

Bone grafting in total hip arthroplasty for insufficient acetabulum

Theodore XENAKIS, Theodosios KOUKOBUS, Konstantine HANTES, Socratis VARYTIMIDIS, Panayotis N SOUCACOS

We assessed the effectiveness of total hip arthroplasty (THA) supplemented with autologous bone grafts in patients with congenital disease of the hip (CDH). 2 groups of patients were evaluated: In Group A, 33 patients with a mean age of 54 years underwent arthroplasties using a threaded ceramic conical acetabular cup without cement (Autophor). In Group B, 85 patients with a mean age of 55 years underwent arthroplasties using a threaded, noncemented, titanium cup (CST). Bone grafts were supplemented the THA in 3 ways: 1) intrapelvic application using the cotyloplasty technique, 2) as bone chips in order to cover small defects around the upper and lateral part of the cup, and 3) as a bulky corticocancellous graft which was secured with screws. Follow-up averaged 11 and 9 years for patients in Groups A and B, respectively.

All the grafts in Group A had consolidated by the

end of 6th month. Only 2 partial absorptions were observed, 1 intrapelvic graft and 1 corticocancellous graft. 2 revisions were performed in this group of patients, but neither were related to bone graft absorption.

By the end of 6 month, 63 of 85 in Group B had consolidated bone grafts. In 16 patients with intrapelvic cotyloplasty, 3 demonstrated complete and 1 partial absorption of the grafts. 3 cup revisions were performed in this group of patients, all with complete graft absorption. Our findings indicate that autologous bone grafts are strong adjunct for satisfactory fixation of THA in patients with CDH, a particularly demanding group of patients to manage. In addition, the ceramic threaded cup was found to be superior to the titanium threaded cup in terms of both bone graft consolidation and the number of revisions required.

Department of Orthopaedic Surgery, University of Ioannina, School of Medicine, Ioannina, Greece. Correspondence: Dr. T Xenakis, Associate Professor, Department of Orthopaedic Surgery, University of Ioannina, School of Medicine, Ioannina 45 110, Greece. Tel +30-651-45 731. Fax -46 222

The treatment of congenital hip disease (CDH) in adults, particularly in cases with hip dislocation, was an unsolved problem for many years, as in most cases total hip arthroplasty was considered unsatisfactory (Charnley and Feagin 1973). During recent years, however, a growing number of articles have reported successful management of these difficult hips using total hip arthroplasty, the most of which are cemented (Paavilainen et al. 1990, Hartofilakidis et al. 1996).

It is well-accepted that good bone coverage of the cup is necessary for adequate longevity of total hip replacements. Because of the insufficient acetabulum in CDH, most surgeons agree that arthroplasties in these patients require supplementation with bone grafts (Ritter and Trancik 1985, Wolfgang 1990). While the use of bone grafts is an accepted procedure by most surgeons, some doubts remain regarding the bulky cortical cancellous bone grafts, particularly in terms of their long-term behavior (Harris et al. 1977, Kwong et al. 1993, Hooten et al. 1996, Hartofilakidis et al. 1996).

We evaluated the long-term behavior of 3 types of bone grafts. Bone grafts were used to supplement the insufficient acetabular wall in patients with CDH undergoing total hip arthroplasty in which a noncemented acetabular cup was used.

Patients and methods

Adult patients with CDH were evaluated both clinically and radiographically for treatment of an insufficient acetabulum using a bone graft to adequately cover the acetabular cup in an arthroplastic procedure. All CDH patients were classified, according to Hartofilakidis et al. (1988, 1996).

The patients were treated with cementless cup THA and the bone grafts were taken from the removed femoral head and neck. Preoperatively, all patients underwent a thorough clinical and radiographic examination including CT for a detailed preoperative assessment. Selection of the femoral stem was based

on the preoperative templating technique using a computer assisted program (Hess and Uber 1978, Xenakis et al. 1996).

