JOURNAL OF BONE AND SOFT TISSUES SURGERY (JBSS)

Original Article

Arthroscopic Debridement for Patellar Crepitations and Clunk Syndrome Post Total Knee Arthroplasty

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Introduction:
Background:
Patellar crepitus and clunk syndrome (PCC) are infrequent but troublesome complications following total knee replacement (TKR) surgeries in patients with end-stage arthritis, often impairing function and patient satisfaction. Arthroscopic debridement offers a minimally invasive treatment. This study aims to evaluate arthroscopic debridement's significance in managing post-TKR symptoms such as PCC in end-stage arthritis patients.

Methods:
A retrospective cohort design was conducted over 10 years at a single center, assessing 825 TKR patients. Of these, 9 (1.1%) were with symptomatic PCC requiring arthroscopic knee debridement. Pre- and post-operative outcomes were assessed using the Insall-Salvati Score, Blackburne-Peel Ratio, Knee Society Score (KSS), Oxford Knee Score, and Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC). Statistical analyses were performed using paired t-tests with significance set at $p<0.05$.

Results:
Trends indicated an increase in knee TKR surgeries, with significant improvements in patient-reported outcomes and surgical measures postoperatively. Post-debridement, symptomatic PCC prevalence declined from 100% to 33.3%. Significant improvements were observed in surgical parameters (Insall-Salvati Score: 1.3 to 1.16, $p=0.022$; Blackburne-Peel Ratio: 0.79 to 0.61, $p=0.010$; TKR joint line level: 20.16 to 20.6, $p<0.001$) and patient-reported outcomes (KSS Part 1: 71.0 to 89.7, $p<0.001$; KSS Part 2: 52.2 to 70.6, $p=0.031$; Oxford Knee Score: 26.0 to 38.3, $p<0.001$; WOMAC: 72.7 to 32.4, $p<0.001$). Three patients reported persistent symptoms.

Conclusion:
Arthroscopic debridement offers a minimally invasive and effective solution for managing PCC post-TKR, with significant improvements in both surgical alignment metrics and patient-reported outcomes. Although PCC is uncommon, it can substantially affect postoperative satisfaction, and its successful management requires individualized consideration of biomechanical and patient-specific factors. Further prospective studies are warranted to validate long-term outcomes and identify predictors of recurrence.

Key Words: Total knee replacement, patellar crepitus, arthroscopic debridement, patient-reported outcomes, postoperative complications.

How to cite: Abbas AM, Khan MAS, Ali MAM, Atieh FM, Ali SM, Jilan SRA, Butt AJ. Arthroscopic Debridement for Patellar Crepitations and Clunk Syndrome Post Total Knee Arthroplasty. (JBSS). 2026; 01(01): 1-10

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Introduction:

End-stage arthritis of the knee joint often necessitates surgical intervention to alleviate pain and restore joint mobility. Total knee replacement (TKR) surgeries have become the gold standard for the treatment of end-stage knee osteoarthritis and the rising incidence of TKR surgeries, given the aging population, have been documented in studies such as the data from Taiwan's National Health Insurance Research Database, which showed a significant increase in TKR procedures from 1996 to 2010, particularly among individuals aged 70 to 79 years[1]. However, TKR surgeries can result in complications such as patellar crepitus and clunk syndrome (PCC) postoperatively, impacting patient satisfaction and functional outcomes. PCC, characterized by painful nodules or grinding sounds in the knee, frequently requires re-operations, negatively affecting patient outcomes [2].

Numerous studies have extensively examined patellar clunk or crepitus post-total knee arthroplasty (TKA)[3–8]. Symptom onset typically occurs around 10.9 months post-surgery, with various risk factors identified including patellar tendon length, femoral component size, and previous knee surgery.[3] Arthroscopic excision for patellar crepitus had a 1.2% incidence, with favorable outcomes reported in 79% of cases[4]. Fixed bearing cohorts showed lower rates of patellar clunk syndrome compared to mobile bearing groups[5]. Incidence rates varied across prosthetic systems, highlighting the influence of design and surgical techniques[6–8].

