Clinical Journal of Sport Medicine
7:199–206 © 1997 Lippincott–Raven Publishers, Philadelphia

Patellar Tendon Ultrasonography and Jumper's Knee in Female Basketball Players: A Longitudinal Study

*†||Karim M. Khan, B.Med.Sci., M.B.B.S., †||Jill L. Cook, B.App.Sci., ‡||Zoltan S. Kiss, M.B.B.S., §||Paul J. Visentini, B.App.Sci., †||Michael W. Fehrmann, M.Eng., †||Peter R. Harcourt, M.B.B.S., ||¶Brian W. Tress, M.B.B.S., M.D., and *||John D. Wark, M.B.B.S., Ph.D.

**Department of Medicine, Royal Melbourne Hospital, University of Melbourne, Parkville; †Alphington Sports Medicine Clinic, Melbourne; ‡East Melbourne Radiology, Melbourne; §Croydon Sports Medicine Centre, Melbourne; ||Victorian Institute of Sport Tendon Study Group (see the appendix for the list of investigators); and ¶Department of Radiology, Royal Melbourne Hospital, University of Melbourne, Parkville, Australia*

Abstract:
Objective: To compare patellar tendon sonographic findings at baseline and at follow-up in active female basketball players with and without symptoms of jumper's knee. We hypothesized that baseline sonographic morphology would not reliably predict prognosis and, in particular, that it would not predict the need for surgery.
Design: Prospective longitudinal study with 12-month minimum follow-up.
Setting: Institutional elite athlete study group in Australia (Victorian Institute of Sport Tendon Study Group).
Patients and participants: A total of 15 female elite basketball players with 23 sonographically abnormal tendons and 15 matched control basketball players with 23 sonographically normal tendons.
Main outcome measures: Sonographic patellar tendon appearance and clinical assessment of symptoms of jumper's knee at baseline and follow-up. Dimensions of abnormal regions were measured.
Results: At baseline, the 23 subject tendons contained sonographic hypoechoic regions (six currently symptomatic, eight previously symptomatic only, and nine never symptomatic). At follow-up, the hypoechoic areas in seven tendons had resolved (and caused no symptoms), the hypoechoic areas in 11 tendons had remained essentially the same size (five were symptomatic), and the hypoechoic areas in five tendons had expanded (three symptomatic). At baseline, there were no differences between the mean ± SD cross-sectional areas of the abnormalities in the tendons that subsequently resolved (15.9 ± 10.1 mm^2) and those that remained unchanged (39.3 ± 25.8) or expanded (25.3 ± 12.5). The presence of a baseline sonographic abnormality predicted symptoms of jumper's knee at follow-up ($p < 0.05$), but the presence of symptoms of jumper's knee at baseline also predicted symptoms at follow-up ($p < 0.05$). No subject or control missed any games or underwent surgical treatment.
Conclusions: Patellar tendon sonographic hypoechoic areas can resolve, remain unchanged, or expand in active sportswomen without predicting symptoms of jumper's knee. Thus, symptoms were not directly related to sonographic tendon morphology. Sonographic hypoechoic regions ought not to constitute per se an indication for surgery.
Key Words: Knee—Ultrasound—Tendinitis—Tendinosis—Basketball—Patellar tendon.
Clin J Sport Med 1997;7(3):199–206.

Ultrasonography is an effective imaging modality for patients with suspected tendon pathology and is routinely used to confirm the diagnosis of jumper's knee in sportspeople (3). Jumper's knee is the clinical syndrome of anterior knee pain and tenderness arising from patellar tendon degeneration (2,13). Whether or not ultrasonography is useful for guiding management of jumper's knee requires further evaluation.

Fritschy and de Gautard (9) reported from a cross-sectional study that ultrasonographic appearances could be used to select and *monitor* treatment for jumper's knee, but these authors did not actually *monitor* their patients with sonography. They proposed three distinct categories of sonographic appearances in jumper's knee, including one labeled "stage with *irreversible anatomical* lesions," but neither followed the patients to test whether "lesions" were irreversible or provided any histological results. Myllymäki et al. (15) claimed that sonographic hypoechoic regions represent degenerative cysts that always *require surgical treatment* but did not follow a conservatively managed group to test their assertion.

Contrary to the finding reported by Myllymäki et al. (15), we have previously demonstrated that some jumping athletes without a current or past history of jumper's knee symptoms have sonographic hypoechoic regions on their patellar tendons (5,6,10). This finding of abnormal

Received November 11, 1996; accepted February 5, 1997.
Address correspondence to Dr. K. M. Khan, Department of Medicine, Royal Melbourne Hospital, University of Melbourne, Parkville, Victoria 3050, Australia.
No reprints available.

morphology in asymptomatic athletes sparked our interest in discovering the natural history of patella tendon sonographic hypoechoic regions in both symptomatic and asymptomatic athletes. This study monitored sonographic hypoechoic abnormalities in actively competing elite athletes.

