Meniscal Allograft Transplantation in the Adolescent Population

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Purpose: To report the results of meniscal allograft transplantation (MAT) with minimum 2-year follow-up in an active adolescent population. **Methods:** After institutional review board approval, all patients aged 16 years or younger who underwent MAT and had more than 2 years' clinical follow-up were identified from a prospectively collected database. Demographic data were collected and summary statistics calculated. Functional outcome scores were collected preoperatively and at 6 months, 1 year, 2 years, and final follow-up. Differences between scores at each time point were calculated using a mixed-model repeated-measures analysis of variance. All prior procedures and reoperations were documented. **Results:** Thirty-seven MAT procedures were performed in 36 children (84% lateral and 16% medial). For 32 of these procedures (86%), the patients met the inclusion criteria with minimum 2-year follow-up. The mean age was 15.4 ± 1.04 years (range, 13 to 16 years). All patients had undergone prior knee surgery. Of the 32 patients, 23 (72%) were girls and 9 (28%) were boys. Eleven patients had open physes. Forty-eight percent of patients underwent concomitant procedures, mainly for chondral defects. The mean length of clinical follow-up was 7.2 ± 3.2 years (range, 2 to 15 years). MAT resulted in significant improvements in the Knee Injury and Osteoarthritis Outcome Score, Lysholm score, International Knee Documentation Committee subjective score, Western Ontario and McMaster Universities Osteoarthritis Index pain score, Western Ontario and McMaster Universities Osteoarthritis Index function score, and Short Form 12 physical score. After MAT, 7 patients (22%) underwent 8 surgical procedures, most of which were for chondral disease. The meniscal reoperation rate was 6%. No revision MAT procedures were required. No angular deformities or limb-length inequalities were reported. **Conclusions:** MAT resulted in predictable improvements in functional outcomes in the adolescent population. The meniscal reoperation rate was low (6%), no revision MAT procedures were required, and no growth complications were reported. Chondral disease remains the primary reason for reoperation after MAT. **Level of Evidence:** Level IV, therapeutic case series.

As the number of adolescents participating in athletics has increased, so has the prevalence of meniscal injuries in this population.[1] It is estimated that 80% to 90% of meniscal injuries in the pediatric and adolescent population occur during sporting activities, and they are often associated with other knee injuries, in particular anterior cruciate ligament tears.[1] A discoid meniscus, seen in 3% to 5% of the US population, is an additional risk factor for meniscal injury.[2] The higher vascularity of the young meniscus makes repair more successful in this population, but in the setting of irreparable tears or failed repairs, meniscectomy might be necessary.[1]

The meniscus plays a critical role in load distribution, shock absorption, joint lubrication, joint stability, and proprioception.[3,4] The effects of subtotal or total meniscectomy are now well recognized and include a higher risk of pain and osteoarthritic changes than healthy matched controls.[5] Even with less aggressive meniscectomy, the outcomes in youngsters are poor. Seventy-five percent of children and adolescents undergoing meniscectomy are still symptomatic 5 years after surgery, 80% have degenerative radiographic changes, and 60% are dissatisfied with their outcome.[6]

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A unique challenge arises in the adolescent patient with persistent pain after removal of a significant portion of the meniscus. The so-called post-meniscectomy syndrome is well recognized in adults and can be treated with meniscal allograft transplantation (MAT).[7] However, meniscal transplantation was traditionally thought to be contraindicated in skeletally immature patients, and many physicians are hesitant to perform this procedure in young patients with high activity demands.[5,8] There are reports of meniscal transplantation after total meniscectomy of a discoid meniscus, but these patients were at least 17 years old.[9] Although most adolescents will tolerate subtotal or total meniscectomy well, others can progress precipitously to have compartment degeneration and severe pain. In this subset of patients, it is difficult to recommend observation until skeletal maturity or adulthood.

A recent systematic review on MAT showed that only 10 of 55 studies included patients aged younger than 16 years, and each study had too few patients in this category to comment specifically on their outcomes.[5] The purpose of this study was to report the results of MAT with minimum 2-year follow-up in an active adolescent population. Our hypothesis was that MAT would have comparable functional outcomes and failure rates in adolescents to those previously described in adults.

