

[Sports Physical Therapy]

Patellar Tendinopathy: Preliminary Surgical Results

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Background: Calcific deposits (CaDs) may be related to chronic postoperative pain and may affect function after patellar tendon surgery.

Study Design: Cross-sectional.

Hypothesis: We hypothesized that patients with CaDs (+CaDs) would rate lower than those without (–CaDs) on measures of knee function and quality of life.

Methods: Patients completed the Tegner Lysholm Knee Scoring Scale (Lysholm), Knee Injury and Osteoarthritis Outcome Score (KOOS), the International Knee Documentation Committee Subjective Knee Form (IKDC), and the Tegner Activity Level Scale. Sixteen postsurgical and 16 age-matched controls were tested. Patients +CaDs were 5.6 years older than those patients –CaDs and had 4.2 years of longer elapse since surgery. Bilateral patellar tendons were examined for CaDs with musculoskeletal ultrasound imaging. One-way analysis of variance was used to determine if differences existed among patients +CaDs and –CaDs and healthy controls. Hierarchical logistic regressions were used to determine which variables best predicted the presence of CaDs.

Results: CaDs were found in 44% (7 of 16) of postsurgical patients, who scored lower than controls on all dimensions of the Lysholm, KOOS, and IKDC. Patients +CaD had lower KOOS scores than controls (symptoms, activities of daily living, and quality of life). Age and time since surgery were both moderately related to the presence of CaDs, and both correctly predicted 71% of patients +CaDs.

Conclusion: Calcific deposits were found in the patellar tendon of 44% of postsurgical patients, who rated themselves lower on all subjective measures of knee function and quality of life following surgery. Age is an important factor for developing CaDs postsurgery.

Clinical Relevance: Calcific deposits may be present in patellar tendons following surgery, but their direct role in functional or clinical limitations remains unknown.

Keywords: anterior cruciate ligament; knee; musculoskeletal ultrasound imaging

Calcific deposits (CaDs) are found in the tendons^{6,14,20,25,26} and cartilage⁷ of the shoulder,^{6-8,14,15,20,25,26} elbow,¹⁸ wrist,¹⁸ and knee.^{3,5,7,8,12,21,28} The precise cause of CaDs in tendons remains unknown.⁹ CaDs in the patellar tendon have been found in volleyball²¹ and basketball athletes,⁵ as well as in postsurgical patients.^{3,12,28}

Ultrasonographic evaluations of the patellar tendon following the harvest of the central third for an anterior cruciate ligament reconstruction suggest that tendinopathies may be present^{12,28} with or without anterior knee pain. In addition to hypoechoic

lesions and patellar osteophytes, CaDs were noted in the patellar tendon in 1 of 14 patients (7%) 1 year after surgery²⁸ and 9 of 31 patients (29%) 10 years after surgery.¹² The cumulative effects of surgical disruption of the tendon and the stresses on the altered tendon over a period of time may lead to the development of CaDs.

CaDs in shoulder tendons^{2,9,13} have been present in acute and chronic tendon disorders.²³ They are associated with the sudden onset of pain in calcific tendonitis,⁹ increased rupture rates,¹³ slower recovery times,¹⁰ and postsurgical complications.² Unlike

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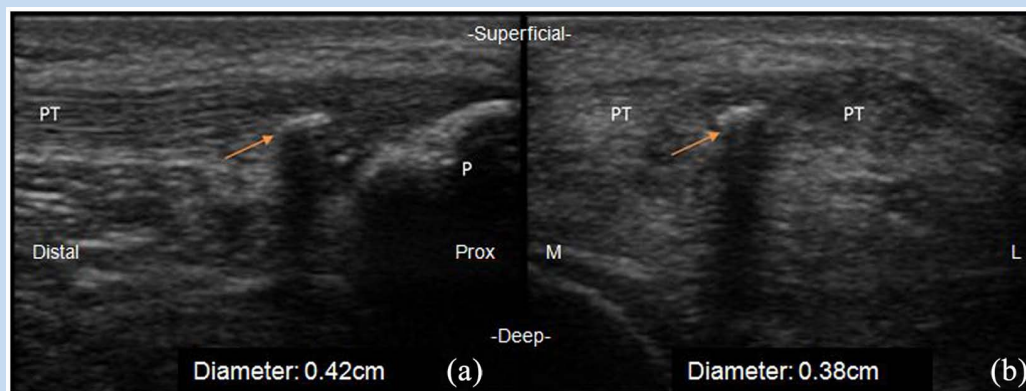


