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Massive structural allograft in revision of septic hip arthroplasty

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Abstract We reviewed 10 patients who had undergone two-stage reconstruction with massive structural allografts following failure of hip arthroplasty due to infection. The mean follow-up time was more than 5 years (range 3–10 years). There was no case of the infection recurring. The most common pathogen isolated at the time of first-stage surgery was *Staphylococcus epidermidis*. The mean preoperative modified Harris Hip score was 27.4 (range 9–58) and the mean postoperative score was 73.5 (range 53–92) with a mean increase in the score of 46.1 points. One patient required revision of the acetabular cup for aseptic loosening and another had a dislocation, which was stable after manual reduction. We conclude that the use of a massive structural allograft in revision of septic hip arthroplasty is a viable option.

Résumé Nous présentons dix patients qui subirent en deux étapes, une reconstruction par allogreffe massive structurale, suite à un échec d'arthroplastie totale de la hanche causée par une infection. Le suivi est en moyenne supérieur à 5 ans (de 3–10 ans). Il n'y eut aucune récurrence d'infection. Le germe le plus fréquemment isolée lors de la reprise chirurgicale fut le staphylococque épidermidis. Le score moyen de Harris modifié fut 27.4 (9–58) et le score moyen post-opératoire fut 73.5 (53–92). Un patient a dû subir une révision pour descellement aseptique, et un autre une luxation qui est demeuré stable après une réduction fermée. En conclusion, nous croyons que l'utilisation de greffes massives structurales pour la révision d'arthroplastie totale de la hanche après infection est une option qui a des bonnes chances de réussite.

Introduction

Septic failure of total hip arthroplasty is often associated with extensive osteolysis on both the acetabular and the femoral sides. The essential treatment for this devastating complication begins with debridement and removal of all the foreign material [4, 5].

Severely depleted bone stock at the end of this stage often forces the surgeon to offer resection arthroplasty to the patient [3]; however, although this may provide pain relief and infection control, the patient is left with a large discrepancy in limb length, instability and poor function [3, 8]. Revision hip arthroplasty, when successful, can provide a much better function for the patient [17]. Several measures such as custom-made prostheses, autografts or allografts have been recommended to overcome the problem of poor bone stock. Although the use of allografts has met with reasonable success in aseptic revisions, their use in total hip revision for septic failure remains controversial [12]. Concern has been expressed that the presence of the allograft might increase the rate of infection [18]. Many authors, however, have reported success without recurrence of infection [15, 20].

The aim of this study was to assess the role of massive skeletal allografts in revision of septic hip arthroplasty and to study the incidence of re-infection and other allograft-related complications.

Materials and methods

Between April 1987 and August 1995, 10 patients (4 women and 6 men) who presented with septic loosening of total hip arthroplasty associated with bone loss were treated with a protocol involving a two-stage revision with allograft bone (Table 1).

The mean age at the time of the first stage of the revision procedure was 61.3 years (range 42–79 years). The initial diagnosis was primary osteoarthritis in 5 patients, traumatic arthritis in 4 and ankylosing spondylitis in 1 patient (Table 1).

The first stage involved removal of the infected prosthesis and a thorough debridement of the hip. A custom-made phantom prosthesis containing a heat-stable antibiotic (PMMA spacer shaped as a Thompson prosthesis, made from Palacos R cement containing

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Table 1 Details of 10 patients undergoing reconstruction with massive allograft for failure due to sepsis and bone loss. (OA Osteoarthritis, T(OA) traumatic osteoarthritis, AS ankylosing spondylitis, PFA proximal femoral allograft, HHs Harris Hip score)

