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CLINICAL RESEARCH

Is Further Treatment Necessary for Patellar Crepitus After Total Knee Arthroplasty?

Bo-Hyun Hwang MD, Chang-Hyun Nam MD, PhD, Kwang-Am Jung MD, Alvin Ong MD, Su-Chan Lee MD

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Abstract

Background Patellar crepitus may occur with posterior-stabilized (PS) TKAs. Several studies have suggested numerous etiologies of patellar crepitus after PS-TKA with patellar resurfacing. However, it is unclear whether and to what degree crepitus influences pain and function without or with patellar resurfacing.

Questions/purposes We therefore determined (1) the frequency of crepitus; (2) which factors predicted the occurrence of crepitus; and (3) whether crepitus influenced pain and function.

Methods We retrospectively reviewed 41 patients (54 knees) with painful or painless patellar crepitus after primary PS-TKAs without patellar resurfacing performed from 2007 to 2008. These patients were compared with a group of 73 patients (94 knees) without patellar crepitus matched for age, sex, and BMI. The minimum followup was 2 years (mean, 2.8 years; range, 2–4.5 years).

Results Five (9%) of the 54 knees with patellar crepitus also had peripatellar pain. Mean time from primary TKA to the onset of patellar crepitus was 4 months. All patients in the patellar crepitus group were asymptomatic within 1 year of onset of symptoms without additional surgical treatment. The development of patellar crepitus was associated with an Outerbridge patellar cartilage Grade 4 (odds ratio [OR], 11.9; 95% CI, 2.2–65.3) and joint line elevation (OR, 5.1; 95% CI, 1.9–8.6).

Conclusions Patellar crepitus is typically benign and self-limited. We continue not to resurface arthritic patellae and counsel patients with patellar crepitus that their symptoms will improve without intervention.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at Himchan Hospital, Seoul, Korea.

B.-H. Hwang, C.-H. Nam, K.-A. Jung, S.-C. Lee (✉)
Joint & Arthritis Research, Department of Orthopaedic Surgery, Himchan Hospital, 404-3, Mok-dong, Yangcheon-gu, Seoul 158-806, Republic of Korea
e-mail: scleeos@gmail.com

B.-H. Hwang
Department of Orthopaedic Surgery, Yonsei University College of Medicine, Seoul, Korea

A. Ong
Rothman Institute of Orthopedics, Thomas Jefferson University Hospital, Philadelphia, PA, USA

Introduction

A posterior-stabilized (PS) TKA that sacrifices the cruciate ligaments improves pain and function in patients with advanced osteoarthritis [10]. Patellar crepitus appears to be attributable to a spectrum of peripatellar fibrosynovial formations [11, 29] and usually is encountered after a PS-TKA [9, 16, 22, 24, 29, 31, 35], which uniquely has an intercondylar box to accept the tibial post, although cruciate-retaining designs also may be associated with crepitus.

Symptoms related to patellar crepitus occur most commonly during terminal knee extension and occur usually from 3 to 9 months after primary PS-TKA [4], and in some cases, this phenomenon is symptomatic enough to warrant an arthroscopic procedure or open arthrotomy [24, 29, 31].

The development of patellar crepitus after a PS-TKA appears related to many factors such as femoral component design [1, 4, 9, 16, 22, 24, 28–30], surgical errors [4, 11, 15, 20, 29, 35], increased postoperative knee flexion [31], and postoperative patellar baja [15, 35], which also are responsible for patellar clunk syndrome. However, it is unclear whether further treatment is necessary for patellar crepitus after a PS-TKA, especially without patellar resurfacing.

We therefore determined (1) the frequency of crepitus; (2) which factors predicted the occurrence of crepitus; and (3) whether crepitus influenced pain and function.

