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Inter-rater Reliability of Sports Medicine Physicians to Assess Healthy Individuals' Patellar Tendon with Conventional Ultrasound and Shear-wave Elastography

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SUMMARY

To evaluate the reproducibility of shear-wave elastography, thickness, power doppler, and hypoechoic region assessments taken from the different parts of the patellar tendon among sports medicine clinicians.

Twenty-one healthy, physically active individuals with dominant legs were included in the study. Shear-wave elastography, thickness, power doppler, and hypoechoic area assessment were evaluated from the proximal, middle, and distal part of the tendon both at 30-degree knee flexion and full extension. To evaluate the reproducibility within and among clinicians, the same measurements were performed at 4-7 days intervals. Evaluations of intra- and inter-rater reliability for examiners I and II were conducted via two-way random effects and absolute agreement type intraclass correlation coefficient (ICC). Gwet's AC1 (GC) agreement coefficient was used to evaluate categorical data agreement.

The intra-rater reliability of both sports physicians on shear-wave elastography was in good to excellent reproducibility in all three parts at the 0–30-degree measurements (intra-observer ICC: 0.60-0.88, inter-observer ICC: 0.67-0.87). Similar results were obtained for the thickness (intra-observer ICC: 0.83-0.94, inter-observer ICC: 0.65-0.83). As a result of the power doppler taken at two different angles were excellently (intra-observer GC: 0.86-1.00, inter-observer GC: 0.86-1.00) consistent both within and among the clinicians but not for the hypoechoic region evaluation (intra-observer GC: 0.58-1.00, inter-observer GC: 0.40-1.00).

This study shows that the reproducibility of local measurements made in different parts of the patellar tendon at two different angles within and among sports medicine physicians is at a good to an excellent level.

KEY WORDS

Patellar tendon; shear-wave elastography; power doppler; ultrasound; sports medicine.

INTRODUCTION

Patellar tendon transfers the force produced by the quadriceps muscle to the tibia as an essential component of the knee extensor mechanism (1). It also acts as a supporter in distributing the kinetic energy generated during the stroke after the jump to the other joints of the lower extremity (2). The tendon actively stores and releases energy with the demand on the knee extension in activities such as sitting, getting up, going up and downstairs in daily life, jumping, landing, sudden sprinting, and changing direction during a sportive performance (1). Therefore, repetitive jumping, landing, sprinting, and changing direction, and not enough recovery may predispose to patellar tendinopathy, a common cause of anterior knee pain in athletes, especially in volleyball and basketball (1). It has been shown that the prevalence of patellar tendinopathy in elite-level athletes in volleyball and basketball can reach up to 45-32%, respectively (3).

As a common imaging modality, ultrasound (US) is used in tendon examinations to assist in diagnosing tendinopathy, monitor the effectiveness of treatments, and assess risk for symptom development (4). Especially compared to magnetic resonance imaging, ultrasound continues to gain more popularity among clinicians working with the musculoskeletal system due to its ease of application, less invasiveness, and rapid availability, and it has been a frequent subject of tendon-related research in the last two decades (4, 5). In this context, the changes that occur as a result of the degeneration of the tendon with the high load over time, that the local increase in the thickness (6) with hypoechoic regions (7), as can typically be detected with grayscale US, and neovascularization (8) be determined by power doppler US. The majority of these changes are observed according to Golman *et al.* (9) (> 70%) that it occurs in the proximal part of the tendon. Besides the advantages of ultrasound, there are also unclear sides. Minor damage to the tendon recently may have caused minimal changes that may be overlooked in gray-scale ultrasound imaging (4). In addition, structural changes observed mainly in athletes that cannot be clearly understood, whether they occur due to the physiological nature of the sport or as a part of the degenerative process because of loading, and which do not overlap with clinical outcomes such as pain and loss of function, even if they are revealed with gray-scale, or power doppler ultrasound may not even be sufficient to explain the individual's complaints (4). Clinical discrepancies with ultrasound raise questions for physicians dealing with the musculoskeletal system. In this context, the inconsistencies between the triad of pain, loss of function and pathology, and the effort to detect damage to the tendon at an early stage have caused alternative imaging methods to be the subject of more research in the field of the tendon (10, 11). Along with technological advances, it has enabled the development of a new ultrasound-based application called shear-wave elastography, which examines the elastic properties of healthy or damaged tissues quantitatively (12).

