Distal Femoral Arthroplasty for the Treatment of Periprosthetic Fractures After Total Knee Arthroplasty

S.M. Javad Mortazavi, MD, Mark F. Kurd, MD, Benjamin Bender, MD, Zachary Post, MD, Javad Parvizi, MD, FRCS, and James J. Purtill, MD

Abstract: Periprosthetic fractures after total knee arthroplasty present substantial challenge if associated with poor bone stock, 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) with a mean age of 69.5 years who underwent revision with distal femoral arthroplasty fracture. Patients were followed for an average of 58.6 months. At the latest follow-up, the mean Knee Society knee and functional score were 82.8 and 40, and the Short Form 36 mean physical functioning and mental functioning scores were 55.8 and 65.6, respectively. There were 10 postoperative complications with 5 patients requiring additional surgery. Distal femoral arthroplasty seems to be a viable option for complex periprosthetic femoral fractures after total knee arthroplasty. However, considering the relatively high rate of complications, this procedure should be reserved for patients where alternative treatments are not possible. Keywords: femoral periprosthetic fracture, total knee arthroplasty, distal femoral arthroplasty.
Materials and Methods

After obtaining institutional review board approval, our computerized institutional database was used to identify all patients who underwent treatment for PPF after TKA between 1997 and 2006. From this cohort, patients who underwent a DFA for the treatment of a PPF were identified. The medical records of these patients were reviewed in detail. All relevant demographic information, surgical data, and functional outcome parameters (using the Short Form 36 [SF-36] and the Knee Society Scores [KSS]) were gathered. Physician examinations, operative reports, discharge summaries, radiographs, and telephone interviews were reviewed.

Demographics

During this period, 62 patients (67 knees) underwent treatment for PPF of the distal femur after TKA. Three patients (3 knees) were treated nonoperatively. Nine patients (12 knees) underwent open reduction internal fixation with plate and screws. Twenty patients (20 knees) underwent internal fixation with an intramedullary rod. Ten patients (10 knees) underwent revision TKA with standard implants. Twenty patients (22 knees) underwent revision TKA with DFA for PPF. There were 17 women and 3 men with a mean age of 69.5 years (range, 54-81 years) at the time of index operation. The average body mass index in this cohort was 31.6 kg/m² (range, 19.1-41.9 kg/m²). Medical comorbidities in these patients included hypertension (16 patients), obesity (8 patients), morbid obesity (2 patients), diabetes (5 patients), rheumatoid arthritis (2 patients), ischemic heart disease (4 patients), atrial fibrillation (2 patients), hypothyroidism (2 patients), gastroesophageal reflux disease (1 patient), malignancy (1 patient), Parkinson disease (1 patient), and asthma (1 patient). Fifteen patients had undergone TKA in the contralateral knee, 1 patient had total hip arthroplasty (THA) in the ipsilateral hip, and 2 patients had THA in the contralateral hip (Table 1).

Fracture Management

The diagnosis before the initial TKA was osteoarthritis in 18 patients (19 knees) and rheumatoid arthritis in 2 patients (3 knees). Periprosthetic fracture was caused by a fall in 15 patients (17 knees), twisting in 1 patient, and a motor vehicle accident (MVA) in 2 patients. Two patients presented with increasing pain in their knee without a history of trauma. In view of World Health Organization definition, 18 fractures fulfilled the criteria for fragility fracture and osteoporosis [20].

The fractures occurred at a mean of 79.7 months (range, 1-300 months) after the initial procedure. Six fractures occurred in 5 patients during the first 3 months after surgery.