Patients and Methods

The total joint registry at our institution prospectively collects clinical and radiographic data of all patients who undergo an arthroplasty. From that database we identified 583 patients who underwent 723 PS-TKAs using the Vanguard complete knee (Biomet Orthopedics, Warsaw, IN, USA) in 2007 and 2008. We excluded 25 knees in 22 patients with inflammatory arthritis, previous knee infection, and a history of major surgical treatment such as patellar realignment surgery or high tibial osteotomy. Thirty patients were lost to followup, and five died for reasons unrelated to their operation. None of these patients required any reoperation before their last followup. These exclusions left 666 knees (529 patients) for consideration. We retrospectively identified from these 529 patients those who had patellar crepitus develop. Patellar crepitus was defined as a palpable, crunching, grinding sensation in the region of the distal quadriceps tendon or over the patella when the knee was brought from flexion to extension. The presence of this phenomenon, with or without pain, was recorded at each followup. Of 57 knees (44 patients) with patellar crepitus, 54 knees (41 patients) with postoperative patellar crepitus (the PC group) were available for clinical and radiographic assessment for at least 2 years (mean, 2.8 years; range, 2–4.5 years) after primary TKA. None of these patients had other causes of peripatellar pain such as osteolysis, loosening, a spine disorder, impingement, bursitis, or an associated medical abnormality. No patients were recalled specifically for this study; all data were obtained from medical records and radiographs. We obtained prior institutional review board approval.

These patients were compared with 73 age-, sex-, and BMI-matched control patients (94 knees) who underwent the same type of TKA (Table 1). Of the patients, 17 had bilateral TKAs and had patellar crepitus in one side only and thus, the 17 well-functioning contralateral knees were used as their own controls. Minimum followup was 2 years (mean, 2.8 years; range, 2–4 years) in the control group.

All TKAs were performed by one of three senior surgeons (SCL, KAJ, CHN). All knees were approached through a midline skin incision using a standard medial parapatellar approach. A tourniquet was used in all procedures. The suprapatellar synovial lining overlying the trochlear groove was routinely excised with the knee in extension. The degree of deterioration of the patellar articular cartilage was graded as described by Outerbridge [27] at primary TKA. The patella was left unresurfaced in all knees except for those with severe patellar deformity or patellofemoral instability. The decision to resurface the patella was not based on age, comorbidities, status of patellar cartilage, obesity, or preoperative radiographs. Patelloplasty was performed to enhance patellofemoral alignment and allow better seating of the patella on the femoral trochlea in all cases. This procedure consisted of excision of marginal osteophytes, smoothing of torn cartilage, soft tissue release, and cauterization of the patellar rim [23]. Surgical data collected from the operation records were femoral and tibial component size, thickness of tibial polyethylene bearing, number of previous knee arthroscopies, and the need for lateral retinacular release.

Patients were examined before surgery and at 6 weeks, 6 months, and 1 year after surgery and yearly thereafter. We used the score proposed by Feller et al. [14] to evaluate patellofemoral function. This scoring system involves allocation of a maximum of 30 points, that is, a maximum of 15 for anterior knee pain and of 5 for each of quadriceps strength, ability to rise from a chair, and ability to climb stairs. The Knee Society clinical scores [21], which include knee scores (maximum of 100 points) and function scores (maximum of 100 points), and WOMAC™ scores also were determined [5]. If the patients reported having peripatellar pain, the degree then was graded with a 10-point VAS. Preoperative and postoperative ranges of motion were measured in an active nonweightbearing mode using a goniometer on the skin surface by measuring sagittal angles among hip, knee, and ankle centers. For some of missing clinical data for five patients, we used the last observation carried forward (LOCF) method, as a common imputation procedure [32]. The LOCF method takes the last available response and substitutes the value into all subsequent missing values.

Table 1. Preoperative patient demographics

Demographic	PC group	Control group	p value
Patients (number)	41	73	
Knees (number)	54	94	
Age* (years)	71 (54–86)	70 (61–82)	0.076
Sex (male:female)	1:53	3:91	0.232
Side (proportion of right)	0.54	0.51	0.163
BMI* (kg/m^2)	26 (19–35)	27 (20–35)	0.621
Followup* (years)	2.8 (2–4.5)	2.8 (2–4)	0.142
Feller's patellar score*	18 (12–25)	17 (14–23)	0.245
The Knee Society score*	97 (39–150)	96 (43–155)	0.512
WOMAC™ score*	41 (17–70)	43 (19–75)	0.412

* Values are given as the median with the range in parentheses.

