C.-H. Hartwig · B. Beele · W. Kusswetter

Femoral head bone grafting for reconstruction of the acetabular wall in dysplastic hip replacement

Received: 20 December 1994

Abstract From 1980 through 1991 we screwed a pre-shaped cortico-cancellous bone graft onto the ilium wall to compensate acetabular deficiency in 94 consecutive total hip replacements. We report the results of 87 hips (79 patients) with an average follow-up of 30 months (12–75 months) postoperatively. Pain in dysplasia-coxarthrosis and congenital dislocation of the hip, destructive coxitis in rheumatoid arthritis and cup loosening was the main indication for surgery. According to the Merle d'Aubigne score the postoperative clinical evaluation demonstrated 77% very good and 18% good results. Due to component loosening the results had to be classified as unsatisfactory in 4 hips (2 cups and 2 stems). At the time of evaluation 90% of the arthroplasties was osteosously consolidated as evidenced by trabecular bridging and structural integrity with host bone. Resorptions of the graft were noted in 32 hips. One cup was removed because of complete resorption and consecutive loosening, a further one was considered clinically and radiologically loose because of partial graft resorption. Two further complete resorptions and 28 partial lateral resorptions had no influence on the secondary stability of the implant. We are aware that these are short-term results. Nevertheless, we recommend the described method as a valuable addition to arthroplasties for acetabular rim defects both in osteoarthritis and in revision surgery.

Introduction

Alloplastic hip replacement is a difficult problem in the treatment of patients with a dysplastic acetabulum and resulting painful osteoarthritis. Frequently, too much of the valuable bone mass in the bed of the acetabulum is reamed away, or the acetabulum is positioned too steeply, thus compromising the secondary stability of the implant [9, 19].

As early as 1973 Chamley and Feagin [3] warned about carrying out an alloplastic hip replacement on patients with an osteoarthritis in congenital dislocation of the hip (CDH), because the bony bed in the cranial part of the acetabulum is too weak.

Nolan et al. [24] pointed out that in most cases with loosened components of the acetabulum, there was insufficient bone stock anterolaterally. Harris [12] in 1976 and Coventry [4] in 1983 advocated an apposition arthroplasty for patients whose acetabulum was covered to an extent of less than 70% by sufficient bone.

The use of a large cancellous bone graft was recommended - either in the form of an autogenous graft or an allograft - which is fixed to the ilium above the acetabulum by means of screws [7, 9, 19]. Results of cemented acetabular components in conjunction with autografts [8, 23] and allografts [18, 20], as well as the use of bone grafts in combination with cementless cups are controversial [2, 25, 29]. One group reported favourable results at an average of 5 years follow-up, while a second group reported a 44% failure rate at 46 months average follow-up [17, 26, 27].

In addition, metal cups of large volume are also used in many cases to improve the lateral support of the artificial acetabulum. However, this means the implantation of a further foreign body, which is prone to the danger of loosening under normal pressure and shearing forces. The purpose of this retrospective study was to evaluate the clinical and radiological outcome of 94 hips in which we performed a graft reconstruction of the acetabular margin due to insufficient bone stock anterolaterally.

Material and methods

The femoral head apposition arthroplasty combined with a total hip replacement was performed in 94 hips between January 1980 and December 1991. Of these, 87 hips (92%) could be checked clinically and radiographically at an average follow-up of 30 months (12–75 months).
There were 52 women and 27 men. The age range at time of operation was 39–84 (average 56) years. In 78 hips the indication for an autograft apposition arthroplasty was painful osteoarthritis in CDH. The CE angle as a measure of femoral head coverage was less than 10° in 55, and between 10° and 20° in 17 hips. Six patients presented with a high dislocation of the hip. Four times the procedure was necessary because of an inflammatory destruction of the weight-bearing rim, mainly in rheumatoid arthritis. In 5 revisions of a cup loosening, we combined the roof reinforcement with an allograft.

The need for bone grafting was decided at the time of surgery. Our preference was to obtain at least 50%–70% coverage of the acetabular component by the remaining iliac bone after reaming into the original acetabulum or slightly cranially.

The graft was constructed by resecting an oval disc of bone about 3 cm wide from the femoral head. Then by means of an oscillating saw and a rongeur we created a rim 0.5 cm in width and 0.5 cm in height, which was shaped into the form of a bone at the caudal end.

Following this, a Lexer chisel was used to make an acetabular groove 0.5 cm in depth cranially, into which the cancellous bone rim of the disc could be exactly inserted (tongue and groove principle). At the same time decortication of the os ilium was performed, so that there was a freshly bleeding bed for the implant. Fixation was carried out with two screws and washers in the 'lag-screw technique'. Once the graft was solidly fixed, an acetabular reamer was used to ream the graft until it was congruent with the host bone (Fig. 1).

In 66 cases a cementless, hemispherical and porous-coated cup (Harris-Galante, Zimmer-Chirurgie, Dietzental, FRG) was inserted, whilst up to 1985 an apposition arthroplasty was also combined with a cemented polyethylene cup (21 hips). We implanted 53 cementless stems (45 custom-made stems, 8 Zweymüller stems) and 34 cemented straight stems.

