The long-term results of meniscus transplantation for articular cartilage defects in the knee joint

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Abstract

Purpose: The purpose of this study was to examine the long-term clinical results of meniscus transplantation for articular cartilage defects in the knee joint. **Type of study**: Case series. **Method**: From October 1990 to June 1995, 8 cases underwent allogenic or autogenic meniscus transplantations for articular cartilage defects, and 7 cases were available for follow-up evaluations. The age at surgery ranged from 14 to 42 years old (average 22.5). In one case, a transplantation of tissue-engineered cartilage was performed due to pain 5 years after surgery. The other 6 cases were followed up for 8 to 13 years (average 10.1). The size of the cartilage defect ranged from 1.0 cm^2 to 6.3 cm^2 (average 2.8cm^2). Patients were evaluated with the Lysholm score and MR images. We also performed arthroscopic examinations in 3 cases at the final evaluation. **Results**: The Lysholm scores ranged from 76 points to 100 points. In MR images, the congruities between the grafted lesions and normal cartilage were evaluated as smooth surfaces in 4, slightly irregular surface in 1, irregular surface in 1, and one had disappeared. In arthroscopic findings at 11 years after surgery, the grafted meniscus could not be found in one knee that had severe osteoarthritis changes, and in the other knee the lesion of the transplanted meniscus resembled a flap tear. In another case, the grafted meniscus and the surrounding cartilage displayed irregular surfaces

during transplantation of tissue-engineered cartilage. In histological findings, at 11 years after surgery a small lesion in the grafted area was not hyaline cartilage but fibrocartilage. **Conclusions**: This study leads us to the conclusion that meniscus transplantation for articular cartilage damage is not compared to ACI although two cases showed good clinical results for a short term but the tissue was remained fibrocartilage tissues for long term.. Level of Evidence: Level 4, case series. Key words: Meniscus transplantation, Articular cartilage defect, Autograft, Allograft

Introduction

It is well known that articular cartilage damage has a poor self-healing capacity. The treatment of full-thickness cartilage defects of the articular surfaces of weight-bearing joints is a frequent problem in orthopedic fields. The osteochondral defects of loading surfaces often cause symptoms, such as pain, swelling and clicking, and are associated with the risk of inducing osteoarthritic change. In the past ten years, new techniques to provide hyaline or hyaline-like repair for articular defects, such as autologous chondrocyte transplantation (ACI), transplantation of tissue-engineered cartilage and autologous osteochondral transplantation have been developed, and the clinical results have been reported [1-5]. However, until ACI and osteochondral

transplantation techniques developed, several materials and methods such as periosteal graft, perichondral graft, drilling, and microfracture have been used for the repair of osteochondral defects [6-12]. As the graft material, we selected an allogeneic or autogeneic meniscus since meniscus contact the articular surface. The theoretical background of the meniscus transplantation for the articular defect is based on the biomechanical function of a normal meniscus, in that a meniscus does not produce adverse effects on an articular surface, although it does bear loads and pressure as a mobile shim between the articular surfaces of the femur and tibia [16]. Therefore, we thought that a grafted meniscus would not have harmful effects on the surrounding and opposing articular cartilage.

The meniscus is composed of fibrochondrocytes that maintain the extracellular matrix. The matrix is also composed of collagen and various proteoglycans. The extracellular matrix gives the meniscus its biological and material properties that allow it to perform its load-bearing function. The collagen fibrils within this matrix are highly structured into 3 layers that together allow compressive forces to be dissipated both peripherally and tangentially into hoop stresses [13]. In biomechanical testing, the meniscus is effective in helping distribute stress across the articular surfaces and in contributing to the normal lubrication of the articular surfaces. We also focused on the

function of the meniscus in the repair of articular cartilage defects. Sumen et al. [14] revealed that meniscus transplantation for articular cartilage defects has proven to be one of the effective methods performed thus far in the rabbit model.

