

# Reproducibility and clinical utility of tendon palpation to detect patellar tendinopathy in young basketball players

J L Cook, K M Khan, Z S Kiss, C R Purdam, L Griffiths, for the Victorian Institute of Sport tendon study group

## Abstract

**Background**—Palpation is an important clinical test for jumper's knee.

**Objectives**—To (a) test the reproducibility of palpation tenderness, (b) evaluate the sensitivity and specificity of palpation in subjects with clinical symptoms of jumper's knee, and (c) determine whether tenderness to palpation may serve as a useful screening test for patellar tendinopathy. The yardstick for diagnosis of patellar tendinopathy was ultrasonographic abnormality.

**Methods**—In 326 junior symptomatic and asymptomatic athletes' tendons, palpation was performed by a single examiner before ultrasonographic examination by a certified ultrasound radiologist. In 58 tendons, palpation was performed twice to test reliability. Tenderness to palpation was scored on a scale from 0 to 3 where 0 represented no pain, and 1, 2, and 3 represented mild, moderate, and severe tenderness respectively.

**Results**—Patellar tendon palpation was a reliable examination for a single examiner (Pearson  $r = 0.82$ ). In symptomatic tendons, the positive predictive value of palpation was 68%. As a screening examination in asymptomatic subjects, the positive predictive value of tendon palpation was 36–38%. Moderate and severe palpation tenderness were better predictors of ultrasonographic tendon pathology than absent or mild tenderness ( $p < 0.001$ ). Tender and symptomatic tendons were more likely to have ultrasound abnormality than tenderness alone ( $p < 0.01$ ).

**Conclusions**—In this age group, palpation is a reliable test but it is not cost effective in detecting patellar tendinopathy in a preparticipation examination. In symptomatic tendons, palpation is a moderately sensitive but not specific test. Mild tenderness in the patellar tendons in asymptomatic jumping athletes should be considered normal.

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Keywords: patellar tendon; ultrasound; palpation; reliability; athletes

Jumper's knee is a clinical condition of pain and subsequent dysfunction in the patellar tendon and the bony attachments. In the literature, this term is used interchangeably with

terms that allude to the histopathology of the condition—for example, patellar tendinitis, tendinosis, and tendinopathy. In this study, the term patellar tendinopathy refers specifically to the clinical picture of jumper's knee combined with characteristic imaging changes.

In clinical practice, jumper's knee is diagnosed by history, knee examination, and palpation of the tendon and its attachments. The patellar tendon is easily palpated, as it lies immediately beneath the skin and has no substantial peritendon. The diagnosis is confirmed with imaging, commonly ultrasonography (US) and magnetic resonance imaging (MRI). Patellar tendon pain, tenderness, and imaging changes are most commonly found at the junction of the inferior pole of the patellar and the tendon attachment.<sup>1 2</sup>

It has been argued that palpation is the "hallmark of patellar tendinitis".<sup>3–5</sup> Duri *et al*<sup>6</sup> found palpation to be the only sign positive in all 27 subjects in a comprehensive biomechanical and clinical examination. This cannot be used to suggest that palpation is 100% specific for jumper's knee as these subjects were diagnosed as having the condition clinically, and there was no imaging or histopathological yardstick. Thus tenderness on palpation is an important diagnostic test but there has, to our knowledge, been no critical evaluation of either its reproducibility or validity compared with any yardstick.

Although it is not feasible to use histopathology as a yardstick in clinical studies, abnormal US and MRI appearances correlated with the pathology of tendinosis in every case where patients underwent surgery.<sup>7 8</sup> Thus we contend that tendon US can serve as a legitimate surrogate measure ("criterion measure") for the presence of abnormal tendon morphology.<sup>9–11</sup> Abnormal imaging morphology, however, does not necessarily mean that symptoms must be present.<sup>12</sup>

The aims of the present study were threefold: firstly, to test the reproducibility of palpation tenderness of the patellar tendon in an at risk population of athletes; secondly, to evaluate the sensitivity and specificity of palpation as an examination technique in subjects with symptoms of jumper's knee, using US as the criterion measure; thirdly, to determine whether palpation tenderness may serve as a useful screening test for US lesions consistent with patellar tendinopathy in an asymptomatic population of at risk athletes—that is, preparticipation examination.