AP and lateral fluoroscopically assisted radiographs, a skyline patellar radiograph, and an AP long-leg radiograph were taken at last followup and used to determine the presence of radiolucent lines at bone-cement interfaces or osteolysis, component positions, and limb alignments, as described by The Knee Society [13]. Two experienced surgeons (BHH, CHN) independently assessed all radiographs for the following parameters. Patellar tilt and lateral displacement as described by Gomes et al. [17] were determined on the skyline radiograph taken at 30° knee flexion. The level of the joint line was obtained for each knee from preoperative and postoperative AP radiographs by measuring the distance from the tip of the fibular head to the distal margin of the lateral part of the femoral condyle and to the distal margin of the lateral femoral component. In addition, the modified Insall-Salvati ratio [19], patellar tendon length [19], patellar height [19], posterior femoral condylar offset [6], and posterior tibial tray offset [15] were measured before and after surgery. All radiographic parameters were measured digitally using a PACS system (STARPACS; INFINITT, Seoul, Korea). The interrater reliabilities of the radiographic parameters were determined by calculating the interclass correlation coefficients (ICCs). An ICC of 1 suggests perfect reliability, and ICCs greater than 0.75 and less than 0.4 generally are considered to represent excellent and poor reliability, respectively. The ICCs for each parameter were more than 0.75 except for the preoperative modified Insall-Salvati ratio 0.74.

Univariate analysis was conducted using Student's t test to determine whether alignment, patellar tendon length, patellar height, Insall-Salvati ratio, femoral component flexion, posterior tibial slope, posterior femoral offset, posterior tibial offset, patellar tilt, change in joint line, femoral component size, tibial component size, and polyethylene thickness differed in patients without and with patellar crepitus and the chi-square test was used to determine whether Outerbridge grade of patellar cartilage and previous knee arthroscopy differed (Table 2). Univariate analysis initially was conducted to determine the possible variables for multiple logistic regression analysis. Multiple logistic regression analysis was conducted to identify various perioperative predictors of the development of patellar crepitus and to correct for confounding variables. Variables included in multiple logistic regression analysis were those with p values less than 0.25 obtained from univariate analysis. All data analyses were performed using SPSS 13.0 ps.exe (SPSS Inc, Chicago, IL, USA).

Results

Five (9.3%) of 54 knees with patellar crepitus were accompanied by peripatellar pain (VAS, 2–4), which occurred during active flexion, squatting, or stair climbing (Table 3). Patellar crepitus had a mean onset of 4.3 months (range, 1–10.5 months) after PS-TKA. All patients in the PC group had medications, quadriceps strengthening exercise, injection, or activity modification and all achieved symptom relief within 1 year of onset without additional surgical treatment. No knee required secondary patellar resurfacing owing to patellofemoral problems after PS-TKA (Fig. 1).

Both groups had improvements ($p < 0.001$ for all) in the patellar score of Feller et al., The Knee Society score, and WOMAC™ score at last followup. Postoperative scores were similar ($p > 0.05$ for all comparisons) in the two groups at last followup. No knees had radiolucent lines wider than 2 mm or probable loosening on any prosthetic components. Of 17 patients in the PC group who underwent bilateral TKAs with postoperative patellar crepitus on one side, no major differences were observed between knees in terms of clinical scores, functional abilities, or radiographic factors.

The major predictors of the development of patellar crepitus were patellar cartilage of Outerbridge Grade IV (odds ratio [OR], 11.9; 95% CI, 2.2–65.3) and joint line elevation (OR, 5.1; 95% CI, 1.9–8.6) (Table 4).

Discussion

Patellar crepitus is a manifestation of a spectrum of peripatellar fibrosynovial formations and usually is encountered after PS-TKA, although this also may occur with the cruciate-retaining design. The incidence of painful or painless patellar crepitus has been reported to range from 0% to 21% [9, 16, 22, 24, 29, 31, 35]. Numerous factors have been implicated as an etiology of this phenomenon after PS-TKA [1, 4, 9, 11, 15, 16, 20, 22, 24, 28–31, 35], but it is unclear whether and to what degree

Table 2. Univariate analysis results for clinical, radiographic, and surgical factors

