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*ORIGINAL STUDY*

# Outcomes of distal femoral arthroplasty after periprosthetic fractures : minimum 2-year follow- up

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***Purpose*** **: distal femoral periprosthetic fracture (DFPPF) is a serious complication following total knee arthroplasty (TKA). Recently, treatment of DFPPF with distal femoral arthroplasty (DFA) has gained popularity because of its posited benefits for both patients and the medical system. Short-term follow-up trials investigating DFA have demonstrated acceptable results with regards to function, pain relief and lower postoperative complications than ORIF in elderly patients. The purpose of the current study was to evaluate a consecutive series of DFPPF treated with DFA, with a minimum 2- year follow-up.**

***Methods*** **: We performed a retrospective study assessing the outcomes of distal femoral arthroplasty (DFA) for patients diagnosed with DFPPF.**

***Results*** **: Twenty patients were identified. The mean age of patients was 76.3 (SD, 9.41), the average time from the fracture to revision surgery was 6.7 days (SD, 11.35), The average operative time was 93.5 minutes (SD,16.6). The average follow-up time was 50.15 months (SD, 20.87). During this time, two patients (10%) had complications. One patient experienced a knee dislocation and the second patient had recurrent periprosthetic infections. At final follow up, the mean knee society score was 86.25 (SD, 9.44), the mean Forgotten joint score was 62.16(SD, 23.45) and 93.7 percent of patients were ambulatory.**

***Conclusion*** **: DFA following DFPPF is associated with high success rates and provides patients with the opportunity for return of function in a safe and reliable manner.**

**Keywords** : revision total knee arthroplasty ; distal femoral arthroplasty ; periprosthetic fracture.

## INTRODUCTION

The number of primary total knee arthroplasty (TKA) surgeries performed in the United-States is projected to increase considerably in the coming decades *(1)*. Consequently, the number of complications after TKA requiring revision surgery will inevitably rise *(2)*. One of the most serious complications following TKA is periprosthetic fractures (PPF). This frequently involves the femoral metaphysis, proximal to or at the level of the femoral flange. The reported incidence of distal femoral periprosthetic fractures (DFPPF) is 0.3% to 2.5% after primary TKA, and 1.6% to 38% after revision TKA *(3,4)*.

The patient population most often affected by this complication is elderly women and often results from a fall from standing height combined with an axial and/or torsional force *(5,6)* . Goals of care for

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patients with DFPPF include achieving a pain-free stable knee that allows for early ambulation, and restoration of limb length, alignment and rotation of the limb, and return to previous level of function. Current data suggests that the overall goals and outcomes of PPF patients is akin to that of hip fracture population *(7,8)*. Therefore, our overall goals of management (including time to surgery and the goal of early weight-bearing and unrestricted mobilization) should follow the same urgency and multidisciplinary teams with which we manage hip fractures. Specifically, early weight-bearing and mobilization should be emphasized. Current estimates of overall mortality in patients sustaining a DFF (both with and without an implant in place) have been shown to be as high as 6% at 30 days, 18% at 6 months, and 25% at 1 year post-injury *(7)*.

Historically, indications for DFA in the setting of fracture included very distal and/or comminuted DFPPFs, questionable bone stock and/or loose implants following injury, lower-demand patients, absence of ligamentous instability (pre- or post-fracture), and previous uncorrectable deformity not amenable to open reduction internal fixation (ORIF) *(9)*. Recently, treatment of DFPPF with distal femoral arthroplasty (DFA) has gained popularity because of its posited benefits for both patients and the medical system. Benefits of DFA over ORIF include a lack of dependence on metaphyseal bone stock or stability of the knee, and no requirements for plate contouring *(10)*. Furthermore, contrary to many fixation techniques such as nailing or plating, patients can be rapidly mobilized and weight-bear immediately after surgery. Lastly, as this mode of treatment does not rely on bone healing, it inherently avoids the risk of fracture malunion or nonunion. While DFA prostheses may present higher implant costs, more recent evidence suggests that the quicker recovery of preoperative mobility status, earlier postoperative rehabilitation, faster time to discharge, and decreased risk of complications or revision may balance out the costs of the procedure as a whole *(6,11)*.

