Autogenous osteochondral grafts for osteonecrosis of the femoral condyle

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ABSTRACT

Purpose. To evaluate the long-term outcome following use of osteochondral autografts for the treatment of osteonecrosis of the femoral condyle.

Methods. Clinical, radiographic and arthroscopic findings were evaluated at follow-up. Patients were 14 women and 2 men, with a mean age of 64.9 years (range, 58–74 years). The osteochondral lesion was equivalent to Lotke 1-B in 12 knees, and was equivalent to 1-C in 4 knees. Preoperative femoral tibia angle ranged from 178° to 190°.

Results. The follow-up period ranged from 28 months to 111 months (mean, 67 months). Functional scores improved from 60 to 75 preoperatively to 80 to 100 postoperatively, and the grafts were satisfactorily accepted. Patients with a femoral tibia angle of less than 180° in particular were found to respond favourably.

Conclusion. Transplant surgery using osteochondral autografting appeared effective for the treatment of osteonecrosis of femoral condyle.

Key words: osteochondral graft; osteonecrosis

INTRODUCTION

The use of an osteochondral graft for osteonecrosis of the femoral condyle was first reported by Lexer1 in 1908, and has been extensively investigated in experimental studies since then. In 1959, Harnach2 introduced the use of the osteochondral shell graft, and many reports of this technique have appeared since this, including those of Gross et al.3 Yet little has been published on the status of the osteochondral graft over time. This paper presents the postoperative clinical, arthroscopic, X-ray, and magnetic resonance imaging (MRI) findings for osteochondral grafts performed on patients with necrosis of the medial condyle of the femur in our hospital since 1991.

METHODS

Patients included 14 women and 2 men, aged from 58 to 74 years (mean age, 64.9 years). The osteochondral lesion on examination was equivalent to Lotke 1-B in 12 knees, and 1-C in 4 knees. Preoperative femoral tibial angle (FTA) ranged from 178° to 190°. Clinical findings, X-rays, MRI, and arthroscopic findings were evaluated for between 28 and 111 months (mean follow-up, 67 months). Clinical findings were
assessed according to the therapeutic assessment standards for morphological gonarthritis of the Japanese Orthopaedic Association (JOA). The method of osteochondral graft was as follows: a columnar hole, 20 mm in depth and 8 mm in diameter, was made in the centre of the osteonecrotic tissue. A bone column with cartilage was taken from the graft (Fig. 1). Two grafts were transplanted at 2-mm intervals in the centre of the grafted portion in patients with foci corresponding to Lotke 1-C over a wide area (Fig. 2). Four knees with a preoperative FTA of 185° or more needed additional high tibial osteotomy. The limb containing the bone donor sites was supported with foot sole plates, with partial weightbearing allowed 3 months after surgery, and full weightbearing 4 months after surgery.

RESULTS
Surgery led to an improvement in JOA score, from a preoperative score of 60 to 75 (mean, 68.1) to between 80 to 100 (mean, 88.8) at follow-up. Two cases with knees previously assessed as Lotke 1-C and one with a genu varum deformity, however, had a mean score of 80 points, with residual pain on the medial aspect of the knees. Patients with knees assessed as Lotke 1-B and a preoperative FTA of 180° or less had good postoperative gain, with a mean score of 93.8. X-rays of all patients showed that the graft had been accepted at 4 months after surgery. MRI revealed some irregular low signals at 3 months after surgery. Low signals were observed more sporadically at one year after surgery, with good adaptation with the adjoining bone marrow seen from 3 to 7 years after surgery. Follow-up arthroscopy was repeated from 18 to 21 months after surgery. While the grafts were satisfactorily accepted, the transplanted cartilage was white in colour and lacking gloss, consistent with the appearance of hyaline cartilage, and the surrounding area was covered with fibrous tissue.
CASE EXAMPLES

Case 1

The patient was a 66-year-old woman with osteonecrosis of the right femoral condyle (Lotke 1-C; FTA, 180°). Clinical findings at initial diagnosis included tenderness in the load-bearing area of the right medial condyle, particularly at night, and a range of motion of 10° to 110°. The patient complained of intense pain on weightbearing, not associated with hydrarthrosis, and was assessed as having a JOA score of 60.

X-rays showed evidence of a bone defect in the load-bearing area of the right medial condyle, with peripheral sclerotic halo and a calcified plate on the articular surface (Fig. 3). Bone scintigraphic findings were characteristic of an abnormal bone accumulation on the right medial condyle. Preoperative MRI scans showed low signals from the necrotised lesion on T1-enhanced images, and low signals enclosing a high-signal range on the T2-enhanced images. Operative MRI revealed a long anteroposterior lesion (26 x 10 mm) of the right medial condyle, with a strap-like chondral surface and evagination of the margin in places. Osteochondral grafting was conducted using a 4 mm–diameter graft for one site and two 18 mm–grafts for 2 sites; in addition, trephination was performed around the grafts. Histopathological examination showed a diminution of cartilaginous cells in the osteochondral transitional zone, with necrosis of the bone tissue (Fig. 4).

At 3 months after surgery, MRI scan of the right medial condyle showed irregular low signals from the osteochondral fragment on the T1-enhanced images at 3 months after surgery, and (b) even signals at 6 months after surgery.

Case 2

The patient was a 70-year-old woman with osteonecrosis of the right femoral condyle (Lotke 1-C; FTA, 178°). In April 1991, she visited our clinic with pain of unknown cause in her right knee. X-rays revealed mild narrowing of the medial joint space, which was initially diagnosed as osteoarthritis. Intra-articular
injection of a steroid was conducted in combination with administration of anti-inflammatory analgesics. However, the pain was not relieved.

