Total hip replacement with a superolateral bone graft for osteoarthritis secondary to dysplasia

A LONG-TERM FOLLOW-UP

We evaluated the long-term results of 116 total hip replacements with a superolateral shelfplasty in 102 patients with osteoarthritis secondary to developmental dysplasia of the hip. After a mean follow-up of 19.5 years (11.5 to 26.0), 14 acetabular components (12%) had been revised. The cumulative survival at 20 years was 78%, with revision for loosening of the acetabular component as the end-point. All grafts were well integrated and showed remodelling. In six grafts some resorption had occurred under the heads of the screws where the graft was not supporting the socket. Apart from these 14 revisions, seven acetabular components had possible radiological signs of loosening at a mean follow-up of 14.5 years, one had signs of probable loosening, and five had signs of definite loosening. These results indicate that this technique of bone grafting for acetabular reconstruction in hip dysplasia is a durable solution for cemented acetabular components.

Dysplastic acetabula can provide a surgical challenge in total hip replacement. Schuller et al. showed that the lateral part of the acetabular roof is important for load transfer and a loaded bone graft in this location reduces stress on the cement-bone interface in a dysplastic hip. Since 1974 we have used multiple small femoral head autografts to reconstruct the superolaterally deficient acetabulum.2-4 Harris, Crothers and Oh5 described short-term success using bulk femoral head grafts combined with cemented sockets in patients with acetabular dysplasia. A follow-up report by Mulroy and Harris,6 showed that 46% of these sockets had failed. Marti et al.4 reported the medium-term results for a group of 84 patients with a mean follow-up of 10.1 years and showed that all but one of the grafts had healed within three months. The ten-year survival was 92.6%, with failure defined as revision for loosening of either component. However, the series included 21 patients who did not have dysplastic hips.

We present here the long-term results for a series of primary cemented total hip replacements (THR) with superolateral bone grafting for osteoarthritis secondary to hip dysplasia at a mean follow-up of 19.5 years. Our technique of femoral head autografting is as described by Marti et al.1 in 1994, and differs from that described elsewhere.5-8

Patients and Methods

Between 1974 and 1993 the senior author (RKM) performed 116 primary THRs combined with a superolateral bone graft in 102 patients with osteoarthritis of the hip secondary to acetabular dysplasia. The mean age of the patients at operation was 64.4 years (35.5 to 84.3), and 76.9% were men.

The severity of dysplasia was estimated from the pre-operative radiographs by measuring the Sharp angle9 and the centre-edge (CE) angle of Wiberg10 in 63 patients (71 hips), but in the remainder the old radiographs had been destroyed. The mean Sharp angle was 45˚ (33˚ to 79˚) and the mean CE angle was 10.0˚ (-20˚ to +40˚). Two male patients had a CE angle of approximately 40˚ as a result of large superolateral osteophytes, although the osteophytes were too weak for weight-bearing and a shelfplasty was therefore performed.

The amount of subluxation of the femoral head was classified according to Crowe, Mani and Ranawat.11 A stage I subluxation was present in 85 hips, stage II in 16, stage III in two, and stage IV in 13. A total of 36 patients had undergone other procedures before their THR: 33 had a previous intertrochanteric osteotomy and three had a Tönnis triple osteotomy.

Technique. All the operations were conducted in a laminar-flow operating theatre using the anterolateral Watson-Jones approach, with the
addition of a trochanteric osteotomy in 33 hips. A cemented Weber Rotation total hip replacement (Allopro, Baar, Switzerland)\textsuperscript{12,13} with a 32-mm femoral head was used as the standard implant. All patients received prophylactic antibiotics and coumarin anticoagulation. Pre-operative planning identified hips which were likely to require an acetabular bone graft, the final decision being made at the time of operation. Although cover by bone of at least 70% of the acetabular component may be acceptable, the principle of supplementing the bone stock as an investment for the future contributed to the generous use of bone grafts.

After minimal reaming of the acetabulum to expose the subchondral bone, care being taken to preserve the subchondral plate superiorly, the acetabulum was assessed. An attempt was made to use the standard hemispherical component with an outer diameter of 52 mm. If acetabular cover was inadequate superolaterally to support the trial implant, bone grafts were used.