Parameter	PC group (n = 54)	Control group (n = 94)	p value
Clinical factors			
Outerbridge grade of patellar cartilage (number, %)			
Grade < 3	37 (69)	76 (81)	Referent
Grade 3	10 (19)	16 (17)	0.132
Grade 4	7 (13)	2 (2)	0.003*
Preoperative alignment† (°)	2.83 ± 4.38	1.86 ± 5.83	0.412
Postoperative alignment† (°)	5.37 ± 1.81	5.82 ± 2.00	0.542
Radiographic factors			
Preoperative patellar tendon length† (mm)	50.87 ± 6.46	48.36 ± 6.54	0.025*
Preoperative patellar height† (mm)	31.79 ± 2.28	31.60 ± 2.77	0.375
Preoperative Insall-Salvati ratio†	0.61 ± 0.08	0.62 ± 0.09	0.512
Postoperative patellar tendon length† (mm)	50.05 ± 6.27	47.79 ± 6.82	0.048*
Postoperative Insall-Salvati ratio†	0.60 ± 0.06	0.61 ± 0.07	0.075
Postoperative patellar height† (mm)	30.94 ± 2.01	30.74 ± 2.50	0.157
Femoral component flexion† (°)	−0.18 ± 2.67	−0.41 ± 3.12	0.211
Posterior tibial slope† (°)	1.13 ± 2.43	1.02 ± 2.29	0.712
Posterior femoral offset† (mm)	4.82 ± 2.38	5.45 ± 3.24	0.571
Posterior tibial offset† (mm)	9.13 ± 2.49	9.18 ± 2.74	0.315
Patellar tilt† (°)	3.83 ± 6.64	2.92 ± 5.77	0.617
Change in joint line† (mm)	6.40 ± 3.72	4.12 ± 2.80	< 0.0001*
Surgical factors			
Lateral release required (number)	No	No	Not applicable
Previous knee arthroscopy (number, %)			
None (0)	51 (94)	92 (98)	Referent
1	3 (6)	1 (1)	0.527
2	No	1 (1)	0.451
Femoral component size† (mm)	61.20 ± 3.21	60.40 ± 2.57	0.225
Tibial component size† (mm)	68.85 ± 3.36	69.13 ± 3.25	0.297
Polyethylene thickness† (mm)	12.30 ± 1.37	12.51 ± 1.60	0.475

PC = patellar crepitus; * statistically significant different between the two groups: $p < 0.05$; †values are given as mean ± SD.

crepitus influences pain and function. In addition, these studies did not specifically explore patellar crepitus in patients having TKAs without patellar resurfacing. We therefore determined (1) the frequency of crepitus; (2) which factors predicted the occurrence of crepitus; and (3) whether crepitus influenced pain and function in a control-matched clinical evaluation.

Several limitations of our study should be considered. First, because we did not directly compare other prosthetic designs with different patellofemoral geometries and kinematic patterns, our findings cannot be applied to all PS-TKA designs. In addition, although this implant had functioned well in our patient cohort, further study is necessary to assess how it would function in a group with patellar resurfacing. Second, this study is negatively affected by its nonrandomized and retrospective design or some missing data but positively affected by the control-matched study groups with TKAs without patellar resurfacing. Third, the followup duration (2.0–4.5 years) was short, but time from index surgery to patellar crepitus onset has been mostly before 12 months [4, 22, 26, 29, 35]. Fourth, the size of the analyzed cohort may be insufficient to provide statistical power for all factors. However, to our knowledge, no large-scale studies have addressed patellar crepitus after PS-TKA without patellar resurfacing. Finally, Asian populations adopt the lotus position and squatting in daily activities compared with Western populations. These differences in lifestyle may affect the development or implication of patellar crepitus.

The femoral component design is reportedly an important factor in the development of patellar crepitus [1, 4, 9, 16, 22, 24, 25, 28–30]. Ranawat et al. [29] noted a major reduction in the rate of painful patellar crepitus development for the PFC Modular Knee (DePuy, Warsaw, IN, USA) as compared with the IB/II (Zimmer, Warsaw, IN, USA) design. Pollock et al. [28] reported the rate of

Table 3. Clinical and radiographic features of knees with and without peripatellar pain

