 0.66 mm) and -0.42 (95% CI of -1.08 to 0.24

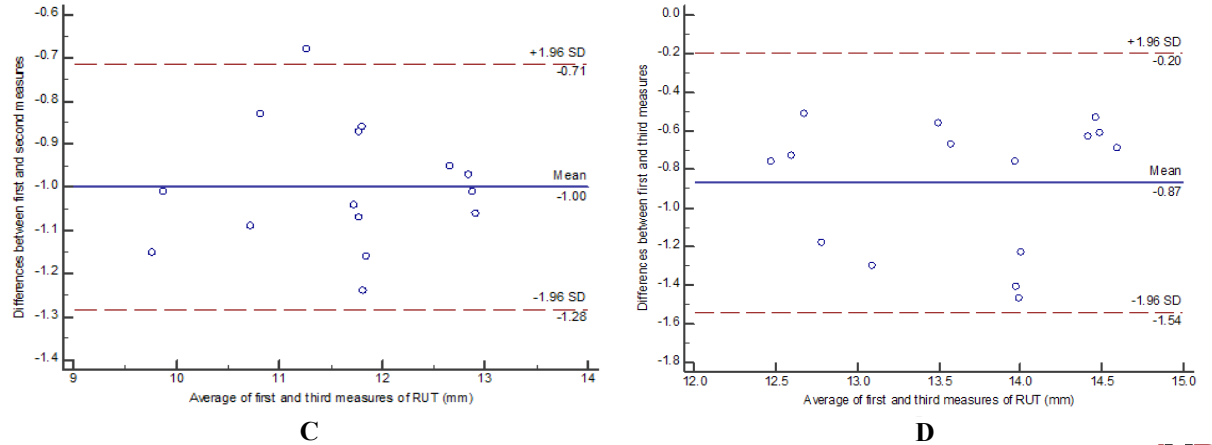

Figure 4. Average of the first and third measures for the right Upper Trapezius (UT)

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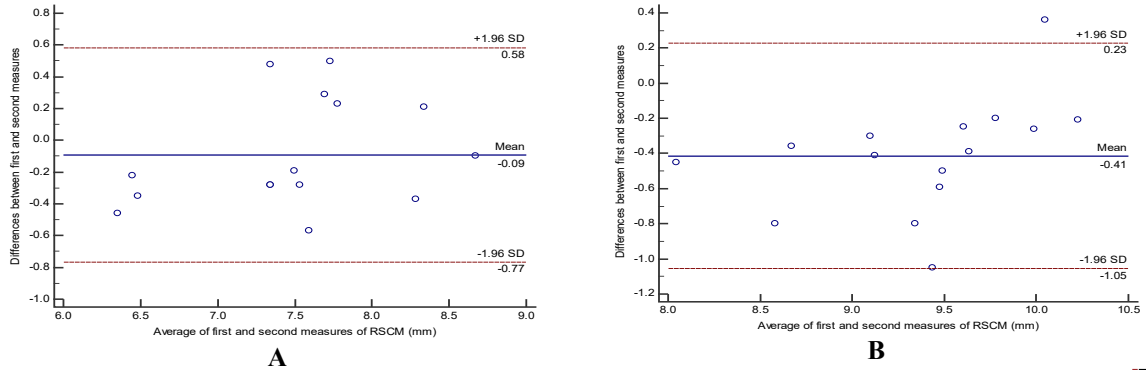

Figure 5. Average of the First and Second Measures for the Right Sternocleidomastoid (SCM)