Methods

Patient Selection

All patients were participants in a prospectively collected, institutional review board–approved research database. Additional approval from the institutional review board for retrospective data analysis was obtained before initiation of this study. Patients having undergone MAT were identified from this database. The inclusion criteria for this study included the following: (1) age of 16 years or younger at the time of the index procedure; (2) MAT for symptomatic meniscal insufficiency (load-related pain and swelling in the compartment undergoing meniscectomy) for which conservative treatment failed; (3) index procedure performed before December 31, 2012; and (4) minimum 2-year clinical follow-up. Patients undergoing revision MAT were excluded.

Outcome Assessment

Patients were evaluated preoperatively and at 6 months, 1 year, and 2 years, as well as yearly thereafter when possible. A standard clinical examination was performed at each visit by the attending surgeon (B.J.C.). In addition, a series of functional outcome questionnaires were administered, including the Knee Injury and Osteoarthritis Outcome Score (KOOS), Lysholm score, International Knee Documentation Committee (IKDC) subjective form, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Short Form 12 (SF-12). Any further surgery on the operated knee, including the type and number of subsequent procedures, was documented. All patients were called in March 2015 by a research assistant who was not involved in the study. Information about subsequent operations was solicited, and patients were referred to a secure online version of the functional outcome questionnaires. If patients could not be reached during this round of calls and had a documented clinic visit more than 2 years from MAT, this information was extracted from their last clinic note.

Surgical Technique

Side-, compartment-, and size-specific fresh-frozen meniscal allografts were obtained for each patient according to a previously described sizing protocol based on height, weight, and gender and radiographic sizing using the Pollard method.[10] The senior author (B.J.C.) performed all procedures using a bridge-in-slot technique, as previously described.[11] This technique is preferred because it is straightforward, maintains the native anterior and posterior horn attachments, provides secure bony fixation, and makes it easier to perform concomitant procedures such as an anterior cruciate ligament reconstruction or osteotomy. In addition, the slot is contained completely within the proximal tibial epiphysis. Before the graft was opened, diagnostic arthroscopy was performed to confirm the diagnosis and indications for transplantation (Fig 1). The injured meniscus was arthroscopically debrided to a stable 1- to 2-mm peripheral rim. Then, a 2- to 3-cm parapatellar arthrotomy was made on the same side as the anticipated graft placement. A tibial slot that was roughly 8 mm wide and 10 mm deep was then prepared. Standard posteromedial or posterolateral approaches for meniscal repair were then made in anticipation of inside-out graft fixation. On the back table, the graft was prepared to obtain a bone block 7 mm wide and 10 mm deep. A traction stitch (No. 0 polydioxanone) was placed at the junction of the middle and posterior thirds of the meniscal graft. A nitinol wire with a wire loop on one end was placed at the junction of the middle and posterior thirds of the native meniscus by use of an inside-out meniscal repair guide and was recovered through the posteromedial or posterolateral accessory incision. The traction stitch was fed through the wire loop, and the nitinol wire was then pulled through the knee capsule until the traction stitch was retrieved through the accessory incision. The bony portion of the graft was inserted into the tibial slot through the parapatellar arthrotomy, while gentle traction was applied to the polydioxanone suture to guide the soft-tissue component of the graft under the femoral condyle. A standard inside-out meniscal repair

