原著論文

Reliability of the Ulnar Collateral Ligament of the Elbow Assessed Using Musculoskeletal Ultrasound

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Abstract : **Background** : Ulnar collateral ligament (UCL) injury to the elbow is common in athletic populations. The anterior bundle of the UCL is the main stabilizer against valgus stress on elbow flexion; it provides the greatest degree of joint stabilization and is therefore the most clinically important component for judo therapy. Recently, musculoskeletal ultrasound (MUS) has been used as a new technique in the field of judo therapy. Because only a few studies have measured the reliability of the UCL using ultrasound, the reliability of each angle of elbow flexion remains unclear. The purpose of this study was to investigate the measurement reliability of the UCL thickness and length at each elbow flexion angle (30°, 60°, and 90°) using MUS.
Methods : MUS was conducted to evaluate the anterior bundle of the UCL of 10 elbows of 10 healthy asymptomatic volunteers. The intra- and inter-rater reliabilities were tested using the interclass correlation coefficients (ICCs).
Results : The inter-rater reliability was good to excellent (ICCs : 0.877–0.951) for the UCL thickness at 60° and 90° of elbow flexion. At 30° of elbow flexion, the ICCs was good (0.872 and 0.761 for the right and left arms, respectively). The inter-rater reliability was excellent (ICCs : 0.945–0.998) for the UCL length at the three angles of elbow flexion. The intra-rater reliability was good to excellent (ICCs : 0.804–0.975) for the UCL thickness at the three angles of elbow flexion in the individual examiners. Similarly, the intra-rater reliability was excellent (ICCs : 0.978–0.996) for the UCL length at the three angles of elbow flexion.
Conclusion : The results of this study suggest that the reliability of the UCL thickness and length does not differ among each angle of elbow flexion using MUS.

key words : judo therapy, ulnar collateral ligament, reliability, musculoskeletal ultrasound

Introduction

Judo therapy is a form of Japanese traditional alternative medicine, used for the non-surgical treatment of orthopedic problems such as fractures, dislocations, sprains, bruises, and torn muscles, among general and athletic populations. Judo therapists use the palpation technique and manual closed reduction and fixation in patients with trauma.

Ulnar collateral ligament (UCL) injury to the elbow is common in athletic populations, especially baseball pitchers [1, 2)]. The UCL of the elbow consists of three components : anterior, posterior, and transverse bundles. The anterior bundle of the UCL is the main stabilizer against valgus stress on elbow flexion [3)]; it provides the greatest degree of joint stabilization and is therefore the most clinically important component for judo therapy. Magnetic resonance imaging (MRI) has been

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successfully implemented in diagnosing acute ruptures of the UCL [4]. However, it has several limitations ; it is time consuming and expensive. Additionally, judo therapists cannot use MRI for the assessment and evaluation of the UCL.

Recently, musculoskeletal ultrasound (MUS) has been used as a new technique in the field of judo therapy in Japan. Because MUS allows a fast, low-cost, and non-invasive examination without radiation, its use is expected to increase in judo therapy clinics in the future. However, the disadvantage of MSU is that it is a highly operator-dependent technique.

To our knowledge, a few studies reported the intra- and inter-rater reliabilities of the UCL at 30-degree elbow flexion [5, 6], and one study reported the inter-rater reliability of the UCL at 80-90-degree elbow flexion [7]. Because only a few studies have measured the reliability of the UCL using ultrasound, the reliability of each angle of elbow flexion remains unclear. Given the clinical significance of the UCL, accurate assessment and evaluation of the UCL are important in MUS for judo therapy. The purpose of this study was to investigate the measurement reliability of the UCL thickness and length at each elbow flexion angle using MUS. We hypothesized that the reliability of the UCL differs depending on each angle of elbow flexion.

Materials and Methods

Participants

MUS was conducted to evaluate the anterior bundle of the UCL of 10 elbows of 10 healthy asymptomatic volunteers recruited by university students who had shown no history of elbow pain and trauma. The 10 subjects (four women) presented the following data : mean age, 22.3 ± 1.6 years ; weight, 56.7 ± 10.3 kg ; height, 168.2 ± 6.3 cm ; and dominant hand (10 right, 0 left).

The present study protocol was approved by the Ethical Committee of Tokyo Ariake University of Medical and Health Sciences. All subjects provided written informed consent before participation. Information regarding the purpose of the study and protection of the subject rights was provided to all subjects.

