Bone Allograft Reconstruction in Revision Hip Replacement

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Introduction

Major bone defects are frequently encountered in revision total hip arthroplasties. We use bone allografts to reconstruct both acetabular and femoral sides to allow successful implantation of a new prosthesis.

Our Bone Bank provides two types of allografts to support this activity. Frozen femoral heads are used for all kinds of acetabular defects and for small femoral defects. Irradiated massive cortical bones are used for major deficiencies of the femur.

Acetabular Reconstructions

Femoral Head Allografts

Femoral head bone banking began in our hospital in 1975. Their use in revision prostheses increased rapidly, as revisions became more and more frequent, and 200 of them are implanted each year in our department.

Procurement is performed by living donors undergoing hip arthroplasty for arthrosis. Complete preoperative examination and routine biology testing is performed when the bone is retrieved, including use of the polymerase chain reaction for HIV and Hepatitis C, allowing strict and efficient selection [2, 5]. Procurement sterility conditions are ideal, because of the operating environment and are verified with bacteriological samples cultured for a month. A computerized data-base allows graft validation and traceability.

Acetabulum Reconstruction Technique

Acetabuli are reconstructed with one or several bone blocks. The grafts are shaped to fit the defect, cartilage is removed and the grafts are impacted and fixed with screws to obtain primary stability. The screws are directed parallel to the mechanical forces, and we protect the reconstruction with a cruciate plate each time we need a large graft or when the acetabulum is fractured. We consider secure fixation to be mandatory for good graft healing and for preventing collapse during the remodelling period. A Charnley cemented cup is finally implanted.
Results

We reviewed our first ten years experience from 1975 to 1984 [3] with 122 large acetabulum grafts excluding the small grafts. All but 3 had very good results at follow-up ranging from 1 to 11 years. There were two infections unrelated to the grafts (negative preoperative graft cultures). One graft collapse occurred at 6 months in a large acetabular defect reconstruction without a cruciate plate (such a plate would have been used in later years). This case was revised with a new allograft and plate with a good final result. In all other cases, the radiological gap between graft and host acetabulum disappeared between the sixth and twelfth month, but healing still progressed during the following two or three years. From the third year all grafts showed union and consolidation, and no further change was observed.

In another study [8], we reviewed the results of 90 one step septic revision arthroplasties, performed between 1980 and 1988, with a two to ten year follow-up. Half of these cases needed femoral head allografts for reconstruction. The use of allografts did not influence the final results (46 cases with allograft: 3 septic recurrences; 44 cases without allograft: 5 septic recurrences). The infection failures were only correlated with the type of bacteria and not with the use of allografts.

Femoral Reconstructions

Small femoral defects were reconstructed with banked femoral heads. The small grafts used for repairing cortical holes or calcar deficiencies healed and, despite frequent superficial areas of resorption, all showed good cortical repair. Major femoral bone loss is not easily reconstructed with femoral heads: primary stability is hard to obtain and requires the use of long stem prostheses. Even with these long stem reconstructions, we observed resorption of grafts. Since 1985 we have therefore used massive cortical allografts in large femoral defect reconstructions.

Irradiated Massive Cortical Allografts

The higher risk of graft contamination due to cadaver procurement, led us to sterilize bones by gamma irradiation [4, 6, 7]. There is no risk of induced tissue radioactivity, owing to the low energy of Cobalt Sixty gamma rays, and tissue penetration is excellent. The efficiency of irradiation depends on the dose, the nature of treated tissue, the type and amount of initial contamination, and the temperature at which irradiation is performed (low temperature stops the sterilizing effect of free radicals). Radiation sterilization increases safety but is no substitution for donor screening. The irradiation dose cannot be increased without deleterious effects on bone strength. A previous experimental study, following the preparation procedure used in our bone bank [4] showed that bending strength decrease on femoral cortical samples was less than 20% after 27000 Gray and 35% after 35000 Gray. The bacteriological safety of this procedure (clean retrieval, graft washing, freezing, and room-temperature gamma irradiation), has been determined [5] using an experimental and statistical method [1]: a 10⁶ Stability Assurance level for bacteriological contamination and achieved after 18500 Gray.

The bone banking procedure follows strict guidelines: after checking the removal authorizations, donor selection includes the same criteria as with unsterilized allografts (medical history, routine serology including (PCR), and autopsy whenever possible). Harvesting is performed in the mortuary operating room, avoiding any massive...