Arthroscopic knee debridement offers a promising solution to address PCC, particularly given the increasing incidence of such cases. Literature has demonstrated the efficacy of arthroscopic debridement in managing complications post-TKA. Arthroscopic intervention resulted in significant pain relief in post-TKA knee pain cases and addressed painful patellar clunk and crepitus effectively[4]. Moreover, arthroscopic debridement improved range of motion and Knee Society Scores (KSS) in case of peripatellar impingement, arthrofibrosis, and generalized synovitis post-TKA[9]. It has shown promise as a treatment option for younger patients with mild to moderate knee osteoarthritis and yielded improvements in patient-reported knee pain and function scores post-primary TKA [10,11]. These findings underscore the importance of considering arthroscopic debridement in managing various complications post-TKA.

Patient characteristics such as age, gender, and laterality influence post-TKA outcomes and the risk of developing patellar clunk or crepitus (PCC). Most studies report similar age distributions among prosthesis types, with mean ages around 67 years[12]. However, gender-related trends remain inconsistent; some studies report higher PCC incidence in males, while others find increased rates in females [5,13]. Additionally, right-sided knee osteoarthritis has been observed more frequently, with distinct radiographic features suggesting biomechanical differences between sides[14,15].

Surgical technique plays a key role in PCC prevention. Patellar resurfacing during posterior stabilized TKA has been associated with a reduced risk of postoperative crepitus and improved clinical outcomes [16]. Factors such as decreased patellar component thickness and increased posterior condylar offset are linked to higher PCC risk[17]. These findings highlight the importance of patellar management and component alignment in optimizing post-TKA function.

Despite existing evidence supporting arthroscopic debridement, there remains a lack of focused clinical data specifically evaluating its outcomes in patients with PCC following TKR. Therefore, this study aims to evaluate the effectiveness of arthroscopic knee debridement as a treatment measure for post-TKR symptoms, particularly addressing issues such as patellar crepitations or clunk syndrome in end-stage arthritis patients. We hypothesize that arthroscopic debridement will result in both symptomatic relief and functional improvement in patients presenting with PCC following TKR.

Methods:

Study Protocol:

A retrospective cohort design was used to assess the impact of arthroscopic debridement through surgical and patient-reported functional outcomes

during the follow-up after undergoing arthroscopic debridement post- total knee replacement for painful PCC. A total of 825 patients from 2012 to 2022 at a single university hospital from the Orthopedic Surgery Department had undertaken either a single knee or both knee TKR and were retrospectively enrolled in the study. Following the set inclusion and exclusion criteria, only 9 patients underwent arthroscopic debridement for PCC and were eligible and therefore, analyzed in this study. A convenience sampling technique was implemented, where all male and female patients above the age of eighteen who met the inclusion and exclusion criteria were enrolled. A total of 4 males and 5 females were consequently enrolled in the study. Data was collected through the HOPE health record system at the King Hamad University Hospital in the Kingdom of Bahrain. The collected data was then used to assess the functional outcomes of patients after undergoing arthroscopic debridement for PCC post-TKR in the enrolled patients. Ethical approval was received by the overseeing research ethics committee. Patients were included if they presented with post-TKR symptoms, such as patellar crepitation or clunk syndrome, after undergoing previous total knee replacement surgery. Furthermore, the selected patients had undergone arthroscopic knee debridement as a treatment for these post-TKR symptoms. Only patients with complete pre- and post-operative data and no surgical and patient-reported outcomes were included, and these included data from standardized scoring systems such as the Insall-Salvati Score, Blackburne-Peel Ratio, Knee Society Score (KSS), Oxford Knee Score, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Exclusion criteria included patients without post-TKR symptoms, patients who underwent TKR revision surgeries during the study period or had incomplete or missing data on surgical or patient-reported outcomes. Moreover, patients with significant post-operative complications unrelated to arthroscopic debridement or TKR surgery, as well as those with contraindications to arthroscopic knee debridement or incomplete medical records, were also excluded.

