NONCEMENTED ACETABULAR REVISION AND BONE GRAFTS

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In a retrospective study 14 acetabular components, implanted as part of a revision total hip arthroplasty, are radiographically analyzed. Major loss of bone was present in all cases. A bone augmentation technique is described in which a hemispherical porous coated cup was used without additional fixation together with morcelized bone grafts. No failure was noted and radiographic evidence of cup stability was noted in all cases.

Keywords : revision ; total hip arthroplasty ; acetabulum ; bone loss ; bone grafts ; stability ; ingrowth.
Mots-clés : révision ; prothèse totale ; hanche ; cotyle ; perte de substace osseuse ; greffe osseuse ; stabilité ; incorporation.

INTRODUCTION

The major problem facing cup revision in total hip arthroplasty is loss of bone, due to osteolysis and loosening. A variety of techniques are used to allow sufficient cup fixation in the case of poor bone stock : PMMA can be used alone or in combination with bone grafts (massive or chips). Recently cementless cups have become more popular, either alone or in combination with bone grafts. The technique used in this series consists of morcelized (mashed) bone grafts and a porous coated hemispherical cup without additional fixation.

The short term results are encouraging in terms of cup stability, cup ingrowth and maintenance of bone augmentation. This study is based upon a retrospective radiologic follow-up ranging from 35 up to 85 months (average 65 months).

MATERIAL

The series consists of 14 cup revisions performed in 12 patients (3 men and 9 women) between 1987 and 1990. At the time of the primary hip arthroplasty, the mean patient age was 51 years ; the mean prosthetic survival was 7,8 years. The primary indication was osteoarthritis (10) 4 of which had severe protrusion, secondary arthritis due to trauma (2) and ankylosing spondylitis (2). The primary cups were the Charnley cemented UHMWPE (Thackray, U.K.) (6), a resurfacing acetabular component (Tharies, U.S.A.) (5) and unknown (3). Primary bony defects in the acetabulum were protrusion (4), a large cyst in the acetabular roof (1) and a large anterosuperior rim defect (1).

The indication for revision was evident radiologic loosening (14) (fig. 1a and 2a), pain (10) and secondary protrusion (1). At revision the mean age was 59 years, with a range from 39 to 73 years. The mean migration of the primary cups was 5,2 mm superiorly and 1,5 mm medially (see "Methods"). All cups were easily removed. Four cups were not grossly loose. The bony acetabular defects were classified acccording to D'Antonio[4] : Segmental defects interrupt the continuity of the acetabular hemisphere, and were seen superiorly (3), anteriorly (6), posteriorly (4) and centrally (2). Cavitary defects do not interrupt the continuity and were seen superiorly (6), anteriorly (4), posteriorly (8) and centrally (5). More often a combination of both types was involved. The main defect was diffuse and severe cavitary bone loss, due to osteolysis. While preparing the acetabulum, cement was removed completely except in one case of

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intrapelvic penetration. Bony reaming was performed in ten cases, four acetabula were curetted only. The sclerotic bony surface was left grossly undisturbed, but some bleeding of the cancellous bone was encouraged. Debris and membranes were always removed as thoroughly as possible. In a central segmental defect the membrane was left, so as not to create a free entrance to the pelvic cavity. The grafts consisted mainly of frozen femoral head allografts and, whenever possible, of autologous femoral head grafts in the case of a resurfacing revision. In all cases the grafts were morcelized (nonstructural) and in one case an additional structural graft was used. Once the graft was laid in the acetabular defect, a digital reshape of the acetabulum was performed. Then the grafts were impacted with a metal or plastic cup template. The cup is a CrCo hemisphere, porously coated with sintered beads and bearing two lateral pegs (P.C.A., Howmedica, U.S.A.). The inner diameter of the PE liner is 32 mm. We tried to obtain as complete as possible a contact zone between the bone or graft and the porous coated metal, especially in the posterior area. In four cases, the free lateral cup edge was covered after cup insertion with impacted bone grafts. The lateral pegs were not essential in obtaining cup stability. Exact fit provided sufficient stability in ten cups ; in four cups press fit was needed. Stability of the cup was assessed by attempting to mobilize the inserted cup with a hemostat. At the time of reduction, impaction of the graft mass was observed a few times. Contact between the cup and the living autologous bone was not sought during the procedure but may have occurred after the reduction. The cup size ranged from 52 to 67 mm, averaging 59 mm. During the same procedure, a cementless revision of the femoral component was performed. Weight bearing was not permitted for 6 weeks to 3 months postoperatively.

