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Original Research

High Incidence of Recurrent Patellofemoral Crepitus in Total Knee Arthroplasty Patients Following Arthroscopic Debridement

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ABSTRACT

Background: Patellofemoral crepitus is an unfavorable complication following total knee arthroplasty (TKA) with a posterior-stabilized (PS) implant. The purpose of this study was to study patellar crepitus recurrence and reoperation rates following arthroscopic debridement in patients with a PS-TKA.
Methods: Our institution database was used to identify patients with a PS-TKA who underwent arthroscopic debridement for patellofemoral crepitus at our institution. Patients must have had a resurfaced patella and minimum 2 years clinical follow-up from the arthroscopic debridement to be included in the study. Recurrence of patellar crepitus, subsequent operations, and any adverse events were documented.
Results: We identified 35 patients who met inclusion criteria with an average follow-up of 8.0 years (range 2.1 to 18.4 years) from their arthroscopic debridement. Nineteen patients (54.3%) had history of a nonarthroplasty knee surgery prior to their TKA. The mean time interval between TKA and arthroscopic debridement for patellar crepitus was 1.6 years (range 0.2 to 5.0 years). Overall, 16 patients (45.7%) developed recurrent crepitus (8 asymptomatic and 8 symptomatic). Six of the symptomatic patients (17.1% of the entire cohort) underwent a repeat surgery for recurrent patellofemoral crepitus. Of theses 6 patients, 3 developed recurrent crepitus but only 1 patient had a third surgical procedure. No postoperative complications were noted following any surgical procedure. The mean knee range of motion following arthroscopic debridement did not change (126.9° preoperatively vs 127.0° postoperatively).
Conclusions: Patients experienced high rates of recurrent patellofemoral crepitus following arthroscopic debridement. One-sixth of the patient cohort required a second surgical intervention for recurrent crepitus.

Introduction

Development of patellofemoral crepitus following total knee arthroplasty (TKA) is a frustrating complication that can result in significant patient dissatisfaction. The incidence of this condition varies widely in the literature, with rates between 0% and 18% [1–4]. It is seen primarily following TKA with a posterior-stabilized (PS) femoral implant [5], particularly implant designs with a high intercondylar box ratio [6,7]. Proliferation of fibrosynovial tissue on the posterior aspect of the distal quadriceps tendon results in tissue irritation and crepitation as the tendon traverses through the intercondylar box when the knee goes from flexion to terminal extension. The condition typically develops within 2 years after surgery (range of 3-21 months [8–11]), with the severity of symptoms varying from asymptomatic to severely symptomatic. Multiple risk factors for patellar crepitus have been identified including a previous knee surgery, use of smaller patellar components, decreased composite patellar thickness, a shortened patellar

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tendon length, smaller femoral components, increased posterior femoral condylar offset, flexed positioning of the femoral component, thicker polyethylene inserts, and increased knee flexion postoperatively [1,3,5,10–14]. Modern femoral component designs with a smaller intercondylar box ratio and a thinner, narrower trochlear flange have shown to have lower rates of patellar crepitus than some older designs [13,15,16]. Many cases improve within 1 year of symptom onset without intervention or become asymptomatic; however, a small portion of patients require surgical treatment [9].

For patients with disabling pain, surgical intervention may be needed to remove proliferative fibrosynovial tissue from the posterior aspect of the distal quadriceps tendon. Intervention can be performed via arthroscopic or open synovial debridement. Good results have been reported with both options [7,8,17,18]; however, the recurrence rates for patellar crepitus have not been well established. The purpose of this study was to evaluate outcomes following arthroscopic surgical treatment of patellar crepitus and to assess reoperation rates for recalcitrant crepitus.

