FAILURE OF STRUCTURAL ACETABULAR ALLOGRAFTS
IN CEMENTLESS REVISION HIP ARTHROPLASTY

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We investigated the radiographic and clinical course of 31 patients in whom a bulk acetabular allograft had been used during the cementless revision of a total hip replacement. Two patients died and two were lost to follow-up within 24 months, but of the remaining 27 acetabular components, 12 (44%) showed radiographic evidence of instability at a mean of 46 months. Five of these have been revised.

In the 12 failures, signs of instability had been noted at an average of 29 months (1 to 60). Failures during the first 24 months were usually due to technical errors, later failures to gradual migration of the cup into the graft. The cups with the greatest amount of their surface supported by grafts were most likely to migrate, but this migration was usually asymptomatic. Screw fixation of the cup, used in 24 cases, appeared to control the mechanism of failure.

Femoral head allografts and distal femoral allografts had been used, with failure in 6 of 16, and 6 of 11 respectively; distal femoral allografts were used only for large defects. The insidious course of late cup migration and graft failure necessitates close radiographic follow-up of patients treated with bulk allografts.

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Aseptic loosening of an acetabular component sometimes leads to damage to the acetabular rim and this may complicate revision surgery. Migration of a loose cup often creates an oblong defect in the acetabular roof which may preclude initial stability of an uncemented cup unless bulk allografts are used. Rather than simply filling the void, structural allografts can be used to restore the centre of rotation of the hip to a mechanically advant-

ageous position in terms of muscle balance and load distribution.

Revision arthroplasty using cemented acetabular components with allografts has not given encouraging results (Jasty and Harris 1987, 1990); graft resorption and component loosening were seen in 18% to 32% of cases within five years. The early success of cementless primary arthroplasty (Callaghan, Dysart and Savory 1988; Engh, Griffin and Marx 1990; Schmalzried and Harris 1992) and of cementless revision of loose acetabular cups (Engh et al 1988; Engh and Glassman 1991; Tanzer et al 1992) led to the use of cementless implants even when acetabular defects required augmentation with bulk graft. Early reports supported the use of bulk allografts with porous-coated acetabular components (Engh et al 1988; Emerson et al 1989; Clarke, Jinnah and Lennox 1990).

In 1982, we started to use porous-coated, hemispherical acetabular components in revision surgery, adding allografts routinely to repair any dome and rim deficiencies. We now review the radiographic and clinical course of these large load-bearing allografts.

PATIENTS AND METHODS

From 1982 to 1987, a total of 31 superior load-bearing allografts were used at revision arthroplasties to support porous-coated cups. Two patients have died of causes unrelated to the revision arthroplasty and two had inadequate radiographic follow-up. Of the remaining 27, 16 had femoral head allografts and 11 had distal femoral allografts. Fresh-frozen femoral head allografts were used to fill defects of 46 mm or less; distal femoral allografts were used to reconstruct larger defects. There were 18 women (one with bilateral grafts) and eight men. The average age at the time of the revision was 51 years (27 to 78).

An ideal reconstruction restores the centre of the hip to its anatomical position, but when there are deficiencies of the acetabular dome, containment of the cup at an acceptable inclination is only possible when it is displaced superiorly and medially. This is not acceptable if the component is mechanically unstable, if limb length discrepancy results, or if the biomechanical advantage of the abductors is significantly diminished and in these cases we used allografts. When a bulk allograft was needed, the rim defect was deepened with hemispherical...
reamers to provide at least partial containment of the graft which was then shaped with resurfacing female reamers to a diameter 2 mm larger than the acetabular defect. The allograft was impacted into the defect to provide a tight press-fit. In 25 of the 27 cases, one or two 6.5 mm cancellous screws were used as well. In the other two the only screw fixation was by the 4.5 mm cortical screws which were placed through the rim of the acetabular component.

The grafted acetabulum was prepared to receive the implant using hemispherical male reamers. A porous-coated acetabular component, with a diameter 2 mm larger than the last reamer, was impacted into place to achieve a press-fit which was tested by applying pressure to its rim. Initial stability was provided by 4.5 mm cortical screws passed through the rim of the cup, through the allograft, and into the host pelvis. We used an average of three peripheral rim screws in each case (range 0 to 6).

