International Orthopaedics (SICOT) (1998) 22:161–164

International
Orthopaedics
© Springer-Verlag 1998

Impaction grafting and acetabular reinforcement in revision hip replacement

R.P. Pitto[1], **G.V. Di Muria**[2], **D. Hohmann**[1]

[1] Orthopädische Klinik der Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
[2] II Clinica Ortopedica, Universita' di Firenze, Italy

Accepted: 6 January 1998

Summary. *A substantial loss of bone stock is frequently encountered at revision of a hip replacement. A mix of autologous and homologous bone chips is a biological method of filling the cavities. Reinforcement implants can be used to anchor the new prosthesis and to impact the bone graft, protecting it during healing. The goals of this study were to evaluate the clinical and radiological results after revision of cups with aseptic loosening. Follow-up examination of 81 revisions in 78 patients at 6.5 years (range 3 to 9 years) showed that 93% of the patients were satisfied with their results. One patient underwent a further revision because of recurrent dislocation of the femoral head, and one had a superficial infection. All the grafts were fused at 3 months after the operation. The bone stock had increased in every case, but 6 of them show some degree of graft resorption. No implant showed impending signs of loosening. These results were encouraging. The reinforcement implants allow sufficient primary fixation and secondary stability can be achieved with the impaction grafting. Careful preoperative evaluation and assessment at operation is important to match bone defects with the grafts and selection of the prosthesis.*

Résumé. *Lors d'arthroplastie de revision un defaut de stock osseux est souvant constaté. Un melange d'os morcellé autogreffe est une solution biologique pour combler les cavités. Des anneaux de soutien peuvent être utilisés pour fixer la nouvelle prothèse et pour impacter les greffons osseux pour les proteger durant la periode de guérison. Les buts de cette étude étaient d'évaluer la stabilité primaire des anneaux de soutien et d'évaluer les resultats cliniques et radiographiques de cupules revisées suite à descellement aseptique. Le contrôle et suivi de 81 revisions pour 78 patients à 6.5 ans (min. 3 – max. 9) montrait que tous sauf 6 étaient satisfait de leurs resultat. Un patient eut une seconde revision dû à une luxation recurente et l'autre avec une infection superficielle. Toutes les greffes étaient soudé 3 mois après l'operation; le stock osseux avait augmenté dans tous les cas, mais 6 d'entre eux avait mis en evidence un certain degrés de resorbtion du greffon. Aucun implant ne montrait un signe de descellement. Ces resultats precoces sont encourageant. Les annaux amènnent une stabilité primaire suffisante. Une évaluation préoperative prudente, une investigation intraoperative pour constater les défauts osseux, les échantillons de greffon et les anneaux de soutiens sont d'une importance capitale.*

Introduction

A substantial loss of bone stock is frequently encountered during revision of a hip replacement [5, 6, 10]. Autologous and homologous cancellous bone chips can be used to fill the cavities in the expectation that incorporation with the host bone will improve the bone deficiency [8, 14, 22]. Reinforcement implants have been developed to achieve stable initial fixation of the new prosthesis and protect the bone grafts during healing [17].

The purpose of this study was to assess the clinical and radiological outcome in a group of patients with aseptic loosening of the acetabular component who underwent revision surgery using impaction grafting and reinforcement acetabular implants.

Reprints requests to: R.P. Pitto, Orthopädische Klinik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Waldkrankenhaus, Rathsbergerstrasse 57, D-91054 Erlangen, Germany

