Clinical and Radiologic Outcomes After Meniscus Allograft Transplantation at 1-Year and 4-Year Follow-up

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Purpose: To assess the clinical and radiologic outcomes of meniscus allograft transplantation (MAT) with serial evaluation at 1 year and at 4 years. **Methods:** Among 151 patients who received MAT between March 2006 and June 2009, we prospectively recruited the patients who had undergone clinical and radiologic examinations at 1 year after the operation. The Lysholm score, International Knee Documentation Committee score, and Knee Society Score were determined. Plain radiography was used for evaluation of osteoarthritis, and magnetic resonance imaging (MRI) was used to assess the cartilage status and meniscal extrusion. **Results:** Thirty-nine patients with a mean age of 40 ± 9 years were recruited. The first visit was conducted at a mean of 13.6 months (range, 11 to 17 months) postoperatively, and the last visit was conducted at a mean of 50.4 months (range, 48 to 72 months) postoperatively. Of the patients, 29 were men. The lateral side was involved in 27 patients. The Lysholm knee score increased to a median value of 89 (range, 75 to 100) at the first visit and 88 (range, 76 to 100) at the second visit from a preoperative median value of 79 (range, 37 to 99), which was statistically significant according to the Kruskal-Wallis test. According to the Kellgren-Lawrence grade based on anteroposterior radiographs, 21 patients (54%) showed no arthrosis progression and the overall status of arthrosis on anteroposterior radiographs was significantly changed ($P < .001$). On MRI, 25 patients (64%) showed no cartilage status change and the overall status was not changed significantly ($P = .178$). The meniscal extrusion extent was 4.2 ± 0.4 mm at the first visit and 4.2 ± 0.6 mm at the second visit ($P = .678$), and the relative percentage of extrusion was 0.44 ± 0.16 and 0.51 ± 0.21, respectively ($P = .059$). The subgroup in which arthrosis had progressed on MRI showed a larger amount of change in the relative percentage of extrusion ($P = .023$). No correlation was observed between meniscal extrusion and various outcomes. **Conclusions:** Repeat assessment at 4 years showed that MAT showed improvement in knee function, but it had decreased over time. Considerable meniscal extrusion was observed, but it did not increase during follow-up and did not show any correlation with other outcomes. Extrusion progression showed significant correlation with arthrosis progression. **Level of Evidence:** Level IV, therapeutic case series.

Meniscus allograft transplantation (MAT) has been popularized as the treatment of choice in young patients who have undergone previous meniscectomy. Many researchers have reported encouraging results after MAT. Encouraging clinical results, a good healing rate on imaging evaluation, and a good chondroprotective effect on second-look arthroscopy have been shown in several reports.[1-3]

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However, there are still many controversial issues. Does the MAT have a chondroprotective effect on long-term follow-up? How much does the allograft extrude during follow-up, and does it relate with clinical outcomes? Furthermore, how do the outcomes change over time? To our knowledge, there has been no serial evaluation of clinical and radiologic outcomes more than 2 years after MAT.

The purpose of this study was to assess the clinical and radiologic outcomes of MAT with serial evaluation at 1 year and at 4 years. The hypotheses were as follows: (1) MAT will improve knee function, but the function will decrease over time. (2) Considerable meniscal extrusion will be observed, but it will not increase during follow-up and will not correlate with clinical outcomes and radiologic findings.

Methods

A total of 151 patients had undergone MAT at our institute from March 2006 to May 2009. The inclusion

criteria were patients who underwent MAT during the aforementioned period and who underwent clinical and radiologic examinations at approximately 1 year after surgery. The exclusion criteria were infection and graft rejection.

MAT was performed in patients who had moderate to severe pain after total or subtotal meniscectomy with a 12-month interval from meniscectomy to MAT on the medial side and a 6-month interval on the lateral side. Contraindications for this surgical procedure were uncorrected instability, moderate to severe osteoarthritic changes, axial-limb malalignment, and age older than 45 years. This study was approved by the institutional review board of our hospital.

