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Original Article

Reliability of ultrasonographic measurement of the supraspinatus thickness at different angles of shoulder abduction in patients with stroke

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Abstract.   [Purpose] The primary purpose of this study was to evaluate the usefulness of the intraclass correlation coefficient for evaluating the reliability of the measurement of the supraspinatus thickness on shoulder ultrasonography at different angles in a resting position in patients with stroke. [Participants and Methods] The study included 20 patients with stroke. The supraspinatus thickness was measured on both sides on ultrasonography, with the participants' shoulders in abduction at 3 testing angles (0°, 30°, and 60° abduction). Each measurement was performed three times, and the average of the three measurements was recorded. The intraclass correlation coefficient was calculated, with the supraspinatus thickness measured twice at an interval of 24 hours as the factor. [Results] All intraclass correlation coefficients for the hemiplegic and normal sides were greater than 0.93 when the shoulders were at the three testing angles. [Conclusion] In this investigation, the reliability of measuring the supraspinatus thickness on shoulder ultrasonography at each angle for 3 times was evaluated and was found to be excellent.
Key words: Ultrasonography, Supraspinatus thickness, Glenohumeral subluxation

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INTRODUCTION

Shoulder subluxation refers to a common complication of poststroke hemiplegia[1]. Glenohumeral subluxation (GHS), a common complication of poststroke hemiplegia, has been found in 17–81% of patients with poststroke hemiplegia[2]. According to a 10-month follow-up investigation, shoulder subluxation was suggested as a cause of further aggravation of hemiplegia in 67% of patients over time[3]. Among the causes of GHS, denervation of the shoulder muscles that is attributed to brain injury is the underlying cause, as the humeral head directed downward out of the glenoid fossa is impacted by the action of gravity[4].

The supraspinatus muscle, which is found at the upper part of the rotator cuff muscles, is located in the supraspinous fossa of the scapula, above the scapular spine. The muscle tendon stretches laterally below the acromioclavicular process and above the humeral head. It fuses with the glenohumeral joint capsule into the upper articular surface of the greater tuberosity of the humerus. The supraspinatus is involved in the dynamic stabilization for the glenohumeral joint[5]. Furthermore, on the

basis of electromyographic studies, the supraspinatus and deltoid muscles are the two critical muscles that maintain the head of the humerus in the glenoid fossa, thus acting as target spots for functional electrical stimulation in the clinical treatment of glenohumeral subluxation[6, 7].

Ultrasonographic imaging has been upheld as a noninvasive method for quantifying muscle shape and contraction and has been extensively applied both in research and as a clinical tool throughout the rehabilitation process[8]. Its advantages are high accuracy, low cost, real-time imaging, contralateral immediate comparison, and radiation-free status[9]. Muscle contraction was difficult to observe on radiography as compared with ultrasonography, which provided an immediate feedback. Recently, ultrasonography has replaced palpation and plain radiography and has become the major modality for assessment of shoulder abnormalities[1]. Resting neutral position was the most common position for measurement of the supraspinatus thickness. However, the reliability of the measurement of the supraspinatus thickness at various angles still requires examination in patients with stroke.

The primary purpose of this study was to evaluate the usefulness of intraclass correlation coefficient (ICC) for evaluating the reliability of the measurement of the supraspinatus thickness on shoulder ultrasonography at different angles in a resting position in patients with stroke.

PARTICIPANTS AND METHODS

Twenty patients with stroke participated (14 males and 6 females; left-side hemiplegia, n=10 and right-side hemiplegia, n=10; Brunnstrom stage I, 5 participants; stage II, 4; stage III, 2 participants; stage IV, 5; stage V, 2; stage VI, 2). The time to onset of hemiplegia after stroke was 5.9 ± 7.3 months (mean ± SD). The participants' characteristics are detailed in Table 1. Shoulder subluxation was determined using the finger-breadth palpation method of assessment. Seven patients had no gap, 4 had a half-finger gap, 3 had a one-finger gap, 2 had a one-and-a-half-finger gap, and 4 had a two-finger gap.