Material and methods

Institutional board review was obtained for this study. We performed a retrospective review of our institution's surgical database to identify patients who underwent arthroscopic debridement for symptomatic patellar crepitus following primary TKA by 1 of our 5 fellowship-trained arthroplasty surgeons between January 2000 and December 2017. Only patients with a PS implant design and a resurfaced patella were included in the study. Patients must have had a minimum of 2 years clinical follow-up from the arthroscopic debridement to be included in the study. Patients with crepitus following revision TKA or patients who underwent arthroscopy for other indications were excluded. Only patients with patellofemoral crepitus (as determined by physical examination) were included in this study. Patients with other forms of crepitus were not included. Patients who underwent open debridement for crepitus were also excluded. Patients who had their primary TKA performed at another institution were included if their surgery for crepitus and follow-up were done at our institution. From an initial pool of 7532 primary TKAs in our database, 68 patients were identified who had arthroscopic debridement for patellofemoral crepitus, but only 35 patients met all inclusion criteria with a minimum of 2 years of follow-up.

The presence of patellofemoral crepitus was diagnosed on physical examination by one of our providers palpating the peripatellar region during passive or active knee range of motion (ROM) in a supine or seated position and documenting the presence of crepitus underneath the quadriceps tendon. If present, the provider would determine if the crepitus correlated with pain during activities and how severe the pain was. Patients with patellar clunk syndrome were also included as this is a variant of patellar crepitus with the same underlying etiology. This portion of the physical examination is done on every patient at each clinical evaluation. The preoperative and postoperative examination findings at each annual visit are recorded in our institutional database. Asymptomatic crepitus was defined as the presence of patellofemoral crepitus on examination that did not cause the patient pain or limit activities. Symptomatic crepitus was defined as patellofemoral crepitus that was painful on examination and caused pain during activities of daily living. If patellar crepitus was present, conservative management options were attempted first and included activity modification with avoidance of patellofemoral activities (ie, kneeling, squatting, excessive stair climbing), nonsteroidal anti-inflammatories (when safely indicated), and sometimes physical therapy to focus on quadriceps strengthening and improving patellar tracking. The decision to proceed with surgical intervention was made if patients had persistent severe pain that had not responded to conservative management. Duration of conservative management varied between patients with no set requirement on duration.

Demographic information was collected on all patients, including if they had any surgical knee procedures prior to their index TKA procedure (along with the number of prior surgeries). We documented any complications resulting from the arthroscopic debridement procedure along with whether or not patients developed recurrent patellar crepitus. Recurrent crepitus was determined on postoperative examination performed at each evaluation as stated above. If present, the provider inquired if the crepitus was painful. Patients' knee ROM from before arthroscopy was compared to that following arthroscopy. The ROM value at patient's most recent follow-up evaluation was included in the analysis. Any subsequent procedures (including the type of procedure) were documented along with complications.

The type of TKA implant and implant sizes were determined from operative records when available. The size and geometry of patellar components were also obtained from operative records when available. Radiographic measurements were made on prearthroplasty radiographs (when available) and postarthroplasty radiographs. The preoperative patellar thickness was measured on Merchant-view radiographs as previous described [10]. The thickness was measured at the thickest part of the patella from the articular apex to the dorsal bone border, with the line remaining perpendicular to the patellar axis. Postarthroplasty bone patellar thickness and composite patellar thickness (bone + implant) were measured on Merchant view radiographs in a similar fashion as previously described [10]. The difference in patellar compositive thickness from prearthroplasty to postarthroplasty was determined between values (postarthroplasty thickness − prearthroplasty thickness).

Results

Demographics

Of the 35 patients who met the inclusion criteria, the majority were female (26 patients, 74.3%) with 9 males (25.7%). The average age was 63.5 years (range 24-80 years), and the mean body mass index was 27.1 kg/m^2 (range 19-45 kg/m^2). The average follow-up duration from the arthroscopic debridement procedure was 8.0 years (range 2.1 to 18.4 years).

Of the 35 patients studied, 19 patients (54.3%) had some type of surgical knee procedure performed prior to their primary TKA (Table 1). Most of these patients only underwent 1 previous surgical procedure (10 patients, 28.6%), which consisted of 8 arthroscopic meniscectomies, 1 anterior cruciate ligament (ACL) reconstruction, and 1 bone grafting procedure. There were 4 patients (11.4%) who had 2 surgical procedures consisting of 3 patients with 2 arthroscopic debridements and 1 patient with a patellar realignment procedure followed by an arthroscopic

Table 1
Surgical interventions performed prior to primary total knee replacement.

