Arch Orthop Trauma Surg (1999) 119:288–291

ORIGINAL ARTICLE

W. E. Michael Mikhail · P. F. Wretenberg
L. R. A. Weidenhielm · M. N. Mikhail

Complex cemented revision using polished stem and morselized allograft

Minimum 5-years' follow-up

Received: 18 May 1998

Abstract The aim of this study was to evaluate the results of complex hip revision using a cemented, collarless and polished femoral stem design (CPT, Zimmer, Warsaw, In.) within a tightly impacted morselized allograft. We have now been using the impaction grafting technique in combination with the CPT stem (Zimmer) for 10 years in complex cases of severe bone loss. In this study we have elected to report only those patients who have been revised at least once before revision using the impaction grafting technique. All the patients in the study group have a minimum follow-up of 5 years after the impaction grafting revision. In total, 43 consecutive hips in 40 patients, 22 men and 18 women, with a follow-up time of between 5 and 7 years are included in the study. The complications related to the revised hip consist of three early dislocations managed by closed reduction. Two patients suffered from periprosthetic fracture, both managed with plate osteosynthesis. Two cementless sockets were revised due to aseptic socket loosening. The Endoklinik rating of preoperative bone loss for the revised hips was 2 in 13 hips, 3 in 23 hips, and 4 in 7 hips. During the first year 29 stems subsided 2–4 mm within the cement mantle. In 8 cases, a subsidence of 5–9 mm was measured. The subsidence was nonprogressive, and no subsidence occurred after the 1st year. The Charnley, D'Aubigne, Postel scoring (maximum 6 points) for pain improved from 2.2 points preoperatively to 4.4 postoperatively, function from 2.3 to 4.3, and movement from 2.3 to 4.1. In conclusion, the concept of impaction grafting in THR revision in our study has so far proven to be successful with good clinical results at 5 years despite the relatively high early subsidence of the femoral component.

P. F. Wretenberg (✉) · L. R. A. Weidenhielm
Department of Orthopaedic Surgery, Karolinska Hospital,
S-171 76 Stockholm, Sweden
Tel.: +46-8-51770000, Fax: +46-8-7315156

W. E. Michael Mikhail
Division of Total Joint & Reconstructive Surgery,
Medical College of Ohio, Toledo, OH, USA

M. N. Mikhail
The Mayo Medical School, Rochester, MN, USA

Introduction

Survival after revision total hip arthroplasty (THA) is 10% less than after primary THA [14]. Failure of revision THA, necessitating re-revision, has been reported to be as frequent as 5%–9% at 2–5 years' follow-up, with long-term follow-up of cemented THA revision results being even worse [12]. However, other studies report better results when a second-generation cementing techniques is used [6]. Because of these variable results and the relatively high re-revision rate after cemented THR revisions, other concepts have been tried. Revision surgery of failed THA has been done with pressfit implants without cement. These prostheses rely on initial fixation and stability of the implant in order to permit bony ingrowth [1, 8]. Some reports have supported the use of cementless femoral stems for revision [11], including extensively coated stems for which distal fixation is likely [5]. Others have obtained satisfactory reconstruction of the proximal femur with the use of a custom prosthesis [15], osteoarticular whole-joint allografts [10] or femoral strut grafts [18].

A different approach is the insertion of a polished tapered stem with cement into a femoral canal that has been tightly packed with morselized bone allograft [3, 7, 9, 13, 17, 21]. Use of cement in combination with tight packing of morselized cancellous bone graft was first reported for acetabular revision [19], and the technique was later further developed and used for femoral revision [7, 13]. We adopted the technique in 1988, using the cannulated instrumentation, which made the surgical outcome more reproducible and predictable [17, 21]. It has been shown that with this technique of impaction of morselized allograft, the proximal bonestock can actually, at least partly, be restored [13]. The early follow-up results have been encouraging. However, a relatively high rate of femoral component subsidence has been reported, and concerns have been expressed that this subsidence might lead to

loosening and clinical failure of the implant with time [16]. There are only a few reports on the intermediate and long-term clinical results available in the literature [3, 9]. We have now been using this technique in combination with the CPT stem (Zimmer, Warsaw, IN) for 10 years in complex cases with severe bone loss. In this study we have elected to report only cases that have been revised at least once before revision using the impaction grafting technique. All the patients in the study group have been followed up for a minimum of 5 years after the impaction grafting revision.