Data Collection:

The data collected from patients included demographic data such as age, gender, and BMI, along with clinical and surgical parameters such as knee distribution (left, right, or both), prosthesis type (posterior stabilized or cruciate retaining), and time to presentation. Surgical outcome measures encompass the Insall-Salvati Score,[18] which evaluates knee function and stability, the Blackburne-Peel Ratio[19] for patellar tracking and alignment assessment, Posterior Condylar Offset Ratio (PCOR) to gauge alignment and positioning of knee prosthesis components, TKR patellar thickness to ensure proper alignment and function, femoral component flexion angle, tibial slope, and TKR joint line level to examine knee joint alignment and symmetry. Patient-reported outcomes were evaluated using standardized scoring systems such as the Knee Society Score (KSS) parts 1 and 2 for assessing knee pain, function, and alignment, the Oxford Knee Score focused on patient-reported outcomes related to pain, function, and mobility post-TKR surgeries, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to measure pain, stiffness, and physical function related to knee osteoarthritis, providing insights into overall quality of life post-surgery [20,21,22]. These measures facilitated a comprehensive assessment of both surgical interventions' effectiveness and their impact on patient well-being.

Statistical Analysis:

All collected participants' data was anonymized and tabulated using spreadsheets. Ethical approval for the study was obtained from the Institutional Review Board prior to data collection, ensuring compliance with ethical standards in research involving human participants. Standard descriptive statistics, including means and standard errors, were used to explore the demographic and clinical characteristics of the study population, while paired t-tests were employed to assess the relationship between pre- and post-operative measures. Categorical variables were shown as numbers and percentages, while continuous variables were presented as mean and standard deviation. Statistical data were analyzed using Statistical Packages for Social Sciences (SPSS) version 28 Armonk, NY: IBM Corporation, to determine the significance of observed changes in surgical and patient outcomes. A p-value <0.05 was considered statistically significant.

Results:

1. Population Data

There were a total of 825 patients that underwent either a single knee or both knee TKR over a 10-year period, of which only 9 (1.1%) patients required PCC. Age, gender, and knee distribution are described in Table 1. There were no statistical differences between the two populations. The surgery distribution per year is illustrated in Figure 1, where the trend lines show that TKR surgeries for both knees are on the rise.

Table 1:

Baseline Clinical Characteristics of Patients Undergoing Total Knee Arthroplasty with and without Patellar Crepitus/Clunk

		PCC (n=9)	*Non-PCC (n=816)*	*Population (n=825)*
Age in years (mean ± SD)		63.5 ± 8.2	65.3 ± 7.9	65.2 ± 7.7
Gender (n, %)	Male	4, 0.5	245, 29.7	249, 30.2
	Female	5, 0.6	571, 69.2	576, 69.8
Knee TKR (n, %)	Left	3, 0.4	264, 32.0	267, 32.4
	Right	1, 0.1	258, 31.3	259, 31.4
	Both	5, 0.6	294, 25.6	299, 36.2

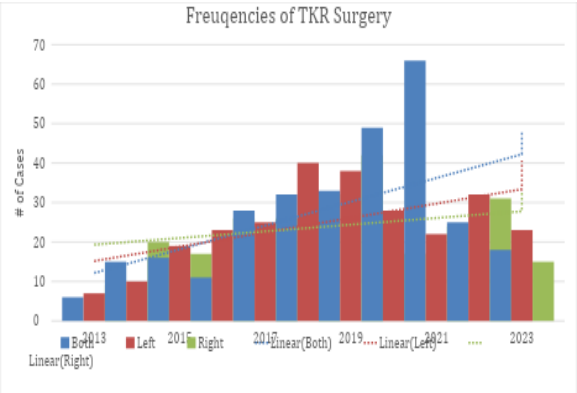

Figure-1: Frequency of TKR surgeries per year based on the type of TKR with a linear trend line

2. PCC population

The PCC population consisted of 9 patients, where the average age (63.5 ± 8.2 years) is lower than the overall population. It was observed that a little over half of this population received knee TKR (5, 55.5%). Prior to arthroscopic debridement, the prevalence of pain and crepitus/clunk was 100% (9 participants). However, post-debridement, the prevalence of pain and crepitus/clunk reduced to 33.33% (3 participants), indicating symptomatic improvement within the PCC subgroup.

