The Trabecular Metal Monoblock acetabular component in patients with high congenital hip dislocation

A PROSPECTIVE STUDY

G. A. Macheras,
K. Kateros,
S. D. Koutsostathis,
G. Tsakotos,
S. Galanakos,
S. A. Papadakis

From KAT General Hospital, Athens, Greece

Between November 1997 and December 2000 we performed 27 total hip replacements in 22 patients with high congenital dislocation of the hip using porous tantalum monoblock acetabular components implanted in the true acetabular bed. Clinical and radiological evaluation was performed at regular intervals for a mean of 10.2 years (8.5 to 12). The mean Harris Hip Score improved from 48.3 (15 to 65) pre-operatively to 89.5 (56 to 100) at the final follow-up. The mean Oxford Hip Score was 49.5 (35 to 59) pre-operatively and decreased to 21.2 (12 to 48) at one year and 15.2 (10 to 28) at final follow-up. Migration of the acetabular component was assessed with the EBRA software system. There was a mean migration of 0.68 mm (0.49 to 0.8) in the first year and a mean 0.89 mm (0.6 to 0.98) in the second year, after excluding one initial excessive migration. No revision was necessary for any reason, no acetabular component became loose, and no radiolucent lines were observed at the final follow-up.

The porous tantalum monoblock acetabular component is an implant offering adequate initial stability in conjunction with a modulus of elasticity and porosity close to that of cancellous bone. It favours bone ingrowth, leading to good mid-term results.

Placement of the acetabular component at the level of the true acetabulum is desirable in total hip replacement (THR) in patients with a high congenital dislocation, for a number of reasons. At the level of the false acetabulum the lever arm for body weight is much longer than normal, resulting in an excessive load on the hip joint, and at the level of the false acetabulum, the shearing forces acting on the acetabular component may lead to early loosening. The bone stock is usually better at the level of the true acetabulum than at more proximal levels. A high acetabulum perpetuates abductor insufficiency, limping and limb-length discrepancy. However, proximal placement of the acetabular component, has been advocated,2,3 as cover of the acetabular component at the level of the true acetabulum may be difficult. We have used the Stamos cotyloplasty technique4 in preference to employing the femoral head as an autograft for augmentating the superolateral aspect of the acetabular rim.

Congenital dislocation is very often associated with anatomical abnormalities of bony structures.5-7 Insufficient bony acetabulum, abnormal configuration of the femoral canal, abnormal location of the centre of the hip, leg-length discrepancy and soft-tissue abnormalities all contribute to making THR a technically demanding operation in these patients.

Various classifications for congenital dysplasia and dislocation have been described,4,8-12 the most commonly used being those of Hartofilakidis et al4,11 or Crowe et al,9 the inter- and intra-observer reliabilities of which were recently examined by Decking et al.13

Good results have been reported using both cemented and uncemented implants.14-16 The surgical technique used for high hip dislocation is different from that for simple acetabular dysplasia. An osteotomy for femoral shortening is frequently needed.17-19 Small-diameter acetabular components are usually used,20 combined in many cases with 22 mm heads, in order to achieve adequate thickness of polyethylene. Maximum initial stability and the potential for quick and safe bone ingrowth should be offered by these acetabular components. The Trabecular Metal Monoblock acetabular components (Zimmer Inc., Warsaw, Indiana) meet these prerequisites.

Patients and Methods
Between November 1997 and December 2000 we performed 27 THRs in 22 consecutive patients with high congenital dislocation of the hip according to the Hartofilakidis classification.4 All patients had a limp and a positive Trendelenburg sign, and 16 had a valgus
deformity of the knee of between 10° and 20°. There were seven patients with bilateral high dislocation, nine had a normal contralateral hip and six had dysplasia of the contralateral hip. All the patients were women, with a mean age of 43 years (29 to 60). Anteroposterior radiographs of the pelvis were taken and frog lateral views. A CT tomogram was obtained to assess the true acetabular position, the anteroposterior and vertical dimensions of the acetabulum, leg-length discrepancy, and possible valgus deformity of the knee. In seven patients there was no leg-length discrepancy, in six the operated side was longer, and in nine patients there was shortening of between 3 cm and 7.5 cm. After operation the leg-length measurements were again assessed with a CT tomogram. The indications for arthroplasty were severe pain and difficulty with walking and performing daily activities. No patient had undergone previous surgical treatment.