Figure 1. Calcific deposits (orange arrows) identified in the proximal left patellar tendon of 1 patient. (a) Sagittal and (b) transverse plane views. PT, patellar tendon; P, patella; Prox, proximal; M, medial; L, lateral.

that in the shoulder, it is unknown if CaDs in the patellar tendon are related to chronic postoperative pain or if they affect functional ability. The authors hypothesized that patients with CaDs (+CaDs) would rate lower than those without CaDs (–CaDs) on measures of knee function and quality of life.

METHODS

Patients

This study was approved by the host institution's Human Research Protection Office, and all participants provided informed consent prior to participation. Patients were recruited from the campus of a Midwestern public university and the surrounding community if they had surgery in 1 knee that involved the patellar tendon. Exclusion criteria were as follows: multiple surgeries in the same knee that directly involved the patellar tendon or injection of corticosteroid, sclerosing agent, or platelet-rich plasma into the patellar tendon on either knee since time of surgery. Age- and sex-matched controls without previous knee injuries were recruited.

Testing Paradigm

Each patient completed 4 self-report questionnaires related to knee symptoms and function, a brief physical knee examination, including bilateral knee active range of motion, and musculoskeletal ultrasound imaging of bilateral patellar tendons. The 4 questionnaires were the Tegner Lysholm Knee Scoring Scale (Lysholm),^{17,27} Knee Injury and Osteoarthritis Outcome Score (KOOS),²⁴ International Knee Documentation Committee Subjective Knee Form (IKDC),¹¹ and Tegner Activity Level Scale (Tegner).²⁷ All testing was completed during a single session, lasting approximately 45 minutes.

Musculoskeletal Ultrasound Imaging

Lower extremities were positioned in 30° of knee flexion to place minimal passive tension on the patellar tendon.¹⁹ The length of

the patellar tendon was divided into proximal, middle, and distal thirds. Ultrasound imaging (MicroMaxx, SonoSite Inc., Bothell, Washington) with a 10-5 MHz linear array transducer was used to visualize the sagittal and transverse planes.

A CaD was identified as a focal hyperechogenic structure with acoustic shadowing (Figure 1).³ The diameter of the CaD was measured in both planes using ImageJ¹ software (National Institutes of Health, Bethesda, Maryland) and the location recorded (proximal, middle, or distal).

Data Analysis

SPSS 19.0 (IBM, Armonk, New York) was used for all statistical analyses, and the criterion for statistical significance was set at $P < 0.05$. A 1-way analysis of variance was used to determine if differences existed on demographics and questionnaires among patients +CaDs, patients –CaDs, and healthy controls. When significant effects were found, Bonferroni corrected post hoc tests were used to determine where differences existed. Pearson zero-order correlations were used to evaluate the relationships between the questionnaire information and the presence of CaDs. Interpretation of the magnitude of the correlation coefficients was as follows: $r > 0.25$, fair; $r > 0.50$, moderate; $r > 0.75$, excellent/strong.²² Two hierarchical logistic regressions were used to determine which variables best predicted the presence of CaDs in patients postoperatively. Independent variables were chosen on the basis of the correlational analysis. The independent variables in the first model were (1) age at time of surgery and (2) time since surgery; in the second model, (1) time since surgery and (2) current age. The dependent variable in both models was presence or absence of a CaD.