Short-term follow-up trials investigating DFA have demonstrated acceptable results with regards to function, pain relief and lower postoperative complications than ORIF in elderly patients *(6)* and include open reduction and internal fixation (ORIF. Additionally, a recent study has shown that at one year follow-up, patients treated with DFA were four times more likely to be ambulatory than patients treated with traditional fixation techniques *(12)*.

The purpose of the current study was to evaluate the results of a consecutive series of DFPPFs treated with DFA with a minimum follow-up of 2 years.

## METHODS

After institutional Research Ethics Board approval was obtained, a search of our prospectively collected arthroplasty database was performed between July 2011 and January 2017. Patients diagnosed with DFPPF and treated with DFA, and patients with DFPPF that were previously treated with ORIF and developed a nonunion of the fracture were identified. Exclusion criteria were any DFAs performed for the management of periprosthetic fractures after sustaining a pathological fracture, or fractures in the absence of a TKA prosthesis.

Data was gathered from the patients' electronic medical records and included gender, age, American Society of Anesthesiologists score (ASA), date of primary arthroplasty, time from primary arthroplasty to fracture, time from fracture to revision surgery with DFA and date of revision surgery. At the time of revision surgery, components utilized and details regarding soft tissue releases were recorded. All patients were followed during routine postoperative visits at 3 weeks, 6 weeks, 3 months, 6 months, 1 year and annually thereafter. Complications and reoperation rates were recorded for each patient where applicable. Preoperative and postoperative radiographs including long leg standing films, knee anteroposterior (AP) and lateral views were routinely obtained during follow-up visits to evaluate for limb alignment, dislocation, loosening, and refracture. In addition, range of motion was documented in all patients by an advanced practice physiotherapist using a standard goniometer. At final follow up, we collected patient Knee Society Scores (KSS) *(13)* and Forgotten Joint Scores (FJS) *(14)*.

Statistical analysis was performed with SPSS software, version 25 (IBM, Armonk, NY). Con-

Table 1.

| | | |
|---|---|---|
| Age at surgery, Mean (SD) | | 76.3(9.4) |
| Gender, n (%) | Male | 2 (10) |
| | Female | 18 (90) |
| Body mass index (m/kg$^2$)* | | 30.97 |
| ASA score n (%) ** | 2 | 6 |
| | 3 | 7 |
| Laterality, n (%) | Right | 10(50) |
| | Left | 10 (50) |
| Etiology, n (%) | Peri prosthetic fracture | 18(90) |
| | Post ORIF non- union | 2(10) |
| Number of previous surgeries, n (%)*** | 1 | 7 (33.3) |
| | 2 | 10 (47.6) |
| Time from primary TKA to fracture, months, Mean (SD) | | 127.8 (92.7) |
| Time from fracture to revision surgery, days, Mean (SD) | | 6.71 (2.26) |

tinuous variables were presented as means with associated standard deviations (SD). Categorical variables were presented as absolute and relative frequencies. Information regarding missing data was stated below each table.

## RESULTS

Over the study period, 33 patients (28 females and 5 males) were treated for DFPPF by the senior author with DFA (Zimmer Segmental, Warsaw, IN). Three patients died during the study period from natural causes, unrelated to the surgery. Four patients fulfilled only 1 year of follow up and were excluded from the study and 6 patients were lost to follow up. A total of 20 patients were identified, two of which were cases having failed previous open reduction internal fixation following a DFPPF.

