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Extended Trochanteric Osteotomy for the Treatment of Vancouver B2/B3 Periprosthetic Fractures of the Femur

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Abstract: Periprosthetic femur fractures after total hip arthroplasty are a growing concern as their prevalence is expected to rise. A retrospective review was performed of all patients undergoing revision total hip arthroplasty with an extended trochanteric osteotomy (ETO) for treatment of a Vancouver B2/B3 fracture at our institution. Fourteen patients were identified having a minimum of 2-year follow-up. Clinical and radiographic evaluation was performed for all patients. At a mean 44.5 months of follow-up, mean modified D'Aubigne and Postel scores were 8.6. In all cases the ETO and fracture healed with radiographic evidence of osseointegration of the femoral component. Use of an ETO for the treatment of periprosthetic femur fractures provides excellent exposure, facilitates component implantation, and is compatible with fracture healing and good short-term clinical results. **Key words:** revision hip arthroplasty, periprosthetic fracture, osteotomy.

Total hip arthroplasty (THA) remains one of the most successful orthopedic operations of the 21st century; however, the rising incidence of periprosthetic fractures remains a growing concern [1-5]. Several factors may explain the rising number of these fractures, including the increasing numbers of THAs performed yearly, expanding indications, and longer life expectancy rates [6,7]. Femoral component revision is the treatment of choice for Vancouver type B2 or B3 fractures, as the femoral component is loose [5, 8-12]. Revising femoral components after periprosthetic fracture, however, can be technically demanding with several associated risks and complications. Lindahl et al [13] reported a 23% reoperation rate and 18% postoperative complication rate in 1049 periprosthetic fractures from the Swedish National Registry.

Options for treating type B2 and B3 fractures include revision of the femoral prosthesis to an extensively porous-coated stem with diaphyseal fixation, a fluted modular noncemented stem, an allograft-prosthesis composite, or a proximal femoral replacement [4,5,12,14-16]. In standard revision THA, exposure for implanting such femoral components can often be simplified with the use of an extended trochanteric osteotomy (ETO) [10,12, 17-19]. It has been shown that a periprosthetic fracture can be converted into an ETO at the time of revision THA with successful outcomes in small series of patients [5,20,21]. The purpose of this study is to review our experience and report the short-term clinical outcome of revision THA with use of an ETO in treating Vancouver B2 or B3 periprosthetic fractures of the femur.

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Materials and Methods

A retrospective review including consecutive patients who had a revision THA for periprosthetic fracture with the use of an ETO between 1997 and 2004 was performed. Institutional review board approval was obtained. Seventeen patients were identified in our database, with a study group consisting of 12 females and 5 males with a mean age of 77.8 years (range, 56-87 years) at the time of revision surgery. Preoperative demographics are listed in Table 1. Eighty-eight percent (15 patients) of the fractures occurred because of a fall from a level height or a twisting injury, and only 2 cases were associated with a high-energy mechanism of injury. Preoperatively, all patients were ambulatory with 7 maintaining an unassisted gait, 7 used a single cane, and 3 used a walker. Only patients with a minimum of 24-month follow-up were included in this study. Two patients were lost to follow-up at an average of 3 months, and 1 patient died of causes unrelated to their revision THA at 9 months follow-up, leaving 14 patients for review.

Clinical notes and radiographs were retrospectively evaluated for all patients. Fourteen patients had a prior THA and 3 a hemiarthroplasty. In 11 cases (65%), the femoral component had been cemented, and in 6 cases (35%), cementless fixation was used. Concomitant procedures included revision of the acetabular component in 5 cases, insertion of a primary acetabular component after hemiarthroplasty in 3 cases, and polyethylene liner exchange in 8 cases. A hemispherical, noncemented acetabular component (Trilogy, Zimmer, Warsaw, Ind) with screws was used in 6 cases and a GAP acetabular cup (Restoration, Stryker, Mahwah, NJ) in 2 cases. Table 2 outlines the femoral and acetabular components used at the time of revision THA. Femoral implant selection was based on the Paprosky classification of femoral defects. In cases in which 4 cm of isthmic bone remained, a fully porous-coated stem was used [22]. In those cases in which 4 cm of "scratch-fit" could not be obtained and patients with an intramedullary diameter necessitating the use of a 19-mm or larger fully porous-coated stem, a modular, tapered cementless has been the authors' implant of choice.