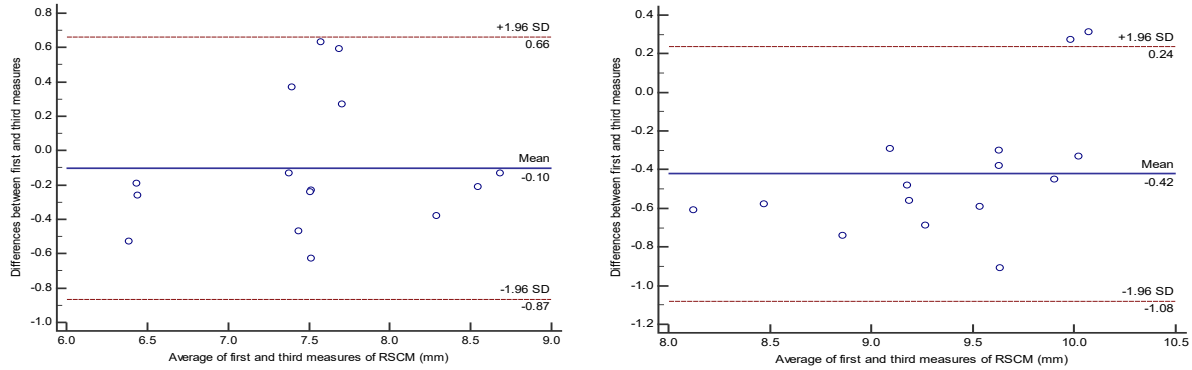

Figure 6. Average of the first and third measures for the right Sternocleidomastoid (SCM)

mm) for healthy and migraine groups, respectively (Figure 6). It indicated a good agreement between the two assessments [28].

4. Discussion

The present study is the first study that specifically investigates the reliability of ultrasonography in posterior and anterior cervical muscles as synergy in patients with migraine headache which showed excellent reliability in this regard. The differences in the thickness of UT and SCM muscles may be attributed to neuromuscular dysfunctions of the neck muscles, the presence of MTrPs in cervical muscles, head and neck malalignment [4], impairment of deep neck flexor muscles and shortening of superficial neck flexor muscles [4, 29]. Trigger points can cause motor impairments, including fatigue, coordination disorders, and an altered pattern of muscular activity [14, 15].

In the current research, a decrease in the thickness of the SCM muscle may be due to the presence of the taut band and MTrPs in this muscle. This finding is consistent with the result of Barton et al. [9]. They have reported SCM muscle weakness and decreased muscle thickness of neck flexor muscle in subjects with unilateral neck pain and headache [9, 10]. Another study reported atrophy and weakness in Semispinalis Capitis Muscle (SECM) using ultrasonography in cervicogenic headache patients [30]. Javanshir et al. (2011) showed that the smaller size of the longus colli muscles indicates muscle weakness in subjects with chronic bilateral neck pain [31].

Posterior muscles

Several studies have examined the dimensions of posterior cervical muscle using ultrasonography. Rankin et al. reported ICC values of 0.98 and 0.99, respectively for intraday and interday reliability for deep posterior muscles (semispinalis cervicis, multifidus, and rotators) and Semispinalis Capitis Muscle in five healthy subjects. Since their study was conducted to evaluate healthy individuals, they used a higher sample size but the comparison of two groups (migraine headache and healthy subjects) is one of the strengths of the present study compared to their study [32, 33]. In another reliability study, measuring the thickness of the lower trapezius muscle and intraday and interday reliability were examined among healthy subjects. Scanning was performed with the subject lying prone, but subjects were in a sitting po-

sition in the present study according to related references and used a lower sample size with shoulder dysfunction. Similar to the present study, they also assessed muscle thickness. The reliability (intraday) at the lateral site, medial site, and combined sites (mean of medial and lateral) were ICC=0.96, 0.90, and 0.99, respectively. Interday reliability was good for the lateral site and combined sites (ICC=0.91, and 0.90, respectively) and moderate for the medial site (ICC=0.89). Therefore, they concluded that the thickness of the lower trapezius muscle was measured reliably with ultrasonography [34].

