

Histological evaluation of a mosaicplasty of the femoral condyle—retrieval specimens obtained after total knee arthroplasty—a case report

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A 43-year-old man presented with persistent pain on the medial side of his left knee, 1 year after a bone-patellar tendon-bone autograft ACL reconstruction. Besides a dysfunctional ACL, earlier arthroscopy had already revealed a focal full-thickness chondral lesion (25 × 12 mm) of the medial femoral condyle (Figure 1A) and mild degenerative changes in the lateral compartment of the knee. The patient was offered a mosaicplasty of the medial femoral condyle.

After a medial arthrotomy of the knee, 3 cylindrical osteochondral plugs (8 mm diameter) were harvested from the lateral trochlea (donor site) and transplanted to the chondral defect in the medial femoral defect (recipient site), using the mosaicplasty technique (Hangody et al. 1998, Bobic 1999, Hangody and Fules 2003, Horas et al. 2003). The donor site defects were each filled with a press-fitted cylindrical osteo-periosteal plug obtained from the proximal tibia. It was hypothesized that these plugs would enhance healing of the subchondral bone and that the covering periosteum would enhance resurfacing of the donor site defects with fibrocartilagenous tissue.

Initially, the patient's symptoms clearly improved and a postoperative MRI showed restoration of the joint surface at the original chondral lesion in the medial condyle 3 months after surgery (Figure 1B). The 3 transplanted osteochondral plugs were still clearly visible in the subchondral bone, with signs of osseous integration. One plug appeared to have been placed rather too deeply, as seen from the step-off in the subchondral bone (Figure 1B, 2A). At the lateral aspect of the trochlea, the 3 donor site defects were also still clearly visible (Figure 1C). The osteo-periosteal plugs from the proximal tibia appeared to have remained in situ and some resurfacing of the defects had occurred.

After 3 years the knee became symptomatic again, with pain and swelling. Radiographic evaluation revealed mild degenerative changes (Figure 1D). Conservative treatment was not accepted and a total knee arthroplasty was performed. This procedure eventually provided good-quality retrieval specimens for histological evaluation of a mosaicplasty.

Histological evaluation

Retrieval specimens from the resected femoral condyle and trochlea were fixed in 4% buffered formalin (pH 7.4) and decalcified in 25% EDTA. An average of 10 sections (7 µm) of each specimen were taken in the sagittal plane to include the mosaicplasty and the donor site defect, respectively. Alternate sections were stained with HE, toluidine blue and Masson's trichrome dye.

Histology of the mosaicplasty showed adequate restoration of joint surface. Chondrocytes in the transplanted cartilage cylinders appeared to have survived the procedure and the cartilage cap had maintained its original hyaline cartilage structure with no signs of disintegration (Figure 2A). From the postoperative MRI, we had learned that 1 of the 3 osteochondral grafts had been placed slightly too deeply, which was in fact confirmed by the eventual histology of the graft (Figure 2A). At the boundaries of the cartilage plug, cluster formation of chondrocytes was seen, indicating cell proliferation and attempt at repair. However, in spite of this cellular response, a fissure remained clearly visible between the plug and the adjacent cartilage. There were no signs of incorporation between the two cartilage layers at the boundaries. Toluidine blue staining was less intense adjacent to the fissure, indicating loss of proteoglycans (Figure 2B). In the area of the subchondral bone, the transplanted