Patients and methods

This revision technique was used in patients with aseptic mechanical failure of cemented and cementless femoral stems, regardless of their length, and bone loss of the proximal femur with cortical defects and thinning from stress shielding and wear-induced osteolysis. In these revisions, the proximal femur was usually only a thin cortical shell. The prerequisite for the procedure was that an intact "tube" could be reconstructed, and the defects were covered with strut grafts and/or wire mesh to allow for tight packing of the bone graft and stable fixation of the femoral component in the impacted graft. Osteolytic lesions in the distal part of the femur or around long stems did not contraindicate this procedure. In these cases, however, the femur was often reinforced with cortical strut grafts. The surgical technique used for the revision hip arthroplasty has been described earlier [21] and will be summarized. Exposure of the hip was performed through a direct lateral approach, with the patient on the contralateral side. The femoral canal was cleaned of any old cement, fibrous membrane, or particulate debris. Defects in the cortex were patched with fine metal mesh or with strut allograft secured with cerclage wires, or both, before the canal was packed with cancellous bone graft. Prophylactic wiring of the femur was performed before packing when the integrity of the cortical bone was judged to be tenuous. A guide-wire was threaded into a stiff medullary plug that was driven distal to the areas of lytic bone. The femoral canal was then packed with morselized fresh-frozen allografts using cannulated tamps, where all the tamps were oversized in relation to the corresponding stem to allow for a minimum cement mantle of 2 mm. A femoral "neomedullary" canal with a 5–6-mm-thick layer of bone graft was rebuilt before cementing the stem of the appropriate size. The packed femoral canal was filled with cement which was pressurized using a proximal femoral seal, and pressure was maintained until the cement reached a doughy consistency. A centralizer was attached to the distal end of the implant before it was inserted. When the socket was loose, it was revised. Defects in the acetabulum were managed using the impaction grafting technique [19]. In most cases, an uncemented socket was inserted, fixated by pressfit and two or three cancellous screws. An example of a case before and after revision is shown in Fig. 1.

In general, the patients were mobilized immediately after surgery with partial weight-bearing for 6 weeks and as tolerated thereafter. Patients with substantial preoperative bone loss near the stem tip were instructed to limit their activities until the osteolytic lesion was completely healed. Two patients were treated in brace for 4 and 6 weeks postoperatively, respectively, because of the postoperative risk for dislocation. The median hospital stay was 9 days.

Forty-seven hips fullfilled the inclusion criteria. The hips had been revised at least once before and had been followed up for a minimum of 5 years.

All the operations were performed by one of the senior authors (W.E.M.M.). All patients he operated on using impaction grafting THR revisions have routinely been followed by him with clinical and radiographic examinations every 3 months during the 1st postoperative year and annually thereafter. Concerning the patients in the study group, the clinical examination at the 5-year review and assessment of the radiographs were done by an independent observer who had not been involved in the treatment of these patients. For the clinical assessments, the Charnley, D'Aubigne-Postel scoring for pain, function, and movement (grading 0–6 points, 6 being the best) was used preoperatively and at the follow-up examination [2]. The radiographic examinations included an anteroposterior (AP) and a lateral view of the hip.

