Reliability of Ultrasonography in Measuring Thickness of Flexor and Extensor Muscles in Healthy Subjects and Patients with Cervical Vertigo

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Abstract

Introduction: Vertigo is the third most common complaint among all outpatients worldwide. The cervical region impairment is one of the peripheral causes of the vertigo. Rehabilitative Ultrasound imaging (RUSI) has been introduced, as a non-invasive method to measure the muscle thickness. The purpose of this study was to assess the intra-rater reliability of musculoskeletal ultrasound (MSKUS), as a tool for measuring cervical flexor and extensor muscles thicknesses in the healthy subjects and the patients with cervical vertigo. **Material and Methods**: in this study, 44 subjects were assessed in similar sitting position and procedure. Examiner measured the cervical flexor and extensor muscles thicknesses, in two separate days, by the same musculoskeletal ultrasound specialists' raters .Data analysis and assessment of reliability were performed using the Intra-class Correlation Coefficient (ICC), Standard Error of Measurement (SEM), and the Smallest Detectable Difference (SDD). **Results**: Results reflected the excellent intra-rater reliability of ultrasonography to measure the cervical flexor and extensor muscles thicknesses in the healthy participants and the patients with cervical vertigo. **Conclusion**: The results of the current study indicate that, MSKUS is a reliable tool for measuring the cervical flexor and extensor muscles thicknesses in healthy subjects and the patients with cervical vertigo.

Keywords: Cervical Spine, Muscle, Ultrasonography

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Introduction

Vertigo is the third most common complaint among all outpatients worldwide (1) The cervical region impairment is one of the peripheral causes of the vertigo (2-4). It is reffered as the cervical vertigo, and is defined as a non-specific sense of change in the space dimension and balance disorder due to abnormal activity of the cervical afferents (3, 5, 6). Also, one of the causes of cervical vertigo is the musculoskeletal disorders (7). the patients with cervical vertigo have postural disorder, ataxia and gait instability, and cervical movement restriction (8). Postural balance and stability require intact visual, vestibular, and proprioceptive control systems (2, 3, 5, 9). Cervical afferents play an important role in the postural control (9), and The functional role of the cervical afferents is mainly dependent on the short and deep intervetebral muscle, specifically the sub-occipital muscles (10). The cervical muscle afferents have the duty of providing information to the central nervous system (CNS) on the orientation of the head in the space and the orientation of the head and neck relative to the trunk, and there are also specific connections among the cervical receptors, vestibular, and visual control systems and CNS (1). Therefore, the evaluation of the cervical muscular impairment through objective, clinical, and reliable tools seems to be necessary for performing the assessment and treatment plans for cervical vertigo (4).Various imaging methods were used in the literature to evaluate the skeletal muscles, including Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and ultrasound (US) (6, 7, 11-14). Accordingly, US is an appropriate method for evaluating the anatomical characteristics of the muscles such as size, thickness, and cross-sectional area (CSA), as well as the quality and structure of the muscle (14-17). Ultrasonography is considered as a safe and

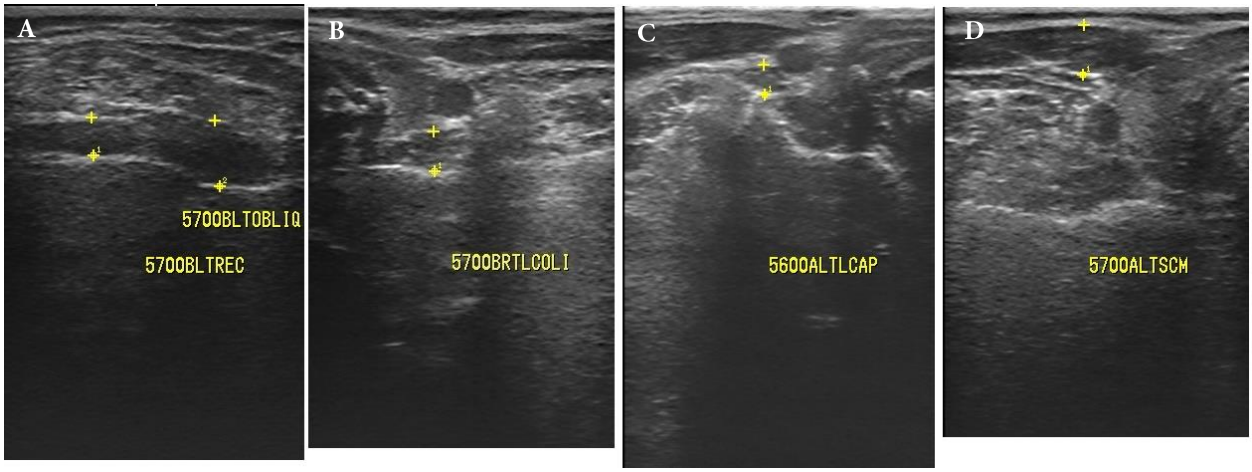

Figure1. Ultrasonographic images of the rectus capitis posterior (A), Oblique capitis superior (A), longus colli (B), Longus capitis (C), and sternocleidomastoid (D) muscles (REC, rectus capitis posterior; OBLIQE, oblique capitis superior, LCOLI, longus colli, LCAP, longus capitis ; SCM, sternocleidomastoid)

inexpensive method for assessing the muscle thickness (12). Evaluation of the reliability of instruments is significant, as it can provide a foundation for future investigations and such works can detect real changes. However, to the best of our knowledge, US has not been applied in the patients with cervical vertigo (16). Therefore, the main purpose of this study was to investigate the intra-rater (between-day) reliability of USI in measuring the Reliability of ultrasonography in measuring thicknesses of flexor and extensor muscles in the healthy subjects and the patients with the cervical vertigo.