Table 1. Patients’ Data

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Reason for Primary TKA</th>
<th>Side</th>
<th>Cause of Fracture</th>
<th>Interval Between TKA and PPF (Mo)</th>
<th>Knee Society Category</th>
<th>Previous IF</th>
<th>Medical Comorbidities</th>
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<td>48</td>
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<td>Right</td>
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<td>Asthma, hypothyroidism, CAD, GERD, obesity</td>
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<td>HTN, hypothyroidism, GERD, breast cancer, obesity</td>
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<td>Falling</td>
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<td>C</td>
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<td>–</td>
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<td>144</td>
<td>B</td>
<td>No</td>
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</tbody>
</table>

IF indicates internal fixation; F, female; M, male; RA, rheumatoid arthritis; OA, osteoarthritis; HTN, hypertension; VTE, venous thromboembolism; PVD, peripheral vascular disease; CHF, congestive heart failure; PUD, peptic ulcer disease; DM, diabetes mellitus; CAD, coronary artery disease; GERD, gastroesophageal reflux disease; PE, pulmonary embolism; TIA, transient ischemic attack; MI, myocardial infarction.
Preoperative radiographs were reviewed to assess fracture morphology, comminution, fixation status of the components, and bone quality. All fractures were classified according to the classification system proposed by Kim et al [2]. All fractures in our cohort were classified as type III (severely comminuted with inadequate distal bone).

For all patients, this was the first revision TKA procedure. However, in 3 knees, a previous open reduction and internal fixation of the fracture had been performed but led to nonunion. The implants were found to be grossly loose in 6 knees. Severe comminution was seen in 7 fractures. Part of the fracture line was located distal to the upper edge of the component’s anterior flange in 15 knees.

The prostheses used at the time of revision TKA were the Modular Segmental Kinematic rotating hinged knee (13) (Stryker Orthopedics, Mahwah, NJ), Finn rotating hinged knee (5) (Biomet, Warsaw, Ind), Maxim rotating hinged knee (3) (Biomet), and S-ROM modular knee (1) (Johnson & Johnson/Deputy, Warsaw, Ind).

All procedures were performed under tourniquet control through a medial parapatellar approach using the previous incision. The tibial and femoral components were cemented in all patients using antibiotic-impregnated cement containing tobramycin and/or vancomycin. The mean operative time was 121 minutes (range, 75-180).

Outcome Measures
Clinical, functional, and radiographic evaluations of all patients were performed by an orthopedic surgeon. The KSS and the SF-36 were obtained.

Anteroposterior and lateral radiographs were reviewed. Radiolucent lines were reported according to the Knee Society rating system [21]. Radiographic criteria for component loosening included a complete radiolucent line of more than 2 mm in width, visible cement fractures around the component, and a change in the position of component on sequential radiographs.

Results
Two patients (2 knees) were lost to follow-up after 12 months. There were 2 deaths (2 knees) 9 and 12 months after the index operations that were unrelated to the knee surgery. Of the 16 remaining patients (18 knees), 13 were women and 3 were men. Mean follow-up time was 58.6 months (range, 24 - 115). The mean age at the time of last follow-up was 74.1 years (range, 62-86). All patients except 3 had multiple joint involvements in the lower extremities. Using Knee Society categories A, B, or C (A, unilateral knee disease; B, contralateral knee disease; C, multiple system disease), 11 knees were in category C, 8 were in category B, and 3 were in category A.

The premorbid functional state of those 10 patients (11 knees) who had primary procedure at our institution and sustained their fracture more than 3 months after primary TKA was evaluated. The mean premorbid clinical KSS was 71.8 (range, 30-90), and the premorbid functional KSS was 42.7 (range, 0-90). The premorbid functional state of patients who presented to our institute for the first time with fracture could not be determined. In addition, 5 TKA patients fractured in the early postoperative period (first 3 months) had not fully recovered from their operation and were not included in the premorbid evaluation.

The mean clinical KSS at the final assessment was 82.8 points (range, 60-95). The mean functional score was 40 points (range, 0-80). Clinical results were excellent in 11 knees, good in 2 knees, fair in 3 knees, and poor in 2 knees. Functional results were good in 1 patient, fair in 1 patient, and poor in 14 patients.

Overall patient satisfaction was high, with 10 patients very satisfied, 4 somewhat satisfied, and 2 unsatisfied with the surgery. The SF-36 mean physical functioning score was 55.8 points (range, 14-89; SD, 26.7), and the SF-36 mean mental functioning score was 65.6 points (range, 12-88; SD, 25.7).