# Surgical procedures prior to TKA	N (%)
0	13 (37.1)
1	10 (28.6)
2	4 (11.4)
3	3 (8.6)
4 or more	2 (5.7)
Total	32

Prior surgeries were not documented for 3 patients.

debridement. Three patients (8.6%) had 3 surgical procedures, which included 1 patient with open reduction and internal fixation of a fracture followed by hardware removal and an arthroscopic debridement; 1 patient with 1 arthroscopic debridement and 2 open debridements; and another patient with 1 arthroscopic debridement, an arthroscopic microfracture, and an arthroscopic lateral release. Two patients (5.7%) had more than 3 previous surgical procedures, including 1 patient who had an ACL reconstruction followed by 3 arthroscopic debridements and another patient with combined open reduction and internal fixation and ACL reconstruction followed by hardware removal with microfracture and then 2 additional arthroscopic debridements. Thirteen patients had no prior surgical procedures on their knee (37.1%), and 3 patients (8.6%) had no pertinent surgical history documented in their medical records.

All except 1 patient had their primary TKA performed at our institution. All TKAs were performed via a standard medial parapatellar approach. Most patients (31 patients, 88.6%) had a femoral prosthesis with an intercondylar box ratio >0.7 (PFC Sigma posterior cruciate substituting knee system; Depuy, Warsaw, IN) (Table 2). Three patients (8.6%) had an Attune PS knee implant (Depuy, Warsaw, IN), and 1 patient (2.9%) had a Persona PS knee implant (Zimmer/Biomet, Warsaw, IN). The mean time between the primary TKA and arthroscopic debridement was 1.6 years (range 0.2 - 5.0 years). All arthroscopic procedures were done at our institution and were performed using 2 or 3 standard arthroscopy portals. Placement of a superolateral outflow portal was at the discretion of the surgeon. Debridement of proliferative fibrosynovial tissue on the undersurface of the quadriceps tendon was performed with an arthroscopic shaver. Debridement was performed until all pieces of proliferative tissue were removed. Arthroscopic visualization was performed during passive knee ROM to ensure all pieces of entrapping synovial tissue were successfully removed. There were no major or minor surgical complications reported following any operative procedure aside from recurrent patellofemoral crepitus (as described below).

Recurrence patellofemoral crepitus

We identified 16 patients (45.7%) who developed recurrent patellofemoral crepitus following arthroscopic debridement (Table 3). The average time to clinical detection of recurrent crepitus was 3.2 years from the arthroscopic debridement (range 0.1 to 9.0 years). Of these patients, 8 (22.8% of the total cohort and 50.0% of those with recurrent crepitus) were symptomatic with pain on examination or during activities while 8 patients (22.8% of the total cohort and 50.0% of those with recurrent crepitus) were asymptomatic. Fourteen of the 16 patients with recurrent crepitus had a femoral component design with a large intercondylar box ratio (>0.7; Table 3). Eight of these patients (50%) had ≥1 surgical procedure prior to TKA. Six of the symptomatic patients (17.1% of the entire cohort) underwent another surgical procedure for recurrent patellar crepitus (Table 4). Five of these patients underwent repeat arthroscopic debridement while 1 patient had open debridement with synovectomy. Of these 6 patients, 3 patients had recurrent symptomatic patellar crepitus, but only 1 patient underwent a third surgical procedure for recalcitrant crepitus (open debridement with synovectomy).

Patient outcomes

The average knee ROM before surgical intervention (126.9°, range 115°-135°) did not appreciably change after surgical intervention with average knee flexion of 127.0° (range 105°-145°) at the most recent follow-up.

