Available online at www.sciencedirect.com
ScienceDirect
The Knee 14 (2007) 465–471
The Knee
www.elsevier.com/locate/knee

Repair of articular cartilage and clinical outcome after osteotomy with microfracture or abrasion arthroplasty for medial gonarthrosis

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Received 17 October 2006; received in revised form 18 June 2007; accepted 26 June 2007

Abstract

This study compared the healing of articular cartilage and the clinical outcome after osteotomy with or without marrow stimulation microfracture or abrasion arthroplasty for osteoarthritis of the knee. Patients with osteoarthritis of the medial compartment of the knee were divided into a group undergoing high tibial osteotomy alone (HTO group: 37 knees), a group undergoing osteotomy plus microfracture (MF group: 26 knees), and a group undergoing osteotomy plus abrasion arthroplasty (AA group: 51 knees). The extent of cartilage repair was compared at 1 year after surgery by arthroscopy with reference to Outerbridge's classification, while the clinical outcome was compared at 1, 3, and 5 years postoperatively. Second-look arthroscopy revealed better repair of the femoral condylar cartilage in the AA group than the HTO group ($p<0.0005$) or MF group ($p<0.01$), with no difference between the HTO and MF groups. Repair of the tibial condylar cartilage was also better in the AA group than the HTO group ($p<0.005$), but there was no difference between the AA and MF groups or the MF and HTO groups. There were no differences of the clinical outcome between the three groups. In conclusion, repair of articular cartilage at 1 year postoperatively was accelerated by abrasion arthroplasty, but not by microfracture. However, there was no difference of the clinical outcome within 5 years after surgery, so the clinical utility of marrow stimulation techniques was not apparent in this study.

Keywords: Cartilage repair; Knee osteoarthritis; Microfracture technique; Abrasion arthroplasty; High tibial osteotomy

1. Introduction

In patients with osteoarthritis of the medial compartment of the knee, degeneration of the articular cartilage progresses as deviation of the functional axis increases. Eventually, the subchondral bone is exposed and the articular surface shows eburnation. However, if the weight-bearing axis is altered by high tibial osteotomy (HTO) or some other procedure, repair of the articular cartilage by growth of new chondroid tissue can occur [1–4]. Akizuki [1] reported that such repair is promoted by combining HTO with abrasion arthroplasty [5,6], a technique that stimulates, the bone marrow and creates blood clots containing mesenchymal cells on the articular surface. Another method of marrow stimulation is the microfracture technique [7], which involves the creation of microfractures in the subchondral bone. Abrasion arthroplasty has the advantage of allowing the whole articular surface to be treated, while the microfracture technique avoids thermal damage to the subchondral bone. However, there have been no published reports comparing these two techniques under the same conditions. Accordingly, the present study was performed to compare cartilage repair and the medium-term clinical outcome after HTO with or without marrow stimulation by microfracture or abrasion arthroplasty in patients with medial gonarthrosis.

2. Patients and methods

At our hospital, HTO is indicated for osteoarthritis of the medial knee compartment when a patient is active and under 70 years old. For patients,

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0968-0160/$ - see front matter © 2007 Published by Elsevier B.V.
doi:10.1016/j.knee.2007.06.008

with severe osteoarthritis (usually older than 70 years), total knee arthroplasty is preferred, and excellent long-term results have been reported by some authors [8,9]. Unicompartmental knee arthroplasty is usually selected for medial gonarthrosis when the patient is older than 75 years and has become inactive.

The patients in this study who underwent HTO with or without abrasion arthroplasty have been reported previously [1]. Between 1987 and 1993, 34 patients underwent HTO alone (two men with two knees and 32 women with 35 knees: HTO group), while 45 patients (seven men with nine knees and 38 women with 42 knees: AA group) were treated by the combination of HTO and abrasion arthroplasty. When eburnation of the medial articular surfaces was observed during arthroscopy prior to HTO, patients were assigned to the AA group or HTO group in turn, expect for the first 14 knees of the AA group. One knee was treated by HTO alone (HTO group), while the other knee received HTO plus AA (AA group) in 8 patients. Another 25 patients (six men with seven knees and 19 women with 19 knees: MF group) who had eburnation of the medial articular surfaces underwent HTO combined with the microfracture technique between 1998 and 2001. The MF group was independent of the other two groups.

Patients in the HTO group and the AA group were assigned prospectively, while the MF group was added retrospectively after the microfracture technique came to be generally accepted. These three groups were compared in the present study and the overall follow-up rate up to 5 years after surgery was 98%.

The clinical features of the three groups are shown in Table 1. Because our indication for HTO was followed strictly, the three groups were similar before surgery, and only body weight was slightly higher in the MF group than in the AA group ($p<0.05$, t-test).

All patients gave written informed consent after receiving an explanation of the purpose of the study as well as the potential risks and benefits of the microfracture technique or abrasion arthroplasty. In addition, this study was approved by the Institutional Review Board of our hospital.

