



ISB 2013
BRAZIL

XXIV CONGRESS OF THE INTERNATIONAL
SOCIETY OF BIOMECHANICS

XV BRAZILIAN CONGRESS
OF BIOMECHANICS

RELIABILITY OF THE PATELLAR TENDON LENGTH AND THICKNESS MEASURES BY ULTRASONOGRAPHY

¹Marcelle Ribeiro Rodrigues, ²Kelly Mônica Marinho e Lima, ²Wagner Coelho de Albuquerque Pereira
^{1,2}Lilium Fernandes de Oliveira

¹School of Physical Education and Sports, Federal University of Rio de Janeiro, Rio de Janeiro, RJ

²Biomedical Engineering Program, COPPE/UFRJ, Rio de Janeiro, RJ, Brazil

email: marcellerodrigues@hotmail.com;

SUMMARY

The aim of the study is to determine the reliability of the patellar tendon (PT) length and thickness measures by Ultrasound (US). A sample of 15 healthy subjects were measured in two visits with an interval of at least 48 hours between them. In each visit, two images of the PT were acquired by Ultrasound (US). The mean value for the PT length was 40.04 ± 5.00 mm and for PT thickness was 3.33 ± 0.61 mm. The reliability of the PT values showed a CV ranging from 0.50 to 6.16%; an ICC 0.800 to 0.999; a TEM 0.29 to 0.52mm (thickness) and 2.74 to 3.96mm (length). The results showed a satisfactory reliability of PT length and thickness measures by US.

INTRODUCTION

US is a reliable, relatively low cost and noninvasive method that can be performed in real-time (Miyatani et al., 2002) for the analysis of tendons *in vivo*, such as the PT (Gelhorn et al, 2012; Reeves et al., 2009), which is a superficial and thick tendon. In US studies, PT is described in terms of dimensions, such as anatomical cross-section area (Reeves et al., 2009), length (Gelhorn, 2012) and mechanical properties, such as stiffness (Liu et al. 2010) and strain (Seynnes et al., 2009). The PT thickness and length are important for clinical assessment, such as tendinopathy (Davies et al., 1991) and patellar instability (Neyret 2002). Moreover, the measurement of the PT length allows the evaluation of its strain, which is estimated from the relative length change to its initial length (Lieber, 2010). O'Brien et al. (2010) observed a PT elongation of 5.2 ± 0.5 mm during isometric voluntary contraction (1321 N) for young men. Given this small amount of elongation, it is clear that accurate measurements of the PT length is of critical importance to assess these and other related biomechanical tissue properties in the normal and pathologic patellar tendon (Gelhorn, 2012). The reliability of measurements from US images involves, besides the resolution of the instrument, the researcher's experience and accuracy in identifying anatomical sites (Blazevich et al., 2006). Thus, the aim of the study is to evaluate the reliability of the measurements of the patellar tendon (PT) length and thickness by US.

METHODS

The sample consisted of 15 healthy subjects (24.2 ± 2.8 years, 67.5 ± 9.4 kg and 1.7 ± 0.07 m), with no history of lower limb injury. The individuals were instructed not to perform any type of physical activity before the tests. First, the subjects sat with knees flexed at 90° and feet on the ground. Ultrasound (US) EUB 405 (Hitachi, Tokyo, Japan) with a linear transducer 80mm and excitation frequency of 7.5MHz was used for image acquisition of the patellar tendon. Gel (Ultrax gel; Farmativa Industry and Trade Ltd., Rio de Janeiro, RJ, Brazil) was used for acoustic coupling on the skin surface. Initially, a guideline connecting the midpoint of the patella base to tibial tuberosity was drawn on the skin of the individual. The transducer was positioned longitudinally along this guideline allowing the visualization of the tendon between the patella and tibia (Figure 1). Individuals participated in two visits with an interval of, at least 48 hours, between them. In each visit, two images of the patellar tendon were acquired, totaling four images per individual. The public domain software ImageJ (Version 1.42; National Institutes of Health, Bethesda, MD, USA) was used to measure the length and thickness of the patellar tendon. The length of the patellar tendon was determined as the horizontal distance between the end of the patella and the slope region where the tendon intercepts the tibia ("v" format) (figure 1a, arrow 1). The thickness of the tendon was determined as the vertical distance between the limits of the patellar tendon (Figure 1b, arrow 2). Data were collected by a single trained examiner. Reliability of the measures was determined by the coefficient of variation (CV), intraclass correlation coefficient (ICC) and typical error of measurement (TEM). The normal distribution of data was verified by the Kolmogorov-Smirnov test. The ANOVA for repeated measures was used to analyze the variables between images and days, with a significance level of $p < 0.05$. The Statistical Analyses were Performed Using the program Prism5® (Version 5.00 for Windows, GraphPad Software, San Diego California, USA).