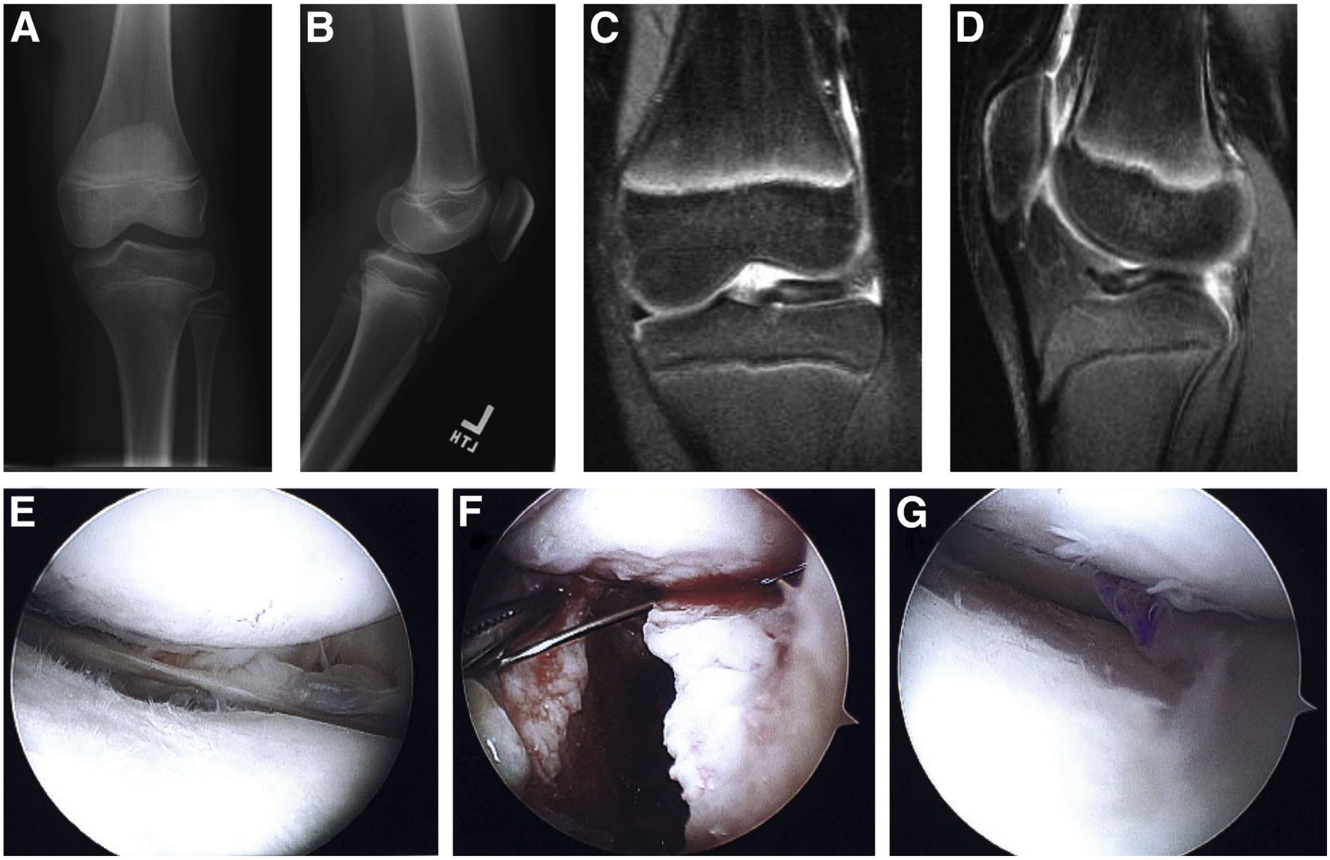

Fig 1. Case example. A 13-year-old girl presented with lateral knee pain and activity-related swelling after a subtotal lateral meniscectomy at an outside facility. (A) Anteroposterior and (B) lateral radiographs showed open distal femoral and proximal tibial physes and no significant degenerative changes in the lateral compartment. (C) Coronal and (D) sagittal slices from the patient's original magnetic resonance imaging showed open physes and a torn discoid lateral meniscus, which was subsequently resected before her presentation. (E) Diagnostic arthroscopy of the lateral compartment showed a subtotal lateral meniscectomy with a 1-mm peripheral rim of meniscus remaining. Diffuse grade 1 and focal grade 2 areas of chondral damage were seen in the lateral femoral condyle and tibial plateau. (F) A slot was prepared in line with the horns of the lateral meniscus, immediately adjacent to the anterior cruciate ligament. (G) A lateral meniscal allograft transplant was then inserted and repaired by a standard inside-out technique.

was performed using No. 2-0 FiberWire suture (Arthrex, Naples, FL) in a vertical mattress configuration that was alternated between the superior and inferior surfaces of the meniscus. The bone bridge was secured in the slot with a 7 × 28—mm or 8 × 28—mm BioComposite interference screw (Arthrex). Anatomic alignment is critical to the success of MAT. If a patient was indicated for MAT but did not have anatomic alignment, an osteotomy was performed.