MATERIALS AND METHODS

Subjects

Subjects were identified from 67 female basketball players (seven teams) who participated in a cross-sectional study of patellar tendon sonography in elite athletes (5,6,10). Of a total of 21 basketball players who had at least one baseline hypoechoic area within the patellar tendon by sonography, 15 were available for follow-up study. The remaining six were playing overseas (three players) or had retired from basketball to have children (three players). No players were lost to the study because of injury.

A matched (age, height, weight, and basketball experience) control group of players from the aforementioned study and whose patellar tendons were sonographically normal at baseline provided 23 control tendons. All players competed in the Women's National Basketball League (WNBL), the highest domestic level of basketball in Australia. Of the 30 players studied, 16 (eight subjects and eight controls) currently play or previously played at the international level.

The study was approved by the Ethics Committee of the Royal Melbourne Hospital (University of Melbourne). All patients provided written informed consent.

Clinical assessment: questionnaire and physical examination

At baseline and at follow-up, all players completed a questionnaire concerning age, height, weight, basketball experience (games played in the WNBL), symptoms of anterior knee pain, hours of basketball per week, and number of weeks of basketball in the 12 months prior to testing. If a player had a past history of anterior knee pain related to activity that caused her to miss games or modify her training, she was categorized as having had jumper's knee previously. At baseline and follow-up, each player was examined by one of two clinician authors (J.L.C. or K.M.K.). At follow-up, these authors were blinded to baseline clinical data and sonographic results.

Sonographic assessment

A single radiologist (Z.S.K.) performed ultrasonography using the identical machine for both baseline and follow-up scans. The mean ± SD time between sonographic studies did not differ between groups [18.3 ± 8.9 months for all participants (range, 12–34 months)].

The radiologist was blinded to players' symptomatic status at all times, and at follow-up scan was blinded to the previous sonographic results. All scans were performed during the basketball season. A sonographic abnormality was defined as either (a) a hypoechoic region, evident in both the longitudinal and the transverse scans, or (b) a fusiform swelling without hypoechoic areas. The latter, a well-recognized sonographic appearance in jumper's knee, was not evident in this cohort of basketball players.

The presence or the absence of any sonographic abnormalities was recorded. Maximum length, width, and height of hypoechoic regions were measured by electronic calipers in both the sagittal (longitudinal) and axial (transverse) planes. Length was measured on the sagittal image, whereas width (mediolateral tendon dimension) and height (anteroposterior tendon dimension) were measured on the axial image. The approximate cross-sectional area of any abnormality at its greatest dimension on the transverse image was determined by multiplying the width/2 by the height/2 (as approximate radii) by pi. Baseline and follow-up hypoechoic areas were compared by expressing follow-up area as a percentage of baseline area. Results were categorized as follows: tendons with regions that had resolved at follow-up (0–5% of baseline) were labeled *resolved* (Fig. 1), those with regions that were <50% of their original size but unresolved were *diminished*, those that were 50–150% of baseline were *unchanged* (Fig. 2), and those with an area >150% of baseline were *expanded* (Fig. 3).

Sonographic reproducibility

We measured short-term intratester reproducibility of tendon sonography in 20 players with 29 sonographically abnormal and 11 sonographically normal tendons. Both in the morning and in the afternoon, the same radiologist who performed all of the ultrasonography in this study (Z.S.K.) answered yes/no to whether an abnormality was present in each tendon and he measured dimensions of abnormal sonographic regions.

Statistical methods

Data were analyzed by using Excel 5.0 software (Microsoft; Redmond, W.A.). Patient characteristics and mean dimensions of hypoechoic regions were calculated by using descriptive statistics. Intratester reproducibility was assessed by using standard intraclass (31) correlation coefficient (ICC) statistics (7,18). Standard error of the mean was calculated from standard formulae (7). Two-by-two contingency tables were used to test whether baseline asymptomatic sonographic regions predicted jumper's knee during the follow-up period and (b) whether baseline symptoms predicted symptoms at follow-up. Cross-sectional areas of three categories of tendons at baseline were compared by analysis of variance (ANOVA). Significance levels were set at $p < 0.05$.

RESULTS

Subject characteristics

The subjects and controls did not differ in age, height, weight, or games played (Table 1). Subjects and controls played and trained for a minimum of 40 weeks each year.