METHODS

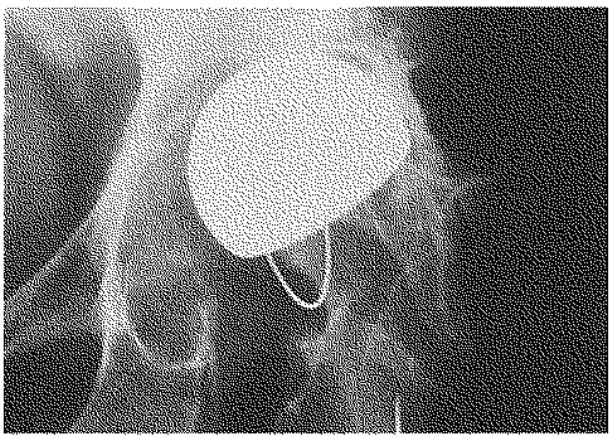
Standard pelvic AP radiographs were used for measurement, of cup migration, a minimal of three and an average of four. The center of rotation (COR) was used as a measurement reference. The vertical component is the perpendicular distance from the COR to the line joining the two teardrops. The horizontal component is slightly more complex to measure : a line is drawn between the teardrop and the outer edge of the sciatic notch. The distance, perpendicular to this line, to the COR is measured. The cup angle is measured between the interteardrop line and the line which links the superior lateral to the inferior medial edge of the cup. Bony changes around the cup consist of sclerosis, trabeculation changes, radiolucency and osteolysis. Loose beads were noted. The acetabular bone around the cup is divided into three equal zones : I, II and III, the latter being the inferior medial one.

RESULTS

The aim of this small retrospective study is a radiologic follow-up evaluation of an exact fit cementless revision cup. The difference in the position of the COR just before and after revision reflects the intraoperative augmentation of bone stock (fig. 1b and 2b). The mean caudalization of the COR was 7.2 mm (ranging from 1 to 17 mm), the mean lateralization was 5.6 mm (ranging from 0 to 14 mm). The revision cup itself underwent a mean migration of 0.4 mm medially (ranging from -4 to 2 mm) and of 0.8 mm superiorly (ranging from -2 to 3 mm). The mean change in cup angle was 0.1° (ranging from -3° to 4°). Loose beads were noted in zone I (around the lateral pegs) in six cups, three of which displayed loose beads on immediate postoperative roentgenograms, and the remaining ones at 3,4 and 6 years postoperatively. In five cups a radiolucency of 2 mm or less was seen in zone III. A radiolucent line surrounding the whole cup and ranging in thickness between 1 and 2 mm, was seen in 2 cups. These radiolucencies were surrounded by sclerotic bone and did not increase in size during the follow-up. In two cases normalization was seen. Two cups showed osteolysis, one in zone II with a defect of 30 by 20 mm and perforation into the pelvis, the other one located in zone I and gradually increasing in size to 6 mm around the pegs. The first postoperative radiologic evidence occurred at 3 years and one year respectively. The lesion in zone II recently showed signs of recovery in terms of reossification. Trabeculation of the bone grafts in zone I was clearly seen in 11 cups. One structural bone graft resorbed completely, without causing significant cup migration.

DISCUSSION

Loss of bone is a major problem when revising the acetabular component of a total hip prosthesis.



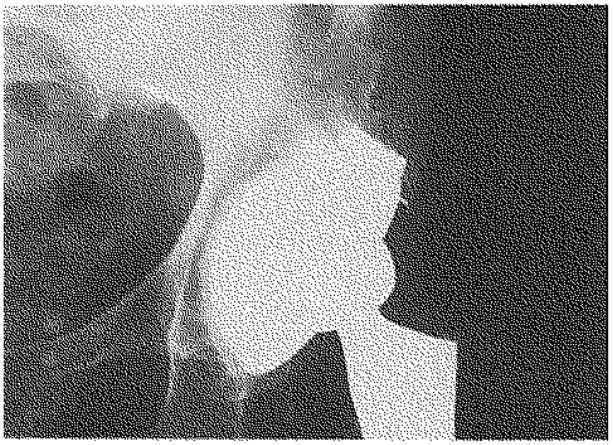


Fig. 1a. — Gross loosening of the acetabular component and loss of bone prior to revision.

b. — Immediate postoperative radiograph showing a morcelized bone graft area around a distalized cup.

c. — Six years after revision there is maintenance of bone augmentation. There is no measurable cup migration. Trabeculation and bone remodelling are evident in zone I. There is a radiolucency of one mm, which has not increased over the last three years, in zone II and zone III.

