Histology of Allograft-Prosthesis Composites for Reconstruction in Severe Bone Loss of the Proximal Femur

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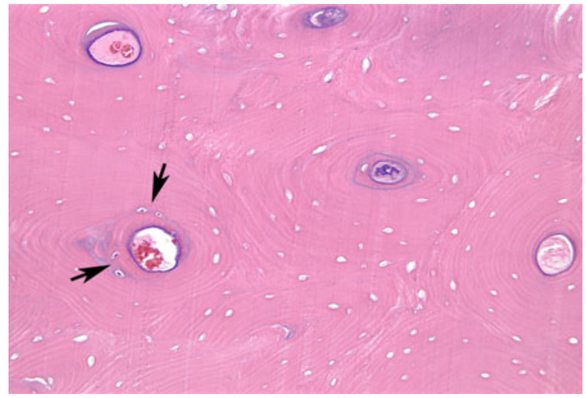
Purpose: Severe circumferential bone loss of the proximal femur due to aseptic loosening, osteolysis, or previous infection is among the more difficult challenges encountered in reconstruction of a failed hip arthroplasty. One method that has been used for reconstruction is the insertion of a whole proximal femoral allograft with a cemented stem, but little is known about the histology of such a construct. We hypothesized that allograft-prosthesis composites retrieved post mortem would demonstrate revascularization, new bone formation, remodeling of the allograft, union with the host bone and minimal inflammatory response.

Methods: Seven femoral allograft-prosthesis composites were retrieved postmortem from 4 females and 3 males, after a mean of 7 (range, 1 to 13) years following revision arthroplasty for severe femoral bone loss associated with aseptic loosening and osteolysis. The patients ranged in age from 61 to 79 years at the time of reconstruction. Harris Precoat (Zimmer, Warsaw, IN) CoCr stems were inserted into the allograft proximal femurs using pressurized cementing techniques. In 4 patients, standard length stems were employed which did not bridge the junction between the allograft and host distal femur. In the other 3 cases, stems 250-300mm in length bridged the junction between the proximal allograft and the host distal femur, where they were also cemented. Vascularized struts of the host medial cortex were retained in 5 patients and secured to the allograft femur. In one other patient, a previously placed allograft strut was retained; and in another, only particulate allograft was employed. The constructs were stabilized with 1 to 2 fixation plates, except for 1 case in which multiple cerclage wires were utilized to secure the allograft femur to the allograft strut. The mean Harris Hip Score at last follow up was 68 (36 to 97). Serial, transverse and longitudinal high-resolution radiographs and stained histological sections of the entire specimen femora were assessed for new bone formation, allograft revascularization, bone resorption, union with the host bone, reaction at the allograft-cement interface, and cellular response to the graft.

Results: High-resolution transverse section radiographs revealed union between the allograft femur and the host vascularized struts, but not the allograft strut. Three allograft femurs that had been in situ for 10 to 13 years demonstrated scalloping of the periosteal surface, and 2 of these had cortical cancellization at the site of union with the vascularized strut. Periosteal scalloping or cortical cancellization were not present in the other 4 allografts that had been in place for 1 to 6 years. Marked cortical resorption was not observed in any of the specimens.

The stained transverse sections showed that new bone was laid down either directly on the periosteal surface of the allograft femur or within resorption cavities that had formed in the outer third of the cortex. In areas of the cortical cancellization, the bone consisted of thick trabeculae often with inner cores of allograft bone. Bone marrow filled the intertrabecular spaces at these sites. There was no histological evidence of graft rejection.



Allograft outer cortex 13 yrs following allograft-prosthesis reconstruction shows partial revascularization and new bone formation. Two Haversian canals (left) contain new vessels, one of which is surrounded by new bone with viable

In contrast to the outer cortex, allograft resorption, revascularization, or new bone formation were rarely observed at the endosteal surface of the allograft femur except in the most proximal and most distal sections. The endosteal surface and the cement were closely apposed. Interposed fibrous membranes or cellular elements were not present between the allograft femur and the cement. No cracks were evident in the bone cement mantle; and the cement appeared well adhered to the femoral stem.

The longitudinal sections showed some degree of cortical or extra-cortical union between the allograft proximal femur and the distal femur in every specimen. In the 3 patients with long stems, however, intrusion of cement between the allograft and the distal femur junction prevented complete union of the cortices.

Conclusions: The proximal femoral allograft-prosthesis composites in this study seemed to be well tolerated with no signs of rejection and with histological evidence of union with the host bone up to 13 years following insertion. Of concern when whole bone allografts are employed in load bearing applications is weakening due to resorption of the graft and potential fracture in the long-term. In this study, marked resorption of the graft did not occur, even in the longest-term specimens. This may have been related to pressurized cementing of the femoral stem which effectively sealed the medullary canal, isolating the endosteal surface and restricting sites for resorption to the periosteal surface and Haversian surfaces in the outer third or the cortex. Better control of cement interposition at the allograft-distal femur junction, or not cementing the stem distally, might further improve union at this site.

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