Radiographic Results
In the 18 knees with more than 2 years of follow-up, 1 patient developed progressive radiolucent lines around the tibial component in zones 1 to 4 in anteroposterior and in zones 1 and 2 in lateral radiographs based on the Knee Society roentgenographic evaluation system that necessitated revision surgery [21]. There were progressive radiolucent lines around the femoral component. No femoral or patellar components were deemed to be loose, and radiographic measurements confirmed that all knees were neutral or within 5° of valgus.

Complications
There were no intraoperative complications. There were 8 complications in 6 patients that were managed non-operatively and 10 postoperative complications in 5 patients requiring additional surgery. One patient experienced intravenous line sepsis. One patient developed an uncomplicated urinary tract infection treated with a short course of antibiotics. One patient had both a symptomatic pulmonary embolism and a peroneal nerve palsy that resolved within 6 months. One patient developed both a pulmonary embolism and atrial fibrillation, which was treated successfully with cardioversion. One patient was noted to have decreased dorsalis pedis and tibialis posterior pulses in the recovery room. The patient received an immediate vascular surgery consult and, subsequently, an emergency arteriogram. No specific intervention was needed, and the pulses returned to normal on the first postoperative day.

The 5 patients who underwent additional surgeries included 1 patient requiring 4 subsequent operations. This patient had persistent wound drainage from a large

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hematoma 1 week after the index procedure. The hematoma was evacuated in the operating room. Four months later, the patient fell sustaining a second PPF above the cemented stem of the femoral component. The fracture was treated with open reduction and internal fixation. Six months later, the patient presented with pain and fracture nonunion. This was managed with hardware removal and placement of another DFA component. This was well tolerated for 3.5 years when the tibial component was found to be loose and was revised.

The second patient presented 3 years postoperatively with a fracture between the proximal end of the DFA component and the distal tip of the femoral component of a THA. This complication was managed with open reduction and internal fixation (ORIF) with plate fixation. Subsequently, the plate fixation failed, and the patient was taken back to the operating room for a second ORIF. At latest follow-up, 1.5 years postoperatively, the fracture had healed. The third patient was operated on 4 years after the index procedure for a subtrochanteric fracture above the cemented stem of the femoral component. The patient underwent open reduction internal fixation of the fracture with a plate and screws. The fourth patient developed a femoral neck and intertrochanteric fracture of the ipsilateral hip 2 months after the index revision knee surgery. This was managed with a THA and cerclage wiring. The fifth patient developed a hematoma 10 days after surgery, which was drained in the operating room. He then presented with a fracture of femoral stem 34 months after the index revision surgery. In this patient, the femoral component was revised using another DFA component (Fig. 1).

The 2 patients who were lost follow-up were complication-free while still under our care at 12 months. The deceased patients were also free of complications during their last follow-up 6 months after surgery. They died 9 and 12 months postoperatively for reasons not related to their knees.

Discussion

Periprosthetic fractures after TKA present a challenging problem for reconstructive orthopedic surgeons, especially in the setting of poor bone stock and loose or malaligned components. These fractures typically involve older patients with associated medical comorbidities who do not tolerate bed rest or weight-bearing restrictions. In addition, these patients are prone to treatment failure secondary to poor healing capacity [22]. When treating these patients, expeditious restoration of a stable limb allows early mobilization, which may minimize the risk of associated medical complications [23]. Although there is no consensus on the ideal treatment for supracondylar PPF, open or closed reduction along with internal fixation is usually the first option. However, this option is not appropriate in the presence of loose femoral component or highly comminuted fracture and poor bone stock. For those patients with loose components and poor distal bone stock, the modern generation of DFA can be a good treatment option. In our series, only one third of knees required to be treated with DFA. There is paucity of published data evaluating the outcome of DFA in patients undergoing revision TKA due to acute PPF. Springer et al [18] studied 26 knees undergoing DFA, 11 of which were performed for nonunion of a PPF and 1 was performed for an acute PPF. In a series reported by Pour et al [19], 4 DFAs were done in patients with PPF. Pradhan et al [24] published the results of 51 knees treated with an Endomodel rotating hinge prosthesis for TKA revision. Only 1 patient was revised for PPF [24]. To our knowledge, the present cohort represents the largest series of patients treated with DFA type prosthesis for a PPF.