Parameter	Knees with peripatellar pain					Knees without peripatellar pain (n = 49)
	Patient 1	Patient 2	Patient 4	Patient 4	Patient 5	
Age of patients (years)	64	76	69	72	72	71 ± 6.3*
Sex	F	F	F	F	F	F = 48, M = 1
BMI (kg/m^2)	23	23	31	27	32	25.9 ± 3.3*
Feller's patellar score†	26	26	27	28	25	27.5 ± 2.2*
The Knee Society score†	175	180	183	177	185	174.8 ± 20.7*
WOMAC™ score†	84	97	74	89	90	89 ± 5.2*
VAS score	2	4	2	2	3	Not applicable
Outerbridge grade of patellar cartilage (number, %)	3	2	2	4	2	2.2 ± 1.0*
Preoperative patellar tendon length (mm)	49	47	52	49	50	51.4 ± 6.4*
Preoperative patellar height (mm)	28	33	32	29	30	31.8 ± 2.3*
Preoperative Insall-Salvati ratio	0.52	0.63	0.72	0.6	0.57	0.61 ± 0.05*
Postoperative patellar tendon length (mm)	50	47	49	48	52	50.6 ± 6.2*
Postoperative patellar height (mm)	29	32	32	31	28	31.0 ± 2.0*
Postoperative Insall-Salvati ratio	0.54	0.63	0.62	0.59	0.6	0.59 ± 5.5*
Patellar tilt (°)	2.2	3.3	2.5	3.1	2.8	3.8 ± 1.4*
Change in joint line (mm)	2.4	3.1	5.4	4.8	5.4	6.4 ± 1.6*

* Values are given as the mean ± SD; †postoperative scores at last followup.

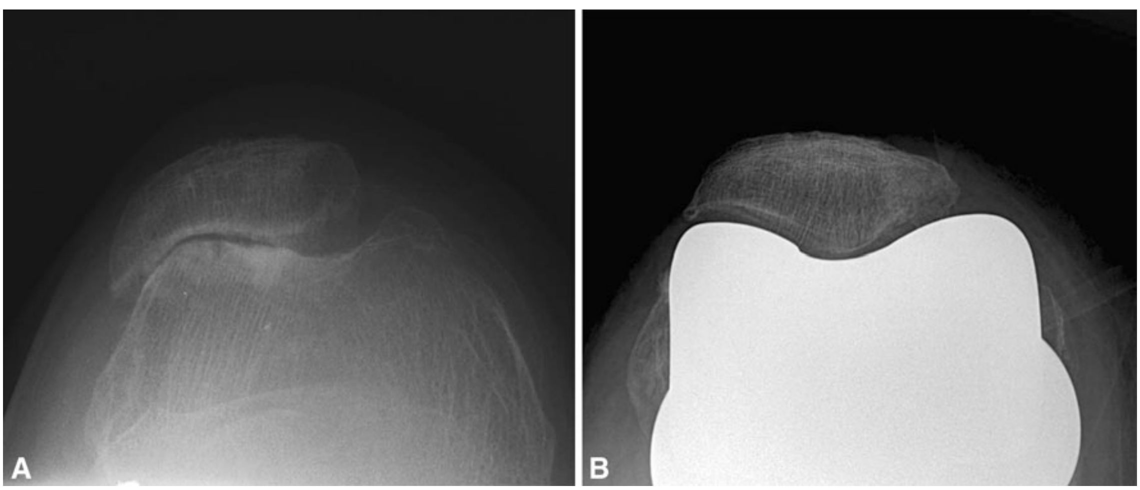

Fig. 1A–B Skyline patellar radiographs of the knee of a 67-year-old woman (PC group) who underwent TKA and patelloplasty without patellar resurfacing shows (**A**) the nonresurfaced patella with advanced patellofemoral arthritis before surgery and (**B**) 4 years postoperatively. Similar to the resurfaced patella, the lateral facet of the nonresurfaced patella is supported, and the trochlear groove of the femoral component well matches the articular surface of the patella. Patellar crepitus resolved within 9 months of onset.

grinding patellar crepitus was 13.5% for the AMK Congruency (DePuy) knee, 3.8% for the anatomic modular knee, and 0% for the fixed-bearing PFC Sigma® knee (DePuy). Improvements in the designs of femoral components with deepening of the trochlear groove and elevation of the lateral flange have been applied to some PS-TKA implants to reduce peripatellar problems [9, 26, 30]. Proximally positioned femoral box designs with an intercondylar box height ratio greater than 0.7 (ratio of the length of the intercondylar box to the AP width of the femoral component) and a sharp transition into the intercondylar notch are at greater risk of this phenomenon. When this ratio is larger, the superior pole of the patella and the anterior edge of the intercondylar box come into contact during earlier flexion. The Vanguard PS complete knee (Biomet) used in this study was designed to optimize patellar tracking and to limit the impingement of soft tissue between the patella and the intercondylar notch with the intercondylar box ratio less than 0.7. In this study, the incidence of patellar crepitus (8.5%) was similar to that of