At follow-up we recorded the modified Merle D’Aubigné and Postel (1954) pain and walking scores. Standardised anteroposterior and coned Judet lateral views of the pelvis were used for serial radiographic evaluation (Judet, Judet and Letournel 1964). Migration of the cup or change in its angle of inclination was determined using methods based on those of Massin, Schmidt and Engh (1989), and our own criteria were used to assess the radiographic stability of the femoral components (Engh, Massin and Suthers 1990).

We recorded the coverage of the cup by the allograft in degrees, both on the anteroposterior (AP) and lateral (Judet) views, as the arc on the hemisphere where allograft and prosthesis were in contact. This was then expressed as a percentage cover in each plane (Fig. 1). Graft healing was defined as radiographic obliteration of the gaps between host and graft bone; atrophy or resorption of the grafts was also recorded. Our criteria for a stable cup were: < 2 mm of superior or medial migration; < 5° change in the abduction angle; no progressive or circumferential radiolucency at the bone-implant interface; no screw fracture or shedding of metal particles from the implant.

RESULTS

At latest follow-up, 15 of the 27 acetabular cups (56%) were radiographically stable, seven (26%) were unstable, and five (19%) had been revised. The 22 unrevised stable and unstable cups had been in place for 30 to 71 months (mean 50). The five revisions had been performed after a mean interval of 27 months (2 to 56). The overall failure rate was 44%.

Radiograph to show the method of measuring the coverage of the acetabular cup by the allograft. In this AP view, the allograft covers 80° of the 180° arc of the cup and the coverage is 44%.

Figure 2a – Anteroposterior radiograph after rerevision of the acetabular component for malposition. The allograft seemed to be well incorporated at the operation. Figure 2b – Two years after the rerevision, there is radiographic evidence of superior migration and tilting of the cup. It can be seen that the cup has settled in the line of the peripheral rim screws.

Fig. 1

Fig. 2a

Fig. 2b
The 15 stable acetabular components included ten with femoral head allografts and five with distal femoral allografts. The coverage of the acetabular component by the allograft averaged 88° (or 49%) on the AP views and 92° (or 51%) on the lateral views. Thirteen of these 15 patients (87%) showed radiographic evidence of graft incorporation; in the other two this was uncertain. The pain scores in this group had improved from a preoperative average of 3.1 to a follow-up average of 5.7. Average walking scores had improved from 2.7 to 4.4. In all 15 patients the femoral component appeared to be optimally fixed. The clinical scores therefore reflect the average expected scores with both components stable.

In the 12 patients with unstable cups, femoral head allografts had been used in six and distal femoral allografts in six. The average coverage of the acetabular component by the allograft was 110° (61%) on both AP and lateral views, which was significantly greater support than in the stable group of hips (by two-tailed, unpaired Student’s t-test AP views, p = 0.015 and lateral views, p = 0.046). Although the cups were unstable, 10 of the 12 hips showed clear signs of graft incorporation. Instability had appeared at a mean time of 29 months (1 to 60), and all 12 acetabular components had tilted, while eight also showed superior migration. The average pain scores in this group had improved from 2.7 to 5.1 and the average walking score from 2.6 to 4.1. All the femoral components were radiographically stable.

The average time to revision in the five hips was 27 months (2 to 56): three were within 24 months and two later than 48 months. Three had shown gross loosening: one early failure was in a case in which no peripheral screws had been used. Two failures were associated with graft resorption. At every rerevision operation, some of the allograft appeared to have healed to the acetabular rim, and was used to help to support a larger acetabular component with no additional grafting. Follow-up after rerevision is too short to allow assessment of results, but in one case there is already some migration of the second cup (Fig. 2).