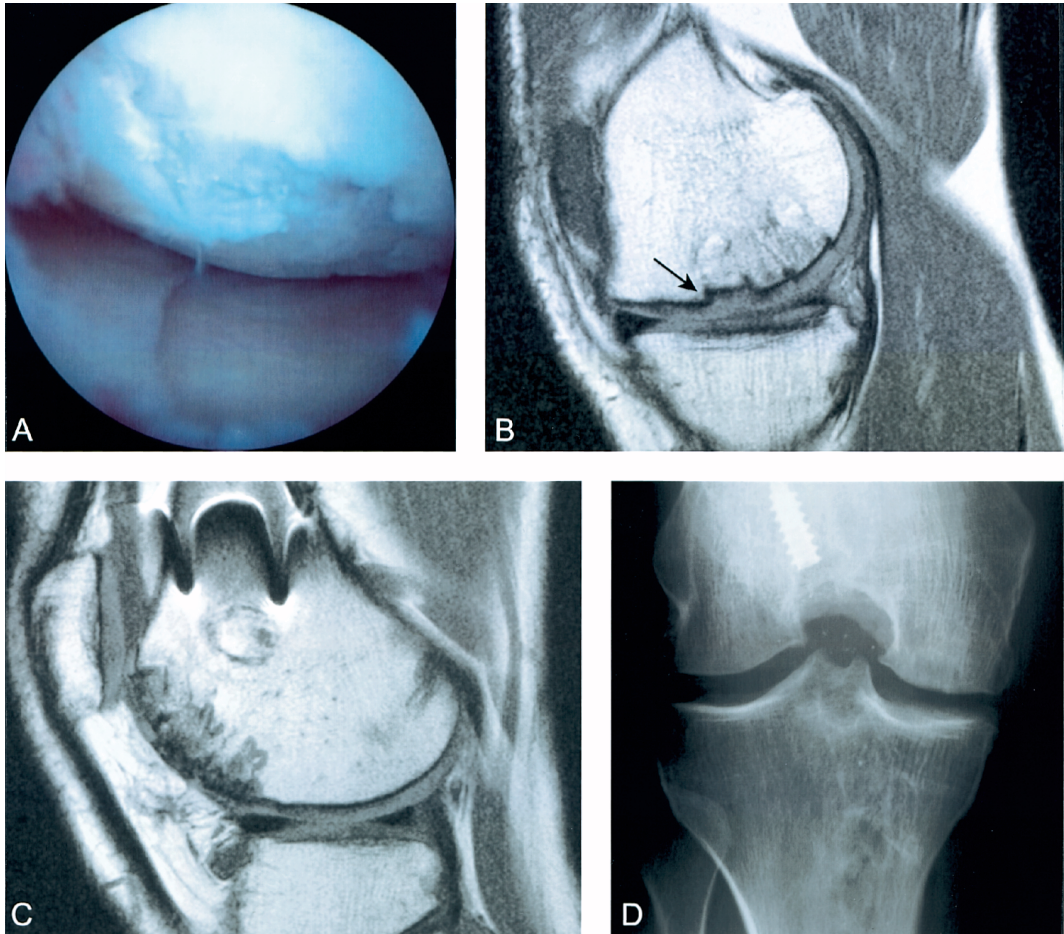


Figure 1. A 43-year-old man with a chondral lesion on the medial side of his left knee 1 year after a dysfunctional bone-patellar tendon-bone autograft ACL reconstruction.

A. Preoperative arthroscopy of a large osteochondral lesion in the medial femoral condyle.

B. MRI of the medial femoral condyle, in which the original chondral defect has been transplanted with 3 osteochondral plugs from the lateral trochlea. Note adequate restoration of the joint surface and signs of osseous integration of the plug in the subchondral bone. One plug has been placed relatively deeply, represented by an irregularity in the subchondral bone (arrow).

C. MRI of the lateral trochlea, where three osteochondral grafts have been harvested. The donor site defects have been filled with pressfitted osteoperiosteal plugs, obtained from the proximal tibia. Note the reasonable restoration of the joint surface.

D. Weight-bearing radiograph of the knee prior to arthroplasty.

plugs showed full incorporation together with full reconstruction of the tidemark between the transplanted osteochondral plugs (Figure 2C).

At the donor site, the transplanted osteo-periosteal plugs from the proximal tibia could still be detected in each defect (Figure 2D-E). Incorporation of the plug had occurred in the subchondral bone. At the level of the host cartilage, there was a reasonable integration between the osseous plug and the adjacent cartilage. No clear osteolysis of

the plug or proteoglycan loss from the cartilage could be detected. Joint resurfacing consisted of a fibrous layer covering the plug. No cartilage formation from the original periosteum was seen.

