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Original Research

The Effect of Periprosthetic Fractures Following Total Hip and Knee Arthroplasty on Long-Term Functional Outcomes and Quality of Life

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ABSTRACT

Background: Periprosthetic fractures (PPFs) after total joint arthroplasty (TJA) can be devastating, yet their long-term impact has not been well described. The aim of this study is to compare the long-term outcomes of patients who sustained a PPF about a TJA with those of patients who underwent an uncomplicated TJA.

Methods: Patients who sustained a PPF after primary TJA between 2005 and 2014 were identified. Seventeen patients with a minimum 2-year follow-up (PPF cohort) were compared to a matched cohort of 67 patients who underwent uncomplicated TJA. Demographic data, comorbidities, surgical details, and complications were analyzed. Quality of life and functional outcomes were assessed with 12-Item Short Form Health Survey (SF-12), Western Ontario and McMasdter Universities Arthritis Index (WOMAC), and Knee Society Function Score.

Results: The overall complication rate was 41.2% in the PPF group, including 3 additional fractures (17.6%), 2 wound infections (11.8%), one prosthetic joint infection (5.8%), and one painful patellar hardware necessitating removal (5.8%). At 2 years, both physical and mental components of the SF-12 were significantly lower for the PPF cohort vs control (SF-12-P, 28.7 ± 4.4 vs 40.8 ± 10.3, $P < .001$, SF-12-M, 36.7 ± 5.07 vs 55.0 ± 8.19, $P < .0001$). WOMAC pain and function scores were also significantly worse in the PPF cohort vs control at 2 years (WOMAC-pain, 38.8 ± 29.9 vs 87.4 ± 22.1; $P < .0001$, WOMAC-function, 40.7 ± 8.7 vs 76.1 ± 20.3; $P < .0001$). At 2 years, score improvements from prearthroplasty baseline were significantly greater in the control cohort vs PPF for SF-12-physical, WOMAC-pain, and WOMAC-function.

Conclusions: Patients who sustained PPFs following TJA have poor long-term outcomes despite appropriate treatment. These results can help counsel patients and encourage heightened efforts to minimize the risk of PPF.

Level of Evidence: Level III.

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Introduction

Periprosthetic fractures (PPFs) are serious complications of total hip arthroplasty (THA) and total knee arthroplasty (TKA) [1]. PPFs can occur intraoperatively or postoperatively as an early or late complication, frequently from a mechanical fall [2]. Rarely, PPFs can be treated conservatively with casting and maintaining nonweight bearing. More commonly, they require surgical treatment with open reduction and internal fixation or revision arthroplasty [3,4].

After THA, the predominant PPF typically occurs around the femoral component, with rare occurrences of fractures about the acetabulum. Femoral fractures around THAs are classified using the Vancouver classification [1] and occur in about 1% of primary cases and 7.8% of revision cases [5]. In TKA, 2.8% of all primary cases require revision for a PPF [6]. The most common type of PPF following a TKA is a supracondylar femur fracture, followed by tibia, and then patella fractures, with an overall incidence of 0.3%-2.5% [7,8]. Similar to hips, treatment is guided by the implant fixation. If the implant is loose, then it generally must be revised for a patient who would like to maintain their ambulation potential [9].

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With longer life expectancy and better implant survivorship, there has been a rise in the incidence of PPF [9]. These fractures can be particularly challenging, depending on the severity of the fracture, and should be treated by experienced surgeons [10-12]. Poor bone stock in an aging population with multiple medical comorbidities makes this patient population even more challenging.

PPF after either THA or TKA can lead to a decreased quality of life [3,4]. There have been numerous studies examining mortality and survivorship of revision arthroplasties following PPFs, with little to no literature on patient-reported outcomes following treatment of PPFs [13-17]. The aim of this study was to compare the functional long-term outcomes of patients who sustained postoperative PPFs about a total joint replacement with a matched cohort of patients who underwent uncomplicated THA and TKA. We hypothesized that patients treated for PPFs do poorly and do not fully recover in terms of functional outcomes and quality of life.