DISCUSSION

There are a number of reports of the use of allografts with cemented acetabular components in revision arthroplasty. Trancik et al (1986) reported success in 18 of 21 hips with an average follow-up of 3.5 years, but the superior portion of an allograft had collapsed in one, and two others showed progressive radiolucencies at the cement-bone interface. Harris (1982) at first reported good to excellent results in 8 of 12 revisions which used graft to support a cemented acetabular component, but in 1987 Jasty and Harris reported failure of bulk allografts in 5 of 29 hips after an average of 3.9 years, and in only one of the rerevisions was there histological evidence of revascularisation of the allograft. In 1990, Jasty and Harris reported a 32% failure rate at 6 years, with allograft resorption in 80%. Failure was usually sudden, at a mean of 5.4 years postoperatively, and correlated with the extent of acetabular coverage provided by allograft.

The absence of a grouting material in cementless revision surgery increases the need for bone grafting. Emerson et al (1989) had poor results using cementless acetabular components with load-bearing allografts. Four of nine porous-coated titanium cups with fins, not screwed into position, showed early migration. This was attributed to inadequate fixation of the graft to the host. Pollock and Whiteside (1992) reported 23 cases using bulk allografts with cementless cups. The allografts were fixed with screws, but the acetabular components were held by pegs. Six cups (30%) required rerevision for loosening and another six initially migrated, but then stabilised. Despite the high rerevision rate, partial success was claimed because there had been some restoration of bone stock.

Cementless acetabular reconstruction with bulk allografts is technically difficult. Intimate contact is needed between host bone and allograft, with the maximal surface area to reduce early mechanical loading. Good fixation with screws and the restoration of an anatomical head position also reduce the load on the reconstruction. Early biological fixation of any porous surface of the implant in contact with living host bone will also relieve loading. Despite attention to these details, our series has a high graft failure rate.

We did not see the sudden, catastrophic failures reported with cemented cups: our failures were by gradually progressive migration often without symptoms. Our use of peripheral rim screws may have helped to prevent sudden, symptomatic collapse of the allograft, and the screws placed through graft and into the host bone appeared to control the direction and severity of cup migration. Some screws eventually fractured, but even this was not usually associated with symptoms.

The allograft failures in our series began at an average of 29 months compared with the 5.4 years reported by Harris for cemented cups. Even earlier cup migration and instability have been reported when pegs or fins were used to anchor a hemispherical cup to bulk allograft. Pollock and Whiteside (1992) found that 12 of 23 cups migrated before two years. Six of these 12 cups migrated until they became stable against host bone, and it may be that the allograft allowed a controlled migration. The other six cups required revision because continued migration became symptomatic. Emerson et al (1989) also used fin fixation, and reported that 4 of 7 cups had migrated at an average 22-month follow-up.

It has been suggested that acetabular reconstruction should be performed in two stages, with success of the first stage defined by the incorporation of the allograft. The second stage, or rerevision, is then made easier by the presence of the new bone stock. Even incorporation and revascularisation of allograft, however, may not ensure its strength and durability. In one of our cases of rerevision the allograft appeared to be viable and fully
incorporated but migration and allograft resorption followed the revision. The inherent strength of allografts changes with time; neither the radiographic nor the operative appearance is adequate to assess the mechanical integrity of the graft.

No bony ingrowth can be expected at a component-allograft interface, and the potential for biological stability therefore decreases as more of the cup is against allograft rather than host bone. We found a definite increase in the failure rate if more than 50% of the cup rested on allograft, and Jasty and Harris (1990) reported similar findings.

Chandler (1992) has emphasised the importance of using strong distal femoral allograft rather than femoral head material. We used distal femur only when a single head was not inadequate; we had failures with both types but distal femoral allografts were used for larger defects.

We consider that weight-bearing allografts do not yield predictable results in cementless revision of acetabular components. Screws may control cup migration and change the presentation of failure, but regardless of the method of fixation, there is a correlation between the percentage of allograft coverage and eventual failure.

When there is no satisfactory alternative to a bulk allograft, close radiographic follow-up is recommended. If cup migration is observed, weight-bearing should be restricted and six-monthly radiographic evaluation arranged. Continued migration or screw breakage will require reversion, at which additional grafting may not be necessary.

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