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ORIGINAL PAPER

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Impaction bone grafting for total hip revision

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Abstract We used impaction bone grafting for total hip revision on 26 hips in 25 patients. Average patient age was 68 (34–89) years, and average duration from last surgery was 9 years. In all cases morselized allograft bone was used for the graft, and the femoral component was a collarless, polished, tapered stem. Average duration of surgery was 2.4 h, intraoperative blood loss 600 cc, blood replacement 2.4 units, and acute-care hospital stay 5 days. Complications were varus placement of the stem in two patients and postoperative development of varus in one, one intraoperative and three postoperative femoral fractures, and one postoperative dislocation. Average subsidence was 0.6 cm. We believe that most, if not all, of these complications could have been prevented.

Résumé Nous avons utilisé greffe à frottement dur pour reprise d'arthroplastie de la hanche totale sur 26 hanches dans 25 malades. L'âge moyen était 68 années, et durée de dernière chirurgie 9 années. L'os allologue morselisee a été utilisé pour la greffe et le composant fémoral était une tige polie conique sans collerette. La durée moyenne de la chirurgie était 2.4 heures; perte du sang intraopératoire, 600 cc,; remplacement du sang, 2.4 unités et le séjour d'hôpital de soin aigu cinq jours. Les complications étaient placement de la tige en varus dans deux malades et développement postopératoire de varus en un. Il y avait une fracture intraopératoire et trois fractures fémorales postopératoires. Il y avait un déboîtement postopératoire. La subsidence moyenne était 0.6 centimètres. Nous croyons que plus, si pas tout, de ces complications avaient pu être prévenu.

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Introduction

Our interest in impaction bone grafting was stimulated by the presentation of a 34-year-old woman who received a cementless total hip replacement 7 years previously for avascular necrosis caused by high doses of immunosuppressive drugs that were required for a kidney transplant. She had done well for 6 years when she began having pain. Her roentgenograms showed good distal fixation of the femoral stem but extensive proximal bone loss (Fig. 1). We did not believe this problem could be satisfactorily managed with a standard cemented or noncemented revision prosthesis. Therefore, impaction bone grafting, along with a collarless, polished, tapered stem

Fig. 1 A 34-year-old woman 7 years after a cementless total hip replacement for avascular necrosis. *Arrows* point to areas of extensive bone loss of the entire proximal femur

Fig. 2 The same woman 6 years after revision surgery

was used. The successful final result 6 years after surgery is shown in Fig. 2.

We have adopted this technique for most total hip revisions and found it particularly helpful when bone loss is present. As we expanded our indications, we had a significant number of complications, which prompted this review. The purpose of this paper is to analyze these problems and to make suggestions as to how complications can be avoided.

Material and methods

Since 1993 members of our orthopedic group performed 26 femoral component total hip revisions using impaction bone grafting and bone cement, and a collarless, polished, tapered stem. The prosthesis is made of a cobalt chrome alloy and supplied in the United States by the Zimmer Manufacturing Company of Warsaw, Indiana. There were nine women and 17 men in our study with an average age of 68 (34–89) years. The primary diagnosis, duration from last surgery, and number of previous hip revisions is given in Table 1. The author reviewed hospital records, office records, and all available roentgenograms of these patients.

Surgical technique

A posterior approach was used in all cases, and the acetabulum was simultaneously revised in five patients. After prosthetic component removal the femoral canal was thoroughly cleaned of all bone cement and fibrous debris. A distal polyethylene plug with a long, centrally placed guidewire was secured 2 cm past the level of where the distal tip of the prosthesis would lie. Morselized allograft bone was then tightly packed into the canal, initially without a tamp and then around a smooth tamp slightly larger than the final prosthetic stem. After completion of bone packing the tamp was removed, leaving a canal formed of morselized bone. Bone cement was then introduced using a cement gun with a long tube so that the canal could be filled from the distal end to the proximal opening. The final prosthesis was then inserted. Postoperative management was touch weight bearing for 6 weeks.

Table 1

Primary diagnosis	
Degenerative joint disease	17
Avascular necrosis	6
Rheumatoid arthritis	1
Femoral neck fractures with a painful prosthesis	2
Duration from last surgery (years)	9 (1–23)
Number of previous total hip procedures	
One	19
Two	5
Three	2

Table 2

Complications	
Varus placement of the stem	2
Postoperative development of varus	1
Subsidence (centimeters)	0.6 (0–3.8)
0	6
1.0 cm or less	12
Over 1.0 cm	3
Postoperative dislocation	1
Femoral fractures	4
Intraoperative	1
Postoperative	3

Results

Average duration of surgery was 2.4 (1.5–4) h, intraoperative blood loss averaged 600 (200–1100) cc, blood replacement averaged 2.4 (0–4) units, and acute care hospital stay averaged 5 (2–9) days. Complications are listed in Table 2.

Varus placement of the stem in two patients at the time of surgery caused no postoperative clinical problems. The patient who developed postoperative varus of the stem required revision. In 21 patients postoperative subsidence could be evaluated. In all cases this occurred within 1 year of surgery, and none of the patients had clinical problems as a result. The one patient with a postoperative dislocation had a simultaneous acetabular revision, and the problem was successfully managed with bracing. The intraoperative femoral fracture occurred during the process of cement removal and was treated with cerclage cables with no sequelae. The three postoperative femoral fractures all occurred at the distal tip of the prosthesis in areas of bone loss. These fractures were precipitated by minimal trauma 3 weeks after surgery in two patients, and 6 weeks in one.

