CASE REPORT

Viability of impacted bone allografts under metal mesh at the calcar in revision surgery of the hip

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Metal meshes are used in revision surgery of the hip to contain impacted bone grafts in cases with cortical or calcar defects in order to provide rotational stability to the stem. However, the viability of bone allografts under these metal meshes has been uncertain.

We describe the histological appearances of biopsies obtained from impacted bone allografts to the calcar contained by a metal mesh in two femoral reconstructions which needed further surgery at 24 and 33 months after the revision procedure.

A line of osteoid and viable new bone was observed on the surface of necrotic trabeculae. Active bone marrow between these trabeculae showed necrotic areas in some medullary spaces with reparative fibrous tissue and isolated reactive lymphocytes. This is interpreted as reparative changes after revascularisation of the cancellous allografts.

These pathological findings are similar to those reported in allografts contained by cortical host bone and support the hypothesis that incorporation of morcellised bone under metal meshes is not affected by these devices.

Impaction allografting is a reconstructive surgical option in femoral revision surgery, with excellent clinical and radiological results at medium-term follow-up. Cadaver specimens and bone biopsies have shown incorporation of bone and allograft trabeculation. In the presence of defects in the cortex or calcar, metal meshes have been recommended to contain these grafts in order to provide rotational stability to the stem. Although the clinical and radiological results have been promising, the viability of allografts under the meshes has been doubtful. Furthermore, in an experimental study, incorporation of the graft under the meshes has been questionable.

Our hypothesis was that incorporation of morcellised bone under metal meshes is not affected by these devices. We describe the histological observations on biopsies from impacted bone allografts contained by a calcar metal mesh in two femoral reconstructions which needed further surgery.

Case one. A 78-year-old man was treated according to a two-stage protocol for an infected total hip replacement (THR) which had been undertaken a year earlier. His medical history included hypertension and coronary artery disease. At the second stage, acetabular and femoral reconstructions with impacted bone allografts and a cemented C-Stem (De Puy, Warsaw, Indiana) were performed. The femur had an Endoklinik grade 3 defect of 30 mm in the calcar. A 35 mm wide hemicircumferential metal mesh was trimmed to cover the femoral defect. It was 3.8 mm thick, with 3 mm2 perforations, and was fixed to the proximal femur with two Ortron 90 (De Puy) cerclage wires. Three femoral heads from our bone bank were used to reconstruct the femur. They had not been irradiated. They were morcellised manually into pieces of 0.4 cm to 0.6 cm in size and mixed for 15 minutes with 1000 mg of powdered vancomycin (Lilly, Indianapolis, Indiana) per femoral head. Impaction grafting was carried out as described by Gie et al. The graft was packed by specific instrumentation (Primary Impaction Grafting Instruments; De Puy Int., Leeds, United Kingdom).

Two years after this revision, the patient presented with pain in the groin and radiographs showing superolateral migration of the acetabular component with rupture of the mesh at the rim (Fig. 1). The stem, cement and allograft were clinically and radiologically stable. The acetabular component was revised using a reconstruction ring (Graft Augmentation Prosthesis (GAP); Stryker Howmedica Osteonics, Rutherford, New Jersey) with impacted allografts and a cemented acetabular component. The patient’s consent was obtained for biopsy specimens from the
reconstructed femur. Six specimens were taken from the calcar zone through the fenestrations of the metal mesh using a 4 mm Jamshidi needle.

**Case two.** A one-stage aseptic acetabular and femoral reconstruction with vancomycin-supplemented impacted bone allografts and a plain cemented Charnley stem (Fico, Buenos Aires, Argentina) was carried out in a 35-year-old woman in April, 2004. She had received a primary cemented THR in 1996 because of developmental dysplasia. She was otherwise well.

Two morcellised femoral heads with vancomycin and a 40 mm wide metal mesh with the same characteristics as in case 1 were used to reconstruct an Endoklinik grade 3 femoral defect of 35 mm at the calcar. Impaction grafting was
performed using specific instrumentation (Primary Impaction Grafting Instruments; De Puy Int).

At 33 months after this revision, she fell and sustained a Vancouver type B1 displaced peri-prosthetic fracture (Fig. 2). At operation, with her prior consent, six biopsy specimens were taken from the calcanea reconstruction with a 4 mm Jamshidi needle through the metal mesh fenestrations by the same surgeon (MB) who had performed the previous revision procedure.

Pathological findings
The six samples from each patient showed the absence of nuclei in the lacunae, corresponding to necrosis of the lamellar trabeculae. A line of osteoid and viable new apposition of bone was seen on the surface of these necrotic trabeculae. Active bone marrow lay between them and showed necrotic areas in some medullary spaces with reparative fibrous tissue and isolated reactive lymphocytes in others (Figs 3 and 4). This appearance is similar to that which occurs after revascularisation of cancellous allografts.

Discussion
The histological appearances of these biopsy specimens support the view that metal meshes do not affect viability of the bone grafts. With segmental defects, the combination of impacted bone allografts and meshes is associated with a favourable outcome.\(^4\)\(^,\)\(^5\)\(^,\)\(^9\)\(^,\)\(^16\) Meshes conform to the remaining bone and allow cancellous grafts to be in contact with the surrounding soft tissue.\(^7\)\(^,\)\(^8\)\(^,\)\(^13\) The fenestrated nature of the devices ensures retention of the graft at the defect and provides a favourable scaffold for bony restoration. However, there have been reports of poor incorporation of bone grafts in tibial defects contained by metal meshes and impacted allografts in rabbits.\(^9\) As these animals were not weight-bearing and considering this as a factor which might influence graft incorporation, we considered that the findings could be different in a clinical situation.\(^14\) Furthermore, recent experimental reports recommend the use of an open wire mesh for reconstruction of segmental femoral defects in combination with impaction grafting to allow for optimal revascularisation in an area of impaired vascularity.\(^7\)

Because our examinations were limited to biopsy specimens and did not include post-mortem studies, we could not demonstrate histologically the three zones described by previous authors.\(^5\)\(^,\)\(^13\) However, we observed necrotic osseous trabeculae, fibrosis and occasional lymphocytes, which are findings consistent with remodelling of bone graft and new bone formation.\(^16\)\(^,\)\(^17\) The viability and subsequent incorporation of the allograft is not judged easily from radiographs and is practically impossible when it is contained by a metal mesh.

Our allografts included vancomycin as a prophylactic agent as there is a significant increase in the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) in most countries, including ours, rising to 40% to 50% in some cases.\(^18\) Vancomycin has been shown not to affect incorporation of bone allograft.\(^19\)\(^,\)\(^20\)

Our findings were seen in femurs reconstructed with two different designs of femoral component. The first was a triple taper polished cemented femoral component similar to the Exeter stem (Stryker Howmedica Osteonecs, Allendale, New Jersey) which gives excellent medium-term results when using the impacted bone allograft technique.\(^4\) The second was a Charnley-type femoral component which has also been shown to give very favourable results.\(^1\)

Although we observed viable trabecular bone in our specimens, additional biopsies and post-mortem retrieval of femurs reconstructed with this technique are needed to confirm our findings.

Our observations encourage the use of metal meshes combined with impacted morcellised bone allograft to reconstruct femoral deficiencies after failure of femoral implants.

References