Materials and Methods

Participants

In the present reliability study, 44 participants were enrolled (22 healthy and 22 patients with cervical vertigo) including 14 males and 30 females, age ranged from 18 to 45 years old (Table 1). Inclusion criteria for all participants were having the age between 18 with 45 years old and Body Mass Index (BMI) between 18 and 30; and for the patients , they were included with insidious incidence of vertigo, duration of vertigo between some minutes to some hours, intensity of vertigo ranging from 1 to 5 based on Visual Analogue Scale (VAS), frequency of vertigo between 1 and 5 times per a day, cervical pain (rest pain or pain at palpation) for more than 3 months with an intensity ranging from 1 to 5 based on VAS, and temporal relationship between the vertigo incidence and cervical pain. The patients were excluded if they had a history of central vertio or any pathology in central nervous system (2, 18), pregnancy(19), any systemic disease (19), psychological disorders(18), trauma to head and neck (18), inner ear disorder (20), vestibular disorder(1) or inability to perform the study procedure. Healthy subjects were matched to the patients based on age, gender, and BMI.

Procedures

Prior to the study, the study procedure was explained to the subjects. All the subjects signed the informed consent after receiving a detailed explanation of the procedure of the study. The study was approved by the Ethical Committee of Shahid Beheshti University of Medical Sciences, Tehran (IR.SBMU.RETECH.REC.1396.178.). The demographic characteristic of the participants were also recorded (Table 1). Moreover, the participants were seated on a low wheel less stool with a straight back and supported feet. They were asked to keep their upper arms in resting position by their sides, the subject's hand was positioned on his/her thigh, their knees and hips at 90 degrees of flexion, and maintained their head and neck in the neutral position. Participant's position was checked during ultrasonography, as any change in position could change the muscle thickness. Ultrasound images were obtained using RUSI device (Ultrasonic scanner, HS 2100, Honda Electronic Co, Japan) with a 7 cm linear probe in the B-mode (7.5 MHz) on the two separate days by an examiner when she observed the best image on ultrasonography monitor. The examiner was a Ph.D. candidate of physiotherapy who was trained for a year by a musculoskeletal ultrasonography researcher.

Imaging was performed on the cervical flexors including Sternocleidomastoid (SCM), Longus Colli (LColi), and Longus Capitis (LCap); and extensors including Rectus Capitis posterior major (RCap) and Oblique Capitis superior (OCap) muscles bilaterally by a US device in the rest position. To obtain images of the RCap and OCap muscles, the examiner placed the probe transversely on the C2 spinous process (21-24). Next, the examiner moved the probe laterally to identify the lamina of the C2 and vertically to identify the C1 lamina (21, 25-27). To

Table 1. Participants' demographic and clinical variables' mean (SD)

Variable	Total sample (n=44)	Healthy controls (n=22, 50%)	Cervical vertigo patients (n=22, 50%)	*P*-Value
Demographic				
Age (year)	38.50 (5.01)	38.05 (4.82)	38.95 (5.26)	0.55
Gender, n female	30 (68%)	15 (68%)	15 (68%)	1.00
Height (Meter)	1.65 (0.08)	1.66 (0.08)	1.64 (0.07)	0.45
BMI	68.05 (10.50)	67.50 (11.79)	68.59 (9.28)	0.73
	24.81 (2.37)	24.30 (2.81)	25.33 (1.75)	0.15
Clinical measures				
Pain intensity (0-10)	-	-	3.14 (0.8)	-
Vertigo frequency (0-5)	-	-	2.59 (0.9)	-
Vertigo intensity (0-5)	-	-	4 (1.23)	-