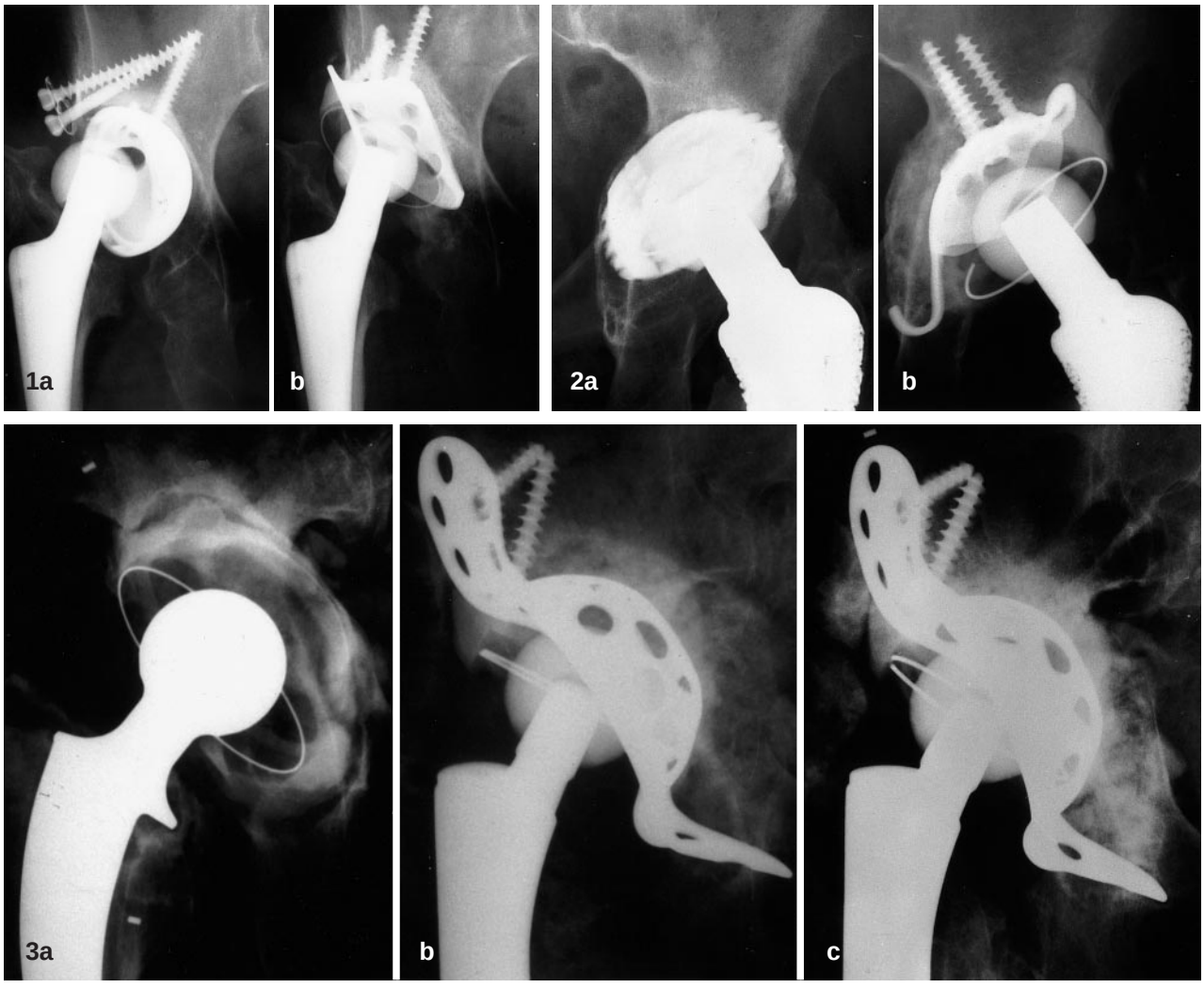

Fig. 1. a Preoperative radiograph showing dislocation of an uncemented press-fit socket with osteolysis. Acetabuloplasty had been performed at the time of primary total hip replacement using the autologous femoral head. **b** Revision using cancellous chips of autologous/homologous bone and a Müller reinforcement ring. The graft was incorporated and the implant stable 5 years after surgery

Fig. 2. a Radiograph showing aseptic loosening of an uncemented screwed acetabular component and severe loss of bone stock. Proximal migration and protrusion of the implant has occurred. **b** Nine years after impaction grafting using cancellous chips of autologous/homologous bone and a Ganz reinforcement ring with a hook to reconstruct the acetabulum. The implant is stable and the graft consolidated.