Table 2:

Case Profiles of Patients with Post-TKA PCC Undergoing Arthroscopic Debridement

Patient	Age	Gender	BMI (kg/m^2)	Time to presentation (months)	Knee -PCC	Prosthesis* - PCC Knee	Prosthesis* – non-PCC Knee
1	69	M	29.2	12	Left	PS	NIL
2	80	M	31.9	8	Left	CR	PS
3	64	M	24.2	4	Left	PS	NIL
4	58	F	35.8	4	Left	PS	CR
5	59	F	37.0	5	Left	PS	CR
6	63	M	37.3	7	Right	PS	PS
7	74	F	31.1	10	Left	PS	CR
8	59	F	38.1	24	Right	CR	CR
9	57	F	43.4	9	Left	PS	NIL

**Prosthesis type: Posterior-stabilized (PS); Cruciate-retaining (CR); NIL (No prosthesis)*

Table 3:

Comparison of Pre- and Post-Operative Surgical Parameters in PCC Patients Undergoing Arthroscopic Debridement

Surgical measure (mean ± SD (min-max))	**Operative Status**		**P-value**
	Pre	**Post**	
Insall-Salvati Score	1.3 ± 0.14 (1.14-1.48)	1.16 ± 0.12 (0.96-1.33)	0.022*
Blackburne-Peel Ratio	0.79 ± 0.23 (0.38-1.17)	0.61 ± 0.17 (0.37-0.85)	0.010*
PCOR**	0.47 ± 0.04 (0.42-0.52)	0.47 ± 0.05 (0.40-	0.959

		0.56)	
TKR Patellar Thickness (mm)	21.0 ± 1.41 (12.1-23.2)	19.1 ± 2.36 (16.2-23.9)	0.028*
TKR Joint Line Level (mm)	20.16 ± 4.71 (15.9-29.3)	20.6 ± 4.70 (16.5-29.7)	<0.001*
Femoral Component Flexion Angle	13.3 ± 6.9 (2.47-22.8)		
Tibial Slope	5.1 ± 2.0 (2.36-7.21)		

**Significant value; **PCOR: Posterior Condylar Offset Ratio*

2.1 Surgical Outcomes

Seven surgical outcomes were measured, of which five measures were based on operative status, and can be seen in Table 3. PCOR was found to be not significant in our PCC population (p=0.959).

2.2 Patient Outcomes

Four patient-reported measures were utilized in both operative statuses and can be seen in Table 4. The Knee Society Score was significant in both parts, with part 1 having a stronger relationship (p<0.001). Similarly, the Oxford Knee Score and the Western Ontario and McMaster Universities Osteoarthritis Index were very significant (p<0.001).

Table 4:

Changes in Patient-Reported Outcome Scores Following Arthroscopic Debridement

Patient-reported measure (mean ± SD (min-max))	**Operative Status**		**P-value**
	Pre	**Post**	
KSS** Part 1	71.0 ± 7.3 (56-77)	89.7 ± 12.7 (67-98)	<0.001*
KSS Part 2	52.2 ± 20.2 (0-70)	70.6 ± 7.8 (55-80)	0.031*
Oxford Knee Score	26.0 ± 7.8 (10-34)	38.3 ± 9.6 (17-47)	<0.001*
WOMAC***	72.7 ± 25.8 (24-90)	32.4 ± 5.9 (24.2-38.6)	<0.001*

**Significant value; **KSS: Knee Society Score; ***WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index*

Discussion:

This study assessed arthroscopic debridement outcomes for patellar crepitations or clunk syndrome following total knee replacement in a cohort of 825 patients over ten years in a single university-hospital. The study confirmed the rising incidence of TKR surgeries, with an increased frequency of bilateral TKR. Only 1.1% of the population cohort developed symptomatic PCC requiring intervention. Among the nine patients treated in the PCC subgroup, significant improvements were observed in objective surgical parameters, including the Insall-Salvati Ratio, Blackburne-Peel Ratio, PCOR, TKR patellar thickness, and TKR joint line level. Moreover, significant improvements were found in patient-reported outcomes such as the KSS Part 1 and Part 2, Oxford Knee Score, and WOMAC scores. The results support the efficacy of arthroscopic debridement in managing post-TKR PCC, with a notable reduction in symptoms and improved function.

