Case Report

Custom Total Femur Spacer and Second-Stage Total Femur Arthroplasty as a Novel Approach to Infection and Periprosthetic Fracture

Seth L. Sherman, MD,* Kieran Phaeleau Cunneen, PT, MS,† Sarah Walcott-Sapp, BA,* Barry Brause, MD,‡ and Geoffrey H. Westrich, MD*

Abstract: Total femur arthroplasty procedures have previously been used after tumor excision and as a last resort for failed revision arthroplasty. The patient in this case presented with massive loss of femoral bone stock, a periprosthetic fracture, and recurrent Staphylococcus epidermidis infection. A specially designed total femoral spacer impregnated with antibiotics was created for a 2-stage revision procedure that successfully restored functional ability and eradicated the infection. Although 2-stage protocols with spacers have been used to treat persistent infections after hip and knee arthroplasty, this is the first reported instance of the creation of a total femur antibiotic-impregnated cement spacer and subsequent total femoral arthroplasty as a 2-stage protocol at our institution. Key words: total femur arthroplasty, periprosthetic fracture, infection.

Total femur prosthesis implantation after tumor resection has been extensively described in the literature [1-4]. In contrast, there is less information with regard to total femur prosthesis for revision arthroplasty. Berend et al [5] conducted a retrospective review of 59 patients who underwent total femoral arthroplasty to treat various end-stage prosthetic disease conditions while salvaging the limb. Their results were favorable with 98% of patients regaining the ability to ambulate and 43% ambulating with only a cane or with no assistive device after an average follow-up period of 4.8 years. In addition to these American studies [5,6], several European authors have presented case series on their limited experiences with total femoral prostheses [7,8]. Friesecke et al [7] published the largest series to date on the use of a total femur prosthesis for aseptic failure of a previous hip or knee arthroplasty. Results were promising with improved functional outcomes in most categories and no complications in 68% of patients. This report suggests that the total femur prosthesis may be a useful option after multiple failed surgeries to avoid the consequences of disarticulation at the hip.

Deep infection of a total joint prosthesis is a potentially devastating complication. Current treatment options include appropriate parenteral antibiotics along with a single-staged exchange revision arthroplasty, 2-staged reimplantation, or resection arthroplasty [9-16,21-23]. Two-stage
reimplantation techniques for infected total hip and total knee arthroplasty have become the treatment of choice in North America with reported success rates between 90% and 95% [13-16,22]. Although the success of the 2-stage technique is well documented for infected hip and knee arthroplasty with preserved native bone, there is little evidence regarding revision of an infected prosthesis in the setting of massive femoral destruction and loss of bone stock. This case report is the first in the literature to describe a 2-staged reimplantation protocol for infection and periprosthetic fracture of a failed revision total hip arthroplasty with the creation of a temporary femoral spacer during the first operation and insertion of a total femur prosthesis during the second operation.

**Materials and Methods**

The patient was a 65-year-old woman who presented to the senior surgeon’s office after revision of a failed total hip arthroplasty. The patient underwent left total hip arthroplasty for osteoarthritis at an outside hospital in 1989. She developed aseptic loosening of the prosthesis in late 2001 and thus underwent revision arthroplasty in January 2002 with a long-stem femoral prosthesis. This was complicated by an intraoperative femur fracture that was stabilized by internal fixation. In April 2002, progressive bowing deformity and pain secondary to nonunion of the femur fracture required repeat internal fixation of the femur. The fracture was treated with allograft struts, cables, and screw fixation; however, the femoral fracture never healed. In May 2003, suspicion of infection led to an irrigation and debridement procedure with retention of the acetabular and long-stem femoral components of the total hip arthroplasty. The patient was placed on a 6-week course of intravenous vancomycin, although culture results at that time were unknown. After the spring of 2003, the patient saw multiple surgeons at outside institutions who all recommended hip disarticulation because of progressive bowing deformity and pain secondary to nonunion and nonunion of the femur fracture. In April 2002, a preoperative computed tomographic scan and fluoroscopy revealed 6 cm³ of opaque fluid, many polymorphonuclear cells, a white blood cell count but an elevated sedimentation rate of 85 and an elevated C-reactive protein level of 4.6, the latter 2 being consistent with chronic inflammation or infection. An aspiration of the left hip under fluoroscopy revealed 6 cm³ of opaque fluid, many polymorphonuclear cells, a white blood cell count of 26,000 and negative culture results. An aspiration of the distal thigh in the region of the periprosthetic fracture revealed a positive culture with methicillin-resistant *Staphylococcus epidermidis*. A preoperative computed tomographic scan and
magnetic resonance angiogram were obtained to better assess the remaining bony soft tissue, and vascular anatomy showed that the patient’s femoral artery was indeed adjacent to one of the remaining broken screws.