Co-author Ochi et al. reported the clinical short term results of allogenic meniscus transplantation for cartilage defects [15]. This report described that the deep-frozen allogeneic meniscus graft was a useful method to repair osteochondral defects, although hyalinization did not occur. We then reviewed whether meniscus transplantation for cartilage defects would be effective in the long term. The objective of this study was to report on the results of long-term follow-up examinations after allogeneic and autogeneic meniscus transplantations for articular cartilage defects in the knee joint.

Materials and methods

We treated 8 cases (8 knees) from October 1990 to June 1995. So we were able to examine 7 cases (7 knees) at the final follow up. One female (case 8) did not contact us at 5 years after surgery. The seven cases consisted of 5 males and 2 females. The age at surgery ranged from 14 to 42 years old (average 22.5).

A transplantation of tissue engineered cartilage was performed on one case at 5 years

after the meniscus transplantation, and the other 6 cases were followed up at 8 to 13 years after transplantation (average 10.1 years).

The locations of the grafted lesions were as follows: the lateral femoral condyle in 3 knees, the patella surface in 2 knees, the medial condyle of the femur in one knee, and the lateral tibial plateau in one knee.

In 2 of the 7 cases, the cartilage was repaired with autologic menisci. They were diagnosed as having osteochondritis dissecans of the lateral femoral condyle associated with discoid lateral menisci. In the 5 other cases, the cartilage was repaired by transplanting allogenic menisci. These allogenic menisci were kept frozen at – 80 degrees Celsius, and they were checked for any infectious viruses. The patients gave us their informed consent for the treatment. During this grafting surgery, the menisci were thrown and kept at room temperature, and the plastic menisci were grafted to adapt to the cartilage defect. The size of the cartilage defect ranged from 1.0 cm^2 to 6.3 cm^2 (average 2.8cm^2).

Surgical procedure [15]

Medial incision was the surgical approach used on all patients' knees. Osteochondral defect lesions were curetted. Several drill-holes were made from the extraarticular site to the defect. The graft meniscus was created with free grafted autogenous synovium

according to the template. After copying the size and shape of the osteochondral defect using bone wax, the graft meniscus was created with free-grafted autogenous synovium according to the template. The meniscus was fixed to the osteochondral defect by suturing through drill-holes at the extra-articular site. The grafted menisci were implanted at the same level as that of the surrounding articular surface. After surgery, the knee was immobilized for 2-3 weeks, and thereafter continuous passive motion was initiated. Partial weight bearing was allowed 4-6 weeks after surgery.

We evaluated the patients with the Lysholm score for daily activity and MR images for the congruity of the surface between the grafted tissues and the surrounding ones. One case (No.5) was evaluated at 5 years, and the other 6 cases were evaluated at the final follow-up consultation. At these arthroscopic examinations, the patients gave us their informed consent about obtaining a small piece of their tissues for histological examination.

Results

The Lysholm scores of these cases are shown in the table 1.

There were no differences among the grafted lesions, and between autologeous menisci and allogenic menisci. The scores were from 76 points to 100 points (average 89

points). The main reason for the loss of points was pain. The score for No.2 patient (habitual dislocation patella) was seventy six points. The score for no.5 patient was seventy eight points (osteochondritis dissecans at the lateral femoral condyle): he had a transplantation of tissue-engineered cartilage at 5 years after meniscus transplantation due to pain and click.

MR images

The congruity between the grafted lesion and normal cartilage was evaluated in MR images. According to our evaluation, 4 knees had smooth surfaces (Fig 1 A, B), 1 knee had a slightly irregular surface (Fig.2), 1 knee had an irregular surface (Fig3), and in 1 knee the grafted meniscus seemed to have disappeared.

On MR images, the grafted lesion 11 years after meniscus transplantation was thinner than the one at 1 year after meniscus transplantation.

Arthroscopic findings

We performed an arthroscopic examination on three cases at the final examination. In case 2, we could not find the grafted meniscus at 11 years after the graft surgery. The patellar articular surfaces, including the grafted area, had disappeared and the subchondral bone was exposed. In case 3, we found that the meniscus transplantation lesion was like a flap tear at 11 years after the graft surgery.