Patellofemoral variables

Patellar component geometry was able to be determined for 28 patients. The most common implant geometries included oval (19 patients) and round dome (8 patients). One patient had an anatomic patella component, and 7 patients had operative reports that did not specify the patella geometry. Of the 16 patients with recurrent crepitus, patella geometry was available for 12 patients and included 5 round domes, 6 ovals, and 1 anatomic patella. In patients who did not have recurrent crepitus, patella implant geometry was available for 16 patients and included 3 round domes and 13 ovals. The patellar component diameter size was available in 34 patients, with an average size of 35 mm (range 32 to 41 mm). The average prearthroplasty patellar thickness was able to be measured for 23 patients due to the high number of missing preoperative radiographs, with an average thickness of 25.8 mm (range 14.3 to 33.3 mm). Average postarthroplasty measurements could be performed on 33 patients, with 2 unable to be performed because of poor image quality. The average postarthroplasty bone thickness measurement was 18.8 mm (range 17.1 to 23.0 mm). The average postarthroplasty patellar composite thickness was 26.1 mm (range 22.3 to 34 mm). A comparison of the prearthroplasty patellar composite thickness to the postarthroplasty thickness was able to be calculated in 22 patients. Most patients had a decrease in patellar composite thickness compared to prearthroplasty thickness with an average of 0.7 mm decrease in thickness prearthroplasty to postarthroplasty (range −7.9 mm to 9.0 mm). In patients who developed recurrent crepitus, the average change in patellar composite thickness was 2.7 mm for asymptomatic patients (indicating an increase from prearthroplasty to postarthroplasty) and −2.7 mm for symptomatic patients (indicating a decrease in thickness from prearthroplasty to postarthroplasty). Patients who did not develop recurrent crepitus had a −1.5-mm change in patellar composite thickness prearthroplasty to postarthroplasty. We had insufficient volume to determine if there was a statistically significant difference between patients who developed recurrent crepitus and those who did not based on the patellar implant geometry, patellar implant size, or change in patellar component thickness.

Discussion

Patellar crepitus is an unwanted complication following TKA with a PS implant that can significantly impact patient outcomes.

Table 2
Type of femoral prosthesis used for primary total knee arthroplasty in patients who underwent a surgical intervention for crepitus.

Femoral component	N (%)	# With recurrent crepitus
PFC Sigma Posterior Cruciate Substituting Knee System (Depuy, Warsaw, IN)	31 (88.6%)	14
Attune Posterior Stabilized Knee System (Depuy, Warsaw, IN)	3 (8.6%)	1
Persona Posterior Stabilized Knee System (Zimmer/Biomet, Warsaw, IN)	1 (2.9%)	1
Total	35	16

Table 3
Patients who developed recurrent patellar crepitus following a surgical intervention along with data on risk factors.

Patient	# Surgeries prior to TKA	Crepitus symptomatic or asymptomatic	Implant type	Patella size (mm)	Femoral size (vendor specific)	Repeat surgical intervention	Outcome
Patient # 1	4	Asymptomatic	PMC Sigma	32	NA	Nonoperative	Resolution
Patient # 2	NA	Asymptomatic	PMC Sigma	35	4	Nonoperative	Resolution
Patient #3	NA	Symptomatic	PMC Sigma	32	2.5	Nonoperative	Resolution
Patient # 4	NA	Symptomatic	PMC Sigma	35	2.5	Arthroscopic debridement	Resolution
Patient #5	1	Asymptomatic	PMC Sigma	35	4	Nonoperative	Resolution
Patient #6	1	Asymptomatic	PMC Sigma	35	4	Nonoperative	Resolution
Patient #7	0	Asymptomatic	Persona	35	7	Nonoperative	Resolution
Patient # 8	1	Symptomatic	PMC Sigma	32	3	Arthroscopic debridement	Crepitus returned but asymptomatic
Patient #9	3	Asymptomatic	PMC Sigma	35	2.5	Nonoperative	Resolution
Patient #10	0	Symptomatic	PMC Sigma	35	4	Arthroscopic debridement	Crepitus returned and symptomatic but declined surgery
Patient # 11	1	Symptomatic	PMC Sigma	NA	NA	Arthroscopic debridement	Crepitus returned and symptomatic and had 2 more arthroscopic debridements
Patient # 12	0	Symptomatic	PMC Sigma	41	5	Nonoperative	Resolution
Patient # 13	2	Asymptomatic	PMC Sigma	38	5	Nonoperative	Resolution
Patient # 14	0	Symptomatic	Attune	41	7	Nonoperative	Resolution
Patient # 15	1	Asymptomatic	PMC Sigma	32	2	Open arthrotomy w/ synovectomy	Resolution
Patient # 16	0	Symptomatic	PMC Sigma	32	7	Arthroscopic debridement	Resolution

NA, not available.