Although shear-wave elastography is a current method to assess tendon stiffness in tendon examination, it has shown promising results from a few studies (11, 13). While more consistent results were obtained, especially in studies on the Achilles tendon, current evidence has demonstrated that tendon stiffness decreases with Achilles tendinopathy (14). In the current literature, fewer studies have been conducted on the patellar tendon than the Achilles tendon, and the studies have no homogeneous results (14). While tendon stiffness increased in some studies (13, 15) some others observed the opposite (16, 17). This situation raises questions about the reproducibility of the methods and practitioners applied for the patellar tendon.

This study aimed to evaluate the reproducibility of shear-wave elastography, thickness, power doppler and hypoechoic region assessments taken from the different parts of the patellar tendon at two different angles among sports medicine clinicians.

MATERIALS AND METHODS

Twenty-one healthy, physically active individuals were included in our study after obtaining informed consent. All measurements were performed on the individuals' dominant legs (all right – 21 extremities). The Istanbul Faculty of Medicine Ethics Committee approved this study conducted according to the Declaration of Helsinki by Istanbul University, Faculty of Medicine (12.08.2020-134599 - Date of approval: 03/07/2020). As exclusion criteria: history of partial or full-thickness tear of the patellar tendon at any time, history of ligament or meniscus injury or operation in the dominant knee region in the last six months, ACL operation history with patellar tendon graft used at any time, history of chronic disease (diabetes, or rheumatic disease, *etc.*), history of active oral contraceptive use, presence of active infection in the knee or surrounding tissues were accepted. Male and female healthy individuals aged between 20-30 years who volunteered to participate in the study were included. Eligible individuals were taken to ultrasound measurements without vigorous or moderate-intensity physical activity or exercise for at least 24 hours. Each participant was evaluated blindly by two different sports medicine physicians independently with three years of experience in the field of ultrasound.

Procedure

All ultrasound measurements were performed with the Toshiba Aplio 500 (Toshiba Medical Systems Corporation, Otawara, Japan) and a 10 MHz (5-14 MHz) linear probe. Aquasonic 100 ultrasound gel was used (Parker Laboratories Inc, Fairfield, New Jersey) at room temperature (23 °C). In the neutral and supine position, patellar tendon examinations of all participants were performed on the ultrasound examination table, first with the knee at 0 degrees (full extension) and then at approximately 30 degrees of knee flexion. A goniometer was used to determine the knee angle. A cylindrical cushion with a length of 30 cm and a diameter of 15 cm was placed under the knee to keep the knee at 30 degrees of flexion. Before starting the ultrasound measurements, the athletes rested on the ultrasound examination table in a neutral position for 10 minutes. The probe was held softly on the skin during the measurement so that the pressure-related values could not be altered, and a large amount of ultrasound gel was used. All measurements were carried out at least twice. A 5-minute rest was given for between all angle changes (from 0 degrees to 30 or from 30 degrees to 0). After starting all measurements with elastography, thickness, echogenicity, and power doppler evaluations were performed, respectively (**figure 1**).

Shear wave elastography (Toshiba Medical Systems Corporation) was used to evaluate the mechanical properties of the patellar tendon. At the three different points (proximal, middle, and distal) of the tendon, rectangular region of interest (ROI) boxes with a length of 1.5 cm and a width of 1.0 cm were placed longitudinally. Then, a circular ROI with a diameter of 0.3 cm was placed in these boxes, and after waiting for 5 seconds, the measurement in kPa was performed (**figures 1, 2**). If there was a difference of more than 20% between the previous measurement, a third and, if necessary, a fourth measurement was taken. At least 12 images (36 round ROIs) were recorded at two different angles of each individual's patellar tendon. (11).