Imaging and clinical findings

Reproducibility study

The intratester reproducibility of detection of an abnormal hypoechoic region (yes/no) was perfect in 40

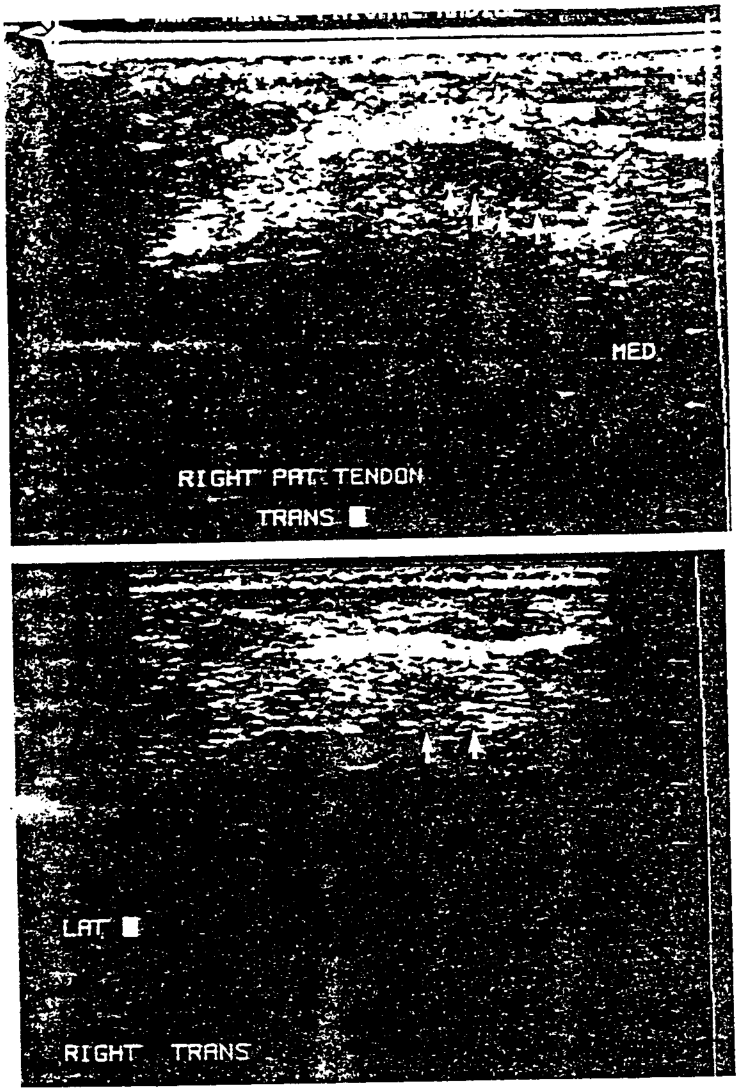

FIG. 1. Axial sonographic studies conducted 22 months apart of a competitive 28-year-old basketball player with symptoms at baseline (A), but who was symptom free at follow-up (B), reveal essential resolution of the baseline hypoechoic sonographic area of the right patellar tendon. x–x, width 8.3 mm, +—+, height 3.3 mm at baseline.

tendons (29 contained sonographic abnormalities, and 11 were normal on both testing and retesting). Measurement of maximal width and height of the sonographic abnormality on the axial (transverse) image on two occasions revealed correlation coefficients of 0.74 (width) and 0.94 (height) by ICC (3,1) and also by Pearson's correlation coefficient (r). When the cross-sectional area of hypoechogenicity was calculated independently by using the two separate length and width measurements, ICC (3,1) and Pearson r both equaled 0.92. Standard errors of measurement were 1.9 mm, 0.4 mm, and 6.3 mm^2 for width, height, and area, respectively. Since the mean areal abnormality was 29.4 mm^2, the 95% confidence interval (CI) was 23.1–35.7 mm^2. Intratester reproducibility of the length of the sonographic abnormality measured on the longitudinal (sagittal) image had a Pearson r and ICC (3,1) of 0.21.

Clinical and sonographic outcomes

The ultrasonographic and clinical findings in basketball players with hypoechoic regions at baseline are summarized in Table 2. Note that although all tendons in the subject group contained sonographic hypoechoic regions at baseline, not all tendons were symptomatic (nine with no history of symptoms, eight with a past history only, and six currently symptomatic).

Tendons that were asymptomatic but sonographically abnormal at baseline were more likely to be associated with symptoms during the follow-up period than were sonographically normal tendons (χ^2, $p < 0.05$) (Table 3). However, tendons that were symptomatic at baseline were also more likely to be symptomatic at follow-up than were those that were asymptomatic at baseline (χ^2, $p < 0.05$) (Table 4).