Fig. 3. a Aseptic loosening of a cemented socket with protrusio and severe loss of bone stock. **b** Radiograph one year after revision impaction grafting and a Burch-Schneider reinforcement cage. **c** Radiograph at the 5 year follow-up. The graft is completely integrated with the host bone at the lateral quadrant of the acetabulum

Material and method

From January 1988 to June 1994, 95 revisions of hip replacements in 92 patients were carried out using autologous and homologous bone grafting, and reinforcement acetabular implants in cases with aseptic loosening of the acetabular component and severe loss of bone stock. The mean age of the patients at the time of the revision was 60 years (±9 years). Of the revised sockets, 54 were cemented and 41 were uncemented. The femoral component was also revised in 75 hips (71 patients). At the time of the index operation, 11 patients (11 hips) had already undergone one revision of the cup and 10 patients (10 hips) had two exchanges.

The acetabular bone stock defects were classified according to the criteria of D'Antonio et al. [3]. The reinforcement ring of Müller (Protek, Münsingen, Switzerland) was used in 12 hips with type I segmental defects, in 15 with type II cavitary defects of the medial wall and the acetabular rim, and in 17 cases with a high secondary centre of rotation (type II, segmental-superior) (Fig. 1). The reinforcement ring with a hook of Ganz (Protek, Münsingen, Switzerland) was implanted in 16 cases with severe protrusion (type I), in 14 cases with complete segmental defects of the iliopubic column (type I) and in 3 cases with pelvic discontinuity (type IV) (Fig. 2). The reinforcement cage of Burch-Schneider (Protek, Münsingen, Switzerland) was used in 16 cases with combined bone stock defects (type III) and in 2 hips with pelvic discontinuity (type IV) (Fig. 3).

Surgical technique

The hip was exposed through an iliofemoral approach in 27 cases, through a direct lateral approach in 38 cases and

through a posterolateral approach in the remainder. Special care was taken to remove as little bone as possible. Irregular contours of the acetabulum were reamed only to provide a better seating for the revision implant. The autografts were usually taken from the anterior iliac crest. When there were large defects the grafts were obtained from the posterior iliac crest or the contralateral femoral head where simultaneous primary total hip replacement was undertaken. Thin sleeves (2–3 mm) of fresh femoral heads received from the local bone bank were sterilised (120° C for 20 min) after removal of fat, cartilage and bone marrow. The bone was morselized into chips of about 0.5 cm^3 using a rongeur during operation and mixed with chips of the autografts (mean ratio 2.1). The quantity of allograft used varied from 1 to 3 femoral heads per patient. The bone was placed into the acetabulum and impacted with a punch. The reinforcement implant was then fixed with at least 3 fully threaded 6.5 mm cancellous screws to buttress the grafts and achieve initial stability. Our aim was to obtain the most extended possible contact of the implant with the host bone in the anatomical position. A polyethylene cup (Protek, Münsingen, Switzerland) was cemented (Palacos-R, Merck, Darmstadt, Germany) and correctly oriented into the ring with 40° of abduction and 10° to 15° of anteversion.

The mean stay in hospital of the patients was 16 days (±4 days). Partial weightbearing was allowed after operation with 2 crutches for 12 weeks.

The clinical outcomes were analysed using the hip score of Merle D'Aubigné and Postel, modified by Charnley [2]. The radiological results were assessed according to the criteria of the American Academy of Orthopaedic Surgeons [9]. The classification of Stringa and Mignani modified from Khüne et al. [12] was used to analyse the appearance of the bone grafts.

Results

At the time of review, at least 3 years after operation, 5 patients had died and 9 could not be traced or were unable to attend. Thus, 78 patients (81 hips) had a complete clinical and radiological examination. The mean follow-up was 6.5 years (range 3 to 9 years). Thirty-six Müller reinforcement rings, 30 Ganz rings and 15 Burch-Schneider cages were assessed.

The Merle d'Aubigné-Postel-Charnley hip score improved after revision from a mean of 9.3 to 14.8. No patient could walk for longer than 15 minutes before the index operation and 87% of them needed 2 crutches. After revision, 41 patients had normal function, 21 used a cane for long distances and the remaining cases needed 2 crutches. Ninety percent of the patients complained of pain before revision and needed analgesic drugs. There was a consistent relief of pain after revision (mean preoperative value 2.8, mean follow-up value 5.1). The range of motion was more than 160° in 84% of the cases followed up (mean preoperative value 3.7, mean follow-up value 5.0). The clinical results were excellent in 23% of the cases, good in 43%, satisfactory in 27% and unsatisfactory in 7%.