The anteroposterior thicknesses of the patellar tendon were measured on the transverse plane with gray-scale ultrasound. The images were taken from 3 different points: from the point where the patella ends in the proximal, 0.5 cm proximal to the most prominent point of the tibial tuberosity in the distal, and the other measurement from the middle of the two proximal and distal points. Two different measurements were made from each point (**figure 1**). The values at the points where the tendon was thickest were recorded. A third measurement was taken if there was a difference of more than 0.5 mm between the two measurements (18). Hypoechoic areas in the patellar tendon were evaluated first in the longitudinal and then in the transverse plane on gray-scale imaging. The tendon was divided into three equal parts, and hypoechoic areas greater than 1 mm were recorded in the 1/3 proximal, middle, and distal (**figure 1**) (19).

0-3 grade classification was used for power doppler imaging. If there is no activation indicates Grade 0. If there is an increase in activation at 1-2 points outside of the tendon indicates Grade 1; 1-2 points within the tendon indicates Grade 2, and 3 or more points within the tendon indicate Grade 3 (**figure 1**) (20). Similar to other measurements, the tendon was divided into proximal, middle, and distal, and the power doppler activation were recorded in these regions. Both sports physicians performed shear-wave elastography, thickness, echogenicity, and power doppler imaging from the proximal, middle, and distal tendons, respectively, at two different angles. At least two measurements were made from all evaluation methods. One clinician performed at least 12 imaging (36 ROIs) for shear-wave elastography, 24 gray-scale ultrasound images (12 thicknesses, 12 hypoechoic fields), and 12 power doppler imaging at two different angles. Two clinicians performed all measurements of 1 participant in a single day, and the exact measurements were performed 4 to 7 days later in a randomized clinician order.

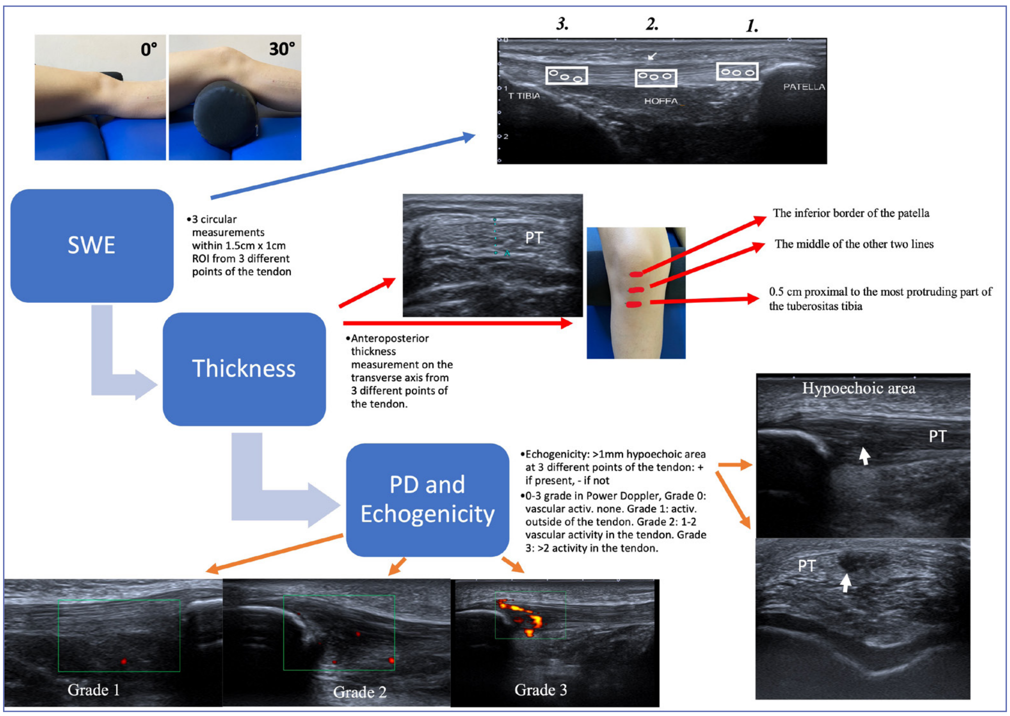

Figure 1. Schematic representation of all measurements made with ultrasound.

SWE: Shear-wave elastography; PD: power doppler; ROI: region of interest; PT: Patellar Tendon.