Material and methods

This retrospective case-control study was done after obtaining approval from the institutional review board. We examined all total joint replacements performed by 2 arthroplasty surgeons from January 1, 2005, to December 31, 2014. We included all patients who subsequently sustained a PPF around a total hip or knee arthroplasty by using International Classification of Diseases-9 code 996.44 (54 patients). Exclusion criteria included a diagnosis of concurrent infection (4 patients), PPF about a revision arthroplasty (5 patients), primary surgery other than total joint arthroplasty (TJA) (5 patients), incorrect coding for PPF (1 patient), incomplete data (2 patients), and less than 2 years of follow-up (20 patients). The ultimate study group of PPFs (PPF group) comprised 17 patients with a minimum follow-up of 2 years. The overall incidence of PPFs about primary TJA was calculated by dividing the number of PPFs about primary TJA, which was obtained via the above methods, by the total number of primary TJAs during the study period, which was obtained via surgeon registries.

We also identified a list of demographically similar THA and TKA to create a matched cohort of 67 patients (control group) using a 3:1 matching strategy. The groups were matched for age, gender, body mass index, the American Society of Anesthesiologists (ASA) grade, original surgery, preoperative 12-Item Short Form Health Survey (SF-12) physical/mental scores, preoperative Western Ontario and McMaster Universities Arthritis Index (WOMAC) (pain, stiffness, and function), and preoperative Knee Society Function Score (KSFS), Table 1.

Table 1
Patient demographics and clinical characteristics of the 2 groups.

Variable	PF group mean ± SD n = 17	Control group mean ± SD n = 67	*P* value
Age	71.0 ± 11.5	71.0 ± 11.0	.98
Gender (%)			.32
F	13 (76%)	43 (64%)	
M	4 (24%)	24 (36%)	
BMI kg/m^2	27.7 ± 4.3	28.7 ± 4.3	.43
ASA	2.7 ± 0.70	2.4 ± 0.55	.066
Original surgery			.41
TKA	6 (35%)	16 (24%)	
THA	11 (65%)	51 (76%)	
SF-12			
P	27.1 ± 5.029	29.5 ± 7.2	.33
M	43.9 ± 11.4	51.2 ± 11.6	.08
WOMAC			
Pain	33.3 ± 23.1	42.8 ± 21.5	.23
Stiffness	20.833	45.0 ± 23.8	.09
Function	40.6 ± 17.2	43.9 ± 22.1	.65
KSFS[a]	50.0 ± 21.75	58.2 ± 21.7	.62

BMI, body mass index.
[a] Used only in the setting of TKA.

The quality of life and functional status were assessed by SF-12 physical/mental scores, KSFS scores, and WOMAC index (pain, stiffness, and function). We recorded epidemiological data (age, gender, body mass index, ASA grade, original surgery, length of hospital stay, discharge location, comorbidities, and mechanism of injury), details of surgery (type of treatment, implant used, type of fracture, anesthesia type, and revision arthroplasty), and postoperative events (infection, refractures, nonunion, hardware failure, and number of reoperations). For knee PPFs (6 patients), function was assessed by the KSFS. The quality of life was assessed by SF-12 physical and mental scores and the WOMAC index (pain, stiffness, and function). For hip PPFs (11 patients) the quality of life was assessed by SF-12, and the functional outcome was assessed by the WOMAC index. The patient comorbidities were represented by the ASA score. Patient-reported outcomes (SF-12, WOMAC index, and KSFS scores) were obtained from our institutional review board-approved institutional joint registry, which collects data preoperatively and then prospectively at 3 months, 1 year, and annually after that. All included patients had a minimum of 2 years of follow-up.

Fractures around a femoral stem in THA were classified according to the Vancouver classification [1]. The femoral fractures around a TKA were classified according to the Lewis and Rorabeck classification [18]. Fractures of the tibial plateau were classified according to the Felix classification [19]. Patella fractures were classified according to the Goldberg classification [20]. A detailed history was obtained from patients to assess for pain, infection, and symptoms of loosening prior to fracture. Treatment philosophy for the PPFs was based on the type of fractures and an assessment of implant stability (Table 2). In general, stable implants were treated with open reduction and internal fixation, and loose implants were revised.

Descriptive statistics included mean, standard deviation, and range for continuous variables. Student's *t*-tests were used for comparing quantitative measures, and chi-square tests were used for comparing categorical measures. The assumption of normality and homogeneity of variance was tested using the Shapiro-Wilk test. $P < .05$ indicated statistical significance for all the tests used. All the analysis was conducted using SPSS (Version 24.0, IBM, Chicago, IL) for windows.