Table 4. Multivariate logistic regression analysis results for the development of patellar crepitus

Parameter	Odds ratio	95% CI	p value
Outerbridge grade of patellar cartilage			
Grade 3	0.8	0.6–1.0	0.212
Grade 4	11.9	7.8–16.3	< 0.0001*
Preoperative patellar tendon length (mm)	0.9	0.7–1.4	0.143
Postoperative Insall-Salvati ratio	0.8	0.7–1.1	0.412
Postoperative patellar height (mm)	0.4	0.2–0.6	0.375
Postoperative patellar tendon length (mm)	0.7	0.6–1.3	0.152
Femoral component flexion (°)	0.5	0.3–0.8	0.075
Femoral component size (mm)	0.4	0.2–0.6	0.311
Change in joint line (mm)	5.1	4.5–5.7	0.0272*

* Statistically significant difference between the two groups: $p < 0.05$.

equivalent fixed-bearing PS-TKAs and no patient had patellar clunk syndrome develop. Although we are unsure of the exact cause for no manifestation of patellar clunk during the study period, we speculate elaborate excision of the suprapatellar synovial lining and use of this design result in decreased entrapment of fibrosynovial hyperplasia in the intercondylar box, limiting patellar excursion.

We found advanced cartilage tear was related to the development of patellar crepitus. Although the exact cause for this correlation is doubtful, we assume advanced patellofemoral arthritis results in increased intraarticular scar formation and increased soft tissue tension, which may increase the risk of development of fibrosynovial proliferation. The study also shows 9.3% of patients with postoperative patellar crepitus had peripatellar pain but that all patients in the PC group eventually achieved relief of their symptoms without a surgical procedure and no patients required revision surgery for secondary patellar resurfacing. Our findings do not support routine use of patellar resurfacing to reduce patellar crepitus in patients with advanced patellofemoral osteoarthritis. Previous studies [3, 7, 8] have reported patellar cartilage status does not influence clinical results, regardless of whether the patella is resurfaced. Although our study did not include knees without patelloplasty, we believe these favorable findings may be related to the patelloplasty to enhance patellofemoral tracking. The patella includes an elastic layer that enables plastic deformation allowing adaptation of the patellar contact surface to the femoral trochlea, which enhances biologic remodeling and decreases peripatellar pain [2, 18, 23]. Thus, a properly remodeled articular patellar surface may result in better patellofemoral tracking, even in knees with high-grade chondromalacia, if patelloplasty and soft tissue balancing are properly performed. Further study is warranted to determine whether patellar resurfacing can reduce the risk of patellar crepitus in patients with a patella of advanced grade.

We also found joint line elevation, which can lead to patella baja, was related to the development of patellar crepitus. Joint line elevation may increase contact stress between the quadriceps tendon and the superior portion of the intercondylar box and cause fibrosynovial tissue formation and entrapment in the box [15, 35]. We recommend excising the synovial lining overlying the top of the femoral component and peripatellar soft tissue by electrocautery to remove nidus to scar tissue formation.

The natural history of patellar crepitus after PS-TKA usually is associated with gradual amelioration of pain. However, problems often are persistent in patients with moderate-to-severe peripatellar pain or patellar clunk syndrome [12, 25, 29, 33, 34] and, thus, open or arthroscopic débridement of the fibrosynovial hyperplasia should be considered in these patients. Previous studies [12, 33, 34] have reported rates of 82% to 100% for successful resolution of patellar crepitus or clunk without recurrence. In our study, no patient required a surgical procedure and all knees were well functioning and symptom-free without evidence of recurrence.

Our study suggests the development of patellar crepitus is associated with advanced patellofemoral osteoarthritis and joint line elevation. Furthermore, all patients achieved complete symptom relief without an arthroscopic procedure or arthrotomy. Patellar crepitus is self-limited and a benign problem. We continue not to resurface arthritic patellae and counsel patients with patellar crepitus that their symptoms will improve without intervention.

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