

Mosaic Osteochondral Autograft Transplantation Versus Bone Marrow Stimulation Technique as a Concomitant Procedure With Opening-Wedge High Tibial Osteotomy for Spontaneous Osteonecrosis of the Medial Femoral Condyle

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Purpose: To evaluate the effects of osteochondral autograft transplantation (OAT) mosaicplasty as a concomitant procedure with opening-wedge valgus high tibial osteotomy (HTO) for spontaneous osteonecrosis of the medial femoral condyle (MFC) on clinical outcomes and cartilage status in comparison with bone marrow stimulation (BMS) by drilling, and to assess the relation between lesion size and postoperative cartilage status. **Methods:** Fifty-eight patients with spontaneous osteonecrosis of the MFC were treated with opening-wedge HTO and a concomitant procedure of BMS (28 patients) or OAT (30 patients). Clinical evaluation was carried out using the Knee Society Score at postoperative 2 years. Postoperative status of articular cartilage was assessed by arthroscopy according to the International Cartilage Repair Society (ICRS) grade at the time of plate removal. **Results:** The Knee Society Score objective score and function score were improved at postoperative 2 years compared with preoperative value in both groups, but no significant difference was found between the 2 groups. According to the ICRS overall repair grade, cartilage status was rated as normal or nearly normal (ICRS overall score ≥ 8) in 41% of the BMS group and 90% of the OAT group. The results suggested that cartilage repair in OAT was significantly better than that in BMS ($P = .0015$). Furthermore, the BMS group revealed that repair with normal or nearly normal was observed in all less than 4 cm² of lesion size, whereas the OAT group exhibited that repair with normal or nearly normal was independent of lesion size. **Conclusions:** This study suggested that OAT is superior to BMS as a concomitant procedure with opening-wedge valgus HTO for spontaneous osteonecrosis of the MFC in the success of cartilage repair. However, clinical outcomes were not significantly different between these 2 procedures. When treating the lesion larger than 4 cm² by joint-preserving surgery, OAT mosaicplasty is recommended as a concomitant procedure with HTO. **Level of Evidence:** Level III, therapeutic case-control study.

Spontaneous osteonecrosis of the knee (SONK) is a well-defined clinical and pathologic entity, distinguishing from secondary osteonecrosis by such factors as corticosteroid therapy.^{1,2} Although the precise

cause remains speculative, 2 classical theories have been suggested: primary vascular insufficiency leading to infarction of bone,^{3,4} or trauma with microfractures and subsequent osteonecrosis.⁵ In addition, another theory by histopathologic findings proposed that the primary event leading to SONK was a subchondral insufficiency fracture.⁶ In any case, the lesion of SONK is usually localized in a superficial subchondral area of the medial femoral condyle (MFC) and smaller in size than that of secondary osteonecrosis.^{3,7} Therefore, the treatment options with joint preservation are available, regardless of nonsurgical or surgical intervention.

Because the lesion in spontaneous osteonecrosis of the MFC lesion rapidly leads to end-stage osteoarthritis,⁸ surgical management is often considered. High tibial osteotomy (HTO) is a joint-preserving surgery to unload the affected femoral condyle. This procedure is

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suitable for the pathologic state of spontaneous osteonecrosis of the MFC, resulting in excellent clinical outcomes.^{9,10} However, postoperative status of articular cartilage has not been characterized, and the effect of concomitant procedures to promote cartilage regeneration, such as bone marrow stimulation (BMS) or osteochondral autograft transplantation (OAT/mosaicplasty), needs to be elucidated. In addition, it is unknown whether the lesion size of spontaneous osteonecrosis of the MFC affects cartilage status after surgical treatment.

The purposes of this study were to evaluate the effects of OAT mosaicplasty as a concomitant procedure with opening-wedge valgus HTO for spontaneous osteonecrosis of the MFC on clinical outcomes and cartilage status in comparison with BMS by drilling, and to assess the relation between lesion size and postoperative cartilage status. It was hypothesized that (1) OAT would be superior to BMS as a concomitant procedure with opening-wedge valgus HTO for spontaneous osteonecrosis of the MFC in clinical outcomes and macroscopic appearance of the cartilage, and (2) the effectiveness of additional cartilage repair would depend on the size of the lesion.