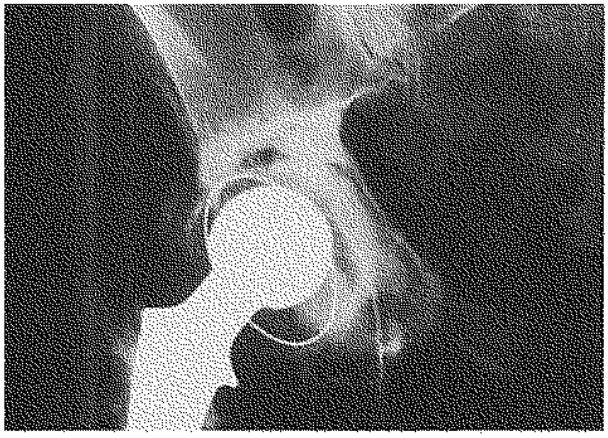


Fig. 2a. — Extensive loss of acetabular bone prior to revision.

b. — Immediate postoperative radiograph.

c. — Seven years after revision there is maintenance of the augmented bone stock. There is no detectable migration of the cup.

PMMA as a substitute is known to result in high failure rates, and cemented cup revision without bone grafts or a reinforcement ring is being abandoned (1, 3, 6). Noncemented cup revision allows removal of bony defects by undersizing or oversizing of the outer diameter of the cup. The former causes a high COR, resulting in a weakened abduction apparatus and the need for using a long neck (4). The latter causes even more bone loss (in case a megacup is used). The combination of a noncemented standard size acetabular component and (morcelized) bone grafts, as used in this series, offers several advantages : augmentation of bone stock (preferable in a young patient), cup ingrowth and restoration of the COR. This ideal could not be entirely met since the average revision cup size was rather large. No prosthetic migration was noted. Evidence of conversion of the graft into living bone was seen in 11 revisions, which showed vertical trabeculation in the weightbearing portion of the acetabulum (zone I) (fig. 1c and 2c).

Rigid initial cup fixation is often not possible when using nonstructural morcelized bone grafts. Screws can enhance intraoperative cup stability, but they could not be used in this particular cup design. Problems have been encountered when using screws for this purpose, e.g. fretting metallosis (12) and backing out of the polyethylene liner (in the case of cup migration). Although structural bone grafts also serve the purpose of improved fixation, early massive graft resorption is a well known phenomenon. Resorption of a structural bone graft can lead to gross loosening in more than 30% of the cups in a minimum of 2 years and a mean of 6 years of follow-up, according to some large series (8, 9). The authors have managed to treat most bone defects, including most segmental deficits, without massive allografts. At the time of revision. osteolysis was found to have created a diffuse, mainly cavitary, loss of bone. Only in one revision case did a truly structural graft have to be used to compensate for a segmental posterior defect.

Osteolytic lesions were seen in two patients, probably as a sign of loosening. These possibly originated from polyethylene wear, which is 2.5 times more frequent in the machined liners that are needed in metal-backed cups, as compared to molded all PE cups (11). Radiolucencies are seen in zone III and are surrounded by sclerotic bone, in this series they tend to stabilize. They are not considered to be a sign of loosening (7), possibly these lesions result from stress shielding and heal once bone remodelling and graft incorporation have occurred. The loose beads, described above, suggest micromovement of an implant but seem unrelated to its loosening (5). Restoration of the COR (a mean loss of 5-2 mm compared to a mean augmentation of 7.2 mm) not only reflects repair of bone stock but also has a biomechanical advantage in terms of a decreased likelihood of prosthetic loosening (2, 10, 13).