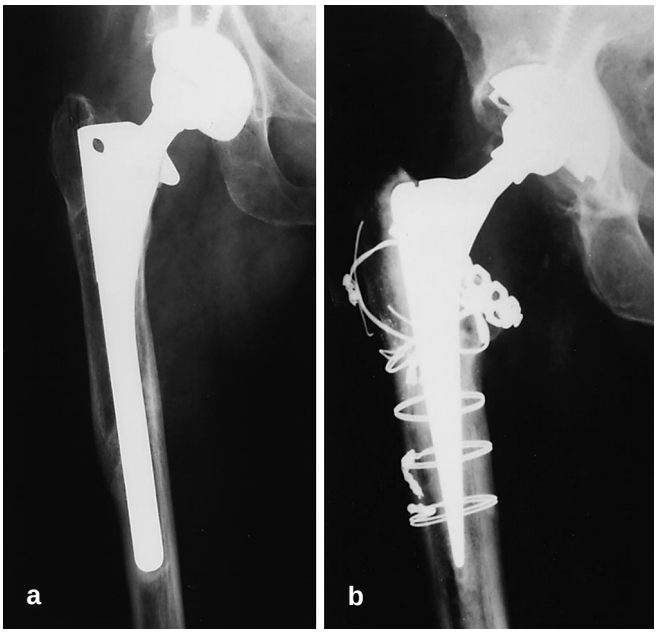

Fig. 1 **a** Patient with severe osteolysis before revision. **b** Result after revision with impaction grafting technique

The serial radiographs of each patient were examined for preoperative loss of bone stock, postoperative stem subsidence, radiolucent zones, postoperative cortical new bone formation and/or trabecular lines indicating trabecular remodeling, resorptive areas, or any other change in appearance. Classification of the femoral bone stock before revision was done using the Endoklinik grading system [4].

Results

Clinical results

Five patients of the original 45 were lost to follow-up, because of reasons unrelated to the operated hip. This left 43 hips in 40 patients, 22 men and 18 women, who constituted the study group. Their average age was 59 years (range 47–84 years). The right side was revised in 23 cases and the left in 20 cases. Twenty-four hips were revised twice, 15 hips three times and 4 hips four times. In 17 cases, the socket was also revised due to loosening; 6 of these were uncemented fixed with at least 2 screws. In 11 of these cases, cancellous bone graft was used to reconstruct the acetabulum; 3 were cemented all-polyethylene cups, and 8 were uncemented cups fixed with at least 2 screws and resting on approximately 70% host bone. The Charnley, D'Aubigne-Postel scoring for pain improved from 2.2 points preoperatively to 4.4 postoperatively, function from 2.3 to 4.3, and movement from 2.3 to 4.1. The follow-up period ranged from 5 to 7 years.

Radiographic results

The Endoklinik rating of the revised hips was 2 in 13 hips, 3 in 23 hips, and 4 in 7 hips. During the first year, 29 stems subsided 2–4 mm within the cement mantle. In 8 cases, a subsidence of 5–9 mm was measured. The subsidence was nonprogressive, and no subsidence occurred after the 1st year. Trabecular remodeling and cortical new bone formation were seen in the majority of cases. However, this finding is subjective and hard to quantify numerically data.

The impaction grafting technique, where the cement penetrates into the impacted graft that often cannot be separated from the host bone, produces a postoperative radiographic appearance that makes conventional zonal analysis hard to interpret. No complete radiolucent zones around the femoral component were seen, but incomplete zones of less than 2 mm width were seen occationally. These radiolucent zones were nonprogressive and were considered clinically insignificant.

Complications

The complications related to the revised hip consisted of three early dislocations, one due to disorientation after developing a cerebrovascular accident. All dislocations were treated successfully by closed reduction. Two patients sustained periprosthetic femoral fractures after trauma (a fall). The fractures occurred at the tip of the femoral stem. Both were treated with open reduction and plate osteosynthesis, and both femoral components were stable at surgery. One fracture healed after 5 months. The other suffered a wound infection which had to be treated by surgical revision, healing was delayed, but the fracture did heal after 7 months, and the prosthesis was not re-revised. Two cementless Harris-Galante sockets were revised due to aseptic loosening, one after 2 years and one after 3 years. In five cases, the prophylactic wires were removed because of trochanteric bursitis.