Postoperative Rehabilitation

Patients were allowed to begin 50% partial weight bearing in a hinged knee brace immediately postoperatively. Knee range of motion was limited from 0° to 90° of flexion for the first 2 weeks; unlimited flexion was then allowed during non—weight-bearing activities. Full weight bearing started at 4 weeks, and unrestricted range of motion out of the brace was initiated at 6 weeks. Gentle strengthening began at 2 to 4 weeks. At 12 to 16 weeks after surgery, progression of functional activities occurred. At 6 months, patients were allowed to return to unrestricted activities.

Statistical Analysis

Means with standard deviations and ranges were calculated to summarize continuous demographic variables (age, body mass index, number of previous surgical procedures, follow-up length). Frequencies were calculated to summarize categorical demographic variables (gender, number of knees with previous surgery, location of allograft transplantation). Differences in functional outcome scores between each time point were calculated using a mixed—method model repeated-measures analysis of variance to properly account for the correlation between the multiple measures being made on the same patient population. Statistical significance was set at $P < .05$. JMP Pro 11 (SAS Institute, Cary, NC) was used for all analyses.

Table 1. Patient Demographic Information

	Data
No. of patients included (minimum 2-yr follow-up)	32
No. of knees included (minimum 2-yr follow-up)	32
Age at time of surgery, mean ± SD (range), yr	15.4 ± 1.04 (13-16)
Gender, no. of knees	
Male	9
Female	23
Body mass index, mean ± SD, kg/m^2	22.1 ± 3.6
Knees with previous surgery, n (%)	32 of 32 (100)
Mean no. of previous surgical procedures	1.8 ± 0.7
Mean follow-up, mean ± SD (range), yr	7.2 ± 3.2 (2-15)
Location of graft, n (%)	
Medial meniscus	5 of 32 (16)
Lateral meniscus	27 of 32 (84)

Table 2. Surgical History of Patients Undergoing Meniscal Allograft Transplantation

Procedure	No. of Procedures
Meniscal repair	6
Meniscectomy (nondiscoid)	43
Meniscectomy (discoid)	5
Loose body removal	3
Chondroplasty	6
ACI biopsy	7
ACL reconstruction	4
Isolated diagnostic arthroscopy	7
OCD drilling	2
Microfracture	1
Realignment osteotomy	1
OATS	1
Total*	85*

ACI, autologous chondrocyte implantation; ACL, anterior cruciate ligament; OATS, Osteochondral Autograft Transfer System (Arthrex); OCD, osteochondritis dissecans.

*Several patients underwent more than 1 prior surgical procedure or multiple procedures performed simultaneously.

Results

Patient Characteristics

A total of 37 MAT procedures were performed in 36 patients. For 32 of these 37 procedures (86%), the patients met the eligibility criteria with minimum 2-year follow-up. Of these 32 patients, 28 could be reached in March 2015 for phone follow-up and provided definitive information about subsequent operations. For the remaining 4 of 32 patients, their final follow-up information was derived from their final clinic note. Five patients were lost to follow-up after their 6-month visit and were excluded from the study. Functional outcomes at minimum 2-year follow-up were available for 27 of the 37 allografts (73%). The mean length of follow-up was 7.2 ± 3.2 years (range, 2 to 15 years). Patient characteristics are summarized in Table 1. Preoperative radiographs were only available for 26 patients (81%). Of these patients, 11 had open or closing physes at the time of index surgery (42%). All patients (100%) had undergone at least 1 prior surgical procedure (meniscectomy), and 59% had undergone 2 or more procedures before MAT. A summary of these procedures is shown in Table 2.