Patient	Age (years)	Sex	Primary diagnosis	Graft	Time between previous and first stage of revision (months)	Infecting organism	HHs Pre-operative	HHs post-operative	Interval between stages 1 and 2 (weeks)	Follow-up (months)	Complications	Previous revisions (no.)
1	74	F	OA	PFA×5 cm	59	<i>S. aureus</i>	9	80	6	36	Non-union	1
2	60	M	T(OA)	Struts×3 cm PFA×9 cm Femoral Condyle	67	Coagulase-negative <i>Staphylococcus</i>	58	92	32	48	None	1
3	66	F	OA	PFA×15 cm	144	<i>S. Pneumoniae</i>	36	53	6	39	None	1
4	46	M	T(OA)	PFA×6 cm	130	<i>S. epidermidis</i>	55	74	8	56	Aseptic acetabular failure	1
5	57	M	T(OA)	PFA×19 cm	18	<i>S. epidermidis</i>	19	77	16	65	None	2
6	63	M	OA	Hemipelvis	24	Klebsiella	18	90	24	120	Haematoma	2
7	72	F	T(OA)	Struts×3	57	Group D streptococcus	14	64	8	56	None	1
8	42	M	AS	Calcar	107	<i>S. epidermidis</i>	22	54	12	98	Dislocation	1
9	54	M	OA	PFA×6 cm	39	<i>S. epidermidis</i>	25	92	12	98	None	1
10	79	F	OA	PFA×14 cm Struts×3 Femoral head	49	Polymicrobial	18	59	12	36	Fracture at host-allograft junction of femur	2

1 g gentamicin) was then inserted in 9 of the 10 patients. Parenteral antibiotic administration was continued for 3 weeks. Oral antimicrobials were continued for a further 6–12 weeks.

The indication for utilizing an allograft during delayed re-implantation was identified at this stage by radiological assessment of severity of bone loss according to the system of the American Academy of Orthopedic Surgeons Committee on the Hip [6, 7]. The deficiency of the proximal femur was classified as type III in 7 cases and type I in 2 cases, there was 1 type III acetabular deficiency (Fig. 1).

During the second stage of the revision procedure, further specimens of tissue were procured for culture and histology. A peroperative gram stain was also performed and parenteral antibiotics administered. The phantom prosthesis was removed, the bone loss was assessed and the appropriate allograft segments were chosen for implantation with a standard prosthesis. The allograft segment used included 7 proximal femorae, 1 hemipelvis and 1 calcar replacement. One patient received cortical struts with impaction allograft of morsellized bone. The proximal femoral allografts had a mean length of 10.57 cm (range 5–19 cm). All the allografts were provided by the Queensland Bone Bank. The grafts were frozen and sterilised by irradiation. All the proximal femoral allografts were prepared to receive the prosthetic femoral stem, which was cemented into it by using antibiotic impregnated (Palacos R) cement. This allograft prosthesis composite was then inserted with a step cut in the host femur in a cementless fashion and abductor muscles reattached to the allograft greater trochanter by using a Dall-Miles cable system and trochanteric grip. This construct was reinforced with cortical strut grafts if further stability was required (Fig. 1). The one hemipelvis used was first secured to the host bone with screws, then reamed to accommodate a cemented polyethylene cup.

Perioperative parenteral antibiotics were continued for 48 h. All patients were assessed clinically with a modified Harris Hip score [9]. All the radiographs were analysed for allograft/host junctional union or resorption, and migration or loosening of the bioprosthesis. Failure was defined as recurrence of infection or failure of the bioprosthetic composite graft requiring further revision. The patients were followed up for an average period of 65 months (range 36–120 months).

Results

All the cultures taken at the time of re-implantation of the allograft prosthetic composite were negative for growth of micro-organisms. The mean time between excision arthroplasty (the first stage) and definitive re-implantation (the second stage) was 13.6 weeks (range 6–32 weeks). Six patients were entirely pain free, while 4 patients had mild pain relieved by occasional analgesics. Only 3 patients used a walking stick for support during ambulation. Limb length discrepancy persisted in all patients although it improved in 6 patients. One patient had aseptic loosening of acetabular component, which required re-operation.

The modified Harris Hip Score was used to assess the patients clinically. The mean preoperative score for the entire group was 27.4 (range 9–58) and the mean post-operative score was 73.5 (range 53–92). The mean increase in the score was 46.1 (range 17–72).

Complications

There were 5 complications (Table 1). Only 2 were related to the use of structural allograft. One was a non-union of

Fig. 1a–c Preoperative radiograph of patient 2. **b** Immediate radiographs after reconstruction with proximal femoral allograft and cortical struts. **c** Radiographic union 4 years post-surgery at graft host junction

proximal femoral allograft to the host. The patient was asymptomatic and bioprosthesis had not migrated. The other case was a fracture at the graft host junction after the patient fell 6 weeks following surgery. The patient underwent stabilization of the fracture with cortical strut grafts.