Also the gap between the grafted meniscus and the articular cartilage was very evident. But the surrounding cartilage and the opposite site femur cartilage did not promote osteoarthritic change (Fig. 4 A). In case 5, the surface of the grafted meniscus was irregular and rugged when we checked the joint surface at ACI surgery (Fig.4 B).

Histological findings

In case 2, we performed arthroscopic examinations 11years after the meniscus transplantation, but we couldn't take a biopsy of the meniscus transplantation because we could not find the lesions in the grafted areas. In case 3, we took a biopsy of the grafted area 11years after meniscus transplantation, and the histological findings showed that the lesions seemed to be fibrocartilage not hyaline cartilage.

In case 5, we removed the grafted meniscus from the transplantation of tissue-engineered cartilage surgery 5 years after meniscus transplantation. The historical findings showed that the grafted area of the meniscus seemed to be like fibrocartilage with the degenerative changes (Fig.6).

Discussion

In this study, we revealed the long-term results of meniscus transplantation for articular cartilage injury. In 5 of 7 cases, the Lysholm score was more than 80 points,

and in the other 2 cases, the Lysholm score was less than 80 points, and one case had an advancing osteoarthritic change because the grafted meniscus had disappeared, with the other case needing transplantation of tissue-engineered cartilage surgery for his knee pain. The main reason for this clinical result is speculated to be congruence between the grafted meniscus and normal articular cartilage, since the long-term congruity of the grafted meniscus and the surrounding surface seemed smooth and slightly irregular in 5 cases. However, even in good clinical cases, the grafted tissues are fibrocartilage rather than hyaline cartilage.

Menisci have been used experimentally as implants, and in clinical attempts degenerated menisci have been replaced with allogenic menisci [17, 18]. Since being introduced clinically by Milachowski et al. [18] in 1989, meniscus transplantation has served as a definitive treatment strategy for symptomatic meniscal deficient patients. In the USA and Europeans countries, meniscus transplantation has become an accepted and important tool in the clinical treatment of symptomatic postmeniscectomy patients [19-21]. Wirth et al. described that frozen allografts induced better clinical results than freeze dried allografts [20]. Fresh allografts run the risk of transmitting infectious diseases. The autograft is of course a safe method which precludes the transmission of infectious diseases. Therefore, for 5 patients who could not use their original menisci,

we transplanted deep-frozen allogeneic menisci and for the other 2 patients who could use their original menisci, we transplanted fresh torn discoid menisci, which induced osteochondritis dissecans.

Some studies have been carried out on meniscus transplantation for articular cartilage defects [14, 22-24]. Heatley et al. [22] described xenogeneic meniscal grafts. Gomar-Sancho et al. [23] reported on the usefulness of autogenous meniscal grafts in repairing articular defects in rabbits, and Sumen et al. [14] reported that deep-frozen allogeneic meniscal grafts are useful as biological implants to repair articular cartilage defects in rabbit models. In clinical reports, Ochi et al. reported about 5 cases of allogeneic deep frozen meniscus grafts for chondrol defects [15]. They described that the grafted meniscal surface was covered by synovial tissue and MR imaging also showed a smooth congruous articular surface at post-operative 1 year. This long-term study included these allogeneic meniscal graft cases. Long-term clinical results showed that 4 of those 5 cases did not become worse, but the grafted meniscus at 11 years after surgery was thinner than one at 1 year after surgery. This method does not repair cartilage defects with hyaline cartilage. Nowadays, the treatments of articular cartilage defects are mainly performed with cartilage or cartilage-like tissue. Some papers have reported their long term results [25, 26]. Hangody et al. [25] reported on

autologous osteochondral mosaicplasty and Brittberg et al. [26] reported on autologous chondrocyte transplantation in a long-term follow-up study. They described that more than 80 % of patients scored excellent or good. Compared with these results, our current operative method is not so good. Therefore, the meniscus transplantation may be supported only where the ACI procedure is not available. Our method can be performed at any hospital without special equipment, and without the cultured chondrocytes. Finally, we can conclude that the meniscus transplantation is not superior to Mosaic plasty and ACI, and also describe that the merit of the meniscus transplantation for the cartilage defect is very restricted.