Lateral meniscal transplantation was performed in 27 of 32 cases (84%), and medial meniscal transplantation was performed in the remaining 5 cases (16%). Concomitant procedures were performed in 15 of 32 cases (47%). A summary of these procedures is shown in Table 3. No perioperative complications were reported in this cohort.

Reoperation

After MAT, 7 patients (22%) underwent a total of 8 subsequent surgical procedures. However, the meniscal reoperation rate was only 6%. In 2 patients (6%), debridement of a torn meniscal allograft was required. Notably, no revision MAT procedures were required. An anterior cruciate ligament rupture requiring reconstruction occurred in 1 patient (3%), and 1 patient (3%) required lysis of adhesions. The most common reason for reoperation was to address chondral pathology of the femoral condyles. Indeed, 7 patients (22%) underwent a chondral debridement, a realignment osteotomy, removal of a chondral loose body, or a cartilage restorative procedure. A summary of these subsequent procedures is shown in Table 4.

Functional Outcome Scores

Functional outcome questionnaires were distributed at 6 months, 1 year, 2 years, and final follow-up. These scores are summarized in Figure 2 (KOOS), Figure 3 (Lysholm, IKDC subjective, and WOMAC), and Figure 4 (SF-12). Raw data are shown in Appendix Table 1 (available at www.arthroscopyjournal.org).

Table 3. Concomitant Procedures With Meniscal Allograft Transplantation

Procedure	No. of Procedures
ACI (femoral condyle of same compartment)	10
ACL reconstruction	2
ACI biopsy	1
OATS (femoral condyle of same compartment)	1
Osteochondral allograft (femoral condyle of same compartment)	3
HTO	1
Total*	13

ACI, autologous chondrocyte implantation; ACL, anterior cruciate ligament; HTO, high tibial osteotomy; OATS, Osteochondral Autograft Transfer System.

*Several patients underwent more than 1 prior surgical procedure or multiple procedures performed simultaneously.

Table 4. Subsequent Procedures After MAT

Patient No.	Index Procedures	Subsequent Procedures	Time From MAT to Subsequent Surgery, mo
1	Lateral MAT	Distal femoral osteotomy	48
2	Lateral MAT, ACI of LFC, microfracture of MFC	Chondroplasty of LFC, partial lateral meniscectomy	34
3	Lateral MAT	Arthroscopic lysis of adhesions	16
4	Medial MAT	Medial meniscectomy, chondroplasty of patella	33
5	Medial MAT, HTO	Chondroplasty of MFC	5
6	Lateral MAT	Chondroplasty of LFC	71
7	Lateral MAT, ACI biopsy	Removal of loose body, microfracture of LFC, ACLR with hamstring autograft, ACI biopsy	52 and 55

ACI, autologous chondrocyte implantation; ACLR, anterior cruciate ligament reconstruction; HTO, high tibial osteotomy; LFC, lateral femoral condyle; MAT, meniscal allograft transplantation; MFC, medial femoral condyle.

Significant improvements were seen in all KOOS subscores with the exception of the KOOS symptom subscore (Fig 2). Lysholm scores, IKDC subjective scores, and WOMAC pain, function, and stiffness scores were all significantly improved after surgery (Fig 3). Finally, SF-12 physical scores were significantly improved, whereas SF-12 mental scores were unaffected by MAT (Fig 4). The only functional outcome that deteriorated over time was the IKDC subjective score, which was lower at final follow-up than at 2-year follow-up ($P =$ .02, Fig 3).

Discussion

In this report of 32 adolescent patients undergoing MAT, functional outcome scores were consistently improved by the operation, and no perioperative complications were reported. Half of the patients in this series underwent concomitant operations, primarily for chondral defects of the femoral condyles. The reoperation rate was 22%, although most of these were for the associated chondral disease. The meniscal reoperation rate was 6%, and no revisions were required.

