

Bone grafting in total hip replacement for acetabular protrusion

Total hip replacement combined with acetabuloplasty was performed in 43 hips in 40 patients with protrusion secondary to arthrosis, rheumatoid arthritis or trauma. Depending on the acetabular defect, the acetabuloplasty encompassed reinforcement of the medial wall with bone grafts, vitallium meshes, protrusion rings and cups. The clinical and radiographic results were uniformly good on average 2 years postoperatively. All grafts appeared to be united and incorporated, without evidence of resorption. The only patient suffering from pain had radiographic signs of progressive varus migration of the femoral component.

Tom J. J. H. Slooff
Rik Huiskes
Jim van Horn
Albert J. Lemmens

Departments of Orthopaedics and Radiology, Sint Radboud Hospital, University of Nijmegen, NL-6500 HB Nijmegen, The Netherlands

A variety of surgical techniques have been described to restore the lack of bone support in acetabular protrusion secondary to disease or a failed arthroplasty. Metal devices to redistribute the stresses and to reinforce the medial wall were developed by Eichler (1973), Harris & Jones (1975) and Schneider (1980). The application of acrylic cement was suggested by Sotelo-Garza & Charnley (1978), whereas Parker & Hastings (1974) and McCollum & Nunley (1978) preferred bone grafts; the autogenous femoral head can be used for previously unoperated hips, or else autogenous iliac bone or allografts.

This paper describes the results of total hip replacement combined with acetabuloplasty for acetabular protrusion.

Patients and methods

During the period January 1978-January 1983, 43 hips had total hip replacement and bone grafting for protrusion of the acetabulum secondary to arthrosis (23 hips), rheumatoid arthritis (15 hips), and trauma (5 hips); 21 of these arthroplasties were primary procedures and 22 were secondary to failure of previous arthroplasties (16 total hip replacements, four surface replacements, and two hemiarthroplasties).

There were 29 females and 11 males; three patients had bilateral operations; and the age range was 21-82 years (Table 1).

In all cases the indications for surgery were pain, progressive functional disability and radiographic evidence of progressive destruction of bone stock, re-

sulting in protrusion as assessed by Köhler's line and disruption of Shenton's line.

The presence of infection was excluded by clinical investigation, serial ESR and pre- and intra-operative aerobic and anaerobic cultures.

Surgical techniques

The severity of the distortion of the normal anatomy and the size and location of the bone stock deficiency were assessed radiographically. The acetabulum was prepared carefully, notably in cases where bone cement from previous arthroplasties had to be removed. In the case of a defect in the medial wall, a cortico-cancellous graft was pressed into the acetabulum to close the gap. After curetting the acetabulum, the graft was surrounded by a wall of cancellous bone chips, moulded and impacted by using the socket trial prosthesis. In this way the acetabular cup was positioned more laterally and distally. Anchorage holes were punched in the acetabular roof and in the graft, which was then covered with a metal mesh. After irrigation with cooled Ringer solution and drying the socket, the prosthesis was ce-

Table 1. Etiology of acetabular protrusion in 43 reconstructed hips

	Primary procedure		Secondary procedure	
	No.	Age	No.	Age
Arthrosis	10	62 (49-79)	13	56 (31-81)
Rheumatoid arthritis	9	44 (21-65)	6	56 (45-68)
Trauma	2	36 (31-41)	3	56 (31-82)
Total	21		22	

Results

All patients but one were pain-free; this patient was unable to put his full weight on the affected hip, and radiographically the femoral component had migrated in varus position; the graft did show signs of union. In only five cases was a radiolucent line evident between the bone cement and the graft. The presence of this line was regarded as normal as it was less than 1 mm in width in all five cases. Radiographic examination showed union of the grafts in all cases.

In all cases a homogeneous structure developed between 2 and 4 months after the operation. Progression of the protrusion and resorption of the grafts were not found. The average consolidation time varied between 3 and 4 months, apparently regardless of type of graft.

Discussion

The technical procedure of total hip replacement combined with acetabuloplasty for protrusion has been well described (Harris & Jones 1975, Salvati et al. 1975, McCollum & Nunley 1978, 1980, Schatzker et al. 1979, Schneider 1980). All authors stress the necessity of repairing and reinforcing the medial wall of the acetabulum and recommend that the acetabulum should be placed in the normal anatomical position. This is important in order to restore normal leg length, to improve the range of motion, and to shift the weight-bearing areas under the acetabular roof (Schatzker et al. 1979). To reconstruct the acetabulum, autogenous bone as well as allografts seemed to be adequate, although metal reinforcements may be helpful; in three cases protrusio rings of the Eichler type and in 33 cases vitallium rigid mesh were used. There are several reasons for using this mesh: in cases of protrusion the acetabulum is weakened, first by the disease, second by the surgical trauma in preparing the acetabulum, and third by the wear of a loose prosthesis.

