Introduction

The goal of the treatment of torn menisci was symptomatic relief through open total meniscectomy in the past. However, the surgical treatment has been shifted for preservation of meniscal functions as well as symptomatic improvement with growing recognition of the importance of biomechanical functions of the meniscus, such as the chondroprotective effect through load distribution and knee joint stabilization.

Currently, transplantation of allograft meniscal tissue is used for reconstruction of biomechanical properties of the meniscus in the meniscus-deficient knee with the aid of advanced arthroscopic equipment, instruments, and techniques.

The ideal long-term result of meniscal allograft transplantation (MAT) is delay of articular cartilage degeneration, which is still to be proven by substantial evidence. Although some animal model studies have shown that MAT can restore chondroprotective function of the meniscus to a certain level, the transplanted menisci failed to provide complete restoration of the functions of the original meniscus. In most studies of the early MAT cases, significant degeneration, deformation, and tear, and structural changes in the remodeling process were observed during the remodeling process. However, MAT is considered as one of the effective alternative options for symptomatic meniscectomized knees because there are few viable treatment strategies in these patients.

Although there are a number of research and literature on MAT, it is not easy to assess their outcomes due to the small number of subjects, various meniscus preservation techniques, operative methods, and indications, various concomitant procedures including anterior cruciate ligament (ACL) reconstruction, high tibial osteotomy (HTO), and cartilage repairing procedures, in addition to the absence of established evaluation methods.
purpose of this article is to improve the understanding of MAT with a review of the mid- and long-term follow-up results and recent published data using objective evaluation methods of meniscal transplants.

Long-term Follow-up Results of Early MAT Cases

The established purpose of human MAT is to relieve pain and improve functions in the meniscectomized knee. In addition, the orthopedic surgeons now expect the meniscal transplants to provide a chondroprotective effect for joint preservation in the long-term follow-up. In 1984, Milachowski et al. first performed MAT in ACL reconstruction on human subjects in an attempt to promote synergistic effects by restoring secondary restraint function of the posterior horn of the medial meniscus against anterior instability based on their animal experiments in sheep. In their study, only three transplanted menisci had to be removed out of 22 cases for a minimum 14 months of follow-up. Wirth et al. evaluated the clinical outcome of MAT in 23 cases consisting of 22 cases in the abovementioned study and 1 additional case with a lyophilized graft at 3 years and 14 years postoperatively. The overall results were satisfactory although the Lysholm score decreased from 84 points at 3 years postoperatively to 75 points at 14 years postoperatively. They compared the 23 MATs with two control groups that underwent isolated ACL reconstruction without MAT (one with previous experience of meniscectomy and the other one with intact menisci). The clinical results were better in the deep frozen graft group than the lyophilized graft group. The lyophilized graft exhibited more shrinkage than deep frozen grafts on magnetic resonance imaging (MRI) and second-look arthroscopy. The results of the lyophilized graft group were more comparable to the meniscus-deficient control group, whereas the deep frozen graft group produced more similar results to the control group with intact meniscus. Of these Milachowski’s cases, 5 cases with a deep frozen graft were evaluated at 20 years postoperatively by von Lewinski et al. The Lysholm score ranged from 21 to 97 points, indicating the clinical results were good in some cases. Although the overall results were satisfactory, clear radiographic evidence of degeneration was observed in all patients: the Kellgren-Lawrence grade was 2 in 2 patients, 3 in 2 patients, and 4 in only 1 patient.

In another recent report by Binnet et al., all of the 4 patients had grade 4 degenerative arthritis at 19 years after lyophilized graft transplantation combined with revision ACL reconstruction, indicating the importance of graft preservation. Currently, lyophilized grafts are rarely used in meniscus transplantation due to the risk of significant changes in the tissue properties and severe shrinkage of meniscal transplants.

These long-term follow-up results of early MAT cases appear less than promising. However, it should be taken into consideration that Milchowski et al. used contralateral lateral menisci for medial meniscus transplantation in 11 of the 22 patients in the absence of established surgical techniques without recognition of the importance of joint congruity and graft size. Recent biomechanical studies have shown that placement of an inappropriately sized graft has a negative impact on the functional recovery of the meniscus. Precise implantation of an appropriately sized allograft using a proper surgical technique is essential for good prognosis of MAT. In addition, lyophilized grafts were used in many of the early MATs and medial MATs were performed as an additional procedure in ACL reconstruction. Therefore, we think that the long-term efficacy of MAT should be evaluated based on studies that involve a high volume of cases and the use of currently preferred cryopreserved or deep frozen size-matched grafts.

The mid-term failure rate of cryopreserved graft transplantation was as high as 35%. In a study by Strollsteimer et al., 8 (35%) out of 23 patients required a second operation due to meniscal symptoms at 13–69 months after MAT. In a 2- to 8-year follow-up study by Rath et al., transplant removal was necessitated in 8 (36%) out of 22 cases with a cryopreserved graft at a mean of 31 months postoperatively. van Arkel and de Boer analyzed the survival rate of cryopreserved meniscal allografts at a mean of 60 months of follow-up. When failure was defined as persistent pain and meniscal transplant tear, the cumulative survival rates of the lateral, medial, and bilateral allografts were 76%, 50%, and 67%, respectively. The failure rate was high in the ACL-deficient knee with ligament instability.

There are some recently reported long-term follow-up studies that demonstrate more favorable results. Hommen et al. followed 20 cases for a mean of 141 months after cryopreserved graft transplantation and observed improvement in the Lysholm score and pain score in 90% of the patients. However, when failure was defined as <65 Lysholm score or no improvement in pain score, the failure rate was 35%. On the objective evaluation results, radiographic joint space narrowing was observed in 10 out of 15 patients, moderate meniscus shrinkage was noted in all of the 7 patients who underwent MRI, 3 of which had grade III signal intensities. Thus, the 10-year survival rate of the allografts based on the clinical outcome and the objective evaluation results became 45% (9 in 20 patients).