Although the preoperative physeal status could not be determined for all patients in this cohort, 11 were known to have open or at least closing physes at the time of MAT. The importance of protecting the proximal tibial physis in this adolescent population that is nearing skeletal maturity is unknown. For this reason, we prefer the bridge-in-slot technique as previously described.[12] The bone slot is entirely contained within the proximal tibial epiphysis. In contrast, the use of a bone plug technique requires drilling of 2 tunnels in the proximal tibia that would cross the physis.[11] Unfortunately, this study was not designed or powered to comment on the effects of MAT on limb length or angular alignment. Another potential technical issue is the availability of appropriately sized grafts for adolescents. It has been shown that MAT size can be predicted based on height, weight, and gender.[10] Therefore many adolescent patients, in particular young female patients, require small grafts that may not be readily available in tissue banks.

The meniscal retear rate in this series was nearly identical to that reported in adults. A recent systematic review reported a 6.3% allograft retear rate in adults,[5] as compared with a 6% retear rate seen in our cohort. Given this low incidence of graft tearing, as well as the fact that no patients required a revision, we are confident that the increased activity level in youngsters is not a contraindication to MAT. However, there is still considerable debate about what degree of activity and sports should be allowed after MAT. Several of our young athletes have returned to recreational or competitive athletics, without any apparent effect on the failure rate. Overall, we believe that the risk of progressive chondral damage with nonsurgical treatment of the meniscus-deficient knee far exceeds the risk of MAT failure, because 100% of our patients have retained their MAT at a mean 7-year follow-up. In addition, consistent improvements in functional outcome scores, activity levels, and quality of life were found in this cohort, as has been well documented in the adult literature.[5] These improvements provide further justification for considering MAT in the adolescent athlete with symptomatic meniscal deficiency.

An important finding is that 47% of adolescent patients undergoing MAT require concomitant procedures, the majority of which are for cartilage restoration. Fortunately, the clinical outcomes and survival of MAT in isolation and MAT combined with cartilage procedures are similar.[5] Nonetheless, the fact that half of adolescent patients with post-meniscectomy syndrome have surgical chondral defects emphasizes the importance of preventing meniscal deficiency. Indeed, the long-term outcomes of chondral defects in children and adolescents are largely unknown. Two studies have reported an 88% to 96% rate of good or excellent outcomes with autologous chondrocyte implantation in children at 2- to 5-year follow-up; however, long-term data are unavailable.[13,14] In addition, only 60% of pediatric patients undergoing autologous chondrocyte implantation will return to their previous level of sports participation.[13] Finally, salvage surgical options such as partial or total joint replacement are unattractive and best avoided in this population.[14] An interesting question for future research is whether MAT