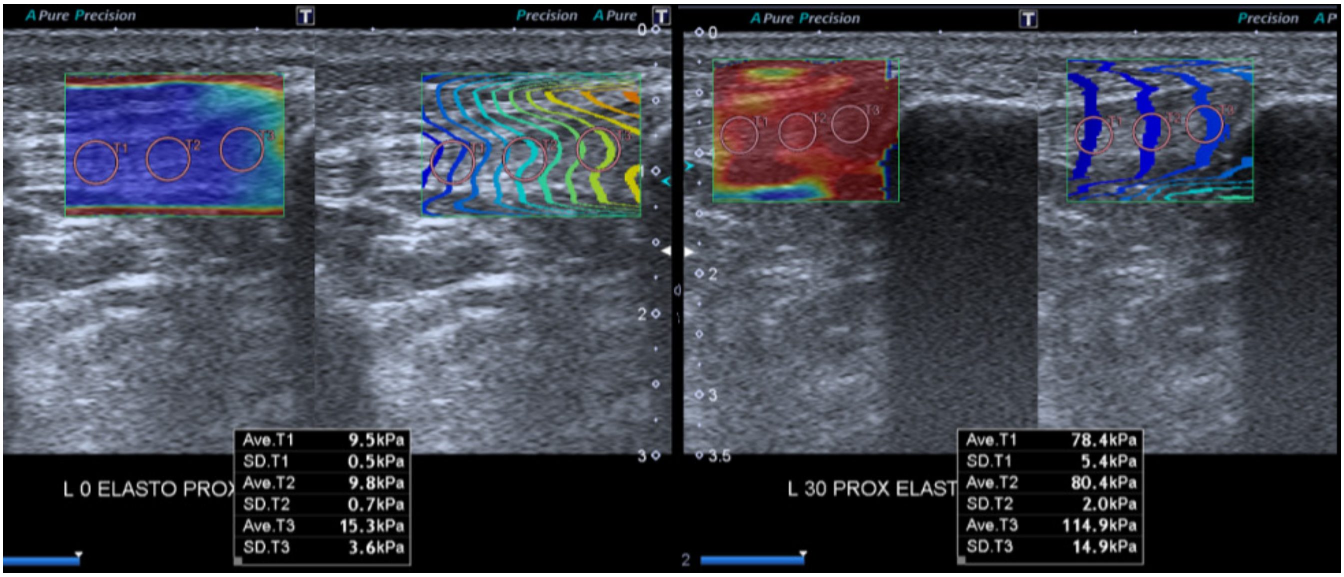

Figure 2. Shear-wave elastography images from the proximal part of the patellar tendon.
(A) 0 degrees, **(B)** 30 degrees of knee flexion.

Statistical analysis

Statistical analysis of the findings obtained in the study was performed with the SPSS (Statistical Package for Social Sciences) for Mac 21.0 program. Descriptive statistical methods (mean, standard deviation, number, percentage) were used while evaluating the study data. Evaluation of inter-rater reliability for examiner I and II was conducted via two-way random effects, single measure model (2,1), absolute agreement type intraclass correlation coefficient (ICC). Interrater reliability using the mean of first and second measurements was analyzed via two-way random effects, average measure model (2, k), absolute agreement type ICC. For evaluation of categorical data agreement, Gwet's AC1 agreement coefficient was used. A minimum sample size of 15 was calculated to provide sufficient statistical power (80%) with alpha = 0.05 error. All ICC results were evaluated according to Shrout *et al.* (21).

RESULTS

The demographic information of the individuals is summarized in **table I**. The intra-rater reliability of both sports physicians on shear-wave elastography were in excellent (intra-observer ICC: 0.76-0.88) reproducibility in all three parts at the 0-degree measurements (**table II**). However, at 30-degree measurements, they showed only good reproducibility in the proximal part (intra-observer ICC: 0.60-0.74), good to excellent reproducibility in the middle part (intra-observer ICC: 0.69-0.82), and excellent level of reproducibility in the distal part (intra-observer ICC: 0.75-0.81) (**table II**). Considering inter-rater levels, at 0 degrees, the proximal and distal parts were excellent (inter observer ICC: 0.84-0.87), the middle part was good (inter observer ICC: 0.68-0.74). At 30 degrees, they were excellent in the distal (inter observer ICC: 0.82) and good-excellent in the proximal and middle part (inter observer ICC: 0.67-0.79) (**table II**). When we look at the thickness, we observed that they were perfectly consistent (intra-rater) in all measurements taken at 0 and 30 degrees (intra-observer ICC: 0.83-0.95) (**table II**). But the measurements among clinicians were only good at all 3 parts at 0 degrees (inter observer ICC: 0.65-0.75): good to excellent in the proximal and middle parts (inter observer ICC: 0.66-0.83), excellent in the distal part at 30 degrees (inter observer ICC: 0.81-0.82) (**table II**).