The acetabular cup was, in all cases, cementless, cone shaped and was screwed into the bone. Two different cup types with a similar shape were used, a ceramic type (Autophor) and a titanium cup combined with polyethylene (CST). Both acetabular cups were designed by Mittelmeier.

The patients were classified into 2 groups. Group A included 42 patients who received the ceramic cup. Of these, 29 patients (33 hips; 4 bilateral) with complete clinical and radiographic follow-up were included in the study. There were 25 women and 4 men, with a mean age of 54 (32-75) years. Two patients had high dislocations, 8 low dislocations and 23 were dysplastic. All patients were followed on a routine basis at 3 and 6 weeks, 3, 6, 12 months, and once a year thereafter, with a mean follow-up of 11 (9-13) years.

Group B comprised 111 patients in whom the CST acetabular cup was used. Of these, complete clinical follow-up study was available in 75 patients (85 hips; 10 bilateral). There were 68 women and 7 men, with a mean age 55 (27-75) years. 8 patients had high dislocations, 8 low dislocations, and the remaining 69 were dysplastic. Follow-up which was at the same intervals as noted above averaged 9 (5-11) years.

Surgical technique: A Watson Jones approach was used without osteotomy of the greater trochanter. After osteotomy of the neck and removal of the femoral head, the false and true acetabulum were identified, followed by reconstruction of the true acetabulum using preoperative data provided by CT. Conical reamers were then used to evaluate the extent of coverage which would be achieved for the acetabular cup. The goal was to locate the cup in the place of true acetabulum and to provide satisfactory stabilization in order for loading stresses to be transmitted to healthy bone and not the bone graft. In this regard, the role of the bone graft was two-fold. First, to provide adequate coverage of the acetabular cup, as well as for better transmission of the loading stress to the bone until the bone grafts were consolidated. Second, bone grafts help to ensure the development of good quality bone which can be used in the future in case a revision was necessary.

Bone grafts were applied using 3 techniques:

1) Once a small fracture was provoked in the thin wall of the true acetabulum, abundant autologous bone graft was applied, thus producing a thick intrapelvic wall in the place where the previous thin acetabular wall existed. This technique, referred to as cotyloplasty was similar to the ones described by Hess and Uber (1978) and Stamos (1984) (Figure 1).



Figure 1. 10 year postoperatively. Successful intrapelvic bone grafting using the cotyloplasty technique.

2) Following the stabilization of the acetabular cup, abundant cancellous bone grafts after decortication of the iliac bone was used to cover the upper and lateral aspects.

3) In a manner similar to that described above, the uncovered part of the acetabulum was covered with the aid of a bulky corticocancellous bone graft taken from the femoral head. First the cup was stabilized in healthy bone of the iliac wing, then bone chips were placed, and afterwards the bulky corticocancellous bone graft was used to cover the upper and lateral aspects and was secured with cancellous screws.

In 17 hips of group A and in 13 hips of group B, cotyloplasty was combined with one of the other two techniques (Table 1). Consolidation of the bone grafts was evaluated using clinical and radiographical control.

All patients were administered second generation cephalosporin 12 hours before the surgical procedure and for 48 hours postoperatively. Prophylactic anticoagulation therapy was also given and included either low dose heparin or low molecular weight heparin. Anticoagulation therapy was continued until the end of the third postoperative week.

Results

In group A, all of the grafts had consolidated between 3 and 6 months postoperatively, with the exception of 1 case with an intrapelvic bone graft which showed

Table 1. Bone grafting technique used to manage insufficient acetabulum in total hip arthroplasty procedures with ceramic or titanium cups

Bone graft	Ceramic	Titanium
Cotyloplasty	3	16
Superolateral	10	22
Bulky corticocancellous	3	17
Cotyloplasty + superolateral	12	18
Cotyloplasty + bulky corticocanc.	5	12
Total	33	85

Table 2. Incomplete incorporation and absorption of bone grafts in total hip arthroplasties using either ceramic or titanium cups with a mean follow-up of 10.7 and 8.6 years, respectively