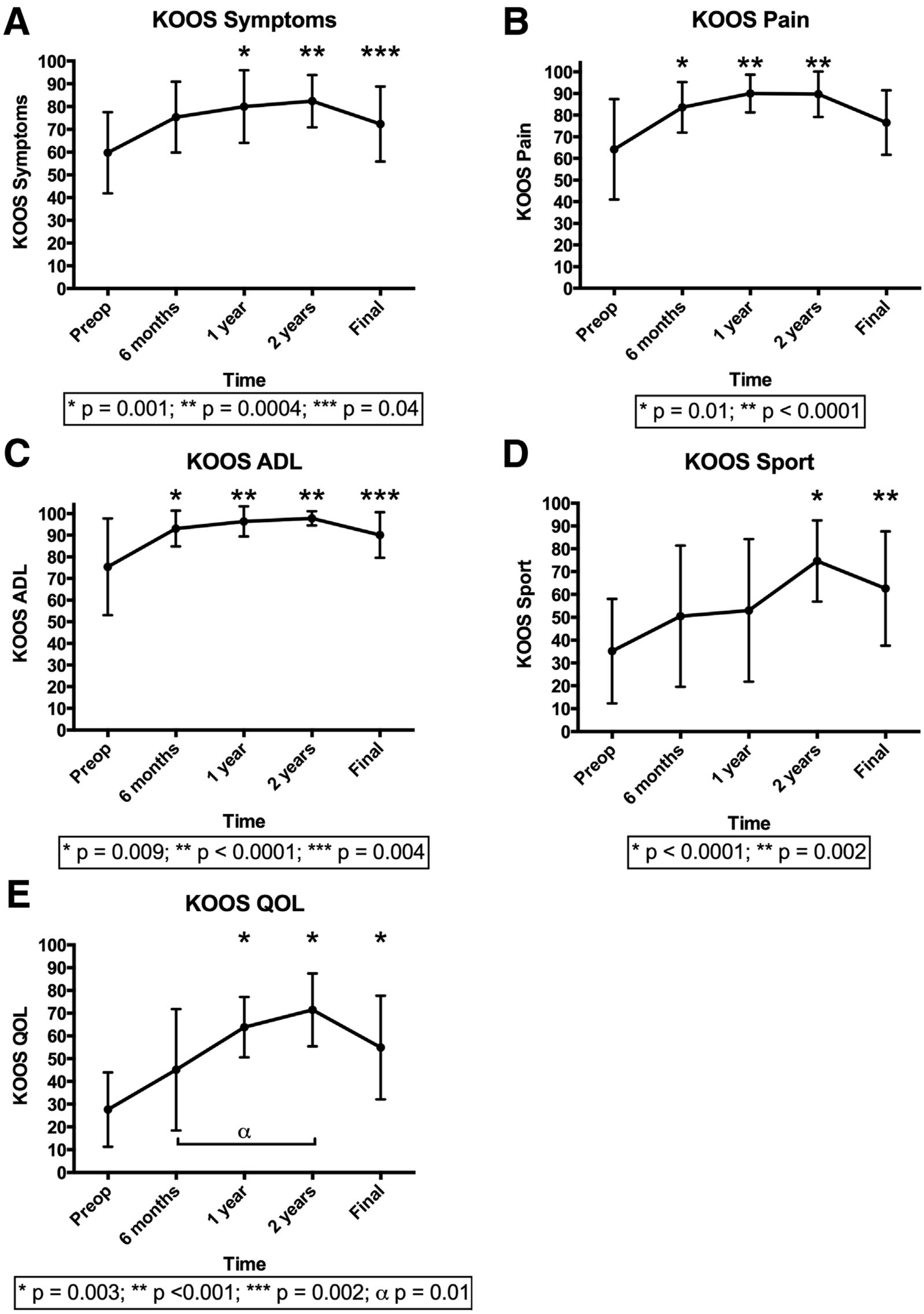

Fig 2. Knee Injury and Osteoarthritis Outcome Score (KOOS) for (A) symptoms, (B) pain, (C) activities of daily living (ADL), (D) sports, and (E) quality of life (QOL). Preoperative (Preop) and postoperative scores are reported as means with standard deviations (error bars). One or multiple asterisks confer a statistically significant difference as compared with the preoperative mean, whereas α confers a statistically significant difference between the time points indicated. Statistical significance was set at $P < .05$.

alters the natural history of chondral disease in this young, meniscus-deficient population. Even in adults, the chondroprotective ability of MAT is still debated, because results in the literature are inconsistent.[5] As a result, we routinely counsel our patients that MAT should be performed to treat symptoms in the "here and now" rather than be viewed as a prophylactic procedure against future osteoarthritis.