Cross-sectional area of sonographic hypoechoic regions

The dimensions of hypoechoic regions at baseline and follow-up are listed in Table 5. At baseline, there were no differences in the mean cross-sectional areas of abnormalities in tendons that subsequently resolved [mean (SD) area = 15.9 (10.1) mm^2] and those that remained unchanged [mean (SD) area = 39.3 (25.8)] or expanded [mean (SD) area = 25.3 (12.5)] (ANOVA).

In the seven subject tendons where the sonographic region had resolved at follow-up, none were symptom-

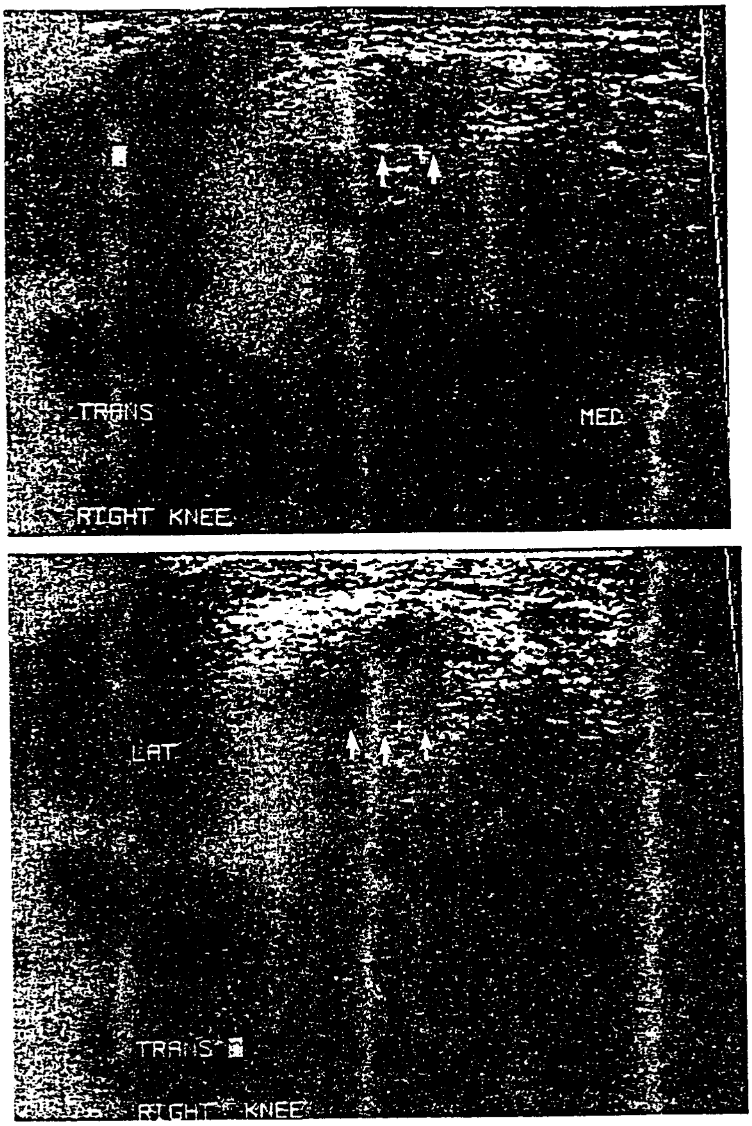

FIG. 2. Axial sonographic studies conducted 14 months apart of a competitive 31-year-old basketball player with symptomatic jumper's knee reveal unchanged cross-sectional area of a hypoechoic region of the right patellar tendon despite full training and competition (7.3 × 5.4 mm at baseline and 7.4 × 6.7 mm at follow-up). x–x, width; +–+ = height.

atic at baseline or follow-up. Thus, the sonographic abnormality resolved only in players who were asymptomatic at baseline. In our study, there were no cases in which tendons fell into the "diminished" category.

Of the 11 subject tendons where the sonographic area remained unchanged, follow-up symptoms were unchanged from baseline in nine (82%). Six of eight tendons were asymptomatic at both baseline and follow-up, and three of three tendons were symptomatic at both. Thus, when the sonographic abnormality did not change significantly in size, most players' symptomatic status remained in status quo.

In the remaining five subject tendons where the sonographic region expanded, clinical status did not change from baseline. Two asymptomatic tendons at baseline remained asymptomatic despite expanding to 160% and 190% of baseline area. The three symptomatic tendons at baseline remained symptomatic. Thus, expansion of a hypoechoic tendon region did not guarantee that symptoms would occur.