Discussion

Initial use of impaction bone grafting for hip arthroplasty was to restore acetabular integrity in both primary and

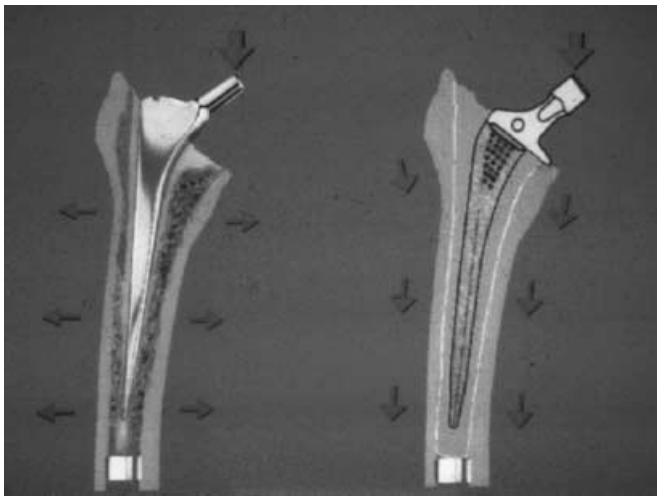

Fig. 3 The figure on the reader's left illustrates that, as the smooth wedge-shaped prosthesis settles into the cement mantle, compressive forces are created in the cancellous bone and femoral shaft. With a standard cemented prosthesis, as shown on the right, where the bone cement is adherent to the rough surface of the prosthesis, axial loading results in the tensile forces at the bone cement interface

revision procedures [4, 7, 11]. Gie et al. from England applied this technique to the femoral side and reported results of 56 revisions in 1993 [3]. This was followed by reports from Elting et al. in the United States on 67 cases in 1995 [2].

An important part of this procedure is the use of a collarless, polished, tapered stem, femoral prosthesis forged with cobalt chrome alloy. The smooth surface of the prosthesis prevents adhesion of bone cement to the prosthesis. The lack of a collar allows the prosthesis to subside, and, when subsidence occurs, the tapered stem acts like a wedge, producing compressive forces within the cement and allograft bone (Fig. 3).

In contrast, a femoral stem with a rough surface results in adhesion of the bone cement to the prosthesis so when axial loading occurs tensile forces occur at the bone cement interface. Under these circumstances any subsidence that occurs would be the result of loosening at the bone cement interface.

Although the initial reports were encouraging subsequent series have illustrated that this is a technically demanding procedure, and complications have been high [1, 5, 6, 8, 10]. This, too, has been our experience; however, we believe that most, if not all, of our complications could have been avoided.

Varus placement of the stem is a technical error that can be prevented by proper placement of the distal plug and guidewire. In addition, the trial tamp must be inserted in slight valgus and secured by initially packing the allograft bone on the medial side of the femur. Postoperative development of varus, in our one case, was the result of failure to provide adequate medial support. If this cannot be accomplished with tight packing of morselized bone because of a deficiency of bone in the calcar, then a strut graft should be used for reinforcement (Fig. 4).

Fig. 4 An immediate postoperative roentgenogram of a patient who had medial bone loss. This was corrected with a strut bone graft held by cerclage cables

We do not consider subsidence of 1 cm or less a complication, but rather to be expected – and perhaps efficacious. Although bone cement is capable of some plastic deformation, it appears in our cases that most subsidence was the result of further compression of the morselized bone. In the initial example shown in Figs. 1 and 2 subsidence was 1.8 cm, which caused no discernible clinical problem and the patient was asymptomatic 6 years from the time of her procedure. Subsidence greater than 2 cm, which occurred in two patients, is excessive and was the result of failure to provide a secure distal plug, so that the entire combination of prosthesis, bone, and cement was allowed to slide further down the canal than was intended. However, these patients were asymptomatic. One patient had a postoperative dislocation that was successfully managed with temporary bracing. This patient had had the acetabulum simultaneously revised. Our experience with other revision hip surgery has been that, when both components are replaced, the rate of dislocation is higher than usual. We believe this is caused by the extensive dissection that is required, and, when the replacement is complete, there is no normal tissue to close. Because of this, routine postoperative bracing should be considered until adequate soft tissue healing has occurred.

In one patient an intraoperative hairline fracture was created in the process of cement removal. It was successfully handled by cerclage cables. This problem can

Table 3

Recommendations
Femur must be converted to intact tube
Secure, centrally placed distal plug
Tightly packed bone graft
Medial support
Protect all areas of bone loss

always occur, no matter what type of revision is used, so the surgeon must be alert to the possibility.

All three postoperative fractures occurred below the stem of the prosthesis in areas of unprotected bone loss. These were serious complications and required additional surgery. We believe these fractures could have been avoided with either the addition of strut grafts or a longer prosthesis that extended at least 2 cm beyond the area of bone loss.

Our experiences resulted in emphasizing and rephrasing the recommendations of Mikhail [9] and others. These are listed in Table 3 and, if not strictly followed, can result in disastrous complications. If the criteria listed in Table 3 cannot be achieved, then another type of hip revision should be used. Although our series is small and does not address the long-term results of this technique of femoral component revision we are optimistic that, if complications in the perioperative period can be avoided, the long-term results will be excellent.

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