The ilium, just proximal to the superolateral acetabular rim was lightly decorticated and femoral head autografts (usually three small grafts) were positioned against the iliac bone. The bone grafts were approximately triangular and measured about 1.5 x 2 x 3 cm.\textsuperscript{4} Cancellous bone was placed between the graft and the ilium. If the ilium was very sclerotic, the cortex was perforated by a few 2-mm drill holes. Usually, two corticocancellous bone grafts were secured by 4.5 mm AO cortical screws with a washer, the third graft being placed between the other two so that it was compressed into position (Fig. 1). If the grafts covered more than a third of the acetabulum a buttress plate was added.\textsuperscript{2,3} The acetabulum was then reamed again to accommodate the 52 mm component with anchoring holes drilled in the cranial part of the acetabulum for cement engagement.

All patients were instructed to bear partial weight for the first eight weeks using crutches, after which they were encouraged to relinquish their crutches and bear full weight.

**Patient evaluation.** All patients were seen biennially after the first two post-operative years. The Harris hip score (HHS) was used for clinical analysis.\textsuperscript{14} Radiological evaluation was undertaken applying the terminology of Johnston et al.\textsuperscript{15} to standardised AP pelvic and lateral hip radiographs. The radiographs were scrutinised for signs of loosening in the zones of DeLee and Charnley\textsuperscript{16} on the acetabular side and scored according to Hodgkinson, Shelley and Wroblewski.\textsuperscript{17} For the femoral side we used the criteria of Harris, McCarthy and O’Neill.\textsuperscript{18} Graft resorption was graded according to Gerber and Harris,\textsuperscript{7} and heterotopic ossification classified according to Brooker et al.\textsuperscript{19} Statistical analysis was conducted using the statistical package, SPSS version 12.0 (SPSS Inc., Chicago, Illinois) with a p value less than 0.05 considered significant.

**Results**

**Patients.** At the time of the review 42 patients had died, five of whom had undergone revision surgery. In one patient the acetabular component was revised after six years, in one patient both components were revised for a late infection after nine years, and in three hips in three patients the femoral component was revised, after three years in two cases and six years in the third.

After a mean of 8.1 years (1 to 15.8) 12 patients were lost to follow-up. All patients were included in the survival analysis for the follow-up time that was available. The remaining 40 patients (47 hips) were examined clinically and radiologically after a mean follow-up of 17.6 years (11.5 to 26.4).

**Clinical evaluation.** The mean HHS for 54 patients with a mean follow-up of 16.5 years (6 to 26) was 90.5 (51 to 100). Thirty-four patients had an excellent score (90 to
100), 11 were good (80 to 90), six were fair (70 to 80) and three were poor (< 70). Five patients had a positive Trendelenburg sign at follow-up. To lessen the influence of co-morbidity on the HHS, we divided the patients into Charnley categories A, B and C. Seven were Charnley category A with a mean HHS of 94.7 (87 to 100), 26 were category B with a mean score of 92.9 (71 to 100), and 21 were category C, with a mean score of 85.7 (51 to 100). The HHS was obtained at a mean age of 77.4 years (63.6 to 94.4).

Complications. Four intra-operative complications occurred. In two patients the femur was cracked during preparation of the femoral canal. In the two other patients, the greater trochanter was fractured. These fractures healed, without additional treatment although the patients were kept non-weight-bearing for eight weeks. Two patients developed a post-operative infection requiring surgical debridement, but resulting in satisfactory healing. One osteotomy of the greater trochanter did not unite and required refixation, leading to union.

Survival analysis. During a mean follow-up of 19.5 years (11.5 to 26.0), 20 hips were revised after a mean of 10.2 years (2.5 to 19.3). In six hips the femoral component was exchanged, in five the acetabular component, and in nine both components. With revision of the acetabular component as the end-point for the survival analysis, the ten-year survival was 95% (95% confidence interval (CI) 90 to 99), the 15-year survival was 85% (95% CI 77 to 93), and the 20-year survival was 78% (95% CI 67 to 90) (19 hips at risk) (Table I). When the survival analysis was performed for all revisions (revision of the stem included), the ten-year survival was 90% (95% CI 84 to 96), the 15-year survival was 79% (95% CI 70 to 88), and the 20-year survival was 72% (95% CI 60 to 85) (16 hips at risk) (Table I).