Discussion

Several surgical treatment modalities for cartilage lesions have been introduced recently (Farnworth

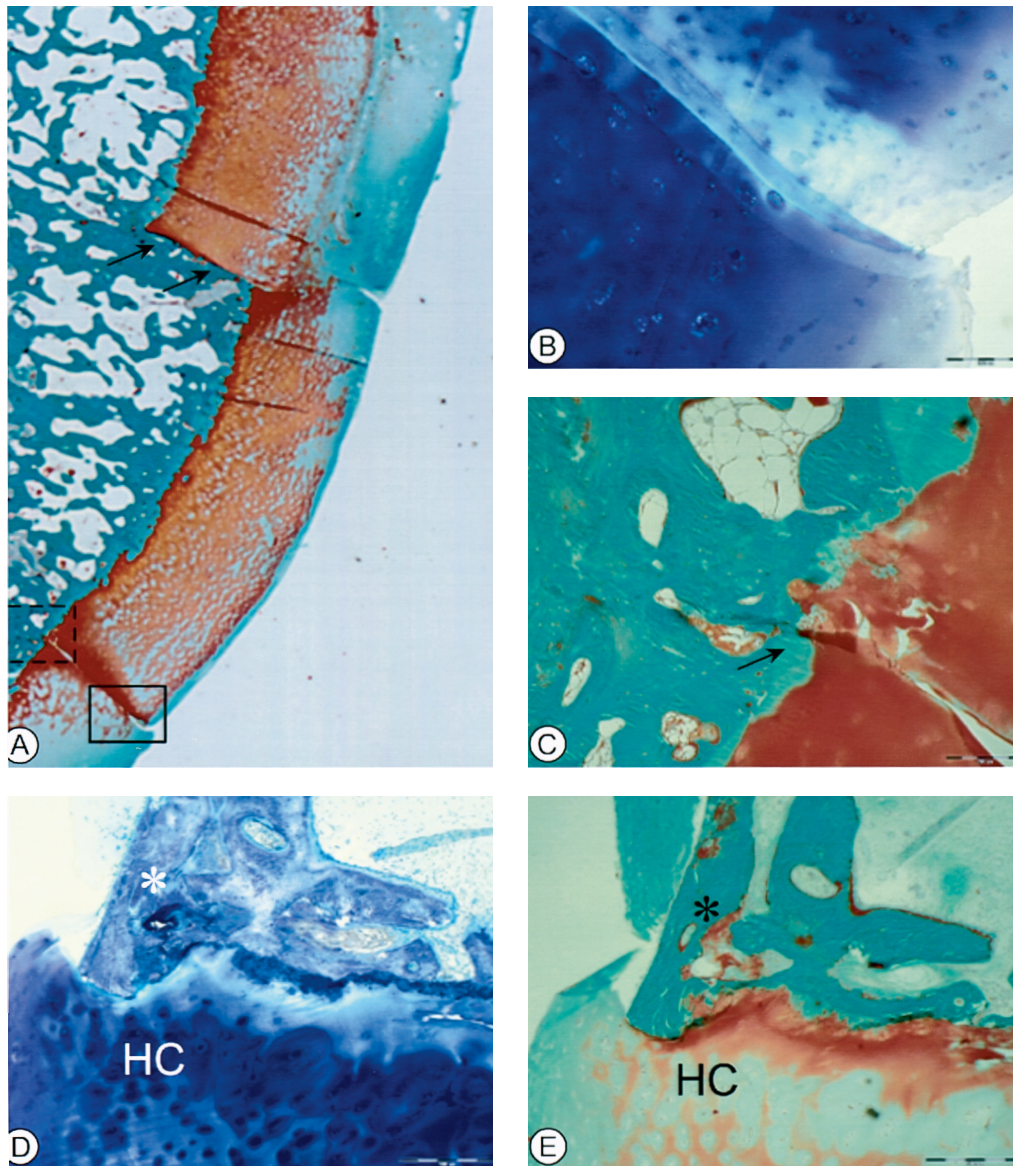


Figure 2.