As a result of the power doppler evaluation, measurements taken from all 3 parts of the tendon at two different angles were excellently consistent both within and among the clinicians (intra-observer ICC: 0.86-1.00; inter observer ICC: 0.86-1.00) (**table III**). In the evaluation of the hypoechoic regions, it was revealed that physicians were consistent at a fair to excellent level in the distal part at 0 degrees (intra-observer ICC: 0.58-0.93; inter observer ICC: 0.40-1.00), while it showed excellent reproducibility in all remaining measurements of the tendon considering the hypoechoic areas (intra-observer ICC: 0.77-1.00; inter observer ICC: 0.75-1.00) (**table III**).

Table I. Demographic features of the participans.

Demographic information		n (%)	Demographic information	Mean ± Std
Gender	Female	6 (50%)	**Age**	25.5 ± 2.6
	Male	15 (50%)	**Height**	177.0 ± 9.8
	Total	21 (100%)	**Weight**	72.5 ± 14.0

Table II. Intra Observer and Inter Observer ICC (Intraclass Correlation Coefficient) of the measurements were taken by two different observers at 0 and 30 degrees. A) Shear-wave Elastography; B) Thickness.

A)		Proximal		Middle		Distal	
		Observer 1	**Observer 2**	**Observer 1**	**Observer 2**	**Observer 1**	**Observer 2**
0°	Intra ICC	0.88	0.76	0.80	0.85	0.84	0.84
	95% CI	0.70-0.95	0.42-0.90	0.51-0.92	0.64-0.94	0.59-0.94	0.61-0.94
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Intra ICC	0.60	0.74	0.69	0.82	0.81	0.75
	95% CI	0.01-0.84	0.34-0.89	0.26-0.87	0.50-0.93	0.53-0.92	0.37-0.90
	P-value	0.026	0.003	0.005	< 0.001	< 0.001	0.002
		Measure 1	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**
0°	Inter ICC	0.85	0.84	0.68	0.74	0.87	0.84
	95% CI	0.66-0.94	0.64-0.93	0.36-0.86	0.32-0.90	0.70-0.94	0.64-0.93
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Inter ICC	0.79	0.76	0.75	0.67	0.82	0.82
	95%CI	0.55-0.91	0.49-0.89	0.43-0.89	0.35-0.85	0.55-0.93	0.61-0.92
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

B)		Proximal		Middle		Distal	
		Observer 1	**Observer 2**	**Observer 1**	**Observer 2**	**Observer 1**	**Observer 2**
0°	Intra ICC	0.87	0.90	0.89	0.94	0.85	0.90
	95% CI	0.67-0.95	0.72-0.96	0.73-0.96	0.86-0.98	0.64-0.94	0.75-0.96
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Intra ICC	0.85	0.92	0.91	0.83	0.94	0.95
	95% CI	0.64-0.94	0.81-0.97	0.78-0.96	0.58-0.93	0.85-0.98	0.87-0.98
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
		Measure 1	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**
0°	Inter ICC	0.68	0.75	0.69	0.72	0.65	0.73
	95% CI	0.33-0.86	0.42-0.89	0.30-0.87	0.38-0.88	0.01-0.87	0.32-0.89
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Inter ICC	0.76	0.66	0.73	0.83	0.81	0.82
	95% CI	0.31-0.91	- 0.10-0.90	0.45-0.88	0.62-0.93	0.31-0.93	0.49-0.93
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

ICC: less than 0.40 is low; 0.4-0.60 is fair; 0.60-0.75 is good; and greater than 0.75 indicates excellent reliability.