Table 1. Patient Demographics

Average age	77.8 (range, 55-87)
Sex	
Male	5
Female	12
Operative side	
Right	4
Left	12
Vancouver classification	
B2	12
B3	5
Prosthesis	
Cemented	11
Cementless	6
Average follow-up (mo)	44.5 (range, 24-96)

Table 2. Femoral and Acetabular Components Used During Revision THA

Femoral component	
Modular, tapered stem	4
6-in fully coated, straight stem	1
8-in fully coated, straight stem	10
Fully coated, bowed stem	2
Acetabular component	
Cementless, porous coated*	6
GAP acetabular cup †	2
Polyethylene liner exchange	8 ‡

*All Trilogy acetabular components (Zimmer).
†Restoration revision system (Stryker).
‡Two polyethylene liners cemented into well-fixed acetabular shells.

Intraoperative parameters evaluated included estimated blood loss, length of ETO, implants used, number of cables used for fixation, use of strut allografts, and complications. Postoperatively, modified D'Aubigne and Postel pain and walking scores were determined for the 14 patients available at latest follow-up. Kaplan-Meier calculations were performed and survivorship curves generated (Graphpad Prism version 4.00 for Windows, Graphpad Software, San Diego, CA) with aseptic loosening of the femoral components and revision surgery for any reason as end points.

Preoperative radiographs for all patients were evaluated and classified according to the Vancouver classification system [23-25]. There were 12 fractures (71%) classified as B2 and 5 (29%) as B3. The Paprosky classification was used to describe the distal femoral shaft fragment as well as to aid in revision femoral component selection [26]. There were 10 type IIIA femurs, 6 type IIIB femurs, and 1 type IV femur.

Serial postoperative hip and femur radiographs were evaluated for evidence of osteotomy healing, fracture healing, and femoral component stability using the criteria of Engh et al [27]. Stems were classified as osseointegrated if there was increased density of bone adjacent to the porous coating and if diverging radiolucent lines, prosthetic subsidence, and a pedestal sign were absent [16]. Clinical (no pain with weight bearing, palpation, or stressing of the site) and radiographic (bridging callus) evidences were used to determine the time of fracture healing.

The overall outcome was graded using the system of Beals and Tower [28]. Excellent results include those with a stable arthroplasty and union of the fracture site with minimal deformity or shortening. A good result is one in which the fracture has united with moderate deformity or shortening and there has been a stable subsidence of the femoral prosthesis. If the component is loose regardless of pain status, or if there is a nonunion, sepsis, new fracture, or severe residual femoral deformity/ shortening, then the result is classified as poor [16].

Surgical Technique

Preoperative planning is crucial in helping to estimate the length of the revision component required, evaluate for femoral deformities/remodeling, and to determine the amount of femoral isthmus remaining below the fracture level. For a fully porous-coated, diaphyseal fitting femoral component, 4 to 6 cm of cortical bone is required for adequate distal fixation and an acceptable rate of osseointegration to occur [29-31]. If less than 4 cm of isthmic bone remains, then a modular, tapered revision femoral component is our implant of choice based on the inferior results associated with the use of a fully porous-coated device in this situation [29].

The surgical technique follows the same principles as that described by Younger et al [18]. A posterior approach to the hip is performed, and the vastus lateralis is elevated to define the extent of the fracture. An ETO extending from the greater trochanter down to the distal level of the fracture site is then executed. Care is taken to respect the soft tissue attachments of the osteotomized fragment as it is retracted anteriorly and the loose femoral component extracted. A thorough debridement of the proximal femur is then performed to remove intervening soft tissue, bone cement, and nonviable fracture fragments.