The increasing frequency of TKR surgeries in our study aligns with global and regional trends, as reported in national joint registries and literature [1]. Rise in these procedures can be attributed to advancements in medical technology and surgical techniques which have made TKA procedures more accessible and effective, in addition to the aging population, increasing rate of obesity and sedentary lifestyles, all which have increased the prevalence of knee osteoarthritis, the primary indication for TKA[23]. While the incidence of PCC in our population (1.1%) was relatively low, its clinical burden remains substantial. Previous studies have associated PCC with prosthesis design, surgical technique, and patient anatomy. We further observed several factors associated with an increased risk of PCC post-TKA, including reduced pre-operative and post-operative patellar tendon length, thinner postoperative composite patellar component thickness, smaller femoral component size, increased posterior femoral condylar offset, and a history of previous knee surgery. Our findings corroborate existing evidence of linking factors

such as patellar thickness, femoral offset, and prior surgeries to higher PCC risk [3–5,16,17].

While the majority of patients experienced improvement, three patients reported persistent PCC symptoms and exhibited recurrent pain post-debridement. The first patient, a 69-year-old male, notably presented with the highest joint line level post-surgery and the lowest WOMAC score within the group subjected to patellar debridement. Subsequently opting for open patellar debridement, this patient experienced relative symptom improvement. In contrast, the second patient, a 64-year-old male, demonstrated consistent Blackburne-Peel ratios pre- and post-surgery. However, a plausible explanation for his recurring pain may stem from prior tibial fixation in the affected knee. Lastly, the third patient, a 59-year-old female, exhibited the highest tibial slope and the second lowest WOMAC score among the patellar debridement cohort. Notably, all three patients had posterior-stabilized prostheses and underwent left-sided TKR [4,9–11]. These cases underscore the complexity of factors influencing post-operative outcomes, hinting at potential avenues for further investigation into optimizing patient selection and treatment strategies.

The comparison between our surgical measures before and after arthroscopic debridement in patients experiencing PCC post-TKA reveals several noteworthy findings. Firstly, a significant decrease in the Insall-Salvati Score was observed from 1.3±0.14 to 1.16±0.12 (p=0.022) post-debridement indicating an improvement in patellar height alignment and indicating mild normalization from a borderline patella alta towards the normal range of 0.8-1.2. In contrast to Peralta-Molero et al. and Gholson et al., who found no significant post-operative change in the Insall–Salvati ratio following debridement, and Yau et al., who identified lower Insall-Salvati ratios as a contributing factor to PCC, our study demonstrated a statistically significant decrease in Insall-Salvati ratio post-debridement, suggesting that patellar height normalization may play a more active role in symptom resolution than previously recognized [4,6,24].

Additionally, the significant decrease in the Blackburne-Peel Ratio from 0.79±0.23 to 0.61±0.17 (p=0.010) post-debridement, along with the decrease in TKA patellar thickness from 21.0±1.4 mm to 19.1±2.36 mm (p=0.028) post-debridement, suggests reduced patellar tilt, lateralization, and surrounding soft tissue hypertrophy around the patella, which may contribute to improved patellofemoral kinematics and reduced impingement or clunk within the joint. This finding is paralleled by Behrend et al.'s study which found that decreases in Blackburne-Peel Ratio significantly predicted better functional scores post-TKA, reinforcing that reductions in patellar height parameters are meaningful markers of symptomatic improvement [25].

The significant increase in TKA joint line level post-debridement from 20.16±4.71 mm to 20.6±4.70 mm (p<0.001) suggests enhanced joint congruency and alignment, contributing to better overall knee function and range of motion. As for the posterior condylar offset ratio, it showed no change post-op, suggesting arthroscopic debridement does not affect posterior femoral alignment. However, the absence of data on changes in the femoral component flexion angle and tibial slope post-debridement limits our ability to assess the intervention's impact on these parameters comprehensively.