Results

Mean follow-up was 2.1 ± 0.5 years for the study group undergoing PPF treatment and 2.4 ± 0.9 years for the control group. There were no statistically significant differences in baseline demographics and clinical characteristics between the 2 groups (Table 1). One index THA was performed using a direct anterior

Table 2
Types of fractures in the TKA group and the types of strategies for the management.

TKA	Femur	Patella
Osteosynthesis	2	2
Revision	2	0
Combined	0	0

THA	Vancouver B1	Vancouver B2	Acetabulum
Osteosynthesis	2	0	0
Revision	0	1	3
Combined	0	5	0

Also showing treatment strategies according to Vancouver classification in THA patients.

Table 3
Quality of life and functional outcomes comparison between the 2 groups at 2-y follow-up.

Variable	PF group mean ± SD n = 17	Control group mean ± SD n = 67	*P* value
SF-12			
P	28.7 ± 4.4	40.8 ± 10.3	<.0001
M	36.7 ± 5.1	55.0 ± 8.2	<.0001
WOMAC			
Pain	38.8 ± 29.9	87.4 ± 22.1	<.0001
Stiffness	46.1 ± 21.0	65.5 ± 27.9	.065
Function	40.7 ± 8.7	76.1 ± 20.3	<.0001
KSFS	29.3 ± 16.8	65.5 ± 33.6	.06
Change SF-12			
P	1.6 ± 7.2	9.9 ± 10.3	.034
M	−1.6 ± 13.1	2.3 ± 11.4	.39
Change WOMAC			
Pain	3.3 ± 52.7	48.0 ± 24.9	.005
Stiffness	4.6 ± 18.5	27.1 ± 28.5	.078
Function	2.0 ± 21.4	31.0 ± 25.9	.018
Change KSFS	−22 ± 31.8	7.0 ± 21.6	.12

approach. The remainder were performed using a posterior approach.

The overall incidence of PPF during the study period was 1.5%. Average time to fracture was 2.5 ± 5.7 years. Two patients sustained the fractures in the hospital within the same hospitalization after their index surgery. The mechanism of injury was a low-energy fall in 10 patients (59%) and low-energy trauma in 7 patients (41%). Of the PPF group, 6 (33.3%) occurred around a TKA with 4 fractures of the distal femur and 2 of the patella. The 4 distal femur fractures were Lewis and Rorabeck type II fractures [18]. The 2 patella fractures were Goldberg type I fractures [20]. 11 (64.7%) fractures were around a THA, with 8 femoral fractures and 3 acetabulum fractures. There were 2 Vancouver type B1 fractures and 6 Vancouver type B2 fractures (Table 2).

Revision arthroplasty was performed in 6 patients (35%), osteosynthesis was performed in 6 patients (35%), and combined revision with osteosynthesis was performed in 5 patients (29%). Six (35%) patients were discharged home after their PPF surgery, and 11 (65%) were discharged to postacute care facilities (PACFs). The average number of comorbidities was 2.4 ± 1.6 in the PPF group and 1.96 ± 36 in the control group ($P = .32$). Spinal anesthesia was used in 4 patients, combined spinal and epidural anesthesia in 3 patients, epidural anesthesia in 1 patient, general anesthesia in 5 patients, and regional anesthesia in 3 patients. One patella fracture was managed nonsurgically in a brace.

The overall complication rate was 41.2% in the PPF group. These complications included 3 refractures (2 of which were treated with re-revision surgery), 2 wound infections (one of which required incision and debridement with gastrocnemius flap), one prosthetic joint infection (which required 2-stage revision), and one painful patellar hardware (which was treated with removal of hardware). The average time to fracture union was 9.1 ± 4.5 months in the PPF group.