SD, Standard Deviation; BMI, Body Mass Index

Table2. Left & Right Muscles thickness reliability

	Left				Right			
	ICC	SEM	SDD	95% CI of ICC	ICC	SEM	SDD	95% CI of ICC
SCM	0.93	0.38	1.05	7.64 - 8.31	0.94	0.41	1.154	7.68 – 8.44
LColi	0.90	0.47	1.32	7.72 – 8.49	0.90	0.53	1.47	7.48 – 8.53
LCap	0.97	0.47	1.30	4.77 – 6.39	0.89	0.27	0.76	3.69 – 4.14
RCap	0.87	0.64	1.78	7.16 – 7.97	0.81	0.78	2.15	7.36 – 8.24
OCap	0.82	1.005	1.39	10.11 – 11.33	0.87	0.64	1.47	9.55 – 10.76

identify the RCap muscle, the examiner moved the probe upward or downward (21, 26). For visualization of the OCap muscle, the examiner moved the probe further laterally at the same level as used for measuring the RCap (21, 26) (Figure 1A). To visualize the LCap and LColi muscle, the probe was placed transversely at the C6 level (21-23, 26) (Figure1B & C). The reason for using this level was the fact that it has no overlap between the LColi and the LCap muscles (21-23, 26). In order to obtain the images of the SCM muscle at this level, the examiner placed the probe transversely on the SCM muscle between its origin and insertion (21, 26) (Figure 1D).To obtain each image, the probe was removed and repositioned at the same level (21, 26). We did not include the facial outline to measure the thickness of the muscles and placed the cursor on the inside edge of the superior fascia at the thickest portion of the muscle, drawing a vertical line to the inside edge of the inferior fascia (21, 26). Imaging of each muscle was performed for three times, and the mean thickness for each muscle was recorded (21). Muscles imaging was performed randomly. In all the measures, the thickness of the muscle was normalized to the subject's weight. Since, settings of the system can affect the clarity of the images; all parameters such as Compression, Gama, Brightness, Gain, and focus were fixed in all the shots (28). All aforementioned procedures were repeated by the same examiner on the second day. The mean thickness of the three images for each day was used for the statistical analysis.

Data analysis

Intra-class Correlation Coefficient (ICC), with a 95% confidence interval; the Standard Error of Measurements (SEM); and the Smallest Detectable Difference (SDD) were calculated to assess the intra-rater (between-day) reliability of RUSI in measuring the cervical flexor and extensor muscles thickness. SEM was calculated as follows: $SD \times \sqrt{1 - ICC}$ and SDD was also computed as follows: $SEM \times 1.96 \times \sqrt{2}$. Data analysis was performed using SPSS version 16.

Results

Demographic characteristics of the participants are given in Table 1. The results for the intra-rater (between-day) reliability of RUSI for thickness measurement are given in Tables 2. Intra-class correlation (ICC) was calculated for relative reliability, and standard error of measurement (SEM) and Smallest Detectable Difference (SDD) were calculated for the absolute reliability.

$SEM = SD \times \sqrt{1 - ICC}$

$SDD = 1.96 \times \sqrt{2} \times SEM$

Discussion

The main objective of this study was to assess the intra-rater (between day) reliability of MSKUS, as a tool for measuring the cervical flexor and extensor muscles thicknesses in the healthy subjects and the patients with cervical vertigo, because Cervical afferents play an important role in postural control (9). The functional role of the cervical afferents is mainly dependent on the short and deep intervetebral muscle, specifically the sub-occipital muscles (10). Also, The cervical muscle afferents have the duty of providing information to the central nervous system (CNS) on the orientation of the head in the space and the orientation of the head and neck relative to the trunk, and there are specific connections among the cervical receptors, vestibular, and visual control systems and CNS (1). Therefore, performing the evaluation of the cervical muscular impairment through objective, clinical, and reliable tools seems to be necessary for conducting the assessment and treatment plans for cervical vertigo (4). The results of the current study show that, our method was a reliable method for measuring the thickness of cervical flexor and extensor muscles using RUSI in the healthy subjects and the patients with cervical vertigo.

In the present study, ICC was computed because this statistical method have been considered as the statistical method of choice in the assessment of reliability (15). The ICC value in our study showed the excellent reliability (22) .We also computed SEM value to measure absolute reliability, as the previous studies considered SEM as the most important index in reliability studies (29). SEM represents variability of scores between measurements, and it also indicates measurement error. Accordingly, the smaller the SEM, the higher the degree of reliability (29). SEM value can be even more useful if it is accompanied by SDD value, because SDD value can exclude measurement error (29), and SDD itself can demonstrate real changes after interventions.

It should also be mentioned that, the current study had some limitations that should be taken into account before generalizing the findings. Our study only assessed the intra-rater (between-day) reliability of RUSI for thickness measurement of cervical flexor and extensor in the asymptomatic subjects and also in the patients with cervical vertigo. More studies are required to assess the inter-rater reliability of RUSI for thickness measurement of cervical flexor and extensor both in the asymptomatic subjects and the patients with cervical vertigo The present study was conducted only on the non-traumatic patients; we also suggest the evaluation of the reliability of RUSI for cervical flexor and extensor_thickness measurement in the patients with traumatic cervical vertigo, as well.

Conclusion

The results of the current study showed that, our method was a reliable method for measuring the thickness of cervical flexor and extensor muscles using RUSI in the asymptomatic subjects and in the patients with cervical vertigo.

The present study can be fundamental to compare the cervical flexor and extensor muscles thicknesses between the participants with and without cervical vertigo to shed light on our knowledge on the role of this muscles in cervical vertigo and evaluate the treatment methods for the patients with cervical vertigo.

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Both authors made substantial contributions to the conception, design, analysis, and interpretation of data.

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