Radiological analysis. The radiographs of all revision cases and of all patients for whom more than ten years of radiological follow-up was available (76 hips) were scored for radiological loosening of the cup after a mean follow-up of 14.5 years (5.6 to 26.3) (Table II). The femoral component was scored after a mean follow-up of 13.7 years (2 to 26.3) (Table II).

A survival analysis was performed using definite loosening of the acetabular component as the end-point, showing a ten-year survival rate of 94% (95% CI 89 to 99) (73 hips...
at risk) and a 15-year survival rate of 82% (95% CI 74 to 91) (43 hips at risk).

Heterotopic ossification was present in 13 hips (17%). Seven hips had Brooker grade I peri-acetabular calcification, three hips grade II and three hips grade III. All bone grafts showed integration and remodelling (Fig. 2). Six grafts showed partial non-progressive resorption under the screw heads. More extensive resorption in the weight-bearing part of the graft was not encountered.

Using Pearson’s correlation test no relationship was found between survival of the implant and the extent of subluxation as defined by the Crowe class (p = 0.299, r = 0.097), nor between survival of the implant and the severity of dysplasia as measured by the CE angle (p = 0.856, r = 0.22).

Using a log-rank test, we also compared rates of survival for the flat and hemispherical acetabular components and found that the difference was not significant (p = 0.0507).

Discussion
Since 1974, we have performed an acetabular roofplasty with autologous bone in THR whenever the containment of the standard 52-mm acetabular component was inadequate.

In addition, restoration of the centre of rotation, preservation of the subchondral plate, and ensuring sufficient thickness of the polyethylene cup as the femoral head was always 32 mm, have contributed to our frequent use of acetabular augmentation. In our earlier series of primary THRs 23% had an acetabular shelfplasty.

Pre-operative planning identified probable cases for acetabular augmentation but the final assessment was made intra-operatively after reaming down to the subchondral plate, which we aimed to retain and place the centre of rotation in the true acetabulum. Jacob et al. and Kobayashi and Terayama have shown the importance of leaving the subchondral plate intact to distribute the forces to the cortical shell and reduce excessive concentrations of stress on the cement-bone interface.

Two types of acetabular component were available, flat and hemispherical, although the latter was mostly used because the flat polyethylene component was thinner at its apex. The flat component had a higher rate of failure in an earlier study from our unit on the long-term results of the Weber Rotation prosthesis in primary THR. In the current study, however, the difference in survival between the flat and the hemispherical sockets just failed to reach significance (p = 0.057), but the use of a hemispherical socket resulted in an increased need for an acetabular roofplasty.

Apart from these biomechanical considerations, the increase in bone stock for future surgery was an additional reason to use a femoral head as bone graft. This accounts for the relatively high number of patients with a Crowe I dysplasia (n = 85; 73%) in our study.

Many reports have shown that incomplete containment of the acetabular implant is associated with a poorer outcome. In a finite element study, Schuller et al showed the important role of the superolateral part of the acetabulum in load transfer. In a model, they showed that cement-bone interface stresses were considerably diminished by adding a superolateral graft to the acetabulum. As an alternative to bone grafting some authors have described the use of small acetabular components in an anatomical or...
superior position. Others have advocated proximal or medial placement of the acetabular component, sometimes even fracturing the medial wall. However, these methods compromise the biomechanics of the hip. The centre of rotation may be considerably displaced and/or the use of smaller components may give rise to a higher rate of wear.

Previous reports on the use of large bulky acetabular autografts generally described failure. This may have been because of the difficulty in revascularising and remodelling such large grafts, and the load they carried during this process. However, in series where smaller grafts were used, it remains a useful option, especially when a cemented acetabular component is used. The centre of rotation is retained, optimal cover is obtained and the subchondral bone layer is spared. It may also be used when an uncemented component needs to reduce the need for additional bone grafting. It is an added bonus, which may even have encouraged some authors to use bone grafts in uncemented procedures.

The 15-year survival for a primary THR with revision for aseptic loosening of the cup, using the Weber Rotation total hip replacement, as reported for a large consecutive series, was 85.5%, similar to the result in this study. This supports our belief that full bony cover of the acetabular implant by multiple small femoral head autografts leads to a long-lasting fixation of the acetabular component in total hip replacement.

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References