After obtaining infectious disease consultation, it was determined that the best course of treatment would be a 2-stage procedure. The first stage was performed in March 2005 and included a radical resection of all remaining foreign material including the total hip arthroplasty and the allograft material. The proximal femur was split in an attempt to preserve some abductor muscle attachments. It was felt by both the infectious disease consultant and the senior surgeon that a femur spacer was necessary to stabilize the limb and to deliver local antibiotics. Because no femur spacer was commercially available or ever manufactured at our institution, a femur spacer was created using a 300-mm trial long-stem femoral component with a unipolar head. This was then covered with antibiotic-impregnated polymethylmethacrylate cement filled with vancomycin (2 g) and tobramycin (4 packets, 2 g per packet). Once the cement was allowed to polymerize, the entire construct was “potted” into the remaining 7.6 cm of distal supracondylar femur with additional antibiotic-impregnated cement. In addition, the proximal native femur that was preserved initially was wired around the proximal aspect of the spacer for stability (Fig. 2). Postoperatively the patient received 6 weeks of antibiotics with intravenous vancomycin (1 g every 12 hours) and clindamycin (900 mg every 8 hours) for the confirmed methicillin-resistant *Staphylococcus epidermidis* infection. She was able to walk and transfer non-weight bearing with a walker, and she also used an abduction brace at all times except for daily hygiene.

In June 2005 the patient returned to the operating room for the second stage of the procedure. A posterolateral approach was used to remove the femoral spacer by vertically splitting the proximal remaining femoral bone with attached abductor mechanism. The acetabulum had enough deficiency...
that an antiprotrusion cage construct was used with bone grafting and a cemented constrained liner. The remaining distal femur fragment was removed, and the femoral artery was carefully dissected off the broken screw medially. The femoral reconstruction required a total femur arthroplasty system (Fig. 3) that incorporated a hinged knee distally (Global Modular Restoration System, Stryker Orthopedics, Mahwah, NJ). Proximally, the preserved femoral bone with attached abductor mechanism was reattached to the proximal aspect of the total femur arthroplasty system. Polymethylmethacrylate cement with antibiotics (vancomycin and tobramycin) was used for fixation of the acetabular component, and the tibial component of the total femur arthroplasty system. The Gram stain and frozen sections had negative results.

Postoperatively, the patient again used an abduction brace for stability and to allow the soft tissues to heal properly without undue stress on the proximal femoral reconstruction. A hybrid approach to physical therapy incorporating total hip and total knee arthroplasty protocols was used, and trochanteric precautions (no active abduction and no passive adduction) were ordered. The patient was discharged to an inpatient rehabilitation facility on the fifth postoperative day, and all final intraoperative cultures were negative for infection. Erythrocyte sedimentation rate and C-reactive protein values were normal.

Results

At her last follow-up visit, the patient had had the 2-stage reconstruction with the total femur arthroplasty for 2 years and was doing well. She had no complaints of pain and was ambulating with a cane, full weight bearing. She had a slight Trendelenburg gait pattern with a limp because of weak abductors. Her left hip range of motion was 0° to 100° of flexion. After the second stage, she was doing well and was ambulating with a cane, full weight bearing. She had a slight Trendelenburg gait pattern with a limp because of weak abductors. Her left hip range of motion was 0° to 100° of flexion.
flexion, 45° of abduction, 20° of adduction, 45° of external rotation, and 15° of internal rotation. Her left knee range of motion was 0° to 100° and completely stable. Her leg length discrepancy was reduced to only 1.75 cm, and her strength had also improved considerably with straight-leg raising against gravity of 5−/5 grade, abductor strength of 4−/5 grade, and quadriceps and hamstrings of 5/5 grade. She was neurovascularily intact distally and had no signs or symptoms of infection. She was pleased to be able to drive a car and care for her sick husband.