DISCUSSION

In certain medical conditions, the relationship between clinical findings and investigation results is not straightforward. Tissue that appears on imaging as a morphological abnormality does not necessarily cause symptoms. This principle is well accepted in musculoskeletal medicine, for example, with intervertebral disc degeneration and joint osteoarthritis. Our study has demonstrated that ultrasonographic hypoechoic regions may or may not be associated with symptoms of jumper's knee.

When documenting past history, it can be difficult to be certain of whether a patient has had jumper's knee or another cause of anterior knee pain, for example, patellofemoral joint syndrome (3). Since an important finding of this study was that patients may develop sonographic hypoechoic regions without ever having had symptomatic jumper's knee, we decided to err on the side of caution and included any patient with previous anterior knee pain as having had jumper's knee. By doing this,

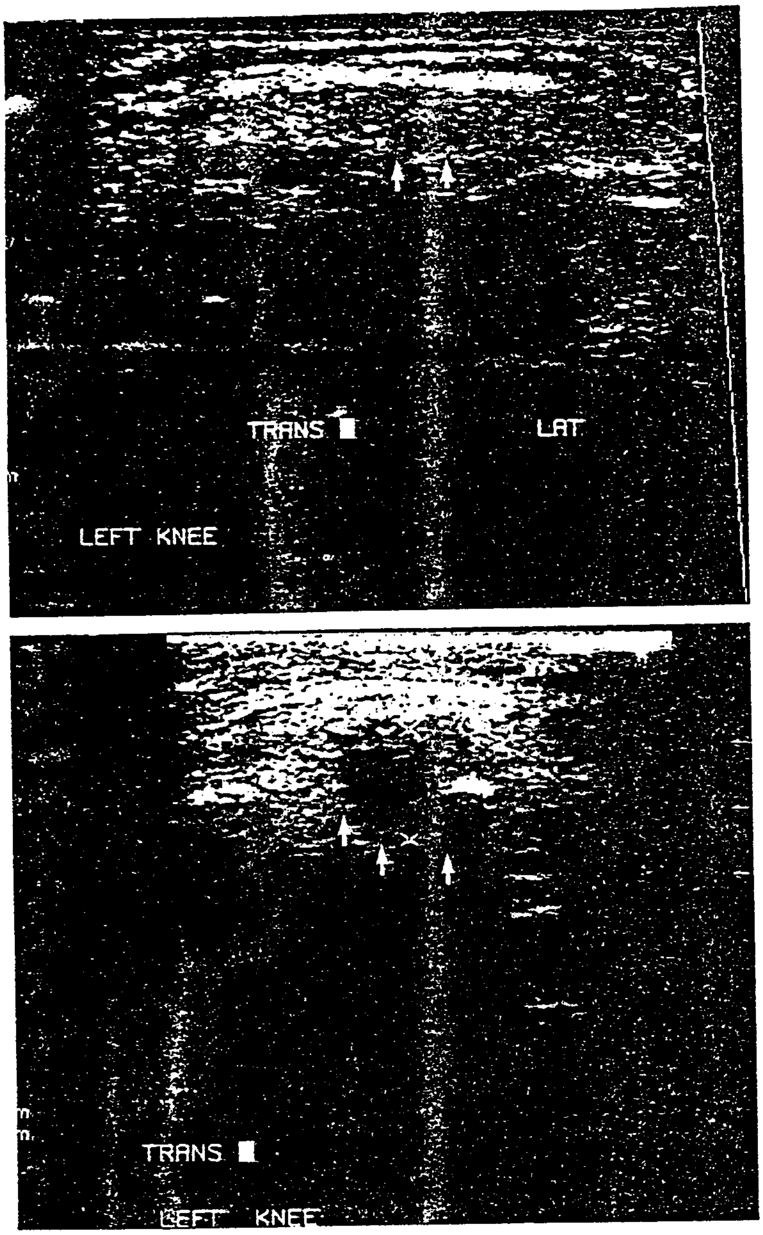

FIG. 3. Axial sonographic studies conducted 14 months apart of a competitive 31-year-old basketball player with symptomatic jumper's knee reveal substantial increase in cross-sectional area of the sonographic hypoechoic region in the left patellar tendon (2.5 × 2.5 mm at baseline and 6.1 × 8.8 mm at follow-up). x–x, height; +–+, width).

we were certain that those patients we reported as having a hypoechoic region without any previous symptoms definitely had not had jumper's knee.

Reproducibility of sonography

Measurement of the "length" of hypoechoic regions as seen in the longitudinal plane was not reproducible because of either (a) variability in selecting which image to "freeze" in this plane or (b) the difficulty in defining the inferior/distal margin of some hypoechoic tendon regions, even from a given image.