Discussion

Failure of revision THA, necessitating re-revision, has added to the complexity of these already challenging cases, and re-revision rates of 5%–9% at 2–5 years have been reported [11]. The results reported by Estok and Harris [6] show that by using a second-generation technique, the results are much better with a survival of 90% at an average follow-up time of 11.7 years. The variable results after revision THR can probably be explained by the greater variety of problems in revision cases compared with primary THR. One concept is probably not sufficient to solve all these problems, and consequently alternative concepts have been developed.

Loss of bone from the proximal part of the femur is encountered relatively often during revision arthroplasties, and in addition to restoring adequate joint function, it is in these cases an advantage if the revision arthroplasty can also conserve or even restore bone in the proximal aspects of the femur. One method currently available for restoring bone in the proximal part of the femur is supplemental grafting [13]. The results demonstrated remodeling of bone and at least partial restoration of bone stock in the proximal femur. Strut grafts or massive proximal femoral grafts may be helpful in some patients, but are unlikely to become fully incorporated during the patient's lifetime. We have used strut grafts as a mechanical support in some cases to restore the proximal femoral canal, because it is necessary to convert the femur to an intact tube to be able to impact the cancellous bone graft. Other patients had large substantial preoperative bone loss near the stem tip, with an increased risk for femoral fracture. Prevention of fracture was achieved using strut grafts and fine metal mesh secured to the femur with cerclage. These patients should be instructed to limit their activities until healing of the osteolytic lesions has taken place. There may be a place for a longer stem in certain cases, but we are opposed to the routine use of long stems in this procedure. A long stem increases the risk for distal fixation and proximal stress shielding. The idea of impaction grafting of the femur using a short polished collarless tapered stem is to load the proximal femur. We think that this is important for graft incorporation and formation of new bone.

Concerns have been expressed that the relatively high subsidence of the femoral component that has been reported after impaction grafting with a collarless polished tapered stem may lead to a high number of clinical failures. However, out of the 43 hips evaluated with a minimum follow-up of 5 years, none has so far been revised due to aseptic loosening of the femoral component. Eight cases have shown subsidence of the stem of 5–9 mm, but none of these patients had any clinical problems. The subsidence was not progressive nor associated with bone resorption, and no subsidence that could be measured with conventional radiographs occurred after the 1st postoperative year. The radiographs have also in some cases shown evidence of trabecular remodeling and cortical hypertrophy.

The costs for the bone grafts from the local hospital bone bank were in our cases between US $ 1200 and 1500. In any surgical procedure, the results are dependent on patient selection. The impaction grafting technique in THR revision is associated with higher costs since bone grafts are used, and we did not want to study cases that could have been managed successfully using a cheaper concept. Therefore, we chose to only include cases that had been revised at least once before. This inclusion criterion generated a series of quite complicated cases. The complications in this series of complex revision cases consisted of two patients with aseptic socket loosening and two patients with periprosthetic femoral fractures. The three early dislocations were due to noncompliant patients and one patient who developed a cerebrovascular accident; all three dislocations were successfully treated by closed reduction.

The quite favorable results in this series of patients support the findings of Gie et al. [9], who reported on 7 years' experience with 68 patients.

We are aware that other stem designs have been used with impaction grafting and that the short-term results seem to be favorable. We cannot at this moment say that the impaction grafting technique requires the polished tapered design, but we feel that it is of importance for the results. Our opinion is also that the concept of impaction grafting in THR revision has so far proven to be successful with good clinical results at 5 years despite the high early subsidence of the femoral component.