There was a complete radiolucent line at the bone-implant interface of the socket without signs of progress or migration in 3 hips (4%). Radiolucency was seen in only one quadrant of the acetabulum in 10 cases (12%); there were no signs of migration of these components. In the remainder, the interface between implant and bone showed no radiolucent lines.

The bone stock was improved in all cases. The graft appeared radiologically fused and alive in most hips. Signs of resorption were present in the lateral quadrant in 6 sockets (7%). The first signs of bony remodelling (stage 6) could be observed in all grafts within 3 months of operation. Definite radiological bone healing with bridging of the trabeculae at the host bone/graft interface (stage 8) occurred uneventfully within the first year after operation.

A lesion of the obturator artery occurred in one case, and transitory palsy of the femoral nerve in 2. Another patient developed transitory symptoms after the operation due to stretching of the sciatic nerve. One patient developed signs of deep infection 2 weeks after operation and had a further successful surgical procedure without removal of the prosthesis. Dislocation occurred in 3 hips and reduction was obtained conservatively in 2 of them. One hip was revised because of malposition of the polyethylene cup.

Discussion

The reconstruction of acetabular bony defects is one of the most difficult challenges in revision hip surgery [5, 15, 19]. The use of impacted, morselized grafts is a biological way of solving the problem [22]. Reinforcement implants which bridge the defect provide support for the acetabulum and allow bone grafting in an area protected from excessive stress [16, 21]. The quantity of autologous bone available for reconstruction is limited and the harvesting procedures are not free of complications. The use of mixed grafts can be helpful when there is a large bony defect. Allografts allow complete filling of these cavities and their osteoconductivity can improve the healing process, but the best methods of preservation and preparation of the bone are still controversial [18, 23, 25].

Post-mortem retrieval analysis and core biopsies after acetabular reconstruction with allografts show progressive incorporation, but the radiological prediction of fusion is not accurate [8]. Nevertheless, radiological examination remains the standard method of assessing the state of the grafts. Scintigraphy can be difficult to interpret because of artefacts due to the presence of the implant, and this can also be a problem in computerised tomography or magnetic resonance imaging.

The radiological appearance of the mixed grafts during the healing phase observed in our study corresponded with that seen with pure autografts [24].

The mid-term outcomes of revision with reinforcement components [1, 7, 13, 16, 20, 21, 26] or similar devices [4, 11] have been encouraging. The present investigation showed similar satisfactory results concerning the mechanical stability of the prosthesis, and confirm the in-vitro findings of a previous study [17]. Failures are mainly due to technical errors [13]. Implantation using correct surgical technique is of paramount importance. Levai et al. and Zehntner and

Ganz stated that durability of the reconstruction can be only expected if support of the revision prosthesis is provided by host bone [26].

There are grounds for cautious optimism for the use of impaction grafting and reinforcement components in acetabular revision surgery with severe bone stock defects. Careful preoperative evaluation and intraoperative assessment to match the bony defects, grafting patterns and prosthesis are essential to achieve stable fixation.