RESULTS

Of the patients who had surgery, 44% (7 of 16) had CaDs in the surgical knee. The mean diameter of the CaDs in the sagittal plane was 2.8 ± 0.1 mm and, in the transverse plane, 2.6 ± 0.1 mm. The CaDs were located in the proximal third of

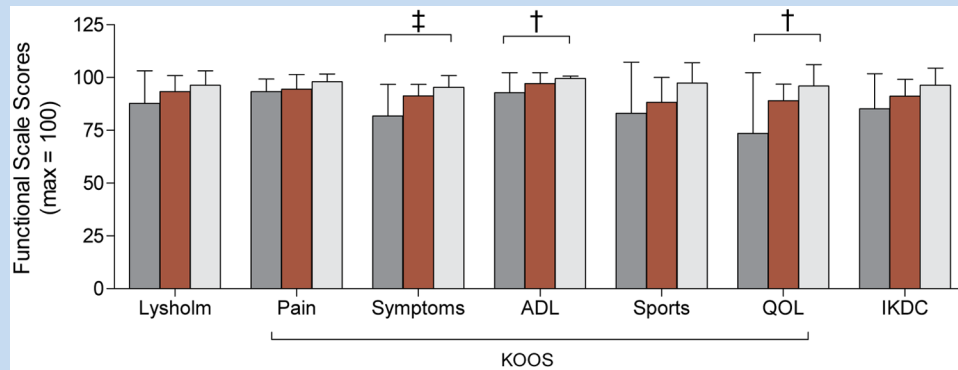


Figure 2. Comparison of functional outcome levels for patients with calcific deposits (+CaDs) (■), without (-CaDs) (■), and controls (□). There were no differences found for any of the measures between patients +CaDs and -CaDs.

† $P < 0.05$. ‡ $P < 0.01$.

the patellar tendon for 5 of 7 patients (71%) and in the distal third for the other 2 patients (29%); no CaDs were located in any nonsurgical patellar tendons.

Mean age for those +CaDs, those -CaDs, and controls were 28.3 ± 5.0 , 22.7 ± 2.2 , and 25.1 ± 4.1 years, respectively. Patients +CaDs were, on average, 5.6 years older ($P = 0.02$) and had 4.2 years of longer elapse since surgery ($P = 0.03$) than those in the -CaDs group. No differences existed between either postsurgical group and controls with regard to age or other patient demographic information. All patients had bilateral knee active range of motion within normal limits.

There was no statistical difference between groups for the Lysholm score, but surgical patients had significantly lower scores than did the controls on the KOOS: symptoms ($P < 0.01$), activities of daily living ($P = 0.03$), and quality of life ($P = 0.02$). Post hoc comparisons indicated that the +CaDs group had greater complaints of symptoms ($P < 0.01$), lower scores on activities of daily living ($P = 0.02$), and lower scores on quality of life ($P = 0.01$) than did the controls (Figure 2).

Of all the variables considered in this investigation, the patients' age ($r = 0.63$), the time elapsed since surgery ($r = 0.55$), and age at time of surgery ($r = 0.26$) had meaningful relationships in those patients +CaDs (Table 1). The first logistic regression model suggested that time since surgery alone correctly predicted 71% of those +CaDs. The second logistic regression model suggested that age alone correctly predicted 71% of those +CaDs. The likelihood ratio for each model was 1.54 (95% confidence interval: 0.96, 2.47) and 2.06 (95% confidence interval: 0.82, 5.18) for time since surgery and age, respectively.

DISCUSSION

There were no statistically significant differences between those +CaDs and -CaDs following surgery on the Lysholm, KOOS, and IKDC, but it was of interest to note a trend toward the +CaDs group reporting lower scores on all subjective

Table 1. Relationships with the presence of calcific deposits

	<i>r</i>
Age	
Current	0.63 [†]
At surgery	0.26
Sex	0.10
Body mass index	0.09
Time	0.55 [†]
Tegner	
Preinjury	0.21
Current	-0.01

† $P < 0.05$. ‡ $P < 0.01$.

measures (Figure 2) and, for some measures, medium and even large effects⁴ (Table 2). The lack of difference between those +CaDs and -CaDs may be due to the wide variability and a small sample (Table 2).