After excluding patients who were deceased or were unable to present for subsequent follow up, a total of 18 females and 2 males remained. The mean age of patients at the time of revision surgery was 76.3 (SD, 9.41 ; range, 54-87) years. Other demographic characteristics are described in table 1. The average time from primary arthroplasty to the fracture was 127.8 months (SD, 92.72 ; range, 2-270) and the average time from the fracture to revision surgery was 6.7 days (SD, 11.35 ; range, 2-11) for patients treated initially with DFA for DFPPF. Most of the patients sustained a type B3 fracture based on the Unified Classification System *(15)*. The average

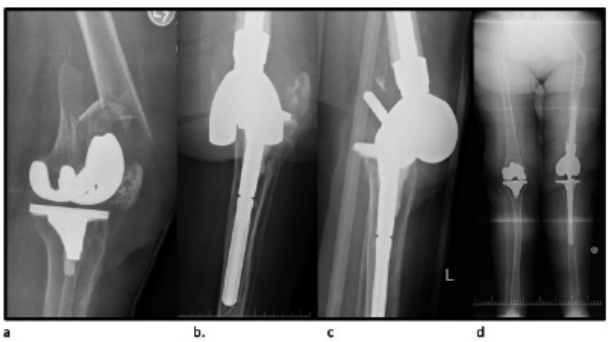


***Figure 1.*** — From Left to Right : 80 y/o male with a distal femoral periprosthetic fracture (a) was treated with distal femoral arthroplasty, and experienced a knee dislocation 2 weeks after revision surgery (b,c). Long leg standing film 72 months after revision surgery (d).

operative time was 93.5 minutes (SD,16.6 ; range, 70-130). Two patients were admitted to ICU unit post-operatively. The average hospital stay was 5.2 days (SD, 2.48 ; range, 2-14), with 19 patients (90.5 %) requiring transfer to a rehabilitation facility upon discharge. The average follow-up time was 50.15 months (SD, 20.87 ; range, 24-90). Two patients (10%) had complications following revision surgery. One patient experienced a knee dislocation due to a manufacturing problem of the hinge locking system (figure 1) and subsequently had a peri prosthetic infection treated with single-stage revision. The second patient had recurrent periprosthetic infections that eventually led to an above knee amputation. The two patients who

Table 2.

| | | |
|---|---|---|
| Classification | | |
| Unified (Number, %) | | |
| b1 | 2 | 10 |
| b2 | 5 | 25 |
| b3 | 13 | 65 |
| OR time, minutes (SD) | | 93.5 (16.6) |
| Total hospital stay, days, Mean (SD) | | 5.2 (2.5) |
| ICU, n | | 2 (9.5) |
| Rehab | | 19 (90.5) |
| Complication, n (%) | | 2 (9.5) |
| Revision Needed, n (%) | | 2 (9.5) |
| Follow up time, months, Mean (SD) | | 50.15(20.9) |
| Flexion, degrees, Mean (SD) | | 104.87(14.9) |
| Extension, degrees, Mean (SD) | | 2.81 (5.15) |
| Ambulatory aid | No aid | 7 (35) |
| | cane | 5(25) |
| | walker | 5(25) |
| | rolator | 2 (10) |
| | wheelchair | 1(5) |
| KSS score, Mean (SD) | | 86.25, (9.4) |
| Forgotten KS, Mean (SD) | | 62.16, (23.46) |
| Final knee alignment | neutral | 17(85) |
| | varus | 3 (15) |

were previously treated with ORIF and developed a nonunion did not sustain any complication.

At final follow up, the mean knee society score for the patient cohort was 86.25 (SD, 9.44 ; range, 30- 70) and the mean FJS was 62.16 (SD, 23.45 ; range, 30.5-95.4). The mean range of motion was 1.88 (SD, 4.03 ; range, 0-15) degrees of extension and 104.87(SD, 14.9 ; range, 80-125) degrees of flexion. Lastly, 93.7 percent of patients who took part in the study and 75 % (3 out of 4) who had follow-up limited to one year after surgery were ambulatory at the time of final follow up, and three did not require any form of ambulatory aids (table 2).