Surgical Technique

MAT was performed by one experienced surgeon (J.G.K.) who had performed more than 200 cases of MAT. Grafts were sized on anteroposterior (AP) and lateral radiographs with a scanogram for correction of magnification, as described by Pollard et al.[4] Medial MAT was performed by a modified bone-plug technique developed by the senior author (J.G.K.),[5,6] in which the graft contains separate bone plugs attached to the horns and the bone plug of the posterior horn is smaller than that of the anterior horn for easy passage. Lateral MAT was performed by the "keyhole" technique described by Wilcox and Goble,[7] in which the graft contains a common bone bridge attached to both anterior and posterior horns.

In all cases we used fresh-frozen allografts. Additional procedures, such as cruciate ligament reconstruction (9 cases, 23%), posterolateral corner reconstruction (1 case), cartilage microfracture technique (2 cases, 1%), high tibial osteotomy (1 case), and autologous chondrocyte implantation (2 cases, 1%), were performed concomitantly or as separate staged procedures.

Evaluation Methods

The Lysholm knee score, International Knee Documentation Committee (IKDC) subjective knee score, and Knee Society Score (knee score and functional score) were used to assess the clinical results. Extension weight-bearing AP radiography (AP view) and 45° posteroanterior flexion weight-bearing radiography (Rosenberg view) were used to evaluate joint space narrowing of the involved compartment. The Kellgren-Lawrence grade was used to grade the osteoarthritic status of the knee. All measurements were documented by 2 different orthopaedic surgeons (J.K.H., H-W.J.) and a radiologist. Grades for which consensus was reached were used after the discussion. Interobserver agreement was observed in 25 to 34 patients for the magnetic resonance imaging (MRI) arthrosis grade and Kellgren-Lawrence grade on AP and Rosenberg views. The intraclass correlation coefficients for interobserver reliability ranged from 0.75 to 0.87.

MRI examinations were performed in all cases using 1.5-T cylinder-shaped equipment (Intera Achieva; Philips, Eindhoven, Netherlands). Meniscal extrusion was defined as the greatest distance from the most peripheral aspect of the meniscus to the border of the tibia, excluding any osteophytes on coronal images. It was measured to the nearest millimeter on the coronal images (fast spin-echo intermediate weighted image; repetition time/echo time, 2,000 to 3,800 milliseconds/35 to 45 milliseconds; 4-mm section thickness; 1-mm interslice gap) using an MRI-generated scale on each image by 2 different orthopaedic surgeons and a radiologist, and average values were used. The relative percentage of extrusion (RPE), defined as the percentage of the width of extruded menisci compared with the entire meniscal width, was also measured.[8,9] This method was developed to standardize the measurement for knees of different sizes (Fig 1). Cartilage status was evaluated according to the modified Outerbridge grading scale.

Rehabilitation Protocol

Immediately after surgery, the patients were placed in a long leg splint, which was worn for approximately 5 to 7 days. The allowed ranges of motion at 3 weeks and 6 weeks were 90° and 120°, respectively, in lateral MAT cases and 120° and full, respectively, in medial MAT cases. Because previous biomechanical studies showed that the lateral tibial condyle moved internally more than the medial side during knee motion, more restricted range of motion was applied to the lateral side for early protection of the sutured graft. Patients were allowed partial weight bearing during the first 6 weeks. Light running was allowed at 3 months, with return to sports at 6 months, although strenuous contact sports were prohibited.

Statistical Methods

We performed repeated-measures analysis of variance for the IKDC and modified Hospital for Special

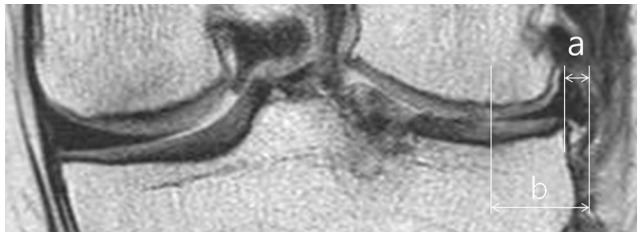

Fig 1. Meniscal extrusion is defined as the greatest distance (a) from the most peripheral aspect of the meniscus to the border of the tibia, excluding any osteophytes on coronal images. RPE is defined as the percentage of the width of extruded menisci (a) compared with the entire meniscal width (b) (RPE = a/b × 100).