School of  
Physiotherapy, Latrobe  
University, Bundoora,  
Australia 3083  
J L Cook

Department of Family  
Medicine (Sports  
Medicine) and School  
of Human Kinetics,  
University of British  
Columbia, Vancouver,  
Canada  
K M Khan

East Melbourne  
Radiology, East  
Melbourne, Australia  
Z S Kiss

Australian Institute of  
Sport, Canberra,  
Australia  
C R Purdam

Griffith University,  
Southport, Australia  
L Griffiths

Correspondence to:  
J L Cook  
cook.evans@bigpond.com

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## Materials and methods

### SUBJECTS AND CLINICAL DATA

One investigator (JLC) palpated the patellar tendons of 163 (80 male, 83 female) junior athletes immediately before a US radiologist (ZSK) examined them with US. All subjects completed a questionnaire that included the Nirschl scale of knee pain and function, and indicated on knee diagrams the location of symptoms. The Nirschl scale consists of a score of 0–7 where 0 represents no symptoms, 1–4 represent increasing symptoms with activity, and 5–7 denote symptoms with daily activities and at rest.<sup>13</sup>

Current symptoms were considered present if the athlete had a Nirschl score of 1 or more and the area of pain marked on the knee diagram was directly over the proximal part of the patellar tendon. If the subject recorded the site of pain anywhere else on the knee diagram, he/she was excluded from the current symptoms group.

Palpation of the patellar tendon attachment to the patella was performed by tilting the inferior pole of the patella anteriorly.<sup>3</sup> Central, medial, and lateral aspects of the attachment were examined. Subjects were asked to grade palpation tenderness on a scale from 0 to 3, where 0 = no tenderness, 1 = mild tenderness, 2 = moderate tenderness, and 3 = severe tenderness.

Palpation was limited to the proximal third of the tendon and the attachment to the patella. Clinically, the inferior pole of the patella and the proximal tendon are referred to most commonly in the literature on knee examination.<sup>3 14 15</sup>

In basketball players,<sup>1 2</sup> and in most jumping athletes, patellar tendon pain presents mainly at the inferior pole of the patella. The relative proportions are quantified as 65% at that site, 25% at the quadriceps tendon, and 10% at the tibial insertion.<sup>16</sup>

Therefore we investigated the clinical utility of palpation as an examination technique for pain and pathology at the inferior pole of the patella.

### US ASSESSMENT

In all subjects, a board certified US radiologist obtained US images in both the longitudinal and axial planes using a high resolution linear array 10 MHz ultrasound transducer (Acoustic Imaging Dornier; ATL Melbourne, Vic, Australia). Blinded to the subject's clinical status, the radiologist recorded the presence or absence of a US lesion using routine clinical criteria. Subjects with abnormal imaging other than at the inferior pole of the patella (three mid tendon imaging abnormalities) or with bony irregularity at the inferior pole (two tendons) were excluded from analysis. Subjects with evidence of Osgood-Schlatter disease were included in the study. The quadriceps tendon was not examined clinically or ultrasonographically.

### RELIABILITY STUDY

Four hours after the tendon palpation described above, the same examiner (JLC)

Table 1 Results of first and second palpation (0–3, where 0 = no tenderness, 1 = mild tenderness, 2 = moderate tenderness, 3 = severe tenderness)

Second palpation score (n=58)	First palpation score (n=58)			
	0	1	2	3
0	9	4	0	0
1	0	17	4	0
2	0	1	12	2
3	0	1	4	4

re-palpated 29 randomly selected subjects (58 tendons). Subjects were inactive between tests. The US examination took place after palpation and the examiner was blinded to the results of palpation in the first test.

### STATISTICAL METHODS

Data were analysed using Excel 5.0 (Microsoft Corporation, Redmond, WA, USA). Patient characteristics and mean dimensions of hypoechoic regions were calculated using descriptive statistics. A 2 × 2 contingency table was used to test palpation in normal and abnormal tendons. Student's *t* test was used to test significance in symptomatic and asymptomatic tendons. Significance levels were set at  $p < 0.05$ .

## Results

### DESCRIPTIVE CHARACTERISTICS

The subjects had a mean (SD) height of 185.1 (11.3) cm, weight of 75.6 (11.8) kg and age of 197.2 (12.2) months. The age range was 14.2–18.7 years.

### PALPATION RELIABILITY

Table 1 shows the reproducibility of the test-retest palpation. Overall reproducibility of palpation was 0.82 (Pearson correlation coefficient). Forty one of 58 test-retest results were identical. In 16 of the 17 (94%) remaining cases palpation scores differed by one point only. Results that follow exclude the second patellar tendon palpation.

### CLINICAL UTILITY OF PALPATION IN ATHLETES WITH THE CLINICAL SYNDROME OF JUMPER'S KNEE

There were current symptoms in 27 tendons. Of these, 16 contained a US lesion and 11 did not. In symptomatic subjects, the sensitivity of palpation was 68% and specificity was 9%. The positive and negative predictive values of palpation in this group were 52% and 17% respectively (table 2).

We compared the incidence of US abnormality in tender tendons (Nirschl score 1–3) with and without symptoms (table 3). Tendons with both symptoms and tenderness were significantly more likely to have US abnormality than those with palpation tenderness and no symptoms ( $p < 0.01$ ). If we excluded mild

Table 2 Symptomatic tendons: palpation vs ultrasonographic (US) appearance

	US lesion	US normal
Tender	11	10
Not tender	5	1

$\chi^2 = 1.85$ . Not significant.

