Extensively Porous-coated Stems for Femoral Revision: Reliable Choice for Stem Revision in Paprosky Femoral Type III Defects

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Abstract

Between January 1999 and August 2008, ninety-six femoral revisions were performed with extensively porous-coated stems in Paprosky type III femoral defects (89 type IIIA and 7 type IIIB defects). Seven type IIIB defects with a mean canal of 16.5 mm were observed; 6 defects achieved stable bone ingrowth and 1 achieved stable fibrous condition. Average postoperative Harris Hip Score was 92.3 ± 8 (range, 77-100), and all scores improved postoperatively. At a mean follow-up of 65.7 months, 92 stems achieved bone ingrowth, and 1 stem (type IIIB) achieved a stable fibrous condition. Three patients died from causes unrelated to the surgery during follow-up.

The most frequent diagnosis for revision of the femoral component was loosening of the cementless stem (53 patients; 55.2%), followed by status after a Girdlestone procedure (21 patients; 21.8%), after total hip arthroplasty with acetabular wear (10 patients; 10.4%), loosening of the cemented stem (7 patients; 7.3%), and periprosthetic fracture (5 patients; 5.2%). The authors performed 65 total hip arthroplasty revisions, 23 femoral component revisions, and 8 revisions of femoral components with cemented liners in patients with well-fixed acetabular shells. Extensively porous-coated stems in femoral revision for Paprosky type III femoral defects provided good mid-term durability.

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doi: 10.3928/01477447-20120621-13
Femoral revision can be technically challenging when femoral defects exist. Reconstruction techniques, including the use of a cementless or cemented implant, an allogenic structural graft, or impaction grafting, have had varying success rates.\textsuperscript{1,2} The use of an extensively porous-coated stem in the revision of a femoral component has been reported with reliable results.\textsuperscript{4} Postoperative weight bearing with a walker was prescribed for approximately 6 weeks for patients with extended slide trochanteric osteotomy, intraoperative fracture, and severe loss of abductor mechanism; however, full weight bearing was allowed immediately postoperatively if these conditions did not exist.

Postoperative radiographs were taken at 6 and 10 weeks, 3 and 6 months, 1 year, and every 2 years thereafter until patients died or could not undergo further follow-up. Implant survival, Harris Hip Score, postoperative bone ingrowth, subsidence, stress shielding, and complications were reviewed at each visit.\textsuperscript{5} A questionnaire administered at last follow-up included questions about the presence of anterior thigh pain and satisfaction with the surgical outcome.

**RESULTS**

At a mean follow-up of 65.7 months (range, 24-135 months), 3 (3%) of 96 patients had died of unrelated diseases. Of the remaining 93 patients, 1 (1%) developed a superficial wound infection successfully treated with local debridement and antibiotics; 2 (2%) developed dislocations successfully treated with closed reduction; 1 (1%) developed a periprosthetic fracture successfully treated with open reduction and internal fixation; and 3 (3%) developed intraoperative perforations successfully treated with augmentation of the onlay structural bone grafts and fixation with cables. No iatrogenic sciatica nerve injuries associated with the 96 revisions occurred.

According to the radiographic criteria outlined by Engh et al.,\textsuperscript{3} 92 patients achieved stable bone ingrowth, and 1 patient achieved a stable fibrous condition. Mean implant migration was 1.2 mm (range, 0.0-2.1 mm). No femoral components were removed or revised during follow-up. Hip and thigh pain were decreased postoperatively. Two (2%) patients developed mild thigh pain at last follow-up (23 and 40 months, respectively), but no limitation of activity was required. Stress shielding developed in 14 (15%) patients, but no patients developed fracture or required further revision. All 8 cases with the onlay structural bone grafts achieved union by an average of 8.2 months. The 3 patients with allograft prosthetic composite achieved union by an average of 10.3 months. Mild to moderate allograft resorption was noted in these 3 cases but led to no further allograft prosthetic composite failure.

All 96 patients had complete functional assessments. Data for this analysis were obtained from hospital charts, telephone interviews, detailed questionnaires,
and clinical records. Postoperative Harris Hip Score was 92.3±8 (range, 77-100). All Harris Hip Scores improved postoperatively, and the patient satisfaction rate was 100%.

**DISCUSSION**

Femoral bone loss is a major challenge in revision THA. Extensively porous-coated stems are a reliable solution for femoral revision.6,7 The purpose of this study was to provide the mid-term results of femoral revision with extensively porous-coated stems in Paprosky type III femoral defects. No aseptic or septic loosening of these revised stems had occurred at last follow-up. The dislocation rate was 2%, and the infection rate was 1%.