Examiners

Inter-rater reliability : Two examiners, identified here as examiners A and B, were involved in the inter-rater reliability analysis. Examiner A was a judo therapist (Y.F.) who had 5 years of experience in MUS, while Examiner B was a university student (S.A.) who studies judo therapy and had 1 year of experience in MUS. The examiners performed the MUS examinations and measurements independently and were blinded to the results of the other examiner.

Intra-rater reliability : Only Examiner A (Y.F.) was involved in the intra-rater reliability analysis. All ultrasound recordings were conducted by the examiner at two periods, with a 7-day interval.

Imaging Technique

To measure the UCL thickness and length of both elbows, MUS images were acquired using GE Logiq E ultrasound system with a multifrequency 12-MHz liner array transducer (LOGIQe ; GE Healthcare) and acoustic coupling gel.

The thickness of the anterior bundle of the UCL at its midportion was measured using the Nazarian technique [2] 8. We defined the UCL length as the distance from the medial epicondyle of the humerus to the coronoid process of the ulna and consequently measured such (Figure 1).

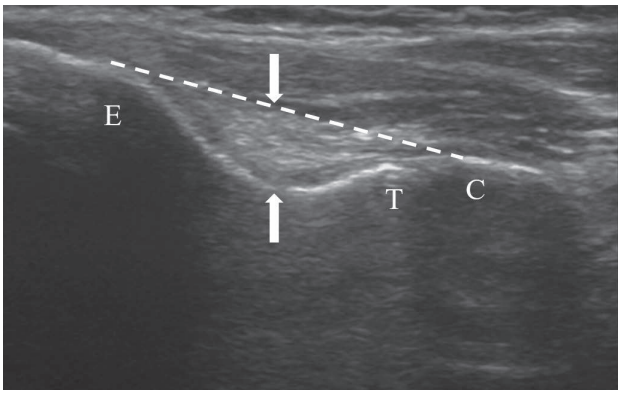

Figure 1. Ultrasound image of the long axis of the anterior bundle of the ulnar collateral ligament (UCL).

For the examinations, the subjects remained seated in front of the examiner with their forearm in supination and elbow flexed at 30°, 60°, and 90° on the upper extremity stand. The ultrasound transducer was placed at the following angles of elbow flexion : medial epicondyle to a 20-degree tilt from the long axis of the forearm at 30-degree elbow flexion ; medial epicondyle to a 30-degree tilt from the long axis of the forearm at 60-degree elbow flexion; and medial epicondyle to a 30-degree tilt from the long axis of the forearm at 90-degree elbow flexion.

Statistical Analysis

Interclass correlation coefficients (ICCs) with 95% confidence intervals were calculated to evaluate the reliability of the UCL thickness and length measurements. The ICCs were interpreted as excellent (0.90–1.00), good (0.75–0.90), moderate (0.50–0.75), and poor (0.00–0.50)[9]. All statistical analyses were performed using IBM SPSS 23.0 for Windows (SPSS Japan Inc, Tokyo, Japan).

Results

Inter-rater reliability

The inter-rater reliability was good to excellent (ICCs : 0.877–0.951) for the UCL thickness at 60° and 90° of elbow flexion. At 30° of elbow flexion, the ICCs was good (0.872 and 0.761 for the right and left arms, respectively). The inter-rater reliability was excellent (ICCs : 0.945–0.998) for the UCL length at the three angles of elbow flexion (Tables 1–3).

Intra-rater reliability

The results of the intra-rater reliability are presented in Tables 4–6. The intra-rater reliability was good to excellent (ICCs : 0.804–0.975) for the UCL thickness at the three angles of elbow flexion in the individual examiners. Similarly, the intra-rater reliability was excellent (ICCs : 0.978–0.996) for the UCL length at the three angles of elbow flexion.

Table 1. Inter-rater reliability of the variables at 30°elbow flexion

Parameter		Examiner A	Examiner B	ICC	95%CI
UCL thickness (mm)	R	4.6±0.5	4.6±0.5	0.872	0.572-0.967
	L	4.5±0.4	4.7±0.4	0.761	0.326-0.933
UCL length (mm)	R	17.3±1.6	17.0±1.5	0.945	0.765-0.987
	L	17.6±1.2	17.5±1.3	0.972	0.865-0.993

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Table 2. Inter-rater reliability of the variables at 60°elbow flexion

Parameter		Examiner A	Examiner B	ICC	95%CI
UCL thickness (mm)	R	4.3±0.4	4.2±0.4	0.891	0.642-0.971
	L	4.3±0.4	4.3±0.4	0.905	0.677-0.975
UCL length (mm)	R	18.0±1.2	18.1±1.3	0.970	0.889-0.992
	L	18.1±1.2	18.1±1.1	0.993	0.973-0.998