Cup type/bone graft	n	Incomplete incorporation	Absorption
<i>Ceramic</i>			
Cotyloplasty	20	0	1
Superolateral	22	0	0
Bulky corticocancellous	8	0	1
<i>Titanium</i>			
Cotyloplasty	46	16	4
Superolateral	40	12	0
Bulky corticocancellous	29	3	1

substantial absorption (Table 2). A stable course of graft maintenance was observed in all patients with the exception of 1 bulky corticocancellous bone graft which was stabilized with screws and which showed major absorption after 8 years. The patient now at 12 years postoperatively, however, is pain-free with no need for a revision arthroplasty (Figure 2).

In Group B, the rate of consolidation was similar to that observed in Group A. By 6 months postoperatively 63 out of the 85 THA had achieved full consolidation, while the remaining 22 patients had partial consolidation. No case, however, demonstrated absorption. By the end of one year, full consolidation of the graft was seen in 61 cases. On the other hand, partial consolidation was observed in 16 cases with cotyloplasty, 12 cases with a bone graft which was placed in the upper and lateral aspect of the cup, and in 3 cases with a bulky corticocancellous bone graft which was secured with screws. Note that some patients had more than one procedure. At final evaluation of these patients, absorption of the bone grafts was observed in those cases treated with cotyloplasty in combination with bone grafts on the upper lateral aspect of the cup, 9 years postoperatively. Despite this, the arthroplasty remained stable and the patients were free of symptoms. Similar findings were observed in patients treated with bulky corticocancellous bone grafts

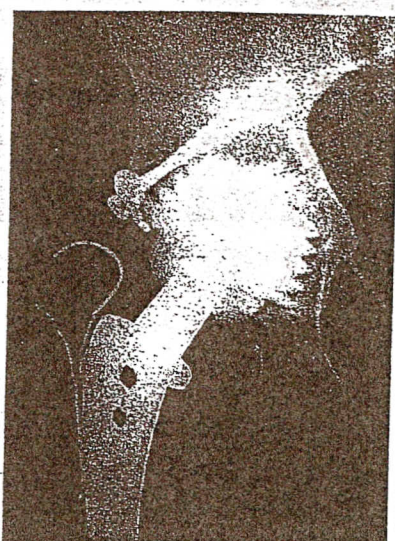


Figure 2. 12 year postoperatively. A combination of bone grafting using the intrapelvic cotyloplasty technique and a bulky corticocancellous bone graft secured with two screws. A ceramic cup was used.

which had undergone partial absorption. The acetabular cups in the latter remained stable.

In Group A, 2 patients underwent revision, because of loosening of the acetabular cup (1 patient) or loosening of both cup and femoral component (1 patient). In both cases, however, the cortical cancellous bone graft showed complete consolidation with the true acetabulum.

In Group B, 2 patients (3 hips) underwent revision. In both patients loosening of the acetabular cup and wear of the polyethylene were observed. In contrast with the patients with ceramic cups, the bone grafts in both of these patients had been totally adsorbed (Figure 3). The remaining arthroplasties of both groups were doing well at final follow-up; the patients had full motion and were pain-free.

Discussion

We observed complete or partial consolidation of bone graft in both groups of patients. Similar findings have been reported in previous studies (Sanzen et al. 1988, Wolfgang 1990). Overall, the outcome of bone grafts in patients treated with ceramic cups was found superior to those in which CST type cups were used. Although the long-term results were the same in both patient groups, bone grafts in those using ceramic cups did not show partial consolidation, where as in the CST group, one quarter of the cases showed satisfactory, but partial consolidation.



Figure 3. 5 years postoperatively showing a titanium (CST) cup with thin polyethylene. The component was loose and the bone grafts were completely absorbed.