References

1. Berry DJ, Müller ME (1992) Revision arthroplasty using an antiprotrusio cage for massive acetabular bone deficiency. J Bone Joint Surg [Br] 74:711–715
2. Charnley J (1979) Low friction arthroplasty of the hip. Springer, Heidelberg New York
3. D'Antonio JA, Capello WN, Borden LS, Bargar WL, Bierbaum BF, Boettcher WG, Steinberg ME, Stulberg SD, Wedge JH (1989) Clin Orthop Rel Res 243:126–137
4. Eichler J (1993) Über einen Stützring zur Verankerung der Kunststoffpfanne für die operative Behandlung der Protrusio acetabuli. Med Orthop Tech 93:28–31
5. Engelbrecht DJ, Weber FA, Sweet MBF, Jakim F (1990) Long term results of revision total hip arthroplasty. J Bone Joint Surg [Br] 72:41–45
6. Engh CA, Glassman AH, Griffin WL, Mayer JG (1988) Results of cementless revision for failed cemented total hip arthroplasty. Clin Orthop Rel Res 235:91–110
7. Haentjens P, Handelberg F, Casteleyn PP, Opdecam P (1986) The Müller acetabular support ring. A preliminary review of indications and clinical results. Int Orthop (SICOT) 10:223–230
8. Heekin RD, Engh CA, Vinh T (1995) Morselized allograft in acetabular reconstruction: a postmortem retrieval analysis. Clin Orthop Rel Res 319:184–190
9. Johnston RC, Fitzgerald RH, Harris WH, Poss R, Müller ME, Sledge CB (1990) Clinical and radiographic evaluation of total hip replacement. J Bone Joint Surg [Am] 72:161–168
10. Kavanagh BF, Fitzgerald RH Jr (1987) Multiple revisions for failed total hip arthroplasty not associated with infection. J Bone Joint Surg [Am] 69:1144–1149
11. Kerboul M (1985) Les réinterventions pour descellement aseptique des prothèses totales de hanche. La reconstruction du cotyle. In: Arthroplastie totale de hanche. Springer, Berlin Heidelberg New York 89–96
12. Kühne J-H, Refior HJ, Jansson V, DeToma G, Liepold K-P, Verpoorten U (1994) Erste klinische Ergebnisse mit wärmebehandelten homologen Knochentransplantaten. Z Orthop 132:102–111
13. Levai JP, Boisgard S (1996) Acetabular reconstruction in total hip revision using a bone graft substitute. Clin Orthop Rel Res 330:108–114
14. Marti RK, Schüller HM, van Stein MJA (1994) Superolateral bone grafting for acetabular deficiency in primary hip replacement and revision. J Bone Joint Surg [Br] 76: 728–734
15. Morscher EW, Dick W, Seelig W (1989) Revisions-Arthroplastik des Hüftgelenkes mit autologer und homologer Spongiosa. Orthopäde 18:428–437
16. Müller ME (1981) Acetabular revision. In: The hip. Proceedings of the 9th Open Scientific Meeting of the Hip Society. Mosby, St Louis, pp 46–56
17. Pitto RP (in press) Primary stability of acetabular reinforcement implants in revision surgery. Chir Organi Mov
18. Resnick L, Veren K, Salahuddin Z, Tondreau S, Markham PS (1986) Stability and inactivation of the HTLV-III/LAV under clinical and laboratory environments. JAMA 255: 1887–1891
19. Retpen JB, Varmarken JE, Röck DN, Jensen JS (1992) Unsatisfactory results after repeated revision of hip arthroplasty. Acta Orthop Scand 63:120–127
20. Rosson J, Schatzker J (1992) The use of reinforcement rings to reconstruct deficient acetabula. J Bone Joint Surg [Br] 74:716–720
21. Schneider R (1982) Die Totalprothese der Hüfte. Huber, Bern Stuttgart Wien
22. Slooff TJJH, Huiskes R, Van Horn J, Lemmens AJ (1984) Bone grafting in total hip replacement for acetabular protrusion. Acta Orthop Scand 55:593–596
23. Spire B, Dormont D, Barré-Sinoussi F, Montagnier L, Chermann JC (1985) Inactivation of lymphadenopathy-associated virus by heat, gamma rays and ultraviolet light. Lancet I:188–189
24. Stringa G, Pitto RP, Di Muria GV, Marcucci M (1995) Total hip replacement with bone grafting using the removed femoral head in severe acetabular dysplasia. Int Orthop (SICOT) 19:72–76
25. Wagner M, Pesch H-J (1989) Autoklavierte Knochenspäne beim Prothesenwechsel an der Hüfte. Orthopäde 18: 463–467
26. Zehntner MK, Ganz R (1994) Mid term results (5.5–10 years) of acetabular allograft reconstruction with the acetabular reinforcement ring during total hip revision. J Arthroplasty 9:469–479