Technical note

Distal femoral allograft for massive proximal femoral deficiency

Robert L Barrack, Michael W Wolfe, Paul Michas and Brian Frentz

Tulane University School of Medicine, Department of Orthopaedic Surgery, 1430 Tulane Avenue, SL32, New Orleans, Louisiana 70112, USA. Tel + 1 504 584-3514. Fax –3517
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Revision total hip arthroplasty (THA) in the presence of massive proximal femoral bone loss presents a challenge to the hip surgeon. Surgical options include proximal femoral replacement (megaprosthesis) (Zehr et al. 1996) or the use of structural allograft with a long-stem prosthesis. Each of these choices has advantages and disadvantages. The megaprosthesis has been advocated because of its ease of implantation and absence of risk of disease transmission. However, hip-joint instability and aberrant gait patterns are often associated with its use. This is due to the difficulty of obtaining good hip abductor strength and soft tissue attachment to the prosthesis. Implant fatigue failure, and increased rates of loosening have also been reported with the megaprosthesis (Zehr et al. 1996).

Special prostheses have been developed for use with large femoral allografts. The Gross Long-Stem Femoral Hip Components (Johnson and Johnson Orthopaedics, Raynham, MA, USA), in particular, has been used in proximal femoral reconstruction (Allan et al. 1991). This implant is a titanium prosthesis designed to provide a press-fit in the distal segment, while allowing cementing in the allograft. This type of reconstruction is usually referred to as an allograft-prosthetic composite (APC).

The proximal femoral allograft has been used in revision total hip replacement for many years (Head et al. 1987, 1993, 1995, Allan et al. 1991, Enneking and Mindell 1991). This allograft offers the surgeon mechanical properties similar to the patient's own bone and allows reconstruction of any size deficit (Pelker et al. 1983, Head et al. 1995). In total hip surgery, the use of a whole bone allograft allows better reattachment of the hip abductors, giving the patient a chance to improve hip function and gait.

One of the problems seen in massive proximal femoral bone loss in the elderly patient is matching the proximal femoral allograft's medullary canal with the patient's distal femoral medullary canal. Most revision patients are older and have larger medullary canals than the often small medullary canals of the donor bone. This problem has been addressed by the use of intramedullary cortical struts, step-cuts, and invagination of the allograft bone (Head et al. 1995). The Gross femoral prosthesis has dealt with this problem by leaving the metaphyseal region small to obviate the need for proximal allograft resection, while leaving the distal stem fluted, circular on cross-section, and conical, to allow a strong press-fit to the bone (Allan et al. 1991).

We describe a technique for correcting the cross-sectional medullary canal mismatch and present early clinical results with a small series of patients.

Technique

A structural allograft is used to replace the massive proximal femoral loss in cases in which bone is absent, fragmented or of such poor quality that it cannot contain cement or particulate bone graft. In cases where the distal canal diameter exceeds

Figure 1. Anteroposterior (A) and lateral (B) radiographs of distal femoral allograft are taken for preoperative planning.

the diameter of any available proximal femoral allograft, a distal femoral allograft is utilized to replace the proximal femur. A distal femoral allograft size is chosen with a canal diameter large enough to allow for the prosthetic stem and an adequate cement mantle. This is checked by obtaining a radiograph of the allograft, and applying the usual transparent templates to ensure adequate length and canal diameter (Figure 1).

A straight lateral skin incision is used with a transtrochanteric approach. The femoral prosthesis is then removed, while retaining all viable bone and soft tissue attachments. The femoral allograft is prepared on the back table (Figure 2). The femoral condyles are resected, using a diagonal cut. The medullary canal of the distal femoral allograft is then gradually reamed and broached to a size that will allow implantation of the selected long-stem femoral component, with an adequate cement mantle. The femoral trial is then placed. The length of the femoral stem should be such that adequate fixation can be obtained distal to the level of the host bone-allograft junction, either with a press-fit, if the defect is supra-isthmal, or with cement, if the isthmus is not preserved. Once a satisfactory length has been determined, stabilization of the host bone-allograft junction can be addressed. Either a step-cut or transverse cut may be

Figure 2. A vice facilitates preparation of the graft on the back table.

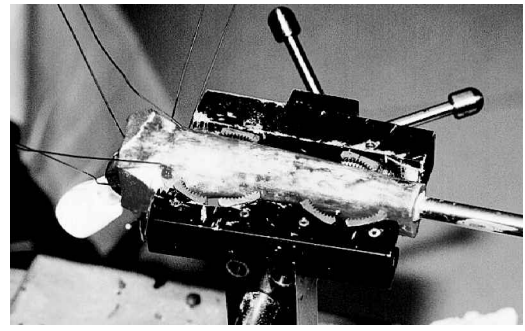

Figure 3. Stem cemented into allograft segment.

performed. The rotation of the composite should be determined during trial reductions and at least two longitudinal lines are placed across the host bone-allograft junction, so that proper rotation can be accurately reproduced at the time of implantation.

Once the surgeon is satisfied with the length and diameter of the femoral component, and the length and rotation of the allograft-prosthetic composite, the stem is cemented into the allograft on the back table (Figure 3). This yields good results clinically and improves the implant-graft interface (Head et al. 1987, 1993, 1995, Enneking and Mindell 1991). Modern cement technique is utilized. Pressurization of the cement in the canal is done by placing a latex glove over the distal canal. The glove is held in place while the implant is placed in the allograft. A small stab incision is made in the glove to allow the distal portion of the stem to pass while still allowing canal pressure to be maintained.