References

1. Callaghan JJ (1993) The clinical results and basic science of total hip arthroplasty with porous-coated prosthesis. J Bone Joint Surg [Am] 75: 299–304
2. Charnley J (1972) The long-term reults of low-friction arthroplasty of the hip performed as a primary intervention. J Bone Joint Surg [Br] 54: 61–76
3. Elting JJ, Mikhail WEM, Zicat BA, Hubbell JC, Lane LE, House B (1995) Preliminary report of impaction grafting for exchange femoral arthroplasty. Clin Orthop 319: 159–167
4. Engelbrecht E, Heinert K (1987) Klassifikation und Behandlungsrichtlinien von knockensubstansverlusten bei Revisionsoperationen am Hüftgelenk – mittelfristige Ergebnisse. In: Endolink, Hamburg (eds) Primare und revisionsalloartroplastik. Springer, Berlin Heidelberg New York, pp 189–201
5. Engh CA, Glassman AH, Griffin WL, Mayer JG (1988) Results of cementless revision for failed cemented total hip arthroplasty. Clin Orthop 235: 91–110
6. Estok DM, Harris WH (1994) Long term results of cemented femoral revision surgery using second-generation techniques. An average 11.7-years follow-up evaluation. Clin Orthop 299: 190–202
7. Fowler JL, Gie GA, Lee AJ, Ling RS (1988) Experience with the Exeter total hip replacement since 1970. Orthop Clin North Am 19: 477–489
8. Galante JO, Jacobs J (1992) Clinical performance of ingrowth surfaces. Clin Orthop 276: 41–46
9. Gie GA, Linder L, Ling RSM, Simon J-P, Slooff TJJH, Timperley AJ (1993) Impacted cancellous allograft and cement revision total hip arthroplasty. J Bone Joint Surg [Br] 75: 14–21
10. Gitelis S, Heligman D, Quill G, Piasecki P (1988) The use of large allografts for tumor reconstruction and salvage of the failed total hip arthroplasty. Clin Orthop 231: 62–70
11. Hedley AK, Gruen TA, Ruoff DP (1988) Revision of failed total hip arthroplasties with uncemented porous-coated anatomic components. Clin Orthop 235: 75–90
12. Huo MH, Friedlaender GE, Salvati EA (1992) Bone graft and total hip arthroplasty. J Arthroplasty 2: 109–120
13. Ling RSM, Timperley AJ, Linder L (1993) Histology of cancellous impaction grafting in the femur. J Bone Joint Surg [Br] 75: 693–696
14. Malchau H, Herberts P (1998) Prognosis of total hip replacement. Revision and re-revision rate in THR. Presented at AAOS, February 19–23, New Orleans, USA
15. Malkani AL, Sim FH, Chao EY (1993) Custom-made segmental femoral replacement prosthesis in revision total hip arthroplasty. Orthop Clin North Am 24: 727–733
16. Meding JB, Ritter MA, Keating EM, Faris PM (1997) Impaction grafting before insertion of a femoral stem with cement in revision total hip arthrooplasty. J Bone Joint Surg [Am] 79: 1834–1841
17. Mikhail WEM, Timperley AJ (1994) Tight packing marcelized allograft: new method for managing bone lysis. Orthop Special Ed 3: 21–22
18. Nelson IW, Bulstrode CJK, Mowat AG (1990) Femoral allografts in revision of hip replacement. J Bone Joint Surg [Br] 72: 151–152
19. Slooff TJ, Huiskes R, Horn J van, Lemmens AJ (1984) Bone grafting in total hip replacement for acetabular protrusion. Acta Orthop Scand 55: 593–596
20. Sloof TJJ, Buma P, Gardeniers B, Schreurs BW, Schimmel JW, Huiskes R (1988) Revision of the acetabular component: bone packing. In: Callaghan JJ, Rosenberg AG, Rubash HE (eds) The adult hip. Lippincott-Raven, Philadelphia, pp 1449–1459
21. Weidenhielm LRA, Neilessen RGHH, Mikhail WEM, Bauer TW (1994) Surgical technique and early results in revision THA with cemented, tapered, collarless, polished stem and contained morselized allograft. J Orthop Techn 2: 113–122