The diameter of the Trabecular Metal Monoblock acetabular components ranged between 44 mm and 50 mm. This acetabular component has unique manufacturing and mechanical properties.21,22 It is hemi-ellipsoid in shape, and the equatorial diameter is 2 mm larger than the polar diameter. The frictional coefficient of porous tantalum on bone is approximately twice that of sintered beads. The average pore diameter of the porous tantalum shell is 550 μm. The high-volume porosity enables extensive tissue infiltration, producing a strong attachment. The strut microtexture is conducive to bone formation.23 The polyethylene liner is compression-moulded into the porous tantalum shell to a depth of 1 mm to 2 mm, leaving 2 to 3 mm of porous tantalum for tissue ingrowth. This type of manufacturing process allows a 48 mm acetabular component to incorporate a minimum total polyethylene thickness of 8 mm for a 22 mm head. The very high porosity of this material (up to 80% of its volume) encourages quick bone apposition and ingrowth into the scaffold of the shell, leading to excellent fixation. The modulus of elasticity of porous tantalum is analogous to that of trabecular bone.24 This results in a more physiological mode of load transfer to host bone. In all cases we used an uncemented femoral component Implex FT (Implex Corp, Allendale, New Jersey), Wagner or Versys (Zimmer Co, Warsaw, Indiana), depending on the anatomy of the proximal femur. The femoral head was either 22 mm or 28 mm in diameter, depending on the diameter of the acetabular component. In all cases the acetabular component was placed at the level of the true acetabulum (Figs 1 and 2). Starting on the second post-operative day, 23 patients were mobilised with toe-touch weight-bearing for the first two weeks. Partial weight-bearing was allowed in the third week, full weight-bearing with crutches after six weeks, and the use of crutches was abandoned at between eight and 12 weeks after operation. In four cases with questionable stability the patients were kept in bed for four to six weeks.

Clinical and radiological evaluation was undertaken at regular intervals and at a mean final follow-up of 10.2 years (8.5 to 12). The Oxford and Harris Hip Scores were used.25,26 The EBRA27-29 software system (Unit Geometry and CAD, University of Innsbruck, Innsbruck, Austria) was employed to measure migration of the acetabular component on the third day and after six weeks, six months, one year and two years. This system uses plain radiographs of the pelvis with a two-dimensional data input. The reference points and positioning of the lines are determined by the software, which also corrects magnification. The method detects and excludes radiographs with serious pre-analytical errors which are not comparable with the rest of those in the series. The interpretation routine plots an

![Fig. 1a](image1.png)  ![Fig. 1b](image2.png)  ![Fig. 1c](image3.png)

Radiographs showing a) Hartofilakidis type III congenital dislocation of the right hip, in a 43-year-old woman, b) the anteroposterior view at ten years: the acetabular component has been placed in the true acetabular bed. Cotyloplasty was not necessary in this case and c) distal femoral osteotomy to shorten the limb and correct valgus deformity of the knee.
aggregate migration curve, based on calculations between all comparable radiographs in the series. Migration is measured across a group of radiographs rather than sequentially on successive films, and includes a linear importance factor so that measurements between those with the highest comparability are given priority in the calculation of migration.

**Surgical technique.** All operations were performed by the senior author (GAM) using the posterior approach. The greater trochanter, with its attachments of gluteus medius and vastus lateralis, was left undisturbed. The hypertrophic joint capsule was resected and the true acetabulum identified by the fibrous tissue overlying the fossa. Dissection continued circumferentially for adequate exposure of the true acetabulum, which is usually narrow and shallow.

A 32 mm reamer was used to start preparing the fossa. Particular care was taken to protect the bone bridge between the true and false acetabula. In order to achieve better cover of and support for the prosthesis, the posterior column was reamed more than the anterior, which is usually weaker and thinner.

In cases with a small deficient acetabular roof, where full cover of the acetabular component was not obtained, we used impacted autologous morsellised bone graft from the femoral head to cover the deficiency. The stabilisation of the acetabular component was based on the intact host bone of the acetabular rim. In cases where the component could not be covered adequately we used the cotyloplasty technique, originally described by Hartofilakidis et al. The central part of the medial wall was intentionally fragmented and pushed medially while preserving the periosteal attachment on the pelvic side. Morsellised graft from the femoral head was impacted into the fossa with reverse reaming (Fig. 2). The acetabular component was then implanted and stabilised by the strong peripheral contact with the rim of the acetabulum.

The stability was checked manually after implantation and considered satisfactory in all but four cases. We used additional screws at the periphery of the acetabular component in eight cases. A shortening osteotomy of the distal femur was performed when we had to correct length discrepancy or valgus deformity of the knee. When needed, an adductor tenotomy was carried out percutaneously. The mean duration of the operation was 120 minutes (92 to 140) and the mean peri-operative blood loss was 1550 ml (852 to 2350). Prophylactic antibiotic therapy with cefuroxime was given for 48 hours and low molecular heparin was administered subcutaneously for six weeks.