Concomitant acetabular procedures can now be performed if required. A prophylactic cerclage cable is then placed around the femur just distal to the extent of the osteotomy/fracture site to prevent propagation, as the canal is prepared. The femoral canal is first reamed by hand and then power until adequate distal fixation (4-6 cm) can be obtained with the revision femoral component. The femur is typically underreamed by 0.5 mm compared to the diameter of the revision femoral component to be used as determined with a hole gauge. Once the femoral component is securely in place, the medial and lateral fragments are draped around the revision component and fixed with multiple cables; strut grafts can be added at this point to augment proximal bone stock if deemed necessary.

Routine perioperative antibiotics were administered and Coumadin (Bristol-Myers Squibb Co., Princeton, NJ) was used for thromboembolic prophylaxis. Touchdown weight bearing with assistive devices was enforced for the first 6 postoperative weeks. Progression to full weight bearing with an assistive device was allowed between 6 and 12 weeks depending on radiographic and clinical evidence of fracture and osteotomy healing. Patients were then allowed to wean from their assistive devices to an unassisted ambulatory status at a minimum of 12 weeks after surgery. Active abduction was restricted for the first 6 weeks and resisted abduction for the first 12 weeks. Routine clinical and radiographic follow-up was obtained at 3 weeks, 6 weeks, 3 months, 6 months, 1 year, and annually thereafter.

Results

Radiographic Results

The ETO and fracture site healed in all 14 hips available at latest follow-up. The mean time to healing was 13.1 weeks (range, 9-24 weeks). In the other 3 patients, all were noted to have healed the osteotomy and fracture sites at 12 weeks postoperatively, before being lost to follow-up. The average osteotomy length at time of revision was 126 mm (range, 58-185 mm). The distal gap between the osteotomy fragment and the remainder of the femur averaged 0.65 mm (range, 0-4 mm). In 3 cases, femoral component subsidence was noted in the first 3 postoperative months. The average subsidence was 4.7 mm (range, 2-8 mm) and was found to stabilize without further change at latest follow-up. In 2 of these patients, a modular, tapered stem was found to subside, and in 1 patient, the component was an 8-in fully porous coated stem. Component stability and apparent osseointegration were coincident with healing of the osteotomy and fracture sites for these patients. All 14 femoral components with a minimum of 24-month follow-up demonstrated evidence of osseointegration based on the criteria of Engh et al [27]. The other 3 patients were also noted to have evidence of osseointegration on their radiographs before being lost to follow-up.

Clinical Results

The average length of follow-up was 44.5 months (range, 24-96 months). Intraoperative data are

Table 3. Intraoperative Findings

Intraoperative Parameter	Data
Estimated blood loss (mL)	1150 (range, 800-2000)
ETO length (mm)	127 (range, 58-185)
No. of cables	4.1 (range, 2-7)
Allograft struts	7 cases

summarized in Table 3. There were no intraoperative complications. Postoperative modified D'Aubigne and Postel hip scores averaged 8.6 (range, 6-11) for the 14 patients with a minimum of 24 months follow-up. The 3 patients who were lost to follow-up all had scores of 8 at 3 months. The breakdown for pain and walking scores included means of 4.8 (range, 3-6) and 3.6 (range, 2-5), respectively. At latest follow-up, 4 patients were able to ambulate without assistive devices, 5 required the use of a cane, 4 the use of a walker, and 1 patient was nonambulatory. According to the Beals and Tower classification, there were 11 excellent, 2 good, and 1 poor result (case of late infection) at latest follow-up. Kaplan-Meier survivorship curves with aseptic loosening of the femoral component and reoperation for any reason as end points were generated at latest follow-up (Fig. 1).

Complications

There were a total of 5 (36%) postoperative complications in our series. One patient experienced a posterior dislocation at 3 weeks postoperatively. This patient was treated with closed reduction and bracing without further episodes of instability. The 2 patients treated with a GAP acetabular cup (Restoration, Stryker) required revisions of their components for aseptic loosening at an average of 63 months (range, 60-66 months) after their revision THA. One other patient sustained a traumatic periprosthetic distal femur fracture below the level of a modular, fluted stem. This patient was treated with open reduction and internal fixation using a distal femoral locking plate without further complication. The last patient developed a late deep infection 3 years after revision THA, necessitating a 2-stage exchange arthroplasty.