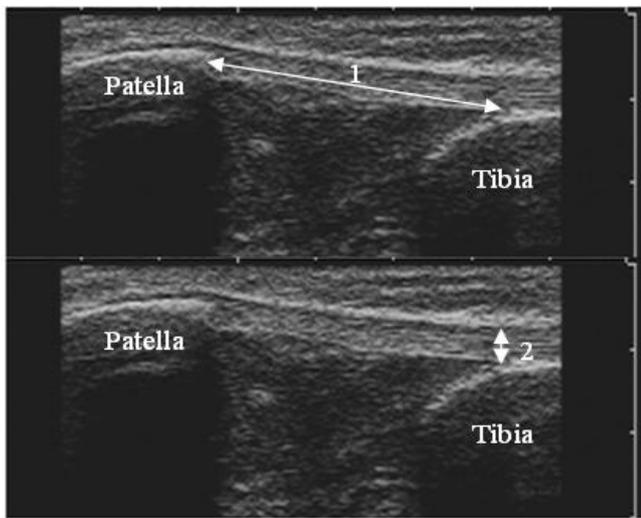


Figure 1: Ultrasound images of patellar tendon, located between the patella and tibia bone region. Arrow 1 represents the length and arrow 2, the thickness of the patellar tendon.

RESULTS AND DISCUSSION

The reliability data are detailed in Table 1.

Table 1: Mean values (SD) and reliability of length and thickness patellar tendon between images (i1 and i2) and days (d1 and d2). TEM: typical error of measurement (cm), CV: coefficient of variation (%), ICC: intraclass correlation coefficient.

		Mean±DP (mm)	TEM (mm)	CV (%)	ICC
PT Length	i1d1	38.59±3.95	2.74	0.53	0.999
	i2d1	38.37±3.81			
	i1d2	41.59±5.51	3.96	0.50	0.999
	i2d2	41.60±5.71			
	d1	38.48±3.88	3.11	6.16	0.800
	d2	41.60±5.61			
PT Thickness	i1d1	3.46±0.42	0.29	2.17	0.963
	i2d1	3.46±0.43			
	i1d2	3.17±0.72	0.52	2.45	0.989
	i2d2	3.23±0.78			
	d1	3.46±0.41	0.31	6.16	0.800
	d2	3.20±0.74			

No significant differences were found for the PT length and thickness measures between the images and days. The mean values of the TP length was 40.04±5.00 mm and thickness 3.33±0.61 mm.

The reliability of the PT values show a CV ranging from 0.50 to 6.16%; an ICC 0.800 to 0.999; a TEM 0.29 to 0.52mm (thickness) and 2.74 to 3.96mm (length). The results showed a satisfactory reliability, since the ICC values were 0.800 to 0.999, CV below 10% and TEM was near zero [Atkinson et al., 2010]. Reliability performed between days was lower (ICC 0.800 and CV of 6.16%) than among the images of the same day for the two measures (table 1), which may reflect the error in positioning the probe in the same site, a lack of relaxation of the limb or different compressions of the probe on the skin. O'Brien et al. (2010) compared the mechanical properties of PT between subjects of various ages and both genders and found a resting TP

length for men, women, boys and girls of 55.00±5.5, 47.60±5.6, 34.87±6.7 and 40.60±5.7 mm, respectively. These results show that the values of PT length of girls were similar to this study (40.04 ± 5.00mm), which can't be explained by the gender of the sample this study, consisted of both girls and boys. Reeves et al. (2009) compared the length PT of males (37±14 years) of the operated knee (anterior cruciate ligament reconstruction) with the control limb and found a length PT of 52±4mm. These values were higher than this study possibly due to of length PT adopted (patellar apex to the most proximal insertion TP into the tibial tuberosity).

CONCLUSION

The patellar tendon length and thickness measured by US are reliable and the error data provided by this study can be considered in future studies focusing the PT adaptation to clinical or training interventions.

ACKNOWLEDGEMENTS

CAPES, CNPq e FAPERJ

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