Many techniques have been reported for femoral reconstruction in revision THA. Low success rates of proximal porous-coated femoral components at early follow-up have been reported.8 Less favorable long-term follow-up results of cemented femoral revisions have been reported, and these techniques are more suitable for low-demand patients.9-11 Other techniques, such as impaction grafting, bulk allograft, modular porous-coated stems, oncologic proximal femoral replacements, and custom-designed stems, are alternatives for femoral revision.1,2,12-14 Low (range, 2%-6%) mechanical failure rates were reported by many investigators with the use of extensively porous-coated stems for femoral revision.15-19 Investigators have reported a high failure rate among patients with Paprosky type IIIB and IV femoral defects or pre-revision cortical bone damage extending more than 10 cm below the lesser trochanter.15,17,20 Bypassing the area of bone deficiency and achieving a 5- to 7-cm diaphyseal fit are the most important goals in femoral component revision.21 Sporer and Paprosky17 reported that the mechanical failure rate among the 9- and 10-inch fully porous-coated stems was 0% in type IIIB defects with femoral canals smaller than 19 mm and 18% in type IIIB defects with femoral canals larger than 19 mm. The current series included 7 type IIIB defects with a mean canal of 16.5 mm. Six patients achieved stable bone ingrowth, and 1 patient achieved a stable fibrous condition. Garbuz et al22 suggested that tapered, fluted modular titanium stems are reserved for patients in whom 4 to 5 cm of scratch-fit cannot be obtained or when stems larger than 18 mm in diameter are needed.

Significant thigh pain after femoral revision is concerning and can be related to bone ingrowth. Moreland and Moreno16 reported significant thigh pain in 7% of ingrown bone, 16% of stable fibrous fixed stems, and 75% of unstable stems. Paprosky et al23 reported similar results, with 9% of patients reporting significant thigh pain, which included all patients with unstable stems. In the current study, 2 patients reported thigh pain at last follow-up; 1 patient had stable fibrous ingrowth, and the other patient had bone ingrowth. However, no functional limitation was reported by either patient.

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Figure 5: Anteroposterior radiograph showing loosening of the cemented stem with a Paprosky type III femoral defect in total hip arthroplasty. Vancouver type B2 peri-prosthetic fracture was noted preoperatively.

Figure 6: Anteroposterior radiograph 8 years postoperatively showing union of the onlay bone graft over the medial aspect of the proximal femur.

Figure 7: Anteroposterior radiograph showing liner wear with proximal femoral defect in total hip arthroplasty.

Figure 8: Anteroposterior radiograph 5 years postoperatively showing allograft prosthetic composite with proximal humerus. Harris Hip Score = 90 points.

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hip system. Bugbee et al24 reported a 23% stress shielding rate; however, no femoral components were associated with clinical or radiographic evidence of loosening. McAuley et al25 reported a 25% stress shielding rate related to older patients and the use of stems larger than 15 mm; no predisposition existed toward thigh pain, loosening, osteolysis, or inferior clinical results at the minimum 5-year follow-up. The current study identified 14 (15%) patients with evidence of stress shielding, although no patient developed loosening or required further revision (Figures 1-4).

Intraoperative perforation during revision of the femoral component occurs more easily than during primary THA due to residual cement in the femoral canal, the presence of a proximal femur deformity, or the requirement for insertion of a long stem. Paprosky et al23 reported intraoperative fractures during stem insertion in 8.8% of patients. In the current study, 3 (3.2%) patients developed intraoperative perforation, which was successfully treated with augmentation of the onlay structural bone graft and cable fixation. Extended slide trochanteric osteotomy may lower the rate of intraoperative perforation. Intraoperative fluoroscopy is routinely performed to detect intraoperative perforation. Other authors reported that significant anterior cortical thinning (Figure 4) was more common in Chinese patients if 200-mm straight stems were used and suggested using bowed 200-mm femoral components instead.26

Onlay structural bone graft is augmented for supporting thinning cortex or intraoperative perforation. Emerson et al27 reported that onlay graft united in an average of 8.4 months through a healing process with round-off, followed by partial and complete bridging. The current study reported similar results of onlay structural bone graft, with an average union time of 8.2 months (Figures 5, 6).

Allograft prosthetic composite is an alternative for advanced proximal femoral defects. Blackley et al28 reported this procedure in 48 hips and recorded a 77% success rate with an average follow-up of 11 years. The current authors performed 3 cases with allograft prosthetic composite for severe proximal femoral defects. The proper size allograft was selected, followed by insertion of vancomycin-impregnated bone cement into the graft canal after approximately 2 mm of cement mantle was achieved around the stem. Using a 0.5-mm under-reaming technique, the distal portion of the porous-coated long stem was securely fixed into the host bone with supplementary cable fixation. Once the joint was reconstructed, the abductor muscle was reattached.
to the allograft–prosthetic composite by nonabsorbable suture or Mersilene tapes (Ethicon, Inc, Somerville, New Jersey) firmly attached to enhance stability and achieve early functional recovery. The proximal humerus was used as an allograft for 1 patient with a small femur (Figures 7, 8). In all 3 patients, the allograft–host junction achieved union within an average of 10.3 months. Allograft resorption developed in all 3 patients; however, no graft failure was noted at last follow-up.

**Conclusion**

In the current series, the most frequent diagnosis for revision of the femoral component was loosening of the cementless stem (53 patients; 55.2%), followed by status post Girdlestone procedure (21 patients; 21.8%), status post THA with acetabular wear (10 patients; 10.4%), loosening of the cemented stem (7 patients; 7.3%), and periprosthetic fracture (5 patients; 5.2%). The authors performed 65 revision THAs, 23 revisions of the femoral component, and 8 revisions of the femoral component with cemented liners in patients with well fixed acetabular shells. Ninety-two patients achieved stable bone ingrowth, and 1 patient achieved fibrous bone ingrowth. The extensively porous-coated stems performed well in these Paprosky type III femoral defects.

**References**