**Results**

The clinical and radiological assessment was performed by two independent orthopaedic surgeons (GAM and KK) and one radiologist. There were two intra-operative complications. A fracture of the greater trochanter was managed with a hook-plate, and a peri-prosthetic femoral fracture with cerclage wires. We had two cases of neuropraxia of the sciatic nerve which recovered fully within three and five months. One overweight patient with arthritis in the contralateral hip mobilised fully weight-bearing after four weeks of bed rest despite our advice and the acetabular component migrated centrally for 5 mm during the first six months. Thereafter no migration or loosening was observed, and at eight years the patient was fully active and pain free. Another five patients experienced paraesthesiae and causalgia in the peroneal distribution of the sciatic nerve for six to 12 weeks after operation, but recovered fully. The distal femoral osteotomies showed evidence of bone healing between ten and 16 weeks, except for one that needed re-operation with supplementary use of bone grafts. No wound problems were observed and no cases of deep-vein thrombosis were detected. The mean Harris Hip score
improved from 48.3 points (15 to 65) pre-operatively to 89.5 (56 to 100) at the final follow-up. The Oxford Hip Score decreased from 49.5 (35 to 59) pre-operatively to 21.2 (12 to 48) at one year and 15.2 (10 to 28) at the final follow-up.

Migration of the acetabular component was assessed with the EBRA software system. The mean absolute migration was 0.85 mm (0.49 to 5.00) in the first year and 1.05 mm (0.60 to 5.00) in the second. If we exclude the one case with 5 mm of migration, the mean absolute migration was 0.68 mm (0.49 to 0.80) at the end of the first year and 0.89 mm (0.60 to 0.98) at the end of the second. No revision was necessary for any reason. No components became loose and no radiolucent lines were observed. At the final follow-up all the hips were pain free, there was a positive Trendelenburg sign in two patients and the valgus deformities had been corrected in all patients. A total of 16 patients could climb stairs and walk without limitation. Six patients were able to walk without support but with a slight to moderate limp.

The mean functional limb-length discrepancy decreased from 4.2 cm (0 to 7.5) before operation to 1.4 cm (0 to 2.5) at the final follow-up. At the final follow-up we observed no measurable wear of polyethylene, no radiolucent lines and no breakage or cutting out of the screws. The mean acetabular component angle was 47° (39° to 58°). All bone grafts used were incorporated (Fig. 2), and the bone around the acetabular wall had a physiological trabecular appearance and thickness, with normal density.

Discussion

The lack of adequate bone stock at the level of the true acetabulum is one of the reasons why Charnley and Feagin advised against the use of low-friction arthroplasty for congenital hip disease. High rates of aseptic loosening of the acetabular component after cemented arthroplasty in congenital dislocation of the hip have been reported. The bony insufficiency of the true acetabulum usually requires the use of small acetabular components. In most cases these components have inadequate thickness of polyethylene even with the use of the smallest femoral head. In order to address this problem the acetabular component with an offset bore has been used, with survival rates of 81.6% at ten years and 46.9% at 20 years.

The use of uncemented press-fit acetabular components has been reported to give favourable results. Quick and adequate biological fixation by bone ingrowth is a prerequisite for successful longevity of uncemented acetabular components. Different materials and external surfaces, such as porous coating and coating with hydroxyapatite have been used with increased porosity of the metal shell in order to increase the potential for bone ingrowth and modify the dynamic bonding process to achieve bony integration with the implanted acetabular component.

Porous tantalum implants have recently been used in orthopaedic surgery. They provide excellent initial stability, with possible osteoconductive and osteo-inductive properties. We have used Trabecular Metal Monoblock acetabular components in primary THR with optimal results at ten years. Careful preparation of the bed, with or without autologous bone graft, at the level of the true acetabulum usually leads to an excellent cancellous wall. The external surface of porous tantalum has a high coefficient of friction with this cancellous bone, offering greater initial stability than any other material. Our previous experience with Trabecular Metal Monoblock acetabular components in primary THR has shown its osteoconductive capacity, filling polar gaps up to 5 mm. A physiological load pattern and trabecular orientation at the host bone have been noted on the radiographs.

Kärrholm et al and Freeman have shown that early migration of the acetabular component is predictive of the long-term survival of the implants. The absolute total migration of 0.89 mm for the first two years in this series is comparable to the 0.67 mm that we have already reported for Trabecular Metal Monoblock acetabular components in primary THR. Our final results confirm the reliability of this method. An advantage of the monoblock implant is that the polyethylene is moulded directly inside the porous material. This has two important consequences: even small acetabular components have an adequate thickness of polyethylene, preventing increased wear rates due to laminar wear, and there is no micromovement between the porous shell and the polyethylene, effectively eliminating the formation of debris from this site. These features, together with the improved bonding by bony ingrowth at the bone-implant interface, lead to decreased rates of aseptic loosening. Restoration of the mechanical axis with supracondylar shortening and varus osteotomy can also contribute to reduced rates of loosening due to normal transfer and distribution of loading.

Patients with high congenital dislocation of the hip can have an uneventful prolonged clinical course before experiencing rapidly deteriorating pain and dysfunction. Undertaking THR in these patients is very difficult. The use of the Trabecular Metal Monoblock acetabular component as described in this paper has provided satisfactory results and the patients are pleased with the functional result. Although our results are very promising, further follow-up is needed to confirm the longevity of this procedure.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