For the clinical evaluation of the hip, we used the Merle d’Aubigné score according to Griss. Six points were allotted to the symptom of pain, and six to the ability to walk [11]. Radiographic assessment included sequential AP and lateral views.

The grafts were evaluated for union to host bone as evidenced by trabecular bridging and structural integrity of the interface between the graft and the ilium. Non-union was defined as a complete radiolucency between graft and host bone.

Partial or complete resorption of the graft was measured in the horizontal and vertical axes of the graft. The horizontal axis was defined as the longest line through the graft parallel to the interteardrop line. The vertical axis was defined as the longest line through the graft parallel to a line drawn perpendicular to the interteardrop line.

For cup evaluation the interface between bone and cement or bone and implant was assessed as described by De Lee and Charnley. Specifically interest was focused on the migration of the component, fracture of the cement, radiolucency at the cement-bone or implant-bone interface.

Definite loosening was defined as migration of the acetabular component, evidenced as a discernible shift in the cup position, a fracture of the cement or a fracture of the cup.

Results

In all, 90% of the patients (n = 71) was satisfied with the result of the operation, and did not complain about pain or only occasionally, and this did not restrict their daily activities. Flexion and abduction were distinctly improved by the alloarthroplasty in nearly all hips. Seventy-three patients who had only been able to walk short distances (up to 500 m) at the most preoperatively regained a normal walking ability postoperatively, or could at least walk long distances (>2 km) with the help of a walking-stick.

According to the Merle d’Aubigné score 67 hips showed very good (12–10 points) and 16 good (9–7 points) results. The functional results of 4 hips had to be classified as unsatisfactory. In two cases this was due to a loosened cup, although there was a loosening of two stems. One cup and one stem have been revised in the meantime (Fig. 2).

Radiographic evaluation showed an average size of the graft of 3 × 2.5 cm, providing in all hips a complete coverage of the artificial cup. The postoperative CE angle measured on average 28°.

Fig. 1 Fixation of the apposition arthroplasty at the os ilium with two cancellous bone screws and washers in the 'lag-screw technique' (tongue and groove principle)

Fig. 2 Merle d’Aubigné score (according to Griss) distribution postoperatively
Table 1 Comparison of graft resorption extent with Merle d’Aubigné score result

<table>
<thead>
<tr>
<th>Graft resorption</th>
<th>Merle d’Aubigné Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–6 Pts</td>
</tr>
<tr>
<td>1–3 mm</td>
<td></td>
</tr>
<tr>
<td>4–7 mm</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>8–10 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Pattern</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sum</td>
<td>3</td>
</tr>
</tbody>
</table>

A further cemented Müller cup must be considered clinically and radiologically loose because of partial resorption of the graft radiolucency and slight component migration. Twenty-eight further partial lateral resorptions of the arthroplasty and two complete ones did not have any influence on the secondary stability and clinical outcome of the implant (Table 1).

We found 19 cups (8 cemented and 11 cementless) with a radiolucency in one of the three zones described by De Lee and Charnely. The distribution was infrequent. Over all zones there were 20 lucencies < 2 mm. Singular cases with a lucency of 3 mm were measured in zones 2 and 3, without any progression during follow-up. As these patients were pain-free at their last visits, we did not investigate further. Nevertheless, we recommend a regular check-up at least once a year.

Perioperative complications

We observed 3 cases of complications in 87 apposition arthroplasties due to deep vein thrombosis diagnosed by phlebogram. In one case there was the additional complication of a protracted pulmonary embolism.

A wound haematoma which occurred on the 5th postoperative day healed after revision with antibiotic treatment and remained free from side-effects.

There was damage to two sciatic nerves due to stretching: in one case after lengthening of the leg by 4 cm and long-standing dislocation of the hip. This was regressive at the time of follow-up examination.

The intraoperative tearing away of a fragment of the trochanter was managed by tension band fixation and healed with no after-effects. Periaricular ossification (grade 2–3, according to the classification of Arcq) was registered in 8 cases; this value is comparable to that after simple hip replacement [1].

Fig. 3 A 52-year-old, female patient with osteoarthritis in congential dysplasia of both hips who had undergone intertrochanteric osteotomy in childhood

Fig. 4 Cementless implant (Harris-Galante cup, Zweymüller stem) right 4/87; cementless implant (Harris-Galante cup, custom-made stem) left 5/88; at follow-up (right): 6 years; left: 5 years; there was a good functional result; consolidated grafts; satisfied patient

Seventy-nine grafts (90%) had united to host bone by the time of follow-up examination (Figs. 3, 4). In 5 hips we observed the development of a radiolucent line between the graft and the wall of the ileum of 1–2 mm, which in no case extended to the total area of contact.

Twenty-nine of the apposition arthroplasties (33%) exhibited a lateral resorption due to a lack of pressure forces during the time of consolidation. In 12 cases it amounted to 1–3 mm, in a further 12 to 4–7 mm and in 5 cases to 8–10 mm. Three autografts were completely resorbed, and the screws were partly loosened.