The early failure and revisions in the patients of both groups can not be attributed to the bone graft alone, as the young age of the patient must be taken into account on the one hand, and the thin polyethylene portion of the acetabular cups used, on the other hand (Livermore et al. 1990, Devani et al. 1997). The latter is now known to lead to a higher rate of failure. The failure rate of cotyloplasty in our series was higher than that reported by Hartofilakidis et al. (1996) where a Charnley prosthesis was used.

In previous studies with a long-term follow-up, 20 percent of the patients underwent revision after 12 years follow-up (Malroy and Harris 1990). Similar results were reported with a follow-up of 10 years (Kwong et al. 1993). In contrast, the patients in Group A of our study demonstrated a much lower revision rate (3/42) after an average follow-up of 11 years. Furthermore, our findings indicate that the absorption rate is very low, even when bulky corticocancellous bone graft were applied.

Preparation of the recipient site is of great importance for maintenance and consolidation of the bulky corticocancellous graft (Jasty and Harris 1990). In addition, a number of other factors, adequate fixation of the graft and avoiding cement between the bone graft and recipient site, have been found to play a decisive role so that the loading stresses are not transmitted through the graft. In turn, these serve as prerequisites for the final consolidation of the graft. (Stamos 1984, Paavilainen 1990, Young 1991, Rodriguez 1995)

True consolidation and remodeling of the bulky

corticocancellous grafts is still controversial. In one report with 2 necropsies in which 2 deep frozen autologous bone grafts had been used, the findings indicated that true consolidation and healing of the graft had not occurred (Hooten 1996). In general, however, it is accepted by most surgeons that the fresh autologous bone grafts are far superior to deep frozen bone grafts (Caffiniere and Postel 1985, Young et al. 1991). Longevity and vascularity of the bone grafts, however, which plays an important role in the stability of the prosthesis is difficult to assess with the available techniques, such as bone scans and radiographs (Caffiniere and Postel 1985, Sanzen et al. 1988).

We found the use of autologous bone grafts in patients with osteoarthritis secondary to congenital hip disease and treated with total hip arthroplasty to constitute a valuable and simple surgical solution for an insufficient acetabulum. The placement of the bone graft and the method used, as well as the arthroplasty selection must be the product of careful preoperative planning. Initial stability of the acetabular cup must be satisfactory and stress load transmission must be through the cup and not through the bone graft. This ensures adequate time for the grafts to consolidate. Based on our findings, we favor cementless threaded cups, supplemented with autologous bone grafts as in a period of 5-13 years, there were only 5 revisions out of 118 arthroplasties. The ceramic threaded cup was found to be superior to the titanium threaded cup in, as far as the consolidation rate of the bone grafts was concerned, as well as the number of revisions performed.

References

- Charnley J, Feagin J. Low friction arthroplasty in congenital subluxation of the hip. *Clin Orthop* 1973; 91: 98-113.
- de la Caffiniere J Y, Postel J M. Analyse de lâimage scintigraphique des greffes osseuses dans les reprises de protheses totales de hanche. *Rev Chir Orthop (F)* 1985; 71(6): 369-76.
- Devani P, Home G, Martin K, Coldham G, Krause B. Three dimensional polyethylene wear of a press-fit titanium prosthesis. Factors influencing generation of polyethylene debris. *J Arthroplasty* 1997; 12(3) : 256-66.
- Harris W, Crothers O, Oh I. Total hip replacement and femoral head bone-grafting for severe acetabular deficiency in adults. *J Bone Joint Surg (Am)* 1977; 59 (6): 752-9.
- Hartofilakidis G, Stamos K, Ioannidis T. Low friction arthroplasty for old untreated congenital dislocation of the hip *J Bone Joint Surg (Am)* 1988; 70 (2): 182-6.
- Hartofilakidis G, Stamos K, Karahalios Th, Ioannidis T, Zaharakis N. Congenital hip disease in adults. Classification of acetabular deficiencies and operative treatment with acetabuloplasty combined with total hip arthroplasty. *J Bone Joint Surg (Am)* 1996; 78 (5): 683-92.