Table III. Intra Observer and Inter Observer GC (Gwet Coefficient) of the measurements were taken by two different observers at 0 and 30 degrees. SEM: Standard error of measurement A) Power Doppler (Grade 0-3); B) Presence Hypoechoic Region.

A)		**Proximal**		**Middle**		**Distal**	
		Observer 1	**Observer 2**	**Observer 1**	**Observer 2**	**Observer 1**	**Observer 2**
0°	Intra ICC	0.86	1.00	1.00	0.93	0.93	1.00
	SEM	0.11	-	-	0.07	0.07	-
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Intra ICC	0.93	1.00	1.00	0.93	0.93	1.00
	SEM	0.07	-	-	0.07	0.07	-
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
		Measure 1	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**
0°	Inter ICC	1.00	0.86	0.93	1.00	1.00	0.93
	SEM	-	0.11	0.07	-	-	0.07
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
30°	Inter ICC	1.00	0.93	1.00	1.00	0.93	1.00
	SEM	-	0.07	-	-	0.07	-
	P-value	< 0.001	< 0.001	< 0.001	<0.001	< 0.001	< 0.001

B)		**Proximal**		**Middle**		**Distal**	
		Observer 1	Observer 2	Observer 1	Observer 2	Observer 1	Observer 2
0°	Intra GC	0.84	0.77	1.00	1.00	0.58	0.80
	SEM	0.12	0.14	-	-	0.20	0.14
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001
30°	Intra GC	1.00	0.86	1.00	1.00	0.93	0.75
	SEM	-	0.11	-	-	0.07	0.16
	P-value	< 0.001	< 0.001	<0.001	< 0.001	< 0.001	< 0.001
		Measure 1	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**
0°	Inter GC	0.86	0.75	1.00	1.00	0.40	0.75
	SEM	0.11	0.15	-	-	0.25	0.15
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	0.01	< 0.001
30°	Inter GC	1.00	1.00	1.00	1.00	0.93	1.00
	SEM	-	-	-	-	0.07	-
	P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

ICC: less than 0.40 is low; 0.4-0.60 is fair; 0.60-0.75 is good, and greater than 0.75 indicates excellent reliability.

DISCUSSION

We show that the evaluation of the SWE, thickness, power doppler, and the hypoechoic region are taken at two different angles from three different points of the patellar tendon can be measured both within the clinicians' measurements and between two different clinicians at a good to an excellent level consistently. The effect of angle differences on the reproducibility of the measurements was not significant. In the measurements taken at 30 degrees, the reproducibility of the SWE values in the proximal and middle parts was found to be less than the others. In this case, all measurements show good to excellent reproducibility.

In line with the results obtained in recent studies on SWE, it has been shown that stiffness changes that occur without structural changes in the tendon may be a precursor to Achilles and patellar tendinopathy (11, 22). Galletti *et al.* (22) showed that sonoelastographic investigations could reveal tendon abnormalities of clinical relevance in an increased percentage of cases in individuals with normal ultrasound findings. The increasing interest in this field in the last decade raises the question of what effect the methodological differences in the studies will have on the results. Obst *et al.* (14), in their meta-analysis study, showed that the SWE (kPa) in patellar tendinopathy cases increased at 30 degrees both globally and locally in the proximal compared to the normal tendon, while at 0 degrees, the values were found to be lower than usual. Also, on the other hand, patellar tendinopathy study numbers were lower than Achilles tendinopathy studies (23). In this context, only three studies evaluated reproducibility among clinicians on the patellar tendon, and the ICC value varied from 0.71 to 0.97 (24-26). While in 2 of these studies (24, 25) the knee was flexed at 30 degrees, in 1 study (26), measurements were made at 90 degrees of knee flexion. No study was found that evaluated the reproducibility of measurements at 0 degrees. Hsiao *et al.* (26) showed that the tendon could differentiate locally due to tension on the tendon because of measurements taken at different angles. Basso *et al.* (27) showed that the amount of strain occurring in the tendon at different knee angles varies, and this change even differs locally in the anterior and posterior parts of the tendon. Eventually, Obst. *et al.* (14) showed differences in tendon structure and loading patterns (tension, compression, or both) wherein areas within the same tendon could display different mechanical or material properties. Moreover, variations during imaging (local, global measurements, and location and orientation of the 2D image plane and tendon load) may play a role. However, this does not affect the reproducibility of the local measurements within or between clinicians in our study.