Table 3 Ultrasonography (US) results in tender tendons (1–3) with and without symptoms

	US lesion	US normal
Symptomatic	11	10
Asymptomatic	35	126

$\chi^2 = 9.2$ ,  $p < 0.01$ .

Table 4 Ultrasonography (US) results in tender tendons (2–3) with and without symptoms

	US lesion	US normal
Symptomatic	11	10
Asymptomatic	23	39

$\chi^2 = 1.5$ ,  $p > 0.05$ .

Table 5 Palpation scores in asymptomatic athletes with and without ultrasonographic (US) lesions in the patellar tendon

	Palpation scores			
	1 Not tender	2 Mild	3 Moderate	4 Severe
US normal (n=236)	110	87	30	9
US lesion (n=63)	28	12	18	5
Predictive value	80%*	12%†	38%†	36%†

\*This represents a negative predictive value—that is, the finding of no tenderness on palpation means that there is an 80% likelihood that there is no US lesion.

†This represents a positive predictive value—that is, the likelihood that this degree of tenderness is associated with a US lesion.

Table 6 Summary of palpation results and ultrasonographic (US) findings in basketball players with asymptomatic patellar tendons

	US lesion	US normal
Tender (1–3)	35	126
Not tender (0)	28	110

US results in tendons that were not tender (0) and in those that had some tenderness (grades 1–3).  $\chi^2 = 0.09$ . Not significant.

tenderness (Nirschl score 1) from the tender group, then tenderness and symptoms was not associated with US abnormality ( $p > 0.05$ ) (table 4).

#### CLINICAL UTILITY OF PALPATION AS A SCREENING TEST: PALPATION AND THE PREPARTICIPATION EXAMINATION

Of the 299 asymptomatic tendons, 63 contained a US lesion and 236 did not (table 5). We calculated sensitivity and specificity of palpation scores in two clinically relevant ways. Firstly, we classified only the palpation finding of no pain as “not tender” (0), and grouped all the tenderness categories (1, 2 and 3) as “tender” (table 6). With this definition of “tenderness”, palpation had a sensitivity of 56% and specificity of 47%. The positive predictive value was 22%.

Secondly, we combined subject tendons with no tenderness (0) and mild tenderness (1) and compared them with subject tendons that had either moderate (2) or severe (3) tenderness (table 7). When grouped in this way, moderate and severe tenderness had a sensitivity of 37% and specificity of 83%. Positive predictive value was 37%.  $\chi^2$  analysis showed that moderate and severe tenderness was a significantly better predictor of US abnormality than was zero or mild tenderness ( $p < 0.001$ ).

Table 7 Ultrasonographic (US) results in tendons that were not tender or mildly tender (0 or 1) and those that were moderately or severely tender (tenderness grades 2, 3)

	US lesion	US normal
Tender (2–3)	23	39
Not tender (0–1)	40	197

$\chi^2 = 12.08$ ,  $p < 0.001$ .

## Discussion

Tenderness on palpation is a key component of the clinical diagnosis of patellar tendinopathy. The present study is, to our knowledge, the first to examine the reliability of this important clinical sign or its clinical utility in the diagnosis of patellar tendinopathy in patients with symptomatic jumper's knee. Further, we tested the utility of palpation as a test in the preparticipation examination to detect underlying US tendon lesions.

### ASYMPTOMATIC LESIONS

Asymptomatic imaging abnormalities have been shown in the tendons of athletes playing volleyball, basketball, and soccer and of track and field athletes.<sup>2 12 17–19</sup> Leadbetter<sup>20</sup> postulated that degenerative tendon pathology could remain asymptomatic for a period when he defined tendinopathy as “a focal intratendinous degeneration that may or may not be symptomatic”. Support for the concept of asymptomatic tendinopathy is found in the study of 891 spontaneous tendon ruptures.<sup>21</sup> Of these, 97% had histopathological evidence of degeneration (tendinosis). However, only 34% of these tendons were symptomatic before rupture.

US is used extensively to image tendons, and clinically, abnormal US appearance is considered to represent abnormal tendon tissue.<sup>22</sup> US characteristically reveals swelling of the tendon and loss of fascicular continuity, and this corresponds histologically to collagen degeneration with increased ground substance and vascularity.<sup>23</sup> The imaging appearance of asymptomatic tendinopathy is indistinguishable from symptomatic tendinopathy.<sup>1</sup> There are, as yet, no studies that show the histopathology of asymptomatic imaging abnormalities.