Sonography proved to be a reliable measure of tendon cross-sectional area in the axial plane, with a correlation coefficient of 0.92. Standard error of measurement of the areal changes was 6.3 mm^2 (95% CI 23.1–35.7 mm^2). When this is converted to a percentage to make it more biologically relevant, it means that in order to have 95% confidence that two sonographic abnormalities differ, their areas must differ by at least 43%. Given that sonographic abnormalities generally only measure a number of millimeters and there is some error in placing the electronic calipers, the magnitude of this test-to-retest variation was anticipated. Since the area of sonographic abnormalities can change substantially over time (Table 5), sonography clearly has the capacity to detect size changes in hypoechoic areas. We suggest that in clinical

TABLE 1. *Descriptive data: subjects and controls (Mean (SD))*

	Age	Height	Weight	No. of games
Subjects	23.7 (5.7)	181 (8.1)	73.7 (11.1)	129 (101)
Controls	24.4 (5.0)	179.0 (7.8)	71.5 (6.9)	132 (69)

TABLE 2. *Flow chart summarizing clinical and ultrasonographic outcomes in the 23 tendons that contained sonographic hypoechoic regions at baseline*

	No.	Symptomatic at follow-up
Subjects who had never had symptoms of jumper's knee and were asymptomatic at baseline (n = 9)		
Baseline clinical status		
Never symptomatic	9	
Follow-up ultrasound		
Hypoechoic region *resolved*	3	0
Hypoechoic region *still present*	6	1
Underwent surgery	0	
Subjects who were asymptomatic at baseline but had previously had symptoms of jumper's knee (n = 8)		
Baseline clinical status		
Previously symptomatic	8	
Follow-up ultrasound		
Hypoechoic region *resolved*	4	0
Hypoechoic region *still present*	4	1
Underwent surgery	0	
Subjects who were currently symptomatic with jumper's knee at baseline (n = 6)		
Baseline clinical status		
Currently symptomatic	6	
Follow-up ultrasound		
Hypoechoic region *resolved*	0	0
Hypoechoic region *still present*	6	6
Underwent surgery	0	

practice areal changes of 50% be used as evidence that a real change in area has occurred.

Sonographic abnormalities and histopathology of jumper's knee

Our study revealed that patellar tendon morphology does not necessarily mirror clinical symptoms of jumper's knee. A sonographic hypoechoic region can (a) predate the development of symptoms of jumper's knee (one player, subject group), (b) be associated with symptoms of jumper's knee (eight players, subject group, at follow-up), and (c) persist for at least some time after the pain of jumper's knee has resolved (four players, subject group).

All of these findings would be consistent with the histopathology of jumper's knee being a degenerative, rather than an inflammatory, condition (11,13,17,20),

TABLE 3. *Presence or absence of ultrasonographic tendon abnormality at baseline versus presence or absence of jumper's knee symptoms at follow-up*

	Tendon with hypoechoic region at baseline	Tendon sonographically normal at baseline
Tendon symptomatic at follow-up	8	2
Tendon asymptomatic at follow-up	15	21

$p < 0.05$ (χ^2).

Tendons with ultrasonographic abnormality at baseline were more likely to produce or cause symptoms at follow-up than were tendons that were sonographically normal at baseline.

TABLE 4. *Presence or absence of jumper's knee symptoms at baseline versus presence or absence of jumper's knee symptoms at follow-up*

	Tendon symptomatic at baseline	Tendon asymptomatic at baseline
Tendon symptomatic at follow-up	6	4
Tendon asymptomatic at follow-up	0	36

$p < 0.05$ (χ^2).

Players with symptoms at baseline were more likely to have symptoms at follow-up than were those who were symptom free at baseline.

and this pathological process was first labeled "tendinosis" by Puddu et al. (16) in relevant studies of the Achilles tendon. It has been hypothesized that some of the tendon fibers may degenerate over time (4) (causing a sonographic hypoechoic region) without necessarily producing symptoms. Similarly, after the symptoms of jumper's knee resolve, morphologic evidence of tendon scar (the sonographic hypoechoic region) may remain. Although we and others have reported the histology of chronic jumper's knee (8,13,20), the mechanism that leads to this pathological state is still unclear. In fact, there may be a number of scenarios that result in patellar tendinosis (1,14).

To our knowledge, there have been no studies describing the histopathology of very early jumper's knee, let alone either the asymptomatic preclinical state or the asymptomatic postclinical state described in this article. Parallels in animal models of the Achilles tendon have, however, been reported (4).

Importantly, and irrespective of eventual histopathological explanation of the phenomenon, we have demonstrated that sonographic hypoechoic regions can both predate and postdate symptoms of jumper's knee, and therefore we strongly disagree with any suggestion that the presence of such regions should serve as an indication for surgery. Conservative management is the first-line therapy for jumper's knee (11,12), and surgery should be contemplated only when appropriate conservative management has failed (12).