2.1. Surgical procedures and rehabilitation

Interlocking closing wedge osteotomy was performed in all patients [10], and a Giebel plate was used for internal fixation (Fig. 1). The extent of cartilage degeneration was assessed by arthroscopy prior to osteotomy. The area of the medial compartment showing eburnation was left untreated in the HTO group, while arthroscopic microfracture was done in the MF group and abrasion arthroplasty was performed in the AA group. In the MF group, a special device was employed to create microfractures 2–4 mm deep at 3- to 4-mm intervals until bleeding from the bone marrow was observed, while avoiding communication between the fracture sites so as not to decrease the strength of the subchondral bone [7,11]. In the AA group, the bone showing eburnation was scraped to a depth of about 1 mm using a steel abrader. From day 2 postoperatively, continuous passive motion exercise was performed for about 3 h daily for 4 weeks. Partial and full weight bearing was allowed from 4 weeks to 6–8 weeks after surgery respectively. The same postoperative procedures were followed in all 3 groups.

Table 1
Clinical profile of the three groups

	HTO group	MF group	AA group
Total number	37 knees (34 patients)	26 knees (25 patients)	51 knees (45 patients)
Male	2 knees (2 patients)	7 knees (6 patients)	9 knees (7 patients)
Female	35 knees (32 patients)	19 knees (19 patients)	42 knees (38 patients)
Eburnation femoral	37 knees	26 knees	51 knees
Tibial	32 knees	25 knees	49 knees
Age (years)	64.0±5.9	65.0±3.8	64.6±5.9
Body weight (kg)	59.8±9.8	61.4±6.3 *	57.3±7.6 *
FTA (degrees)			
Preoperative	185±5.4 (Varus 5)	185±4.3 (Varus 4)	185±4.3 (Varus 5)
Postoperative	166±3.3 * (Valgus 14)	168±3.6 * (Valgus 12)	167±2.9 (Valgus 13)
Preoperative JOA score	49.8±6.8	52.5±8.7	52.4±6.0
Postoperative JOA score			
One year after surgery	86.5±6.8	84.0±5.9	86.0±7.2
Three years after surgery	86.8±7.0	86.6±6.6	88.9±7.0
Five years after surgery	88.9±4.8	85.6±7.4	87.0±7.8

Values are the means±S.D.
* $p<0.05$ (two group t-test).

2.2. Assessment

The extent of cartilage repair was assessed from the arthroscopic and histological findings at the sites of eburnation that had been observed arthroscopically on the medial femoral or tibial condyles, with reference to the video recordings made during surgery. Repeat arthroscopy was done during removal of the Giebel plate and screws about 1 year after HTO, and all patients gave consent to second-look arthroscopy. Assessment was performed with reference to Outerbridge's classification [12]: Grade 0 is normal cartilage; Grade I is softening and swelling of the cartilage; Grade II is fragmentation, fissuring and fibrillation of an area half an inch or less in diameter; Grade III is the same changes as Grade II affecting an area more than half an inch in diameter; and Grade IV is exposure and eburnation of the subchondral bone. Histological examination was performed using a punch biopsy specimen about 2 mm in diameter that was taken from the site of cartilage repair on the medial femoral condyle based on the video recording made at the time of surgery. Biopsy was only performed when patients gave consent, and was done in 22 knees (59%) from the HTO group, 25 knees (98%) from the MF group, and 37 knees (73%) from the AA group. Biopsy specimens were subjected to hematoxylin–eosion staining and double staining with PAS-Alcian blue.

To investigate the mechanical effects of HTO, the varus–valgus angle and the femorotibial angle (FTA) were measured on standing anteroposterior X-ray films taken immediately before surgery and 1 year after surgery.

The clinical outcome was assessed by using the Japanese Orthopaedic Association knee score (JOA score) [13] immediately before surgery, as well as about 1, 3, and 5 years postoperatively. This score is the sum of subscores for pain on walking (0–30 points), pain on ascending and descending stairs (0–25 points), range of motion (0–35 points), and joint swelling (0–10 points). A normal score is 100 points. A single senior surgeon performed scoring for all of the patients.

2.3. Statistical analysis

Results are expressed as the mean±standard error. Statistical analysis was performed by the paired or unpaired t-test, Fisher's exact probability test, and the Mann–Whitney U-test using Statview 5.0 software (SAS Institute, Cary, NC). A probability (p) value of less than 0.05 was considered to indicate statistical significance.

3. Results

Standing anteroposterior X-ray films taken immediately before surgery and about 1 year postoperatively revealed improvement of knee joint mechanics in all three groups. There was no difference of the preoperative FTA between the three groups. The postoperative FTA was slightly larger in the MF group than in the HTO group ($p<0.05$; t-test), but there was no difference between the AA and MF groups or between the HTO and AA groups (Table 1).

The mean JOA scores obtained at 1, 3, and 5 years after surgery are displayed in Table 1. There was significant improvement in all 3