Another study determined the reliability of ultrasonography measurement of UT thickness in women suffering from its latent trigger points. They measured the change in muscle thickness in the prone position with the upper extremity in 90° shoulder abduction and 90° elbow flexion. UT muscle can be contracted in this position. Hence, it was measured in sitting position in resting status in the present study. They demonstrated that intrarater intraday reliability was good both for the first examiner (ICC=0.95) and the second examiner (ICC=0.95) and inter-rater reliability was good between examiners (ICC=O.87). Hence, they reported that ultrasonography can be used reliably with low grades of errors to measure UT thickness. However, the results of this study also confirmed the results of our study [35]. Similar to our study, Fazeli et al. evaluated the reliability of UT muscle thickness using B-mode ultrasound images in patients with latent trigger points. They performed UT on 10 women with latent trigger points. The thickness of UT muscle was measured in a sitting position on an armchair consistent with the present study, but the sample size was smaller. The results for ICC of the UT at rest were ICC=0.91 [23]. Finally, Akhbari et al. (2015) measured muscle thickness similar to Seifolahi's study. Their results were consistent with our study. They indicated that ultrasonography is a feasible tool to assess muscle thickness of UT muscle with high to very high intra- and inter-examiner reliability in patients with UT trigger points [24].

Anterior muscle

Different studies have been performed on the deep cervical flexor muscles, especially the longus colli muscle, but based on our numerous types of research, few studies were conducted on the SCM muscle [10, 13]. Rezaeian et al. have focused on the SCM muscle and evaluated the thickness measurement of this muscle, impaired in migraine patients. They used the same position to evaluate SCM muscle thickness. In addition, they reported a positive relationship between decreased muscle thickness due to MTrPs biomechanical properties and migraine symptoms [13]. However, due to the lack of resources for this muscle, the authors should discuss the deep cervical flexor muscles.

According to Cibulka's study, weakness of the SCM muscle has been implicated in cervical problems. They determined the reliability of assessing the SCM muscle for length and strength of SCM muscle in subjects with and without neck pain. Intratester reliability was excellent (ICC>0.90) for the left and right SCM. The difference between their study and the present study was that SCM muscle length and SCM strength were reliably assessed using a bubble goniometer and handheld dynamometer [26]. However, in the present study, the exact value of thickness and reliability of the measurement of SCM muscle by using ultrasonography was assessed and reported.

Two studies conducted similar studies. Javanshir et al. reported ICC of 0.82-0.93 (excellent reliability) for intraday and interday reliability for measurement of longus colli muscle in non-specific chronic neck pain patients [36]. Abaspour reported excellent reliability (0.84-0.98) of the ultrasound measurement of longus colli in patients with cervicogenic headaches [37]. Both of them performed the measurements in three sessions similar to present study, but they evaluated deep flexor cervical muscle while the present study measured superficial muscle.

Cagnie and her colleagues evaluated the reliability and validity of ultrasound to measure the Cross-Sectional Area (CSA) of the longus colli as compared to magnetic resonance imaging. The ICC for the intra- and interrater reliability for the CSA of the longus colli was 0.71 and 0.68, respectively. The study's results showed that the validity and reliability of the ultrasound to evaluate the CSA of the longus colli is questionable, which may be due to both anatomical characteristics and methodological limitations. In this study, measurements were performed in a single session, which can increase SEM. Hence, repeating the measurements at least three times as in the present procedure may reduce the error rate [38].

Based on the consistency of the results of the mentioned studies, the higher reliability of ultrasonography measurement in the present study suggested the application of the same method and position to measure the thickness of UT and SCM muscles in migraine patients.

Limitations

We did not compare muscle thickness and its reliability in the contraction stage. It is recommended to investigate

these issues in future studies. This study was performed only in migraine patients with active trigger points of UT and SCM muscles. Consequently, these results cannot be generalized to other migraine patients.

5. Conclusion

The present study showed that ultrasonography can be a reliable tool to measure cervical muscle thickness in migraine patients. Additionally, the ultrasonography protocol of the current study, the position, and the measurement level can be used with high reliability in future studies.

Ethical Considerations

Compliance with ethical guidelines

The Ethics Committee of the University of Social Welfare and Rehabilitation Sciences (USWR) approved this research (Code: IR.USWR.REC.1395.192).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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