Quality of life and functional outcome assessment

At 2-years after treatment of a PPF, both physical and mental components of the SF-12 were significantly lower for the PFF group when compared to the control group (SF-12 P, 28.7 ± 4.4 vs 40.8 ± 10.3, SF-12 M, 36.7 ± 5.1 vs 55.0 ± 8.19, $P < .0001$). (Table 3, Fig. 1) WOMAC pain and function scores also demonstrated significantly poor outcomes in the PFF group in comparison to the control group at 2-year follow-up (WOMAC-pain, 38.8 ± 29.9 vs 87.4 ± 22.1; $P < .0001$, WOMAC-function, 40.7 ± 8.7 vs 76.1 ± 20.3; $P < .0001$). (Table 3, Fig. 1) The difference in KSFS scores between the PFF group and control groups approached significance at 2 years (29.3 ± 16.8 vs 65.5 ± 33.6, $P = .06$). (Table 3, Fig. 1) Improvement in scores from prearthroplasty baseline were significantly greater in the control group in comparison to the PPF group at 2 years for SF-12 P, WOMAC pain, and WOMAC function ($P < .05$). (Table 3, Fig. 2) Those who sustained PPF more than 90 days postoperatively had inferior 2-year SF-12 M scores relative to those who sustained PPF within the 90-day postoperative period (37.3 ± 3.04 vs 43.4 ± 5.01, $P = .047$). Other patient-reported outcomes did not significantly differ based on the time of PPF after index surgery.

Discussion

In this study, we found that the patient-reported outcomes, as reflected in the WOMAC index (pain, stiffness, and function) and SF-12 (physical and mental), were significantly worse in the PPF group at 2 years following fracture treatment. There are many studies in the literature that have examined outcomes after surgical

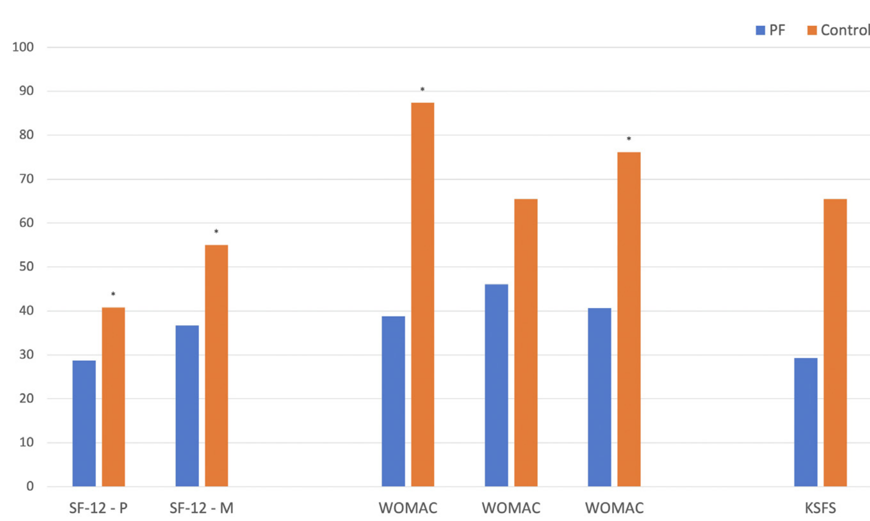

Figure 1. Quality of life and functional outcomes comparison between the 2 groups at 2-year follow-up. KSFS is used only in the setting of TKA. *Significant difference.

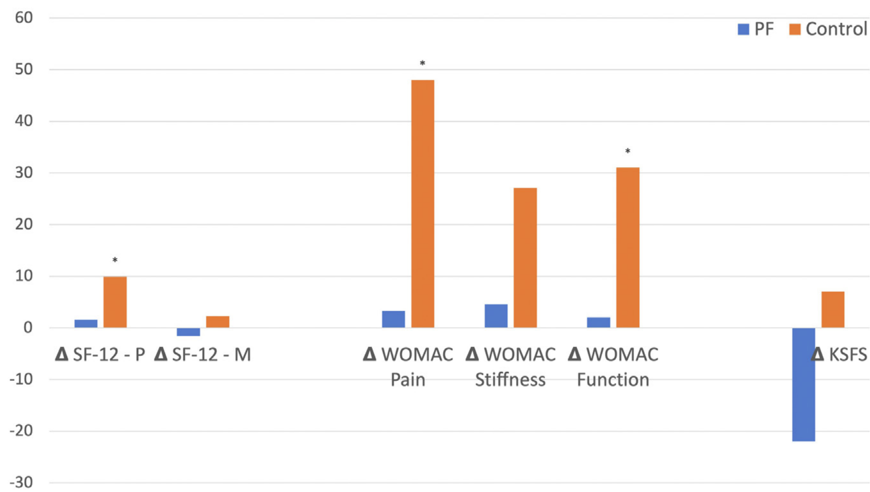

Figure 2. Change in quality of life and functional outcomes between the 2 groups at 2-year follow-up from preoperative baseline. KSFS is used only in the setting of TKA. *Significant difference.