Methods

Patients

Between April 2005 and March 2012, 72 consecutive patients with spontaneous osteonecrosis of the MFC who underwent opening-wedge valgus HTO and a concomitant procedure of BMS or OAT were assessed by the board-certified orthopaedic surgeons. The senior surgeon (T.S.) performed or supervised all procedures in this study series. Of the 72 patients, 14 patients were excluded from the analysis because of loss to follow-up

Table 1. Demographic Data

	BMS	OAT	P
Number of patients	28	30	
Female	23	21	.28
Male	5	9	
Age, yr*	69.7 (58-81)	68.1 (49-82)	.51
Body weight, kg*	58.8 (43-82)	60.6 (42-79)	.42
Body mass index*	24.3 (19.6-30.4)	25.4 (19.4-29.7)	.47
Lesion size, cm ² *	2.9 (0.8-7.2)	4.4 (2.4-8.1)	.0001
Koshino's classification, n			
Stage 2	4	3	.91
Stage 3	5	8	
Stage 4	19	19	
Second look (postoperative months)*	20.2 (7-32)	21.3 (9-33)	.52
Follow-up (postoperative months)*	29.8 (24-41)	30.2 (24-45)	.47

BMS, bone marrow stimulation; OAT, osteochondral autograft transplantation.

*Mean (range).

Table 2. International Cartilage Repair Society (ICRS) Cartilage Repair Assessment

Criteria	Points
Degree of defect repair	
Protocol A (subchondral drilling)	
In level with surrounding cartilage	4
75% repair of defect depth	3
50% repair of defect depth	2
25% repair of defect depth	1
0% repair of defect depth	0
Protocol B (mosaicplasty/OAT)	
100% survival of the initially grafted surface	4
75% survival of initially grafted surface	3
50% survival of the initially grafted surface	2
25% survival of the initially grafted surface	1
0% (plugs are lost or broken)	0
Integration to border zone	
Complete integration with surrounding cartilage	4
Demarcating border <1 mm	3
3/4 of graft integrated, 1/4 with a notable border >1 mm width	2
1/2 of graft integrated with surrounding cartilage, 1/2 with a notable border >1 mm	1
From no contact to 1/4 of graft integrated with surrounding cartilage	0
Macroscopic appearance	
Intact smooth surface	4
Fibrillated surface	3
Small, scattered fissures or cracks	2
Several, small or few but large fissures	1
Total degeneration of grafted area	0
Overall repair assessment	
Grade 1 normal	12
Grade 2 nearly normal	11-8
Grade 3 abnormal	7-4
Grade 4 severely abnormal	3-1

OAT, osteochondral autograft transplantation.

(7 patients), no chance of second-look arthroscopy (3 patients), and insufficient data (4 patients). A total of 58 subjects available for review included 28 subjects with BMS and 30 subjects with OAT (Table 1). The mean age at the time of surgery was 69.7 ± 6.9 years (median age

Table 3. Clinical and Radiographic Outcomes

	BMS	OAT	P*
KSS objective score (points)†			
Preop.	55 (25-78)	55 (28-67)	.66
Postop.	92 (77-100)	93 (69-100)	.81
KSS function score (points)†			
Preop.	60 (25-70)	60 (35-80)	.94
Postop.	90 (70-100)	90 (70-100)	.85
FTA (deg)‡			
Preop.	180.7 (176-185)	181.1 (177-185)	.58
Postop.	169.7 (167-174)	169.6 (166-173)	.89

BMS, bone marrow stimulation; KSS, Knee Society Score; OAT, osteochondral autograft transplantation.

*Mann-Whitney U test, BMS vs OAT.

†Median (range).

‡Mean (range).

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