Table 4
Surgical interventions for patients with recurrent patellofemoral crepitus following arthroscopic debridement.

Type of surgical procedure	N (%)
Arthroscopic debridement	5 (83.3%)
Open arthrotomy w/ synovectomy	1 (16.7%)
Total	6

While good results have been reported with surgical intervention [1,7,8,11,17,19], recurrence rates and outcomes following surgery for patellar crepitus have not been well established. We evaluated 35 patients who underwent arthroscopic debridement for patellofemoral crepitus and found a recurrence rate of 45.7%, with 17% of the cohort undergoing a second procedure for symptomatic crepitus.

To our knowledge, this is one of the largest series evaluating rates of recurrent patellar crepitus following surgical intervention. The rate of rrecurrence found in our study (45.7%) is higher than that reported in other studies. Other studies have shown recurrence rates ranging from 0-5% following arthroscopic debridement [1,7,8,11,17,19]. Beight et al. [14] found 4 recurrences (28%) of patellar clunk syndrome in their series of 14 patients who underwent arthroscopic debridement, with all recurrences treated with open arthrotomy. Gholson et al. [20] identified 3 out of 18 cases (16.7%) of recurrent patellar crepitus that were successfully treated with a second arthroscopic debridement. Another study by Dajani et al. [18] found a recurrence rate of 13% (2 out of 15 patients) following arthroscopic debridement, with both patients requiring a second open procedure to eliminate their symptoms. One explanation for our higher recurrence rates may be the follow-up duration of the current report. The average follow-up of our study was 8.0 years, allowing us to potentially capture more patients with symptomatic crepitus that failed to resolve with conservative management. This is longer than most other studies evaluating outcomes following surgery for crepitus (range 1.1 - 5 years) [7,8,18–20]. Another explanation could be related to the higher knee ROM in our patient population. The average ROM prior to the surgical intervention was 126°, which is higher than what has been reported in some other studies (range of average motion 117°-119°) [18,20]. Increased knee flexion has been cited as a potential risk factor for the development of crepitus secondary to the increased forces between the femoral component and patella/quadriceps tendon that could promote proliferative synovial tissue [11]. The higher incidence of recurrent crepitus could also be related to the predominant implant analyzed in this report (PFC Sigma posterior stabilized; Depuy Synthes, Warsaw, IN; Table 2), which has a large intercondylar box ratio (>0.7). Fukunaga et al. [1] defined the intercondylar box ratio as the intercondylar box height vs the anterior-posterior height of the femoral component. They observed that PS femoral components with an intercondylar box ratio >0.7 had a greater risk of developing patellar crepitus, likely due to the increased contact of the distal quadriceps tendon with the superior aspect of the intercondylar box earlier in flexion than components with a lower ratio. As almost all our patients with recurrent crepitus had an implant with a high intercondylar box ratio (Table 4), this could be a reasonable explanation for our high recurrence rate. There were 4 patients in our study with an implant containing an intercondylar box ratio <0.7, only 2 of which developed recurrent crepitus (Table 2). Our study was not powered to detect a difference in development of recurrent crepitus between different implant types.