On average, patients +CaDs had the highest Tegner scores presurgery but reported the lowest scores on all subjective measures of knee function and quality of life. CaDs may contribute to these lower scores. Note, however, that even though CaDs in the knee have been associated with anterior knee pain^{12,21} and limited range of motion,²¹ tendinopathy does not always equate to symptoms.

The high percentage of patients +CaDs is most likely not due to presurgical presence of CaDs, as 100% of the nonsurgical knees in our sample were -CaDs. The first regression model,

Table 2. Mean scores and effect sizes for patients with and without calcific deposits (+CaDs and –CaDs, respectively)

	+CaD (n = 7)	–CaD (n = 9)	Cohen <i>d</i>
Lysholm	85.4 ± 16.6	93.4 ± 7.5	0.47
KOOS			
Pain	91.7 ± 6.1	94.4 ± 7.0	0.16
Symptoms	74.3 ± 16.2	91.3 ± 5.4	0.85
Activities of daily living	89.7 ± 10.2	97.0 ± 5.1	0.55
Sports/recreation	76.0 ± 26.1	88.3 ± 11.7	0.27
Quality of life	61.3 ± 30.8	88.9 ± 14.2	0.68
IKDC	81.4 ± 17.5	91.2 ± 7.9	0.45

Lysholm, Tegner Lysholm Knee Scoring Scale; KOOS, Knee Injury and Osteoarthritis Outcome Score; IKDC, International Knee Documentation Committee Subjective Knee Form.

which included time since surgery and age at time of surgery, suggested that time since surgery was better at predicting CaDs following surgery. The second regression model revealed that current age was the better predictor. Note that the significant factors in the models were highly collinear ($r = 0.78$), with age having the strongest correlation with presence of CaDs (Table 1). This study was cross-sectional, with a mean time since surgery of 80 months. The 2 patients in this study who had the most recent surgeries (10 and 21 months) were –CaDs. Although the patients' mean age was in only the midtwenties, patients +CaDs were older and had more time elapse since surgery when compared with patients –CaDs. These results parallel previous research findings in which the further out from surgery the study was conducted, the higher the percentage of patients who were found to have CaDs in the postsurgical patellar tendon.^{3,12,28}

Level of activity may also account for the higher prevalence of CaDs in this sample compared with that of previous studies reporting CaDs in the patellar tendon following surgery (44% compared with 7%, 10%, and 29%, respectively).^{3,12,28} Of 16 postsurgical patients, 10 (4 of 7 +CaDs) had played or were playing collegiate sports at the time of the investigation. Interestingly, another study found that approximately 41% of quadriceps tendons examined in professional beach volleyball players had CaDs.²¹

In the shoulder, CaDs are more prevalent in chronic tendonitis, particularly in older individuals.¹⁵ Advancing age may regulate cartilage intermediate layer protein, which has been linked to chronic inflammation and osteoarthritis.¹⁶ Additionally, in the chronic presence of this protein, tendinous calcifications have been noted in mouse models.²⁹ Further research is needed to determine additional factors for the development of CaDs in the patellar tendon following surgery, including whether cartilage intermediate layer protein is present for an extended period following surgery or if activity levels influence the levels of the protein.

Limitations

Four limitations are evident. First, it is not known if CaDs are problematic. Second, no objective outcome measures were used. These would likely have provided valuable clinical information. Third, this was a sample of convenience; the sample size was small, particularly for a regression analysis; and no power analysis was performed. Larger numbers may have altered the results. Fourth, this was a cross-sectional study. A prospective longitudinal study, starting preoperatively, would have allowed preoperative imaging to confirm if and when CaDs develop after surgery.

CONCLUSION

A high percentage of patients had CaDs in their postsurgical patellar tendon and self-reported lower ratings on all subjective measures of knee function and quality of life following surgery when compared with those –CaDs. However, these data do not prove that CaDs are problematic. These patients were most often older and had more time elapse since surgery than did those –CaDs in the patellar tendons.

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