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Outcomes of Mixed Femoral Fixation Technique Using Both Cement and Ingrowth in Revision Total Hip Arthroplasty: Minimum 2-Year Follow-up

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ABSTRACT

The use of a modular femoral stem in revision total hip arthroplasty (THA) has been increasing recently. However, complications such as subsidence, dislocation and stem fracture are still noted, especially in hips with high grade femoral deficiency. We retrospectively studied a consecutive 41 hips (40 patients) that underwent revision THA with allograft reconstruction of the proximal femur in conjunction with hybrid fixation (proximally cemented and distally press-fit) of a modular femoral component. At a mean follow-up of 5.2 years (2 to 8 years), no hips sustained dislocation, subsidence or fracture of the stem in the follow-up period. We provided evidence that this technique may be a good alternative in the management of proximal femoral bone loss during revision THA.

The numbers of revision procedures are projected to increase because of the increased numbers of primary total hip arthroplasty (THA) performed yearly [1,2]. Because metaphyseal and diaphseal bone loss in some failed THAs is highly variable, a traditional long-stemmed femoral component may not be adequate in providing a good proximal and distal fixation. Therefore modular femoral revision stems designed with variable proximal and distal geometries, allowing proximal fill and distal fit, has been introduced to improve implant fixation [3–6].

Several series using the modular prosthesis have demonstrated early clinical improvement, with low failure rates [3–10]. However, different degrees of stem subsidence, stem fracture or dislocation have been reported [4,7–9,11–13]. Köster et al [14] reported a 14.3% implant subsidence rate in their 73 non-cemented modular revision stems (Profemur-R) at an average follow-up of 6.2 years; 2 of them required a revision procedure. Kang et al [13] reported a mean subsidence of 4.4 mm (range, 0–55 mm) among 37 hips using Zimmer modular revision (ZMR) stems, with more than 5 mm subsidence in 5 hips and 1 hip requiring a revision procedure. Adequate osseous contact and firm fixation of the implant are required to minimize micromotion and allow for osseointegration of the implant [15–17]. Although proximal fill can be maximized with different shapes and sizes of proximal bodies, metaphyseal bone is often sclerotic or avascular in high-grade proximal femoral deficiency and intimate contact between bone and implant is difficult to achieve, in which rotational stability of the revised implant may not be adequate in early postoperative period, especially with cylindrical porous design stem [18–20]. Therefore, techniques should be devised to achieve rotational and longitudinal stability of the proximal body and facilitate osseointegration on the porous surface of the femoral stem in the femoral diaphysis.

The purpose of this study was to report early clinical and radiographic outcomes of revision THA with a modular, extensively porous coated stem (ZMR, Zimmer, Warsaw, IN) using mixed fixation (proximal cemented and distal press-fit) technique in patients with proximal femoral bone loss.

Materials and Methods

Institutional review board approval was obtained for this study. Between August 2006 and September 2012, consecutive 43 hips underwent revision THA with a modular femoral component (ZMR; Zimmer, Warsaw, IN). Two patients were lost to follow-up. Therefore, 30 men and 10 women (41 hips in 40 patients) aged from 41 to 87 (mean, 61 years) were included in the study. There were spout body in 39 hips, calcar body in 2 hips; 220 mm long bowed stems with 13.5 to 18 mm diameter in 38 hips and 170 mm straight stems with 12 to 15 mm diameter in 3 hips. Thirty-one hips (76%) had concomitant revision of the acetabular component. The index revision was the first femoral revision in 24 hips (59%). 11 hips (27%) had undergone 1 previous revision arthroplasty and 6 (15%) had undergone at least 2 previous revisions prior to the index procedure. All patients had various degrees of femoral bone loss at the time of revision surgery. According to the Paprosky classification of femoral bone defects [21], 7 femurs were type II (17%), 18 were type IIIA (44%), 11 were type IIIB (27%), and 5 were type IV (12%) defects (Table 1). The indications for femoral

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Table 1
Femoral Defects (Paprosky Classification).

Defect Type	Description of Femoral Defect	No.
I	Minimal bone damage	0
II	Metaphyseal bone damage, minimal diaphyseal damage	7 (17%)
IIIA	Metadiaphseal bone loss, with intact cortical bone present more than 4 cm distal to the isthmus	18 (44%)
IIIB	Metadiaphseal bone loss, with intact cortical bone present less than 4 cm distal to the isthmus	11 (27%)
IV	Extensive metadiaphyseal damage, thin cortices, widened canals	5 (12%)
Total		41 (100%)

revision surgery were aseptic loosening in 27 hips (66%), reimplantation after a periprosthetic infection in 10 hips (24%), long stem fracture with femoral nonunion in 3 hips (7%), and recurrent dislocation in 1 hip (2%).

For cases of periprosthetic joint infection, the secondary prosthesis was not implanted until antibiotic treatment had been terminated for at least 4 weeks without any clinical or paraclinical signs of relapse, and the C-reactive protein (CRP) level was within normal limits. A staged procedure was performed in 15 hips, including 10 hips with a previous periprosthetic infection (34%), 3 with a periprosthetic fracture (7%), and 2 with no available femoral prosthesis size during the first procedure (5%). The median interval since the most recent previous removal of the prosthesis to reimplantation in 10 septic loosened hips was 4.5 months (range, 2 to 33 months).