treatment of periprosthetic hip and knee fractures [7,12,21-27]. However, these studies mainly focused on the type of surgery performed, type of fractures, complications, and mortality. Functional outcomes, if mentioned, were reported by knee society scores, knee range of motion, and Hospital for Special Surgery or Oxford hip scores for hips. Few reports have focused on functional outcome Knee Society Score and quality of life for periprosthetic (SF-12 and WOMAC) fractures following TKA [28]. Similarly, for PPFs following total hip replacement, there is scant literature focusing on outcomes using the WOMAC index and SF-12 scores for assessing quality of life and functional outcomes, respectively [29].

In order to highlight the distinction between our study group and control group, we compared the study cohort to a control cohort of our own demographically similar patients, who had no complications following TKA and THA. Our findings demonstrate that functional outcomes and quality of life in patients following PPFs were significantly decreased when compared to the control group, as demonstrated by the change in the patient-reported outcome measures. This can aid the surgeon in counseling patients about the long-term outcomes following treatment for a PPF.

We confirm similar findings reported by Mardian et al. [28,29] for the SF-12 and WOMAC index for quality of life. They found that PPFs following hip and knee arthroplasty are accompanied by a significant decrease in quality of life as well as high complication rates. Our study builds on theirs by including a control group for comparison, including a minimum of 2 years of follow-up, and including revision TKA patients in our PPF group.

The complication of infection with PPF was high in our study group (7 of 17, 41.2%). The reported coincidence of infection with PPF ranges from 9%-26% [25,27,30-34], thus some of these may have been missed infections present at the time of fracture presentation. Combined with the infections excluded from our group, we report an overall coincident infection rate of 10.4% (5 of 48) with PPFs. This underscores the importance of a complete diagnostic workup for infection when faced with a PPF [35,36].

Limitations of our study include its retrospective nature. Prospective studies with longer-term follow-up would be needed to confirm and strengthen our study; however, the inherently low incidence of PPFs makes this less feasible. Furthermore, the sample size is small for our PPF group (17 patients). However, the sample size was large enough to reach statistical significance. Though predictable, the loss of patients to follow-up and the bias that this may induce are worth acknowledging. As noted, patients with less than 2 years of follow-up were excluded from the study.

Conclusions

Our study showed that PPFs following TKA and THA result in significant deterioration of quality of life. Secondarily, we were also able to demonstrate a high complication rate compared to a negligible rate in our matched cohort of uncomplicated TKA and THA patients. PPFs are very severe complications that predispose to further complications, especially in the older population. Future efforts should be directed toward improved implants and improved fixation techniques, with a focus on preventing injury after the index hip or knee reconstruction.

Conflicts of interest

H. J. Cooper is a 3M speaker; is a paid consultant for 3M, Canary, DePuy, Zimmer-Biomet, and Polaris; has stock options in Polaris; receives research support from Smith and Nephew; is an editorial board member of the Journal of Bone and Joint Surgery; and is a board/committee member of AAOS and the Eastern Orthopaedic Association. J. A. Geller is a Smith & Nephew speaker and receives royalties from them; is a paid consultant for Nimble Health and Smith & Nephew; has stock options in Zimmer; receives research support from Orthopaedic Scientific Research Foundation, Ortho-Sensor, and Smith & Nephew; and is an editorial board member of Clinical Orthopaedics and Related Research, Journal of Arthroplasty, and Journal of Bone and Joint Surgery. R. P. Shah is a paid consultant for Link Orthopaedics, Monogram, and Zimmer; is an unpaid consultant for OnPoint; has stock options in Parvizi Surgical Innovations; and is a board/committee member of the American Association of Hip and Knee Surgeons and the U.S. Food and Drug Administration. All other authors declare no potential conflicts of interest.

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CRediT authorship contribution statement

Andrew Luzzi: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Akshay Lakra:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis. **Taylor Murtaugh:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis. **Roshan P. Shah:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Conceptualization. **H. John Cooper:** Writing – review & editing, Project administration, Methodology, Investigation. **Jeffrey A. Geller:** Writing – review & editing, Project administration, Methodology, Investigation.

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