CONCLUSION

Restoration of bone stock and cup ingrowth are two major issues when revising the acetabular component of a total hip replacement in a young patient who may suffer significant bone loss. To improve restoration, morcelized bone grafts and a noncemented porous coated cup are a successful combination in the short term. However bony ingrowth remains hard to prove in a noncemented cup. While the long term prognosis of most revision arthroplasties is still uncertain, the importance of rigid fixation devices, such as screws and structural grafts, in the absence of massive segmental bone defects may be questioned. Biologic factors, on the other hand, such as vascularity and osteoinduction are necessary to create a favorable environment for bony ingrowth. Furthermore this technique is able to maintain the bone augmentation achieved during revision surgery.

REFERENCES

1. Barrack R. The results of revision : cement and cementless. 9th Annual Current Concepts in Joint Replacement, Orlando, 1993, 38.
2. Callagan J. J., Salvati E. A., Pellici P. M., Wilson P. D., Ranawat C. S. Results of revision for biomechanical failure after cemented total hip arthroplasty. J. Bone Joint Surg., 1985, 67-A, 1074-1085.
3. Chandler H. Management of acetabular bone deficiency. 9th Annual Current Concepts in Joint Replacement, Orlando, 1993, 35.

4. D'Antonia J. A. Periprosthetic bone loss of the acetabulum : classification and management. Orthop. Clin. N. Am., 1992, 23, 279-290.
5. Davey J. R., Harris W. H. Loosening of cobalt chrome beads from a porous coated acetabular component. Clin. Orthop., 1988, 231, 97-102.
6. Emerson R. H., Head W. C., Berclacich F. M., Malinin T. I. Noncemented acetabular revision arthroplasty using allograft bone. Clin. Orthop., 1989, 249, 30-43.
7. Hedley A. K., Gwen T. A., Ruoff D. P. Revision of failed total hip arthroplasty with uncemented porous coated anatomic components. Clin. Orthop., 1988, 235, 75-90.
8. Jasty M., Harris W. H. Salvage total hip reconstruction in patients with major acetabular bone deficiency using structural femoral head allografts. J. Bone Joint Surg., 1990, 72-B, 63-67.
9. Pollock F. H., Whiteside L. A. The fate of massive allografts in total hip acetabular revision surgery. J. Arthroplasty, 1992, 7, 271-276.
10. Ranawat C. S., Dorr L. D., Inglis A. E. Total hip arthroplasty in protrusio acetabuli and rheumatoid arthritis. J. Bone Joint Surg., 1980, 62-A, 1059-1065.
11. Ritter M. Cemented all poly cups. 9th Annual Current Concepts in Joint Replacement, Orlando, 1993, 13.
12. Salvati E. Metal Debris : a question of magnitude ? 9th Annual Current Concepts in Joint Replacement, Orlando, 1993, 3.
13. Yoder S. A., Brand R. A., Pedersen D. R., O'Gorman T. W. Total hip acetabular component position affects component loosening rates. Clin. Orthop., 1988, 228, 79-87.

SAMENVATTING

N. VAN DER HAUWAERT, L. VANDENBERGHE, M. DEMUYNCK. Niet gecementeerde acetabulumrevisie en botgreffen.

Retrospectief werden 14 cuprevisies van een totale heupprothese radiologisch nagekeken. Het probleem stelt zich van aanzienlijk acetabulair botverlies. We beschrijven een techniek waarbij gebruik wordt gemaakt van een hemisferische poreus beklede cup en gemalen botgreffen. Bijkomende fixatie werd niet gebruikt. Deze methode maakte een behoorlijk herstel in beenderstock mogelijk. Er werd geen significante cupmigratie vastgesteld gedurende en gemiddelde opvolging van 65 maanden.

RÉSUMÉ

N. VAN DER HAUWAERT, L. VANDENBERGHE, M. DEMUYNCK. Reprise par cotyles non cimentés et greffes osseuses.

Quatorze reprises de cupules de prothéses totales de hanche ont été revues rétrospectivement. Dans tous les cas se posait un problème de résorption osseuse massive. Une technique de reprise est décrite ; il s'agit de l'emploi d'une cupule hémispherique recouverte de matériel poreux associée à des greffes osseuses morcelées et sans fixation complémentaire. Cette méthode a permis d'augmenter la réserve d'os. On n'a pas constaté de migration significative de la cupule avec un recul moyen de 65 mois.