Recurrence of infection

There was no recurrence of infection at the most recent follow-up in any of the patients. The mean preoperative erythrocyte sedimentation rate (ESR) was 86 mm/h (range 68–110). The mean postoperative ESR at the most recent follow-up was 9 mm/h (range 5–12). The mean preoperative CRP was 20 mg/l (range 6–38) and the mean postoperative CRP at the last follow-up was 5 mg/l (range 4–7).

Discussion

Use of structural allografts for combating severe osseous deficiencies during the revision of septic failure of the total hip arthroplasty has always been a matter of concern, as allografts are nonvascularized osseous segments that can theoretically increase the incidence of infection in such cases.

Unfortunately, there is no single large series existing to recommend or refute the use of massive skeletal allografts in septic revisions. Most of the reported experience is from a small cohort of patients who had undergone revision for septic failures as a part of a large series by using massive skeletal allografts for aseptic failure of total hip arthroplasty with severe skeletal deficiencies [12, 13, 16].

Although the structural allograft is feared to increase the risk of re-infection [11, 19], there are several other factors associated with the risk of re-infection following revision of infected total hip arthroplasty. These include rheumatoid arthritis, raised ESR, virulent organisms, duration of systemic antibiotic treatment [15], serum level of antibiotics [12], timing of re-implantation and retained cement [14]. On the other hand, re-infections associated with allografts in such cases may be related to the technique of bone banking. Advances in bone banking techniques have reduced the risk of disease transmission due to bone transplant. Two previous infections in our series were caused by virulent organism viz. *Klebsiella* and Group D streptococci and these were re-implanted 24–28 weeks after the first-stage debridement, respectively. Infection in both the cases was successfully controlled. Though McDonald et al. [14] have recommended at least 1 year interval between resection arthroplasty and delayed re-implantation for infection with virulent organisms, our decision to re-implant prostheses earlier in these cases was guided by an excellent patient well-being and with the clinical picture and laboratory parameters (ESR and CRP) suggesting subsidence of infection.

Adequate surgical debridement, appropriate antibiotic treatment and a sufficient interval between stages in controlling infection cannot be over emphasized. The use of a PMMA spacer rather than gentamicin beads prevents limb shortening. It reduces the dead space and improves patient comfort and function between the stages [22]. It also makes dissection during the second stage easier.

Another key question in the management of infected total hip arthroplasties requiring allografts is whether they should be done in a staged manner. Most available literature suggests that reconstructions needing allograft should be done in 2 stages [2, 10]. If adequate control of infection is achieved, a structural graft provides almost immediate stability and the patient can be ambulant and comfortable earlier without waiting for the particulate grafts to mature and consolidate sufficiently to support the implant.

A higher recurrence rate of infection has been reported in the literature with the passage of time following revision for septic failures of total hip arthroplasty [15, 21]. In the patients followed up for more than 8 years in our series we have not encountered recurrence, but certainly the surgeons dealing with septic revision should be aware of the possibility of late recurrence of infection in such cases.

Several authors have reported good early results with the use of skeletal allografts in septic revision [1, 2, 20]. They have all emphasized the necessity for meticulous clearance of infection and for addressing bone loss. The options are severely restricted. A Girdlestone arthroplasty may substantially decrease the rate of recurrence of infection but leaves the patient with residual pain and poor function. A megaprosthesis is a useful option in some patients but does not restore bone stock and soft tissue attachment is compromised. The use of structural allograft bone in our cases provided immediate stability to the joint (particularly in view of the deficient host femur), restored bone stock, improved limb length discrepancy and allowed physiological loading of the host bone with forces of early weight bearing.

Loty et al. [13] emphasized the role of safe bone banking techniques, irradiation of graft and use of antibiotic loaded cement in composite reconstruction in reducing the risk of allograft related infections. In their 25 reconstructions using massive allografts in the presence of infection, there was only 1 case when infection recurred.

Although this study includes a small number of patients, the results are encouraging. The initial emphasis during the revision of septic hip arthroplasties should be an adequate control of infection, and then achieving a stable reconstruction. The success of structural allografts in reconstructing defects in revision of infected total hip arthroplasty failure depends on sound surgical principles, meticulous technique, and close patient monitoring and follow-up. The immediate restoration of anatomy, improved implant stability and return to function makes the use of major allografts in septic total hip failures a viable option.

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