Discussion

Treatment of periprosthetic femur fractures can be quite challenging, and to meet our goals of a united fracture, stable prosthesis, early mobilization, and return to prefracture function, effective management strategies for postoperative periprosthetic fractures have been developed [4,5,32,33]. Femoral component revision is the preferred method of treatment of Vancouver B2/3 periprosthetic femur fractures. In this series, an ETO was used at the time of femoral component revision in 17 consecutive cases. In all cases, there was healing of both the fracture and the ETO, and in those patients with a minimum of 2-year follow-up, all of the femoral components were osseointegrated. Early femoral component subsidence was noted in 3 cases but was subsequently nonprogressive and associated with femoral component osseointegration. Although there was a substantial rate of complications (36%) seen in this complex subset of patients, none of the observed complications were directly related to the use of an ETO.

In all 17 cases, we found the ETO to heal at an average of 13.1 weeks. Femoral component subsidence was found in 3 cases and was subsequently nonprogressive after the osteotomy and fracture were noted to have healed. There were 2 cases of modular, tapered stem subsidence and 1 in which an 8-in fully porous-coated stem was used (Fig. 2). A gap between the osteotomy fragment and the distal femoral shaft was noticed in 7 cases and did not delay or alter the ultimate healing process in any of these patients. There have not been any cases of hardware failure, local irritation requiring removal of hardware, or trochanteric escape/migration.

The above results are similar to those recently reported by Mulay et al [21] and Stiehl [20] for the treatment type B2 and B3 periprosthetic femur fractures. Mulay et al [21] reported on 24 patients with an average age of 74 years, sustaining a periprosthetic femur fracture requiring revision THA. In all cases, a transfemoral approach was used with concomitant placement of a modular,

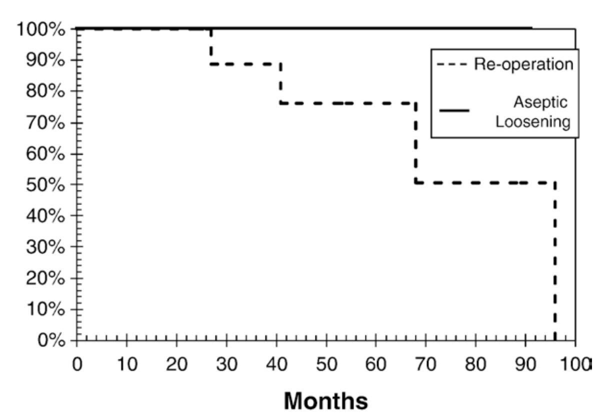

Fig. 1. Kaplan-Meier curves with aseptic loosening of the femoral component and reoperation for any reason as the end points.