One cementless Harris-Galante cup had loosened because of complete resorption of the graft in combination with an unsuccessful cancellous bone-plasty of the acetabular floor. Revision was necessary already by 1 year postoperatively.
Discussion

The goals of arthroplasty in the presence of a dysplastic acetabulum are widening and enlargement of the deficient acetabular rim, to provide support for the artificial cup, restore normal anatomy as well as create sufficient bone stock for future revision surgery [4, 6, 8, 13]. Operating techniques for the stabilisation of the dysplastic acetabulum have been presented by various authors. Harris et al. [14] in 1977 came to the conclusion that 'normal' endoprosthetic management could not be considered for patients with congenital dislocation of the hip because of the unbalanced anatomical conditions and the extremely insufficient bony bed. Since that time different stem geometries have been presented for the hypoplastic femoral shaft, as have varying techniques for the reconstruction of the deficient acetabulum.

In 1978 Harris [13] described augmentation of the defect in the area of the acetabular margin with grafts from the resected femoral head. He carried out this procedure both with autogenic and allogenic bone material, the latter only if there was no femoral head left in the case of a revision.

Gerber and Harris in 1986 [8] and Mulroy and Harris in 1990 [23] reported on 7- and 12-year results of the so-called Harris procedure. At an average of 7 years postoperatively, the grafts seemed to have been a successful adjunct to the arthroplasty, while 5 years later the total incidence of loosening of the acetabular component amounted up to 46%, a fact which caused them to abandon this method. Nevertheless, the use of bulk grafts to reconstruct a deficient acetabulum remains a controversial topic.

Various operating techniques used today in the reconstruction of a dysplastic acetabulum were evaluated by Jensen et al. [19] in 1989. They found that the best technique in arthroplasty for congenital hip dislocation was restoration of the rotational centre of the hip joint and roof reconstruction with a femoral head graft. This contributes to a success rate of more than 90% at an average of 5 years postoperatively. From a biomechanical point of view, we disagree with the cementation of the cup into the neoacetabulum as described by Lund and Tønnesen [21] as with the medial wall decompression technique outlined by Dunn and Hess [6, 16]. Both methods disregard the 'normal' hip anatomy, which in our opinion will lead to cup failure sooner or later. Crowninshield et al. [5] in 1983 showed that the highest stresses are transmitted to the depressed medial wall in cemented polyethylene cups.

At present, there is a consensus that with a porous-coated hemispherical implant, good primary and secondary stability can be achieved by ingrowth of bone. Few studies have presented encouraging results with cementless cups in combination with shelf autografts for acetabular reconstruction of the dysplastic hip [2, 25, 29].

Our results are comparable to those of Gleissner et al. [9], who 2 years after implantation of a cemented cup in conjunction with an arthroplasty observed bony ingrowth of the graft onto the ileum in 92% of cases. Pauwilsae et al. [25] reported on cementless, roof-reinforced cups. For the porous-coated, pressfit components he found no evidence of radiographic or symptomatic loosening 3-5 years after implantation. Silber and Engh [29] treated 19 dysplastic hips. During 3-year follow-up all the porous-coated, hemispherical acetabular components remained stable.

In our series we noted a failure of the acetabular component in 2 cases. Of our arthroplasties 90% was consolidated to host bone, both with cemented polyethylene and cementless porous-coated cups. In 33 cases we discovered a 'remodelling' of the corticocancellous bone graft with increased radiological sclerosis and structural integrity in the zones on which pressure was exerted, but on the other hand there was also resorption of parts of the graft which did not have to bear any weight. The remodelling can only be optimised if it is subject to sufficient load on the grounds of its localisation. To ensure this, there must be a tight fit between the screwed-on block and the acetabulum, which is in position to absorb the pressure forces affecting the acetabular margin [23]. We obtain this tight fit with our so-called 'tongue and groove' principle, meaning to shape a small tongue onto the caudal end of the graft which fits snugly into a groove at the dorsolateral aspect of the deficient acetabulum. It seems that sufficient pressure forces lead to consolidation, mechanical overloading to a failure of the construction, and too little stress force to resorption of the bone block. Nevertheless, an important factor in achieving success when using structural grafts to reconstruct a deficient acetabulum is 50% coverage of the cup by host bone. This factor has been well documented in the literature [8, 10, 17, 23, 26, 27].

In contrast to reinforcing the acetabulum with metal implants of large volume, the presented method supports the use of a corticocancellous graft for the reconstruction of the deficient acetabulum. Independent of the cup fixation, high success rates can be achieved as evidenced clinically and radiographically as long as the cup is covered by solid bone. As other authors [23] have demonstrated failures of this biological roof-reinforcing method in the long term, we will very carefully follow these patients during the coming years.

References

13. Harris WH (1978) Total hip replacement for osteoarthritis secondary to congenital dysplasia or congenital dislocation of the hip. Int Orthop (SICOT) 2; 127