Table 1. Participants' characteristics

	Mean ± SD, n=20
Age (years)	57.1 ± 14.8
Height (cm)	168.6 ± 6.0
Weight (kg)	73.5 ± 14.5

The exclusion criteria were instability of the general condition, presence of neurological symptoms, osteoarthritis, and cognitive and psychiatric disorders. Patients with brainstem or bilateral lesions or exercise-restricted respiratory and circulatory diseases were excluded. All the participants provided informed consent for participation in the study. The International University of Health and Welfare Ethical Review Committee reviewed and approved all the experimental procedures in this study (IRB no. 19-Io-45).

The patients were seated in a chair, with both feet flat on the ground, in a resting position, with the elbow at 90° flexion and the forearm in pronation, and with the elbow joint unsupported. A goniometer was used to set 3 angles of shoulder abduction in active motion (0°, 30°, and 60°). The researcher assisted the patients if they were unable to move their arm. The transducer was placed vertically at the midpoint of the mesoscapula and then moved in parallel until the thickest cross-section of the supraspinatus was identified. The image was frozen, and the distance to the thickest part of the supraspinatus was ascertained. Each measurement was performed three times, and the average of the three measurements was recorded. The measurement was repeated after 24 hours.

In all the patients, the supraspinatus thickness on both sides was measured using an ultrasonography scanner (Sonosite180 Plus, USA) in combination with a 7.5-MHz linear transducer. All the measurements were performed by the same physical therapist.

The ICC was used to determine the reliability of the ultrasonographic measurement of the supraspinatus thickness as the factor, measured twice at an interval of 24 hours. The data were analyzed using SPSS Ver. 17.0 for Windows.

RESULTS

The results of the measurements of the supraspinatus thickness in all the participants are shown in Table 2. All ICCs of the supraspinatus thickness on the hemiplegic and normal sides were >0.93 when the shoulders were at the three testing angles (0°, 30°, and 60° abduction).

Table 2. Supraspinatus thickness (cm) and ICC

	0° Hemiplegic side	0° normal side	30° Hemiplegic side	30° normal sides	60° Hemiplegic side	60° normal side
1st time	1.64 ± 0.32	1.91 ± 0.31	1.75 ± 0.31	2.08 ± 0.36	1.88 ± 0.34	2.24 ± 0.36
2nd time	1.63 ± 0.32	1.90 ± 0.34	1.74 ± 0.30	2.08 ± 0.36	1.86 ± 0.31	2.25 ± 0.37
ICC	0.99**	0.98**	0.99**	0.97**	0.98**	0.98**

**p<0.01.

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DISCUSSION

In this investigation, we evaluated the reliability of measuring the supraspinatus thickness at three abduction angles on shoulder ultrasonography and found excellent reliability. Regardless of the side measured, on the hemiplegic or normal side, ultrasonographic imaging allowed for muscle constriction monitoring.

Ultrasonographic imaging was intuitional and operable. It is therefore being increasingly used as a research and clinical evaluation tool in clinical and rehabilitation applications. The above-mentioned study provided evidence of the reliability of ultrasonography for measuring the thickness of the supraspinatus muscle[10]. This study further demonstrated that for hemiplegia, supraspinatus thickness measurement was highly reliable at a 0° static state. Furthermore, its reliability remained high when the measurement was performed at different angles. Therefore, in the case of patients with stroke-induced hemiparalysis, ultrasonography was useful for the objective evaluation of supraspinatus muscle thickness at different angles.

The results of this study were repeated at an interval of 24 hours, but the between-assessor reliability was not ascertained. Therefore, should these conditions change, the reliability of ultrasonographic imaging would have to be studied again.

Conflict of interest

The authors declare that they have no conflicts of interest related to this work.

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