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Legends

Table 1: All cases of meniscus transplantation

Fig.1: MR imaging: The congruity between the grafted lesion and normal cartilage was a smooth surface.

The white arrow shows the grafted meniscus

A Case 1;11 years after meniscus transplantation

B Case 4; 9 years after meniscus transplantation

Fig.2: MR imaging: The congruity between the grafted lesion and normal cartilage was a slightly irregular surface.

The white arrow shows the grafted meniscus

Case 3; 11 years after meniscus transplantation

Fig.3: MR imaging: The congruity between the grafted lesion and normal cartilage was an irregular surface.

The white arrow shows the grafted meniscus

Case 5: 5 years after meniscus transplantation

Fig.4: Arthroscopic findings

A: Case 3: The meniscus transplantation lesion was like a flap tear at 11 years after the graft surgery.

The gap between grafted meniscus and articular cartilage was evident. But the surrounding cartilage and the articular cartilage of the femur did not promote the osteoarthritic change.

The black arrow shows the grafted meniscus

B: Case 5: The surface of the grafted meniscus was irregular.

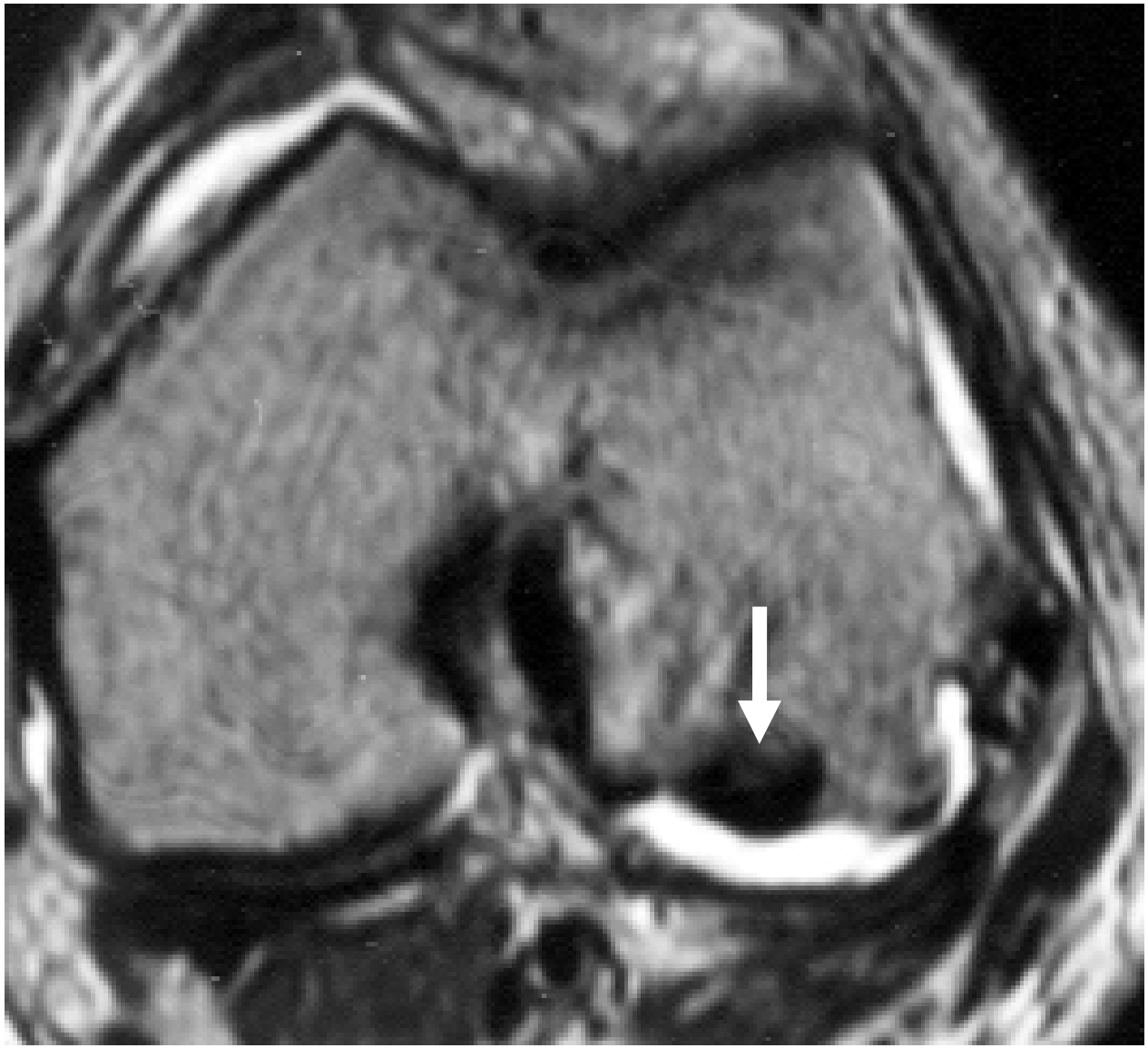
The white arrow shows the grafted meniscus