Clinical relevance: sonographic appearances and jumper's knee

Our data have significant implications for management of jumper's knee. One subject had a long history of bilateral jumper's knee managed conservatively, and she trained fully with the Olympic basketball team. A few weeks after the follow-up ultrasonography scan for this study, while sprinting at practice she developed a sudden, severe tearing pain at the patellar tendon attachment to the patella, consistent with an acute partial tendon tear. She was unable to walk for a few days. A subsequent ultrasound scan (not part of the study) showed no change in the size of the large hypoechoic region of her symptomatic tendon. She was managed conservatively and returned to playing after 2 weeks and competed at the Olympic Games 4 weeks later, with fewer symptoms

TABLE 5. *Summary of measurements of sonographic hypoechoic regions in 23 subject tendons at baseline and at follow-up (area = 3.14 × height/2 × width/2)*

	Sonographic measures at baseline			Sonographic measures at follow-up		
	Length (mm)	Height (mm)	Area (mm^2)	Length (mm)	Height (mm)	Area (mm^2)
Sonographic abnormalities that resolved during the study (n = 7)						
Mean (SD)	6.5 (2.48)	3.0 (1.46)	15.9 (10.12)	0	0	0[a]
Range	3.5–11.0	1.9–5.4	5.5–31.3	0	0	0
Sonographic abnormalities that remained unchanged during the study (n = 11)						
Mean (SD)	8.8 (2.63)	5.4 (2.64)	39.3 (25.75)	9.5 (3.21)	4.7 (2.47)	37.0 (26.68)
Range	3.8–12.5	1.9–10.0	7.6–86.4	4.3–13.0	1.1–10.0	8.8–94.2
Sonographic abnormalities that expanded during the study (n = 5)						
Mean (SD)	7.5 (2.71)	4.2 (1.7)	25.3 (12.48)	10.6 (2.79)	5.8 (1.01)	48.1[a]
Range	5.0–12.0	2.2–6.7	8.6–38.6	7.4–14	4.1–6.7	32.2–69.2

[a] $p < 0.01$ versus baseline (paired *t* test).

than she had had prior to the episode. Her symptoms remained at this new, lower level subsequently. If there had been an inappropriate overemphasis on sonographic morphology, particularly in the absence of baseline sonographic data, she may have been excluded from competition prematurely by the diagnosis of acute partial tendon rupture. Similarly, if the contention that all hypoechoic ultrasonographic regions require surgery had been heeded (15), she would have been in the hospital about the time she stood on the medal dais.

CONCLUSIONS

Although ultrasonographic appearances may provide evidence supporting the clinical diagnosis of jumper's knee in a sportsperson, there is no evidence for using the sonographic appearances of the patellar tendon as a guide to prognosis and management at the expense of clinical findings. Further longitudinal studies are required in order to correlate imaging appearances and clinical outcomes.

The fact that ultrasonographic morphology of the patellar tendon and clinical features of jumper's knee do not necessarily marry perfectly may also have implications for management and investigation of other major tendon conditions. Further research is warranted in conditions such as rotator cuff disease and Achilles tendon conditions.

In conclusion, we emphasize that the presence of clearly defined hypoechoic regions should not be used as an absolute indication for surgery. These sonographic abnormalities are commonly seen in chronic jumper's knee, a noninflammatory degenerative condition of the infrapatellar tendon, that generally responds well to conservative management (19).

Acknowledgment: The Royal Melbourne Hospital Department of Radiology, Acoustic Imaging Dornier (Meditron, East Malvern), Basketball Australia, the Women's National Basketball League, and the Victorian Institute of Sport provided essential support. The authors thank the staff of the Departments of Medicine and Radiology at the Royal Melbourne Hospital, particularly Pam Lukaszewski, Mark Stein, Kim Bennell, Professor Richard Larkins, and Stephen McEwan. The support and patience of the staff at East Melbourne Radiology is gratefully acknowledged. Grants were received from

The Australian Sports Research Programme (ASRP)
The Olympic Athlete Program (OAP)
The ASMF–Syntex Research Foundation
Australian NHMRC Postgraduate Medical Scholarship 958160

Investigators in the Victorian Institute of Sport Tendon Study Group are I. Anderson, J. Bartlett, S. Bell, K. Bennell, F. Bonar, D. Bracy, C. Bradshaw, F. Burke, B. Caldwell, J. Cook, K. Crichton, R. Dalziel, P. Desmond, R. Dowling, P. Ebeling, M. Fehrmann, P. Fuller, A. Garnham, M. Grant, P. Harcourt, W. Hare, I. Henderson, D. Kellaway, K. Khan, Z. S. Kiss, P. Larkins, C. Morris, P. O'Brien, R. O'Sullivan, C. Purdam, R. Quirk, J. Read, P. Robertson, R. Shnier, B. Tress, P. Visentini, J. Wark, P. Wilson, and D. Young.