Three periprosthetic fractures with nonunion and broken long stems, which had been treated for stem fracture at other institution with long stem revision, a long cortical window of the femoral shaft was required to remove the retained broken long stem. Because of poor bone stock by the previous revision procedure and removal of the broken stem. To avoid second failure of the revision procedure, we decided to perform two stage operation. First, we repaired the nonunion with open reduction and internal fixation using an interlocking nail and reconstructed the femoral deficiency with a long strut allograft and autogenous iliac bone grafts. After fracture union, reimplantation was performed. The intervals between fracture fixation and reimplantation were 10, 9.5 and 14 months, respectively.

Clinical and radiographic evaluations were performed before the operation as well as 6 weeks, 3 and 6 months, and 1 year after the operation, after which they were followed at 1-year intervals until the final follow-up visit. Clinical evaluations included a detailed history-taking, a physical examination, calculation of the Harris Hip Score [22], and the West Ontario McMaster University Osteoarthritis Index (WOMAC) pain score, in which the scores were normalized to a range of 0–100, with 0 being the worst and 100 being the best [23]. The initial postoperative radiograph was compared to the most recent radiographs to determine the extent of femoral component subsidence by comparing the landmarks of the femur and the prosthesis, as described by Köster et al [14]. The extensively porous coated stem in this study was considered osseointegrated if there did not exist a bony pedestal around the distal tip of the stem and there did not exist progressive stem subsidence [19,24].

Surgical Technique

A single senior experienced surgeon (J.-W.W.) performed or supervised all the revision procedures. All operations were performed with the patient in the lateral position using a posterolateral surgical approach. Once the previous femoral stem was removed and the fibrous tissue or cement in the femoral canal was thoroughly debrided, the femoral canal was prepared with sequentially larger cylindrical reamers before introduction of the revision stem. Any cement mantle if present was removed with curettage or high-speed burring. Twenty hips (49%) required a femoral cortical window to extract the remaining bone cement, sclerotic bone, previous pedestal or fractured stem.

Before insertion of the femoral stem with proximal cement, we fully utilized allograft in our cases depending on the bone defect (Table 2), including morselized allografts (100%), short strut allografts (83%) and long strut allografts (>10 cm) (29%). Twelve hips (29%) with pre-existing inadequate bone stocks of the femoral shafts because of stem penetration, mechanical effect of the loose stem or open window of the femoral cortex, were reconstructed with long strut allografts and autogenous iliac bone grafts (Fig. 1). Thirty-four hips (83%) required a short strut allograft to restore the calcar defect (Fig. 1). All hips with various cavitary proximal femoral defects were reconstructed with morselized allografts using impaction techniques during trial of the femoral stem. At that time, the short strut allograft was fixed to the lesser trochanter with cerclage wires (Fig. 1).All the femoral components were fixed using the mixed fixation techniques (press-fitting the distal stem and cementing the proximal segment to where calcar and morselized allografts were reconstructed) (Fig. 1). During the insertion of the ZMR stem in the femoral canal, the proximal body was packed with cement (Stryker Simplex-P) in doughy stage. Then the femoral component was driven in the optimal version and depth which were decided during trial of the prosthesis. In this manner, the proximal body was cemented to the morselized and strut calcar grafts, and the diaphyseal part of the stem was non-cemented. The cement was loaded with antibiotics determined based on the previous causative bacteria. In case of non-infected loosening, vancomycin-loaded cement (1 g vancomycin in 40 g PMMA) would be used to minimize postoperative infection, as we reported previously [25].

Various wire fixation techniques were used for different conditions. Cerclage wires were used for calcar reconstruction in 34 hips (83%) (Fig. 1), femoral shaft open window protection in 20 hips (49%), and long strut allograft reconstruction in 12 hips (29%) (Fig. 1). Tension-band wiring combined with circumferential wiring techniques was used for fixation of greater trochanteric fracture, non-union or osteolysis in 13 hips (32%) (Fig. 1), as we previously reported [26]. Patients commenced partial weight-bearing postoperatively for at least 6 weeks. An abduction brace was worn for at least 6 weeks if there was nonunion on the greater trochanter repaired with bone grafts and wires. Full weight-bearing was allowed if there was radiographic healing of the allografts, which usually takes at least 3 months.

Results

Overall implant survival was 95% (39/41) at a mean follow-up of 5.2 years (2 to 8 years). The mean operative time for revision THA was 315 min (range, 180–540 min). The mean blood loss was 1650 ml (range, 650–3650 ml); the mean length of hospital stay after surgery was 9 days (range, 5–24 days); the mean Harris Hip Score improved from 34.5 (range, 20–70) to 81 (range, 65–100) points ($P < 0.01$); and the mean West Ontario McMaster University Osteoarthritis Index (WOMAC) pain score improved from 45 (range, 30–70) to 82.5 points (range, 55–100) ($P < 0.01$) (Table 3).

Postoperative complications included 2 recurrent deep infections (5%), 1 superficial wound infection (2%), 3 cortical perforations (7%) of the femoral shaft, 1 late femoral cortex linear fracture (2%) and 1 greater trochanteric fracture non-union (2%) (Table 4). Three hips (7%) had a

Table 2
Allografts Used in Revision THA.

Bone Graft Use in Revision THA	No.
Short strut allograft use for calcar reconstruction	34 (83%)
Long strut allograft use for extensive proximal femoral deficiency (combined with autogenous iliac bone graft)	12 (29%)
Morselized allografts use for proximal femoral defect	41 (100%)