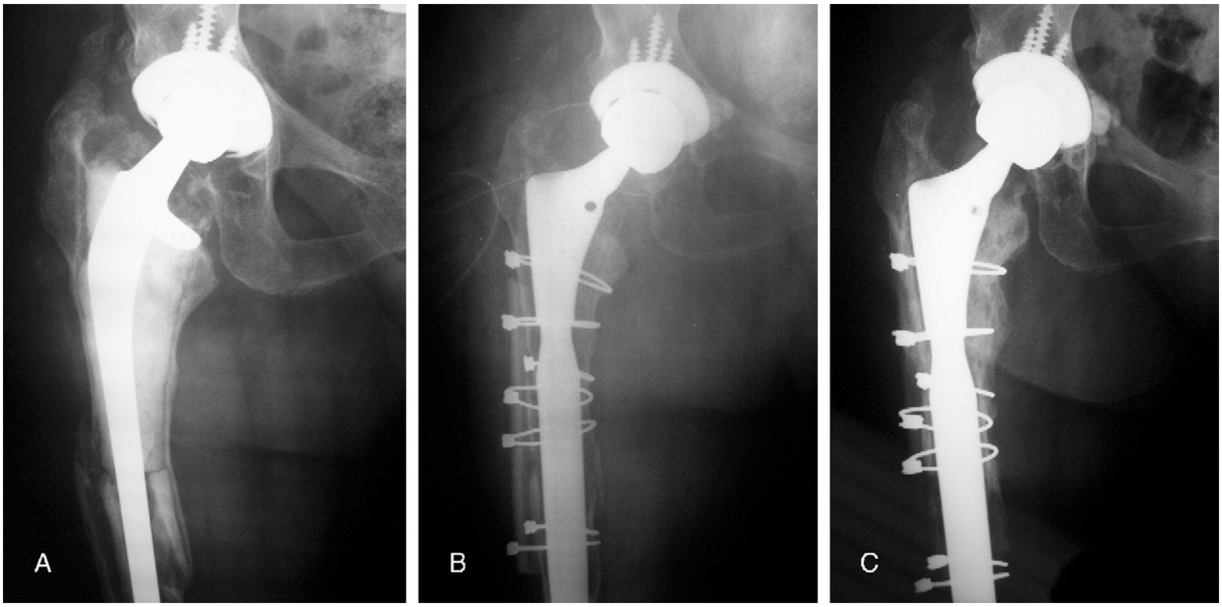

Fig. 2. Preoperative (A) and postoperative (B) radiographs showing treatment of a type B2 fracture with a fully coated stem initially and (C) at latest follow-up 58 months (Early postoperative subsidence was noted in this patient with subsequent stabilization of the stem and union of the fracture.)

tapered femoral component. They found a 91% union rate of the osteotomy/fracture with an average subsidence of the femoral stem of 5 mm in the first 6 months.

The average Harris hip score in the series of Mulay et al was 69 at latest follow-up. Although this does represent return to an acceptable level of function, it remains a relatively low score and is likely related to the significant medical comorbidities, frail nature, and limited preoperative activity levels in these patients. We found a similar trend in our study with a relatively low average modified D'Aubigne and Postel scores at latest follow-up (8.6 of 12). Age, medical comorbidities, and relatively poor preoperative levels of function contribute to the limited postoperative ambulatory capacity for these patients. Several studies have confirmed these low postoperative hip scores with average Harris hip scores ranging from 59 to 71 in treating periprosthetic femur fractures [14,21,34,35]. The main objectives to be emphasized in treating periprosthetic femur fractures are fracture union and a diminished level of pain. Although unassisted ambulation is always a goal for these patients, several studies have shown that typically greater than 50% will require a postoperative assistive device and maintain a limited ambulatory status [14,34]. Beals and [28] reported 52% poor results in treating 93 periprosthetic femur fractures with a variety of modalities.

Stiehl [20] reported on 7 cases of type B3 variant periprosthetic femur fractures. All 7 patients were female with an average age of 77.5 years. All patients underwent revision of the femoral component only using a posterior approach with an ETO. Strut allografts were used in 4 cases and either a fully porous, coated, straight femoral stem (5 cases), or a fluted, tapered titanium modular stem (2 cases) was used for the revision. Stiehl [20] reported no femoral component subsidence at a minimum of 2-year follow-up and all fractures united without complication. Femoral strut allografts were noted to have incorporated by 6 to 12 months.

Despite excellent rates of fracture union, the most common complication after revision THA for a periprosthetic fracture is dislocation. Postoperative dislocations have been reported to range from 5% to 21% after revision THA for a periprosthetic fracture [14,15,21,34,36]. In our series, 1 patient (7.1%) sustained a single posterior hip dislocation treated nonoperatively. Despite using modular, tapered stems, Mulay et al reported 5 dislocations in 24 patients (21%). Use of an ETO in itself does not appear to affect the rate of postoperative dislocations when treating periprosthetic fractures; however, attention to abductor tensioning and the overall stability of the hip must be thoroughly evaluated intraoperatively.

Limitations of this study include the retrospective nature of data collection, relatively short-term length of follow-up, and the small patient population. Because of the limited number of patients, no statistical significance could be determined for outcomes based on fracture classification or femoral implant type used. Furthermore, a more detailed review of patients' preoperative medical status may have lead to a correlation with some of the postoperative complications. Despite the above and inherent limitations of a retrospective study, we were able to show that high rates of osteotomy and fracture union can be obtained when performing an ETO during revision THA for a periprosthetic femur fracture.

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