From analyses of Jacob et al. (1976), Pedersen et al. (1982), Pekman & Brown (1983) and Crowninshield et al. (1983), it is known

that in the absence of subchondral bone the stress levels in the bone cement and the trabecular bone are increased. On the basis of these computerized stress analyses, one may assume that in our cases the addition of a metal mesh to the reconstructed acetabulum reduced the stresses. A further reason for using a metal mesh is the thermal conductivity of the metal, which reduces the thermally induced osteocyte-necrosis and vascular damage (Huiskes 1979). Finally, by using a metal mesh, the contact surface between cement and bone graft is reduced, which may decrease the adverse side effects of the cement (Willert et al. 1974).

In spite of the good clinical results that have been reported using bone grafts in combination with total hip replacement (Parker & Hastings 1974, Harris & Jones 1975, Salvati et al. 1975, Heywood 1980, McCollum et al. 1980 and Marti & Besselaar 1983), little is known about the behaviour and fate of the grafts that have been covered with polymethylmethacrylate. However, with reference to the experimental work of Roffmann et al. (1982, 1983) and the clinical investigation of McCollum et al. (1980), it seems reasonable to continue this technique of reconstruction.

References

- Crowninshield, R. D., Brand, R. A. & Pedersen, D. R. (1983) A stress analysis of acetabular reconstruction in protrusio acetabuli. *J. Bone Joint Surg.* **65-A**, 495-499.
- Eichler, J. (1973) Ein Vorschlag zur operativen Behandlung der Protrusio Acetabuli. *Arch. Orthop. Unfall-Chir.* **75**, 76-80.
- Harris, W. H. & Jones, W. N. (1975) The use of wire mesh in total hip replacement. *Clin. Orthop.* **106**, 117-121.
- Heywood, A. W. B. (1980) Arthroplasty with a solid bone graft for protrusio acetabuli. *J. Bone Joint Surg.* **62-B**, 332-336.
- Huiskes, R. (1979) Some fundamental aspects of human joint replacement. Analysis of stresses and heat conduction in bone prosthesis structures. *Acta Orthop. Scand.* Suppl. 185.
- Jacob, H. A. C., Huggler, A. H. & Dietschi, C. (1976) Mechanical function of subchondral bone as experimentally determined on the acetabulum of the human pelvis. *J. Biomech.* **9**, 625-627.

- Marti, R. K. & Besselaar, P. P. (1983) Bone grafts in primary and secondary total hip replacement. In: *Progress in cemented total hip surgery and revision*. pp. 107–130. Excerpta Medica, Elsevier Science Publishers, Amsterdam.
- McCollum, D. E. & Nunley, J. A. (1978) Bone grafting in acetabular protrusion. A biologic buttress. In: *The Hip: Proceedings of the sixth open scientific meeting of the Hip Society*, pp. 124–146. C. V. Mosby, St. Louis.
- McCollum, D. E., Nunley, J. A. & Harrelson, J. M. (1980) Bone grafting in total hip replacement for acetabular protrusion. *J. Bone Joint Surg.* **62-A**, 1065–1073.
- Parker, S. M. & Hastings, D. C. (1974) Protrusion acetabuli in rheumatoid arthritis. *J. Bone Joint Surg.* **56-B**, 587.
- Pedersen, D. R., Crowninshield, R. D., Brand, R. A. & Johnston, R. C. (1982) An axisymmetric model of acetabular components in total hip arthroplasty. *J. Biomech.* **15**, 305–315.
- Pekman, W. M. & Brown, Th. D. (1982) A finite element analysis of acetabular reconstruction following metastatic bone loss. In: *Biomechanics Symposium*, (Ed: Woo, S. L. Y.). A.M.D., Vol. 56, pp. 43–44. ASME, New York.
- Roffman, M., Silberman, M. & Mendes, D. G. (1982) Viability and osteogenicity of bone graft coated with methylmethacrylate cement. *Acta Orthop. Scand.* **53**, 513–519.
- Roffman, M., Silberman, M. & Mendes, D. G. (1983) Incorporation of bone graft covered with methylmethacrylate onto acetabular wall. *Acta Orthop. Scand.* **54**, 580–583.
- Salvati, E. A., Bullough, P. & Wilson, P. D., Jr. (1975) Intrapelvic protrusion of the acetabular component following total hip replacement. *Clin. Orthop.* **11**, 212–227.
- Schatzker, J., Hastings, D. E. & Broom, R. J. (1979) Acetabular reinforcement in total hip replacement. *Acta Orthop. Traumat. Surg.* **94**, 135–141.
- Schneider, R. (1980) Die Armierung der Pfanne bei der Totalendoprothese der Hüfte. *Unfallheilk.* **83**, 482–488.
- Sotelo-Garza, A. & Charnley, J. (1978) The result of Charnley arthroplasty of the hip performed for protrusion acetabuli. *Clin. Orthop.* **132**, 12–18.
- Willert, H. G., Ludwig, J. & Semlitsch, M. (1974) Reaction of bone to methylmethacrylate after hip arthroplasty. *J. Bone Joint Surg.* **56-A**, 1368–1382.