## DISCUSSION

Distal femoral periprosthetic fractures (DFPPFs) pose a significant threat to the ongoing health and function of the elderly 'at risk' population. The main goals of treatment for DFPPFs is return of function, allowing for pain-free, stable weight-bearing and ambulation through the affected limb. Distal femoral arthroplasty (DFA) provides patients with the opportunity for return of function in a safe and reliable manner. In this study, most patients were ambulatory at the time of final assessment with several patients not requiring the use of any ambulatory aids. Furthermore, patients demonstrated good range of motion at a minimum two-year follow-up. On average, patients achieved near full extension (1.88 degrees) and greater than 100 degrees of flexion. Lastly, contrary to previously held beliefs, the complication rate demonstrated in this cohort (10%) is much lower than that previously cited in the literature. In a study looking at functional outcomes following the use of a modular rotating-hinge distal-femoral replacement, Jassim et al. *(5)* found that mean maximum flexion at final follow-up was 87.5° (range 50-110°, mean follow-up 33 months). Furthermore, all patients were able to achieve full weightbearing immediately postoperatively, with only two of the total 11 patients requiring increased support for mobility *(5)*.

Early weight bearing offers surgeons the ability to provide improved care and avoid the repercussions

associated with weight-bearing restriction in the generally elderly and frail patient population generally affected by DFPPF. For instance, previous studies have quoted an average of 4.5 +/- 2.7 months for patients to achieve full weight-bearing postoperatively when ORIF was the choice of management for periprosthetic fractures around the knee *(16)*.

The complication rate in the current study population is nearly half of that cited for previous studies. For instance, Mortazavi et al. *(17)* fracture comminution, and loose or damaged components. Revision total knee arthroplasty with distal femoral arthroplasty is often necessary in these injuries. We reviewed 20 patients (22 knees reported a complication rate of nearly half in patients treated with DFA and concluded that the DFA should only be considered as a 'salvage' type procedure in the setting of severe bone loss. On the other hand, Berend et al. observed an overall low complication rate of 18%. The authors, however, assessed all-comers treated with DFA for non-tumour indications and did not restrict their study population to DFPPF *(9)*. In a more recent study published in 2016, Bettin et al *(18)* assessed eighteen elderly patients (average age 77 years) undergoing cemented modular DFA for the treatment of distal femur fractures in native knees. They noted a complication rate similar to the present study of only 11%. Overall, the longer-term (>2 year) complication rate for DFA in the setting of DFPPF may be lower than previously reported, as suggested by our study and multiple other similarly powered studies.

One of the concerns of using a DFA in the setting of DFPPF is the concern for aseptic loosening of the components. In the present study, no patients demonstrated radiographic or clinical signs for loosening at final follow-up. This was also replicated by a previous study, up to just under 3 years postoperatively *(5)*. In contrary, Berend et al. quoted an overall aseptic loosening rate of 12.5% at up to 5 years *(9)*.

A second critique of the use of DFA in the treatment of DFPP is the concern that this procedure may be longer and more technically challenging than ORIF. In the present study, the mean operative time was 93.5 minutes, 47 minutes shorter than reported by Jassim et al. *(5)* and therefore can explain their higher complication rate.

There are several limitations to the current study. Firstly, the study is retrospective in nature which has the potential to bias the findings. Second, the patient population, while similar to the demographics in previous studies in the literature (i.e. elderly female patients with poor bone stock), limits the generalizability of the success of DFA for younger patients, or those with or appropriately bone stock. Additionally, the minimum follow-up was 2 years (mean follow-up : 50.15 months) which is probably too short to evaluate early aseptic loosening as described previously by Berend et al. *(9)*. Lastly, we included two patients treated with DFA after failed ORIF resulting in non-union. We acknowledge the possibility that this could have affected our results, however, no post-operative complications were observed in these patients. Furthermore, we propose that future research into the outcomes of patients converted from fracture ORIF to DFA would be of benefit to the orthopaedic community.

In summary, this study represents the first cohort of DFPPF patients with a minimum 2-year follow- up. The study demonstrates that DFA is an appropriate choice of management for the elderly fracture population. The benefits of management with DFA include early weightbearing, near-full return of functional range of motion, and lower complication rates. Furthermore, contrary to historic belief that the DFA should be reserved for sedentary or frail patients, our data provides further impetus for surgeons to consider revision arthroplasty for the treatment of DFPPF as this may allow for earlier and safer return to pre-fracture function.

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