### DO TENDONS WITH ASYMPTOMATIC IMAGING ABNORMALITIES BECOME SYMPTOMATIC?

A longitudinal study of basketball players in the same age group as this study showed that symptoms at baseline conferred 4.2 times greater risk of developing symptoms than normal tendon at baseline.<sup>24</sup> Similar studies in adult female basketball players also showed that a hypoechoic tendon at baseline conferred an increased risk of symptoms at a 17 month follow up.<sup>25</sup>

### IS PALPATION A RELIABLE EXAMINATION?

In the hands of a single examiner, palpation can reliably grade tenderness on a 0–3 scale. Further investigation is needed to examine intertester reliability.

#### IS PALPATION AN EFFECTIVE CLINICAL EXAMINATION TOOL IN PATIENTS WHO HAVE SYMPTOMS OF JUMPER'S KNEE?

In this group of elite junior athletes, if US evidence of tendon lesions was used as a criterion, palpation was a moderately sensitive but not specific test for patellar tendinopathy. Symptomatic tendons with palpation tenderness were more likely to have US abnormality than asymptomatic tendons with palpation tenderness. However, if tendons with mild tenderness were excluded, then tenderness in association with symptoms was not an indication of US status.

#### IS PALPATION A USEFUL COMPONENT OF THE PREPARTICIPATION EXAMINATION TO DETECT ASYMPTOMATIC US LESIONS IN THE PATELLAR TENDON?

Tenderness on palpation is not a useful predictor of a US lesion in the patellar tendons of high risk, but asymptomatic, subjects. This is the population that undergoes the preparticipation examination. The positive predictive value of tenderness was low for both the mild to severe classification (tenderness grades 1, 2, and 3) and the moderate and severe classification (tenderness grades 2 and 3 only).  $\chi^2$  was significant when moderate and severe palpation tenderness was required before palpation was considered positive. Our data indicate that elite heavily training young athletes may have mild tendon soreness without US tendon pathology. Although no tenderness on palpation was strongly associated with normal tendons, the purpose of a preparticipation examination is to detect modifiable pathology.

#### SINDING-LARSEN-JOHANSSON DISEASE

Although Sinding-Larsen-Johansson (SLJ) disease in girls of this age cannot be totally discounted, it is generally considered to occur at an earlier age than that of the subjects in this study (10–11 years). Almost all of the boys in this study were outside the age group for SLJ in males (13–14 years).<sup>26</sup> US imaging of this condition can disclose abnormal morphology such as bony irregularity and tendon swelling.<sup>27</sup>

#### CLINICAL IMPLICATIONS

(1) In subjects of this age group, palpation is a reliable examination technique. Thus further research into its clinical utility in various populations is warranted.

(2) As a diagnostic test in subjects presenting with symptoms consistent with jumper's knee, the sensitivity and specificity of tendon palpation were 68% and 9% respectively, suggesting that the test is only somewhat useful in the diagnostic process. We found that moderate and severe tenderness (positive predictive value 36% and 38% respectively) were better predictors of patellar tendinopathy than was zero or mild tenderness (positive predictive value <20%). This implies that clinicians should not attach undue significance to mild tenderness at the patellar tendon attachment site.

(3) As a part of the preparticipation examination in asymptomatic, but high risk subjects, moderate and severe palpation

tenderness detected 37% of US lesions—that is, there is a false positive rate of 63%. Thus, if bilateral patellar US scans are costed at £50, screening 100 tendons would cost £2500. In a population such as reported in this study, and in others, the prevalence of tendons with asymptomatic US lesions is about 20%.<sup>1,2</sup> A positive predictive value of 40% would lead to detection of only eight of the 20 abnormal tendons, at a cost of over £300 per tendon. Furthermore, 12 US abnormal tendons would remain undetected because palpation tenderness was absent. Given that the clinical significance of asymptomatic US lesions remains unclear,<sup>2,12</sup> our data provide no indication that patellar tendon tenderness at preparticipation examination should be followed by US.

Investigators in the Victorian Institute of Sport tendon study group are: Departments of Medicine and Radiology, Royal Melbourne Hospital; Physiotherapy School, LaTrobe University; Australian Institute of Sport; Victorian Institute of Sport; East Melbourne Radiology; J Bartlett, F Bonar, B Coleman, J Cook, K Crichton, M Fehrmann, M Grant, L Griffiths, P Harcourt, D Kellaway, K Khan, Z S Kiss, C Purdam, B Tress, P Visentini, J Wark, D Young. The following institutions are represented: Department of Medicine, University of Melbourne, Royal Melbourne Hospital; Department of Radiology, University of Melbourne, Royal Melbourne Hospital; Australian Institute of Sport; Victorian Institute of Sport.

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**Take home message**

This study indicates that palpation of the patellar tendon may not offer the clinician diagnostic certainty of tendon pathology as shown on US examination. An accurate history and other examination techniques should be used to confirm the diagnosis in symptomatic athletes. Palpation tenderness does not indicate US status in asymptomatic athletes and should not be used to screen athletes for potential problems in this tendon.