Radiographs 1 year after the procedure indicated a well-fixed total femur arthroplasty in satisfactory alignment without any evidence of loosening. Proximally the bone sleeve about the femur was intact; however, the cables had frayed and broken. The acetabular construct was also well incorporated with good bone grafting consolidation (Fig. 4A and B).

Discussion

The total femur prosthesis is not a novel concept. This technique has been described after tumor resection for almost 4 decades; however, most of the reports on this topic either had extremely small patient cohorts or did not adequately address functional outcomes. Ward et al [17] had one of the larger series on the use of the total femur after tumor resection, failed partial femoral endoprostheses, or complex fracture/nonunion. They reported satisfactory results in 16 of 19 patients (good in 7, fair in 9) with better functional outcomes seen in younger patients (<60 years). The relative success of this implant in avoiding hip disarticulation has encouraged increased use in recent years.

The use of the total femur prosthesis for revision arthroplasty is a relatively new indication. In 1983, Nieder et al [18] suggested that the total femur could be used after failed joint arthroplasty when gross bone loss resulted in an unloadable femur. Porsch et al [19] described the use a total femur arthroplasty after periprosthetic fracture between a total hip and total knee arthroplasty in 2 patients with rheumatoid arthritis. The most extensive survey of total femoral arthroplasty at an American institution was conducted by Berend et al [5]. They reviewed the cases of 59 patients who had presented with multiple revision total hip or knee arthroplasties, radical debridement surgeries for recurrent infection, or failed periprosthetic fractures and were treated with total femoral arthroplasty. Most (95%) were done with a constrained, uncemented acetabular component and rotating hinge or constrained total knee arthroplasty components. The procedure successfully improved function and decreased pain overall in spite of 18 complications (including 8 infections) or additional surgeries. Of the 14 patients whose femurs were severely compromised because of attempts to eradicate persistent infections, none were treated with an antibiotic-impregnated spacer such as the one used in this case. Another recent American investigation by Peters et al [6] reviewed 2 approaches to creating intramedullary total femoral arthroplasties in 22 patients. These approaches were relatively successful and may have advantages over the traditional total femur arthroplasty method in some circumstances.

In 2005, Friesecke et al [7] from a German institution published the largest known series of total femur prosthesis use for aseptic failure of a hip or knee arthroplasty. Prostheses were used in 100 patients to treat total hip or total knee arthroplasty complications, femur fracture between a total hip and total knee arthroplasty, or complex diaphysial femur fracture between native hip and knee joints. Patients with aspiration positive for periprosthetic infection at the time of revision were excluded, although some of the patients had a history of infection. Functional status of the hip and knee joint were evaluated both preoperatively and postoperatively with a mean follow-up duration of 59 months using the Enneking score [20]. Results showed improved Enneking scores in all categories with good or better function in all 7 knee categories and 6 of 7 hip categories. Sixty-eight percent of patients had no complications during the follow-up period. Of the complications experienced by patients, the most frequent was periprosthetic infection, which occurred in 13% of patients. This high infection rate was attributed to the large extent of the wound, size of the implant, multiple previous surgeries, and lack of routine perioperative intravenous antibiotics in most cases.

To the best of our knowledge, this is the first article to describe the creation of a total femur spacer for periprosthetic infection as part of a 2-stage reimplantation with a total femur prosthesis for a failed total hip arthroplasty. Although there is no known literature to support the efficacy of this procedure in eradicating infection, one can extrapolate the probability of a successful outcome from data found in the total hip and total knee arthroplasty literature [13-16,21-23] and from existing studies on total femoral arthroplasty for other indications. By applying a 2-stage reimplantation technique and creating a unique femoral antibiotic-impregnated cement spacer, hip disarticulation can be avoided and limb salvage is a possibility. Clearly, patients must be
counseled that this is a limb salvage type of technique with a potentially high rate of complications. However, if done successfully, the infection can be eradicated, and the patient can have excellent pain relief and restoration of limb function as evidenced in this case report.

References