Patient-reported outcomes following arthroscopic debridement also portrayed significant improvements across various measures compared to preoperative status. The Knee Society Score Part 1 showed a substantial increase from a mean of 71.0±7.3 pre-TKA to 89.7±12.7 post-debridement (p<0.001), indicating enhanced functional outcomes and knee joint function, from "good" to "excellent" clinical knee function. Similarly, KSS Part 2 demonstrated improvement, with the mean score rising from 52.2±20.2 to 70.6±7.8 post-debridement (p=0.031), reflecting improved mobility and independence among our patients, from "poor/fair" to "good" clinical function.

Additionally, the Oxford Knee Score exhibited a significant increase post-debridement (p<0.001), indicating a clinically meaningful

improvement in pain and functional ability after debridement. Lastly, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores showed a substantial improvement, with the mean score decreasing from 72.7 ± 25.8 to 32.4 ± 5.9 post-debridement ($p<0.001$), highlighting enhanced pain relief and functional recovery. It is noteworthy to mention that WOMAC raw scores (0-96) were used, where higher scores indicate joint worsening, and lower scores indicate better outcomes and function. These findings align with existing literature demonstrating the favorable impact of TKA on patient-reported outcomes, emphasizing the effectiveness of the procedure in improving knee function and quality of life post-debridement [4,5,10,13,16,17].

The time to presentation for PCC symptoms in our cohort ranged from 4 to 24 months, differing from the average of 10.9 months reported in previous studies [3]. This variation may reflect differences in patient demographics, implant design, surgical technique, and follow-up practices. Our cohort, composed primarily of patients with posterior-stabilized and cruciate-retaining prostheses, showed similar age and gender distributions to existing literature, supporting dataset reliability [2–5,12,14]. While BMI varied widely and aligned with reported trends, its role in PCC development remains multifactorial and not yet fully defined [15]. Further investigation is warranted to clarify the influence of biomechanical, prosthetic, and patient-specific factors on PCC onset and recurrence.

Future studies should explore the long-term durability of arthroscopic debridement, particularly in relation to prosthesis type, joint alignment metrics, and patient-specific risk factors such as BMI and prior surgeries. Prospective, multicenter trials with larger PCC cohorts and standardized imaging and follow-up protocols are needed to establish predictive markers for poor outcomes and recurrence. Given that PCOR was not found as a modifiable factor via debridement, future studies can stratify outcomes by pre-op PCOR or assess correlation with recurrence to explore the prognostic value of PCOR for PCC. These findings reinforce arthroscopic debridement as a valuable minimally invasive treatment for PCC, with demonstrable benefits in select patients. Further prospective trials are essential to refine patient selection and confirm long-term durability.

Limitations:

While our study offers valuable insights into TKA surgeries and PCC management, it has limitations. Its retrospective design restricts longitudinal data availability to pre-TKA and post-arthroscopic debridement scores, limiting the assessment of intermediate changes. Reliance on medical records may introduce bias, and the small sample size and single-center nature affect generalizability. Additionally, post-operative values for tibial slope and femoral component angle were not available, which may have limited interpretation of sagittal alignment changes. Despite these constraints, our findings underscore arthroscopic debridement's efficacy. Prospective studies with larger samples and comprehensive assessments are needed to validate our findings and guide clinical practice.

Conclusion:

Arthroscopic debridement offers a minimally invasive and effective solution for managing PCC post-TKR, with significant improvements in both surgical alignment metrics and patient-reported outcomes. Although PCC is uncommon, it can substantially affect postoperative satisfaction, and its successful management requires individualized consideration of biomechanical and patient-specific factors. Further prospective studies are warranted to validate long-term outcomes and identify predictors of recurrence.

ABBREVIATIONS:

TKR – Total Knee Replacement

PCC – Patellar Crepitus and Clunk Syndrome

TKA – Total Knee Arthroplasty

KSS – Knee Society Score

WOMAC – Western Ontario and McMaster Universities Osteoarthritis Index

PS – Posterior-Stabilized

CR – Cruciate-Retaining

PCOR – Posterior Condylar Offset Ratio

SPSS – Statistical Package for the Social Sciences

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