When cementing of the composite is complete, trimming of the condyles on the composite is performed to allow maximal range of motion,

Figure 4. Strut grafts and cables stabilize host bone-allograft junction.

without impingement and reduce unnecessary prominence in the trochanteric region. Two longitudinal and two transverse wires are placed in the condylar region for reattachment of the greater trochanter.

The remaining femur should be reamed to the proper size, then prepared for cementing. Standard third-generation cementing techniques are used. Cementing distally into host bone is reserved for elderly patients with limited life expectancy. Cementless stems are inserted with line-to-line reaming. Placement of the composite should be performed with careful attention to rotational alignment, and removal of cement at the composite/femoral junction. Minor differences in length can be made up by the use of modular prosthetic heads. The hip is reduced and the greater trochanter is wired into place, with attention to obtaining proper abductor tension.

After the composite is fixed in place, the junction is reinforced with cortical struts, if additional rotation stability is needed (Figure 4). This is usually obtained from the remaining piece of the structural allograft. The struts are fixed with circumferential wires or cables. Morselized bone graft, obtained from the cut portion of the allograft femoral condyle, is then impacted into any gaps occurring between the strut graft and the femur.

Results

We have used this technique in 10 patients (mean age 72 (48–90) years) over a 6-year period. 1 patient died of unrelated causes during the first 2 years. Follow-up was obtained on the remaining 9, mean 4 (2–6) years. The stem was cemented distally in 3 patients and by press-fit in 6 (Figures 5 and 6). All of the patients are community ambulators, and 8 ambulate with a cane in the opposite hand. The ninth is over 90 years of age and requires a walker. The host trochanteric fragment healed to the allograft in 7 of the 9 patients. In the other 2 patients, migration of approximately 1 cm was seen. 5 of the patients had a negative Trendelenburg gait and strong active abduction against resistance. The 2 patients with trochanteric migration had a slight Trendelenburg gait and mild abductor weakness, but were still able to ambulate well with a cane. There was no evidence of component migration or loss of fixation. 2 patients sustained dislocations in the early postoperative period, but there were no dislocations after 6 months from the time of surgery. We now recommend routine abduction bracing or use of a pantaloon spica cast in the early postoperative period in such cases. There was no evidence of significant structural graft resorption. All host bone-allograft junctions united radiographically.

Conclusion

Absence of bone in the proximal third of the femur is an infrequent but difficult challenge for the revision total hip surgeon. In these cases, the diameter of the residual femur is frequently large. In such cases, when an allograft-prosthetic composite is planned, a dramatic geometric mismatch is encountered if a proximal femoral allograft is employed. The use of a distal femoral graft obviates this problem.

We have used the described technique during a 6-year period, with acceptable short-term clinical results; the prospect of proximal graft resorption remains a concern. Healing of the host greater trochanter to the allograft was obtained in 7 of 9 patients. This gives the advantage of maintaining continuity of the abductor mechanism, as evidenced by good abductor strength and absence of Trendelenburg gait in most cases.

These patients are at risk for dislocation in the early postoperative period because of the exten-

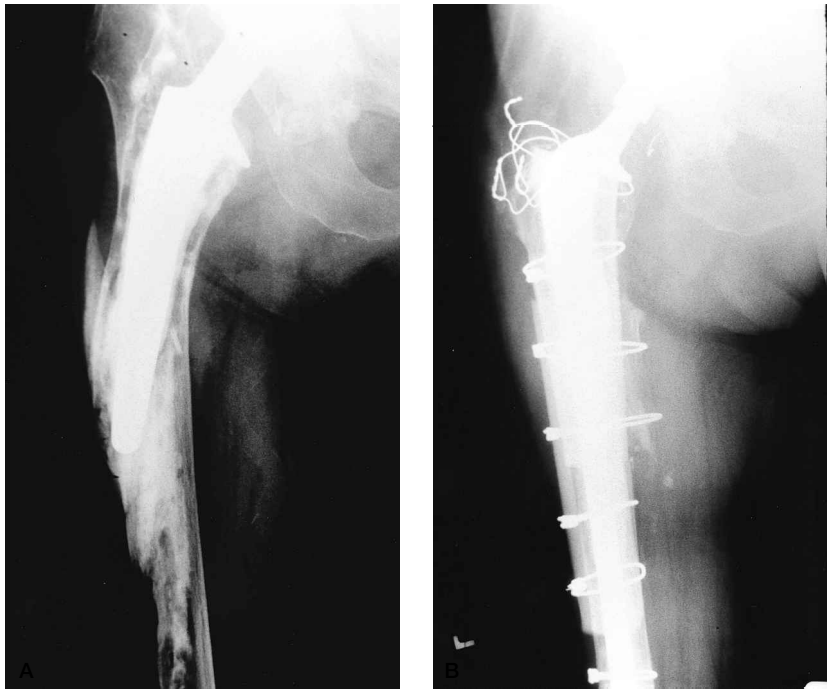

Figure 5. Preoperative radiographs of 90-year-old patient with proximal femoral bone loss and fracture malunion (A). Postoperative radiograph of cemented allograft-prosthetic composite (B).

Figure 6. Periprosthetic fracture through area of massive lysis in 48-year-old patient (A).

Allograft-prosthetic composite with distal cementless fixation (B).

sive soft-tissue dissection and absence of viable soft-tissue attachments to the proximal graft. For this reason, we now place smaller patients in a pantaloon spica cast for 4 –6 weeks following the procedure. In larger patients, or those who cannot tolerate a pantaloon spica, we routinely use an abduction orthosis.

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