- A. Histological appearance of 3 adjacent plugs at the recipient site. Note adequate restoration of the joint surface with hyaline cartilage and the relative deep placement of one plug (Masson's trichrome; $\times 12.5$).
- B. Enlargement of boxed area in A. Note cluster formation of chondrocytes at the boundary of each plug and less staining, indicating loss of proteoglycans (toluidine blue; $\times 100$, bar = 200 μm).
- C. Enlargement of dotted boxed area in A. Note reconstruction of the tidemark (arrow) at the transition zone, a clearly visible fissure between the two cartilage plugs and full incorporation of the plugs in the subchondral bone (Masson's trichrome; $\times 100$, bar = 200 μm).
- D/E. Histological appearance of the donor site defect. The osteoperiosteal plug from proximal tibia (*) is pressfitted in the host cartilage (HC). Note the reasonable resurfacing with fibrous tissue, no obvious cartilage formation from covering periosteum and reasonable integration at the transition zone, without osteolysis or proteoglycan loss (toluidine blue/Masson's trichrome; $\times 50$, bar = 500 μm).

2000, Cain and Clancy 2001). Over the past 10 years, the mosaicplasty has become increasingly

popular for the treatment of articular cartilage defects (Hangody et al. 1998, Jakob et al. 2002).

Various studies have shown good clinical results from mosaicplasty of the weight-bearing part of the femoral condyle (Hangody et al. 2001, Jakob et al. 2002, Bentley et al. 2003, Horas et al. 2003). After 10 years of follow-up, Hangody and Fules (2003) described good-to-excellent results in 92% of 597 treatments with mosaicplasties. Despite these enthusiastic reports on mosaicplasty, there is still concern about the fate of transplanted cartilage and the repair potential of the donor site defect. Most studies have reported sufficient repair of both the original cartilage defect and the donor site defects on (occasionally performed) repeated arthroscopy.

Unfortunately, these studies have been based mainly on data from subjective clinical scores. Histology is of course difficult to obtain for ethical reasons. Occasionally, limited histology from a needle biopsy of the graft has been described, with promising results. To date, however, specimens sufficient in quantity for histological analysis have not been reported in the literature. Here, good-quality full-thickness specimens for histological evaluation could be obtained because of the total knee arthroplasty performed in our patient. 3 years after a mosaicplasty, histology of the recipient site showed vital grafts with excellent incorporation in the subchondral bone. The transplanted cartilage had retained its hyaline structure and seemed to provide a good resurfacing of the joint.

In clinical practice the donor site defects are commonly left empty, and spontaneous repair with fibrocartilagenous tissue is assumed (Hangody et al. 1998, Jakob et al. 2002, Horas et al. 2003). From earlier animal experiments on donor site defects, this potential for spontaneous repair appears to be very limited (van Susante et al. 2003). In an attempt to stimulate the repair of the donor site defect, we transplanted an additional osteo-periosteal plug from the proximal tibia to the donor site defect. Incorporation of this graft into the subchondral bone was observed; however, no chondrogenesis from the covering periosteum could be detected. Thus, we believe that no substantial benefit can be gained from this additional procedure, except perhaps some additional structural support to the adjacent subchondral bone, preventing early collapse. These findings are also supported by an earlier animal experiment using this technique (van Susante et al. 2003).

To our knowledge, this is the first case report on histological analysis of retrieval specimens from a complete mosaicplasty. We believe that these histological results support the current literature on mosaicplasty. Indeed, it appears to be possible to repair chondral defects with vital osteochondral transplants. Full incorporation of the plug into the subchondral bone is achieved; however, a fissure between the covering cartilage cylinders remains visible. The repair potential of the donor site defect, as well as the value of an additional osteo-periosteal plug from the proximal tibia, must not be overestimated.

No competing interests declared.

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