Studies have shown in athletes that the tendon's thickness increases over time in the relationship of load adaptation (18, 28), and pathological tendons with patellar tendinopathy (6). Tendon thickness in patellar tendinopathy cases has been shown that especially the proximal part of the tendon is affected by this condition (9). This situation brings thickness measurements to the fore to follow-up tendon-related pathologies or load tendon response. In many studies about thickness: respectively, Dudley *et al.* (29) inter-rater ICC 0.69, intra-rater ICC 0.58-0.85, Toprak *et al.* (30) found intra-rater ICC as 0.87-0.99, Ekizos *et al.* (31) inter-rater ICC 0.69-0.79, intra-rater ICC 0.59, Skou *et al.* (32) found inter-rater ICC as 0.70-0.78, intra-rater ICC as 0.70-0.95, del Bano-Aledo *et al.* (33) found inter-rater ICC as 0.85, intra-rater ICC as 0.82-0.91, and Castro *et al.* (34) found the inter-rater ICC as 0.84-0.96 and the intra-rater ICC as 0.97-0.98. It is seen that the results in all studies had good to excellent reproducibility. Our study's results also have good-excellent reproducibility, which supports the literature. Intra-rater reproducibility rates were higher than inter-rater and did not show significant differences between regions.

Structural changes in the tendon that can be detected by ultrasound may not be clinically compatible. Patellar tendon abnormalities are common, especially in young asymptomatic athletes, and these structural changes may remain asymptomatic for a lifetime. In their meta-analysis study, McAuliffe *et al.* (4) found the rate of becoming symptomatic in the future as 21% of the tendons of asymptomatic athletes with increased thickness, vascular activation, and hypoechoic areas. Similarly, such structural tendon changes can be seen in the healthy sedentary population, although less frequently than in athletes (35). In our study, except for one measurement, the inter-rater and intra-rater reproducibility of power doppler and hypoechoic region presence in all the remaining parts' ICC was found to be excellent level. However, in the hypoechoic region measurements made from the distal of the tendon at 0 degrees, the intra-rater ICC of the 1st Observer was 0.58, while the second observer was 0.80. Inter-rater ICC was found to be between 0.40 and 0.75 at a fair to a good level. We thought that this situation might be due to the difficulty in interpreting the echogenic properties of the tendon due to the folding of the tendon on itself at the distal part during the measurement at 0 degrees. Two studies investigate clinicians' reproducibility about doppler activation on the patellar tendon in the literature. Watson *et al.* (36) found the inter-rater ICC as 0.8 and the intra-rater ICC as 0.95 in the power doppler measurements taken from the patellar and Achilles tendon. Macia-Villa *et al.* (37) obtained an excellent (ICC: 0.9) level of reproducibility in power doppler measurements taken from triceps, quadriceps, patellar and Achilles tendons. In another study examining the Achilles tendon, Sengkerji *et al.* (35) found the inter-observer ICC 0.85. When we look at the studies on echogenicity, few studies are in the literature. Castro *et al.* (34) found the inter-rater ICC as 0.83-0.90 and the intra-rater ICC as 0.97-0.98 from the patellar tendon. Cheng *et al.* (38) in the study examining the plantar fascia, showed that the inter-rater ICC was 0.76-0.79, and the intra-rater ICC was 0.86-0.92 with excellent reproducibility.

CONCLUSIONS

Today, ultrasound is widely used in the evaluation of tendon pathologies. With the increase in technological developments, the emergence of new examination methods raises questions about the reproducibility of these methods. This study shows that the reproducibility of local measurements made in different parts of the patellar tendon at two different angles within and among sports medicine physicians is at a good to an excellent level.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

SD: conceptualization, methodology, writing - original draft preparation. SD: data curation, writing - reviewing and editing. OE: visualization, investigation. OP: formal analysis, editing. BB: supervision.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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