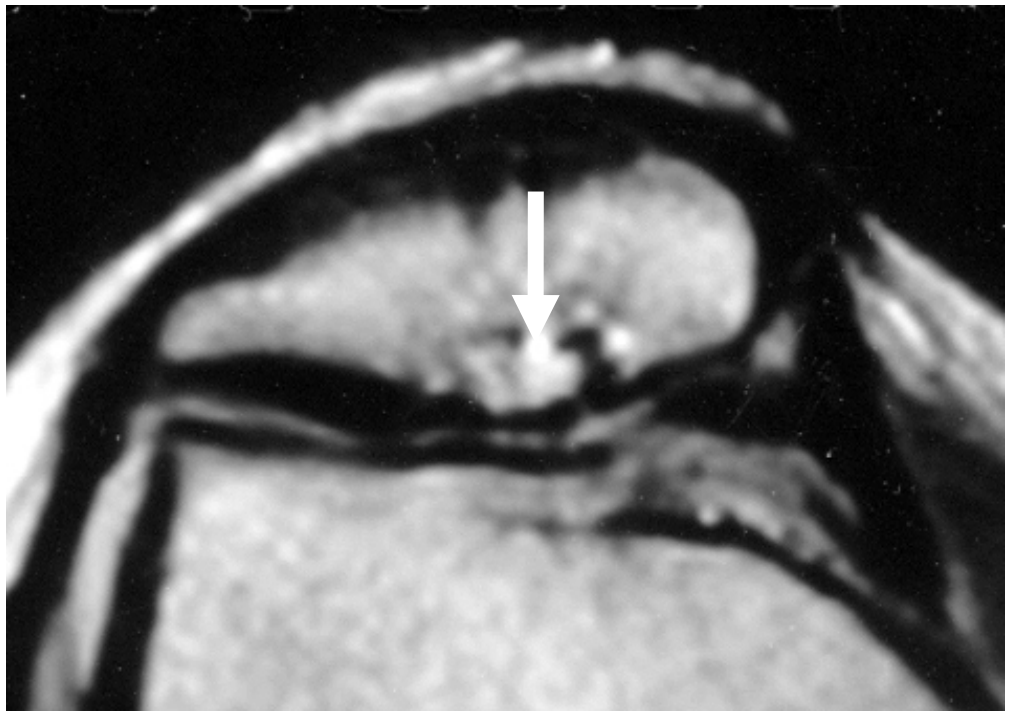
Fig.5: Histological findings

Case 5: the grafted area of the meniscus resembled fibrocartilage with degenerative changes

Case	Age at surgery	grafted meniscus	grafted areas(cm2)	lesion of graft	follow-up terms (years)	Lysholm score	MR imagings
1	33	allo	6	lateral femoral condyle	13	95	good
2	42	allo	6.3	patella	11	76	disappered
3	17	allo	1.1	lateral plateau of tibia	11	84	slight irregular
4	16	allo	2.3	patella	8	100	good
5	18	auto	1.5	lateral femoral condyle	5	78	irregular
6	14	auto	1	lateral femoral condyle	8	100	good
7	18	allo	2.4	medial femoral condyle	8	88	good
Avg.	22.5		2.9		10.1*	89	

* expect case 5



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