Cancellous Impaction Grafting in Femoral Revision THA

DOUGLAS E. PADGETT, MD; STEFAN KINKEL, MD

Abstract

Options in the management of the deficient femur during revision hip arthroplasty include cemented or cementless fixation. The results with cemented femoral revision have not been historically successful. While the use of extensively coated implants in revision total hip arthroplasty has been more uniformly excellent, issues, such as thigh pain, stress shielding, and lack of bone stock restoration, have been raised. Impaction grafting in revision hip arthroplasty is an attempt to reconstitute bone stock and avoid problems associated with excessively large or long uncemented stems. The original concept of impaction grafting was promoted by Slooff and applied to the femur by Gie and Ling. While originators’ results were promising, issues, such as fracture and poor graft delivery, were noted. Modifications to the original technique were recently described by Howie, which used longer stems when necessary, as well as an improved graft delivery system. We report our results with 30 consecutive hips using this method. At follow-up, 3 patients were known to have died, leaving 27 for evaluation. Two of the 27 were failures: 1 recurrence of infection and 1 loose stem. The remaining 25 were clinical successes with bone stock restoration in all and no periprosthetic fractures. We believe that impaction grafting remains a viable option for the management of the severely deficient femur in whom cementless fixation methods are questionable.
Options for reconstruction of the deficient femur requiring revision total hip arthroplasty (THA) include either cemented or cementless reconstruction. The results of cemented revision THA have not been encouraging, with early loosening rates of 19% within 10 years. It has been suggested that the failure of cemented femoral fixation is a result of the loss of the mechanical interlock between the cement and the host bone.

Dohmae et al demonstrated the effect of revision surgery on the interfacial shear stress between bone and cement in a cadaveric model. This significant reduction in the mechanical properties has been implicated in the cause of early loosening of cemented revision. The poor results of cemented revision led others to abandon cemented fixation in favor of cementless options. The longer-term results of revision femoral reconstruction using extensively porous-coated implants has been demonstrated by numerous authors, and cementless femoral reconstruction remains the gold standard of treatment in revision THA.

Despite the success with cementless reconstruction, several issues regarding applicability to all cases have surfaced. Specifically, problems of thigh pain in large diameter stems, risk of fracture, difficulty in stem removal in instances of infection, as well as the association with longer-term stress shielding have been raised. In addition, as the age of patients receiving THA continues to decrease, bone loss in this group remains a major issue, and the concept of bone restoration remains appealing.

The ideal method of femoral reconstruction would involve the ability to restore bone mass, restore implant stability, and finally, restore bone mechanics. This concept of reconstruction was initially suggested by Slooff et al in the reconstruction of acetabular bone defects. These authors noted the restitution of acetabular bone stock with the technique of vigorous impaction of morselized allograft bone into a prepared acetabular bed into which a cemented polyethylene cup is placed. The success of this technique was adapted to the femoral side for revision by Gie et al. The requisites for this technique are an intact femoral tube (or the ability to create one), adequate host biology, which would allow impacted bone to heal, and the initial ability to protect weight bear.

The surgical technique involves an extensile surgical approach and a thorough surgical debridement removing all cement, granulomatous tissue, and any metal debris. An assessment of cortical defects is performed, and the use of containing mesh if necessary to contain the tubular femoral canal (Figure 1). At this point, preparation of morselized bone fragments is performed using a bone mill or pre-prepared cancellous bone chips in the range of 3 to 5 mm (Figure 2). A cement restrictor plug is placed distally to contain the bone graft, and at this point, a series of smooth bone tamps and broaches are used to compact the bone graft until the graft is stable (Figure 3). A smooth, wedge-shaped, tapered stem normally intended for primary hip arthroplasty is then cemented into this newly reconstructed cancellous bone bed.

The early results of revision surgery using this impaction grafting technique from the developers demonstrated uniform success. These authors had no clinical failures due to loosening, although they described 2 periprosthetic fractures in their initial series of 56 patients. Unfortunately, there were other reports of problems using this technique. In the report from Indiana, Meding et al using this technique, had mean subsidence of 10 mm in 38% of patients and an 18% fracture rate, prompting these authors to abandon this approach. It was apparent that improvements in graft delivery and compaction were needed, as well as consideration of the use of longer stems to bypass cortical defects to prevent fracture. These modifications of technique have recently been described by Howie et al with no fractures reported in their series.

Since 2001, we have been using this modification of the impaction technique on select patients undergoing revision THA who met the criteria for inclusion. Our goal was to report the results of this selected group of consecutive patients operated on by a single surgeon.

**Materials and Methods**

Between 2002 and 2008, 30 patients with 30 hips were identified in our registry who had undergone revision THA using the modified impaction grafting technique. The indications for surgery were for either failed cemented THA (Figure 4A), failed uncemented THA, or as part of the second stage of a 2-stage reimplantation for infection. The indication, specifically for impaction grafting, was extensive bone loss extending down to the isthmus with anticipated limited isthmus support. These types of defects were described by Della Valle and Paprosky as type IIIB defects. In this cohort of 30 patients: 13 failed ce-
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...mented THR, 10 failed cementless, and 7 replantations. The reconstruction technique used longer stems to bypass cortical defects and the use of antibiotic impregnated cement in the replantations.

RESULTS

Patients were seen for follow-up at minimum 2 years (range, 2-6 years). Three patients were known to have died. There were 2 clinical failures in this group of 30 hips: 1 recurrence of infection in a patient with methicillin-resistant Staphylococcus aureus and 1 aseptic loosening with rotational instability requiring revision to a modular, extensively-coated implant. The remaining 28 hips were considered clinically successful. There were no fractures in this group of patients. Graft consolidation was apparent by 1 year as evidenced by the typical trabecular pattern of bone. Radiographic analysis revealed that subsidence of 2 mm at the prosthesis cement interface was common but not associated with any clinical sequelae (Figure 4B).

DISCUSSION

The results of this series of impaction grafting revision demonstrated that by improving graft delivery, graft impaction and the use of revision stems, which bypass cortical deficiencies, the outcomes can be successful, and the short-term problems of fracture and subsidence avoided. It is important to emphasize that this technique is limited to the more deficient femoral reconstructions in which standard cemented techniques may not be appropriate. The management of the deficient femur in revision THA remains somewhat controversial. While extensively-coated cementless implants, whether monolithic or modular remain the workhorse of reconstruction, these implants are difficult to use in situations where there is extensive expansion of the diaphyseal bone and isthmus or in patients in whom bone restoration is a priority. The frequency of impaction grafting revision has diminished even at our institution due to the success and ease of cementless techniques. However, in selected cases and indications, impaction grafting revision has a place. It is a technique that requires patience and attention to detail, but in the right patient with the right indication, and if performed using the appropriate technique and implant, the result can lead to a predictable outcome.

REFERENCES


Figure 3: The newly reconstructed proximal femur with the compacted cancellous allograft bone.

Figure 4: Preoperative radiograph demonstrating a loose cemented implant with expansile bone loss to the isthmus (A). Postoperative reconstruction with proximal mesh to contain graft and supplemental cerclage cables to contain hoop stresses (B).