The clinical outcome associated with the DFA prosthesis has been evaluated in several studies with variable results. Earlier studies praised the success of the rotating hinged prosthesis in restoring function and alleviating pain [25,26]; however, recent reports have highlighted the major complications that can occur in association with the use of these prostheses [18,19]. In the study by
Pour et al [19] infection and aseptic loosening were the main causes of failure, leading the authors to conclude that severity of bone loss, preexistent comorbidities, and multiple previous surgical procedures were the probable causes of the high complication rate. They further recommended that these prostheses be considered as a salvage device and used primarily for elderly, sedentary patients with complex knee problems [19].

The present cohort of patients sustaining PPF after TKA consisted of older patients with considerable medical comorbidities. The amount and quality of bone stock encountered at the time of revision TKA were poor, often lacking ligamentous integrity. This necessitated the use of a hinged prosthesis. The DFA prosthesis was used to compensate for bone loss, restore limb length and alignment, and provide stability.

According to postoperative clinical knee scores, all patients had pain relief and stability with appropriate range of motion. Our data showed that the ability of the patient to walk and climb stairs as well improved just to the premorbid functional state. Functional scores reported for this cohort of patients were generally inferior to those reported for other revision TKA series [27,28]. This disparity can be explained by the age, relative inactivity, and comorbidities of this patient group. In addition, most patients had some dysfunction in other joints of the lower extremities, making them less able to recover complete mobility than patients without these issues. The DFA procedure was successful at relieving knee pain and restoring stability and range of motion to the affected knee.

Patients undergoing DFA represent only one third of all patients sustaining distal femoral PPF at our institution. In general, these patients present with difficult reconstructive issues such as loosening of the femoral component, highly comminuted fracture, and poor bone stock. With the absence of these issues, open reduction internal fixation with plate and screws or fixation with an intramedullary device is the preferred treatment. Distal femoral arthroplasty is therefore a salvage option for patients where simpler measures are not appropriate.

Using DFA for TKA revision could be associated with intraoperative and postoperative complications. In our cohort, we did not observe any intraoperative complications. Postoperatively, infection has been reported as the most common complication [18]. This has been attributed to soft tissue compromise from prior surgery, extensive exposure, longer operative times, and comorbidity profile in older patients. We did not have any failures due to infection. This series of patients had not experienced multiple previous surgeries leading to significant soft tissue compromise.

Aseptic loosening has been shown to be a medium-term complication, and the probability of aseptic loosening seems to be very low in the first 3 years [29]. One of our patients showed tibial component loosening 3.5 years after the index procedures. We did not observe any signs of radiologic loosening in the other patients.

Postoperative femoral fracture has been reported at a rate of 1% to 8%. The higher rate of fracture (18.1%) seen in our cohort could be due to the fragile nature of these elderly patients. Of 22 fractures in our cohort, 18 were classified as fragility fracture based on World Health Organization criteria. This may account for the high rate of fracture seen after revision surgery. Patellar maltracking was not seen in this cohort of patients.

Allograft-Prosthetic composite is another available option to treat PPF in the setting of poor distal femoral bone stock. However, allograft resorption, nonunion, and infection may limit the usefulness of this approach [17,30-33]. In addition, weight bearing is generally not allowed until radiologic evidence of union is apparent [17,34]. Limiting mobility for an extended period in this patient population can be deleterious [23].

The limitations of this study include its retrospective nature, a relatively small number of patients, short duration of follow-up, and lack of a control group.

The results of revision TKA with DFA for periprosthetic distal femur fracture after TKA are inferior to those reported for less-complicated knee revision arthroplasty. However, for sedentary, elderly patients, this reconstructive option reliably provides pain relief and functional recovery. With the caution that a potentially high postoperative fracture risk exists, DFA should be considered a valuable salvage tool for the treatment of PPF after TKA.

References