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Table 3. Inter-rater reliability of the variables at 90°elbow flexion

Parameter		Examiner A	Examiner B	ICC	95%CI
UCL thickness (mm)	R	4.3±0.4	4.3±0.4	0.877	0.575-0.968
	L	4.2±0.3	4.2±0.3	0.951	0.817-0.988
UCL length (mm)	R	18.2±1.5	18.2±1.5	0.998	0.992-0.999
	L	18.3±1.5	18.4±1.5	0.995	0.977-0.999

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Table 4. Intra-Rater Reliability of the variables at 30°elbow flexion

Parameter		Repeat 1	Repeat 2	ICC	95%CI
UCL thickness (mm)	R	4.6±0.5	4.6±0.4	0.808	0.426-0.948
	L	4.5±0.4	4.6±0.4	0.804	0.418-0.947
UCL length (mm)	R	17.3±1.6	17.1±1.4	0.978	0.918-0.994
	L	17.6±1.2	17.6±1.1	0.991	0.967-0.998

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Table 5. Intra-Rater Reliability of the variables at 60°elbow flexion

Parameter		Repeat 1	Repeat 2	ICC	95%CI
UCL thickness (mm)	R	4.3±0.4	4.4±0.4	0.975	0.910-0.994
	L	4.3±0.4	4.4±0.4	0.947	0.813-0.986
UCL length (mm)	R	18.0±1.2	17.9±1.2	0.989	0.960-0.997
	L	18.1±1.2	18.1±1.1	0.991	0.967-0.998

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Table 6. Intra-Rater Reliability of the variables at 90°elbow flexion

Parameter		Repeat 1	Repeat 2	ICC	95%CI
UCL thickness (mm)	R	4.3±0.4	4.3±0.4	0.962	0.865-0.990
	L	4.2±0.3	4.3±0.4	0.882	0.462-0.952
UCL length (mm)	R	18.2±1.5	18.3±1.5	0.995	0.980-0.999
	L	18.3±1.5	18.3±1.5	0.996	0.987-0.999

Values are represented as mean (SD), where SD is standard deviation.
ICC : Interclass correlation coefficients, 95%CI : 95% confidence intervals

Discussion

In this study, we investigated the measurement reliability of the UCL at three angles of elbow flexion (30°, 60°, and 90°) using MUS. The main finding of the present study was that the reliability of the UCL thickness and length did not differ among the angles of elbow flexion.

This study showed high inter-rater and intra-rater reliabilities of the UCL thickness at each angle of elbow flexion. We speculated that it might be the effect of the method used for the UCL thickness measurement. UCL thickness measurements have been described primarily by two published methods in the literature. The Nazarian technique assesses the midportion of the UCL from the superficial aspect of the ligament down to the bone located between the medial epicondyle and trochlea in the vertical axis of the image [8]. In contrast, the Jacobson-Ward technique evaluates the midpoint of the UCL in the vertical axis of the image, with the underlying echogenic fat excluded from the measurement[10, 11]. Shukla et al[12]. found that the Jacobson-Ward technique had less reproducibility (ICC : 0.51) than the Nazarian technique (ICC : 0.82) at 30° of elbow flexion. In the present study, we used the Nazarian technique for the measurement reliability of the UCL thickness. Therefore, we found a high reliability of the UCL thickness at each angle of elbow flexion.

With regard to the high reliability of the UCL length at each angle of elbow flexion, Bica et al [5]. evaluated the reliability (ICCs : 0.79 and 0.72 for the right and left sides, respectively) of the UCL length at 30° of elbow flexion. Compared with their results, our results indicated a high reliability, as our study used a different method for MSU. Specifically, we decided that the examiners must place the ultrasound transducer at each angle of elbow flexion before confirming on the screen. Therefore, we think that it is important to place the ultrasound transducer at each angle of elbow flexion.

This study has several limitations. First, the sample size was not large enough to reach a definitive conclusion. Nevertheless, we believe that the process of statistical evaluation was appropriate for our small sample size. However, further studies with larger sample populations are required to confirm the findings. Second, although the measurements of both parameters were highly reliable, they were not measured with the elbow in the valgus stress position. Recent studies have reported that stress ultrasound identified the UCL in the elbow of baseball pitchers [6, 13–15]. In addition, judo therapists use a special test for the elbow (i.e., valgus stress test) for the initial assessment of trauma. We plan to perform stress ultrasound of the elbow in the future.

In conclusion, the results of this study suggest that the reliability of the UCL thickness and length does not differ among each angle of elbow flexion using MUS. We believe that these results can provide useful information for judo therapists.

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