On January 4, 1992, further X-ray examination disclosed a bone defect in the right medial condyle, osteophyte formation, and narrowing of the articular interstice, all indicative of osteonecrosis of the right femoral condyle. The range of motion of the knee was 10° to 100° (FTA, 178°; JOA score, 60). Operative findings were that the cartilage on the weightbearing area of the left medial condyle had a ‘fluffy’ texture, and in the centre there was white cartilage lacking gloss, extending over an area of 20 mm x 15 mm that peeled like a membrane (Fig. 7). Osteochondral grafting was undertaken for 2 sites. Postoperative MRI findings included low signals from the entire graft on the T1-enhanced image, and a mixture of low signals and high signals on the T2-enhanced image. At 17 months postsurgery, arthroscopy of the right knee joint showed a smooth graft surface with a pearl-like lustre (Fig. 8).

Histopathological examination revealed progressive fibrosis of the stroma in the surface layer, irregular cell arrangement, and most tissue consisting of viable vitreous cartilage (H&E, x40). At 88 months after surgery, the number of osteophytes seen in the tibia had increased slightly, but the irregular articular surface of the femur had attenuated, and the JOA score improved to 95.

DISCUSSION

High tibial osteotomy (HTO), hemiarthroplasty, and total knee replacement are extensively used for necrosis of the femoral condyle. In terms of recovery of normal joint function, however, use of an osteochondral graft is more satisfactory. In 1975, Benum5 carried out an osteochondral graft to the load-bearing area of the medial femoral condyle of puppies. The graft was found to have been accepted satisfactorily after 14 months. In 1977, Lane et al.6 achieved favourable results in experiments on domesticated rabbits using osteochondral autografts. In recent years, attempts have been made to apply osteochondral grafting for the treatment of osteonecrosis of the femoral condyle, and the results have been reported...
to be satisfactory. Tomatsu\(^7\) performed osteochondral autograft transplantation for the treatment of bone necrosis in the femoral condyle in a 65-year-old woman in 1980. Arthroscopy after 10 months showed that the implant area had been covered with cartilage. In 1981, Ganel et al.\(^8\) performed identical osteochondral grafting in a 65-year-old woman with condylar bone necrosis. It took 30 months to achieve complete relief from pain, and X-rays showed satisfactory results. Similarly, in 1989, Meyers et al.\(^9\) conducted autogenous osteochondral grafting in 3 cases of femoral condyle necrosis, with favourable outcomes in all cases evident at follow-up after 3 years or more. In 1993, Marco et al.\(^10\) reported the findings following insertion of an osteochondral graft, 5 mm in thickness and 6 cm\(^2\) in area, in 4 cases of femoral condyle necrosis, with devices to allow the graft to project 2 mm from the surrounding bone surface, and to use a resorptive suture if needed. At 20 months after grafting, electronic microscopy of the graft revealed cartilaginous cells with abundant glycogen deposition, indicating that the chondral graft had been accepted. Marco et al.\(^10\) thus indicated that success could be achieved with a graft 5 to 10 mm thick, by firm fixation using a suture and pins.

Following the method of Tomatsu\(^7\) we inserted a columnar graft (diameter, 8 mm; depth, 20 mm) which was not shell-like, into the lesion which had been resected in advance with a drill of the same diameter. The graft was then tapped to achieve firm fixation. In cases of 3-site grafting for a wide lesion, no evidence of graft damage was observed during follow-up. Although grafts were as large as 20 mm in thickness, they were twisted into a column 8 mm in diameter, resulting in enhanced fixation and satisfactory engrafting of the cancellous tissue. Unlike the method of Marco et al.,\(^10\) our new method was effective for extensive lesions, by grafting into several sites rather than using a shell-like graft. At biopsy of the transplanted osteochondral graft, histopathological findings included favourable vitreous cartilage with well-preserved cell morphology and arrangement, and maintenance of the stroma. These supported 'graft take'. The osteochondral graft was taken from the non-weightbearing area of the femoral lateral condyle, and the portion of bone defect was filled with hydroxyapatite, which produced no pain in the articular interstices. X-rays taken showed that hydroxyapatite adhered well to the adjoining spongy tissue, without any adverse effects on the tibia.

Another key to the success of an osteochondral graft at a weightbearing joint is to observe 3 months of non-weightbearing. Gross et al.\(^3\) reported the outcomes of 100 allografts, including failures, in 5 patients with osteonecrosis of the femoral condyle. The failures were attributed to the graft subsiding or breaking, due to an insufficient non-weightbearing period in middle- and older-aged patients. In our series, all patients were only allowed to start partial weightbearing 3 months after surgery, and became fully weightbearing 4 months after surgery. Therefore, very good results were obtained. In the patients without improvement in their genu varum deformity associated with a FTA in excess of 180°, however, osteochondral tissue changes occurred, leading to pain. In contrast, the patients with a FTA of less than 180° reported little pain, and improved condition in the cartilage of the knee joint after the implantation of an osteochondral autograft. While further long-term observation is required, the extensive follow-up of the current patient group indicated the results were very satisfactory using our methods.

CONCLUSION

Transplantation of osteochondral autografts for the treatment of osteonecrosis of the femoral condyle was undertaken in 16 patients. Clinical findings demonstrated improvements, and in particular, patients with a FTA of less than 180° were found to respond favourably. Transplant surgery using autogenic osteochondral grafts using the methods described is an effective treatment for osteonecrosis of the femoral condyle.

REFERENCES