The following institutions are represented: the Department of Medicine, University of Melbourne, Royal Melbourne Hospital; the Department of Radiology, University of Melbourne, Royal Melbourne Hospital; the Australian Institute of Sport; and the Victorian Institute of Sport.

REFERENCES

1. Archambault JM, Wiley JP, Bray RC. Exercise loading of tendons and the development of overuse injuries: a review of the current literature. *Sports Med* 1995;20:77–89.
2. Blazina M, Kerlan R, Jobe F, Carter V, Carlson G. Jumper's knee. *Orthop Clin North Am* 1973;4:665–78.
3. Brukner P, Khan K. *Clinical sports medicine*. Sydney: McGraw-Hill, 1993.
4. Clancy WGJ. Tendon trauma and overuse injuries. In: Leadbetter WB, Buckwalter JA, Gordon SL, eds. *Sports-induced inflammation: clinical and basic science concepts*. Park Ridge, IL: American Academy of Orthopaedic Surgeons, 1990:609–18.
5. Cook J, Harcourt P, Khan K, Kiss ZS, Grant M, Fehrmann M, and the Victorian Institute of Sport Tendon Study Group. Ultrasound appearance of the patellar tendon in elite athletes: gender and sport differences (Abs). In: *Proceedings of the Australian Conference of Science and Medicine in Sport. Hobart, Australia*. Canberra: Sports Medicine Australia, 1995.
6. Cook J, Khan KM, Harcourt P, Kiss ZS, Fehrmann M, and the Victorian Institute of Sport Tendon Study Group. Patellar tendon sonography of active athletes and controls: hypoechoic regions are present in asymptomatic athletes. *Clinical Journal of Sport Medicine* 1997 (submitted).

7. Denegar CR, Ball DW. Assessing reliability and precision of measurement: an introduction to intraclass correlation and standard error of measurement. *J Sport Rehabil* 1993;2:35–42.
8. Ferretti A, Ippolito E, Mariani P, Puddu G. Jumper's knee. *Am J Sports Med* 1983;11:58–62.
9. Fritschy D, de Gautard R. Jumper's knee and ultrasonography. *Am J Sports Med* 1988;16:637–40.
10. Harcourt PR, Cook J, Khan K, Fehrmann M, Grant M, Kiss ZS, and the VIS tendon study group. Patellar tendon ultrasound of 200 active elite athletes: hypoechogenic lesions present in 40% of individuals (Abs.). In: *Proceedings of the Australian Conference of Science and Medicine in Sport. Hobart, Australia.* Canberra: Sports Medicine Australia, 1995.
11. Karlsson J, Kalebo P, Goksor L-A, Thomee R, Sward L. Partial rupture of the patellar ligament. *Am J Sports Med* 1992;20:390–5.
12. Karlsson J, Lundin O, Lossing IW, Peterson L. Partial rupture of the patellar ligament: results after operative treatment. *Am J Sports Med* 1991;19:403–8.
13. Khan K, Bonar F, Desmond P, et al. Patellar tendinosis (jumper's knee): findings at histopathologic examination, US and MR imaging. *Radiology* 1996;200:821–7.
14. McLoughlin RF, Raber EL, Vellet AD, Wiley JP, Bray RC. Patellar tendinitis: MR features, with suggested pathogenesis and proposed classification. *Radiology* 1995;197:843–8.
15. Myllymäki T, Bondestam S, Suramo I, Cederberg A, Peltokallio P. Ultrasonography of jumper's knee. *Acta Radiol* 1990;31:147–9.
16. Puddu G, Ippolito E, Postacchini F. A classification of Achilles tendon disease. *Am J Sports Med* 1976;4:145–50.
17. Raatikainen T, Karpakka J, Puranen J, Orava S. Operative treatment of partial rupture of the patellar ligament: a study of 138 cases. *Int J Sports Med* 1994;15:46–9.
18. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull* 1979;86:420–8.
19. Torstensen ET, Bray RC, Wiley JP. Patellar tendinitis: a review of current concepts and treatment. *Clin J Sport Med* 1994;4:77–82.
20. Yu JS, Popp JE, Kaeding CC, Lucas J. Correlation of MR imaging and pathologic findings in athletes undergoing surgery for chronic patellar tendinitis. *Am J Roentgenol* 1995;165:115–8.