There are several other risk factors that have shown to increase the risk of patellar crepitus following TKA. In a study by Dennis et al. [10], patients who had one surgical procedure prior to their arthroplasty surgery had an odds ratio of 3.1 for developing

patellofemoral crepitus, and patients with more than one prior surgery had an odds ratio of 6.5. It has not been established if specific types of prior surgery place patients at a higher risk of crepitus, such as arthroscopic vs open procedures. In our series, we had a combination of open and arthroscopic procedures performed prior to TKA, and our study was not powered to determine if the type of prior surgery impacted recurrence rates. While some of the patients who developed recurrent crepitus had 4 or more knee surgeries prior to their TKA, many patients had 1 or less (Table 3). Future studies to investigate if the type of prior surgery performed has an impact on recurrent crepitus rates would be helpful in counseling patients prior to TKA. Other reported risk factors for patellofemoral crepitus include the use of smaller patellar components and a decreased patellar composite thickness, presumedly due to the higher contact forces between the quadriceps tendon and intercondylar box that stimulates fibrosynovial proliferation [10]. We observed a wide range of patellar component sizes in our cohort and did not observe a specific trend in component size in patients with recurrent crepitus (Table 3). Furthermore, there was a similar distribution of patellar geometry between those that developed recurrent crepitus and those that did not. Patients with symptomatic recurrent crepitus showed a trend for decreased patellar composite thickness at −2.7 mm compared to patients that did not have recurrent crepitus at −1.5 mm. However, we were only able to make patellar composition measurements on 22 of 35 patients (62%).

There are several limitations to our study. This was a retrospective review including only patients who underwent surgery for symptomatic patellar crepitus. Patients with symptomatic crepitus who elected not to have surgery and cases with asymptomatic crepitus were not included in this study. Also, other types of crepitus from scar tissue in the gutters or other areas of the knee were not evaluated in this study. Surgeon discretion along with the severity and duration of patient symptoms were used to guide when to perform surgical intervention, but these factors are highly subjective. We decided to focus only on patients who underwent arthroscopic surgery to better understand patellar crepitus recurrence rates with this surgical intervention. It is possible that some of our symptomatic patients who had surgery may have had resolution of their symptoms with a longer period of observation. This study was not intended to determine resolution rates of crepitus with nonoperative management or the impact of crepitus on patient pain and function without operative intervention. Second, there are subtle differences in surgeon technique both during the primary TKA and arthroscopic debridement. All TKAs were done via the medial parapatellar approach, so we were unable to analyze the difference in recurrence rates between different approaches, which has been suggested as a risk factor for crepitus [21]. It is difficult to determine if discrepancies in surgical technique may have had a significant impact on the development of recurrent patellar crepitus.

Conclusions

While the incidence of patellar crepitus may be decreasing with changes in implant design [13], it is important to counsel patients on expectations following arthroscopic surgery for symptomatic crepitus. We found that 45.7% of our patients developed recurrent crepitus following surgical intervention, with 17% of our patient population requiring a second surgical procedure to address it. Due to our low patient volume, we were not able to determine whether certain factors such as implant type, geometry, size, or other patient factors had a significant impact on recurrence rates. Patient knee ROM following surgery did not show significant improvement with the surgical procedure. Studies with a larger patient volume are needed to better understand recurrence rates and outcomes following surgery for crepitus, but these preliminary data will hopefully help guide clinicians in counseling patients on expectations prior to surgery.

Conflicts of interest

Dr. D. A. Dennis receives royalties from DePuy, a Johnson & Johnson Company; is in the speakers' bureau of or gave paid presentations for Corin U.S.A. and DePuy, a Johnson & Johnson Company; is a paid consultant for Corin U.S.A. and DePuy, a Johnson & Johnson Company; has stock or stock options with Corin U.S.A. and Joint Vue; receives research support as a principal investigator from DePuy, a Johnson & Johnson Company, Corin U.S.A., and Porter Adventist Hospital; receives financial or material support from Wolters Kluwer Health—Lippincott Williams & Wilkins; and is in the editorial or governing board of *Clinical Orthopaedics and Related Research*, *Journal of Arthroplasty*, *Journal of Bone and Joint Surgery-American*, and *Orthopedics Today*. Dr. J. Jennings is a paid consultant for Total Joint Orthopedics and Xenex and receives research support from DePuy, a Johnson & Johnson Company, Corin U.S.A., and Porter Adventist Hospital. Dr. L. T. Kleeman-Forsthuber is an unpaid consultant for Corin. The other authors declare no potential conflicts of interest.

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