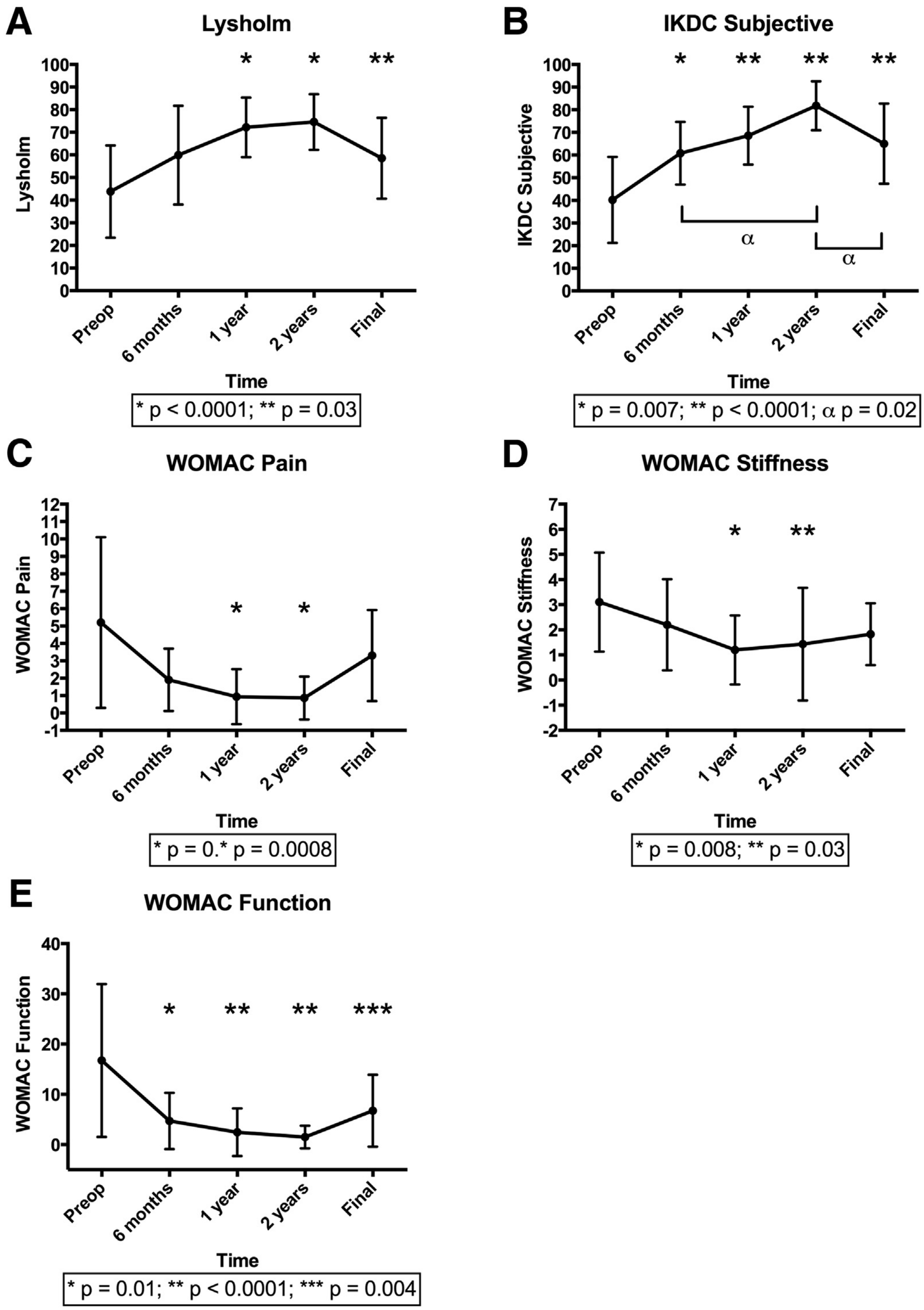

Fig 3. (A) Lysholm, (B) International Knee Documentation Committee (IKDC) subjective, and (C-E) Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Preoperative (Preop) and postoperative scores are reported as means with standard deviations (error bars). One or multiple asterisks confer a statistically significant difference as compared with the preoperative mean, whereas α confers a statistically significant difference between the time points indicated. Statistical significance was set at $P < .05$.

Limitations

This study has several limitations. The small number of patients makes it impossible to correlate demographic factors such as age, body mass index, previous surgery, and graft location with survival and outcomes. In addition, over half of the patients required concomitant procedures that may have confounded the results. However, this is consistent with all other MAT cohorts described in the literature.[5,15] There is certainly a potential for detection bias in our study because patients with poor outcomes may have sought care at another institution without our knowledge, which would lead to an underestimation of failure rates. One must also consider the possibility of performance bias because a high-volume surgeon with extensive experience in meniscal transplantation performed all procedures in

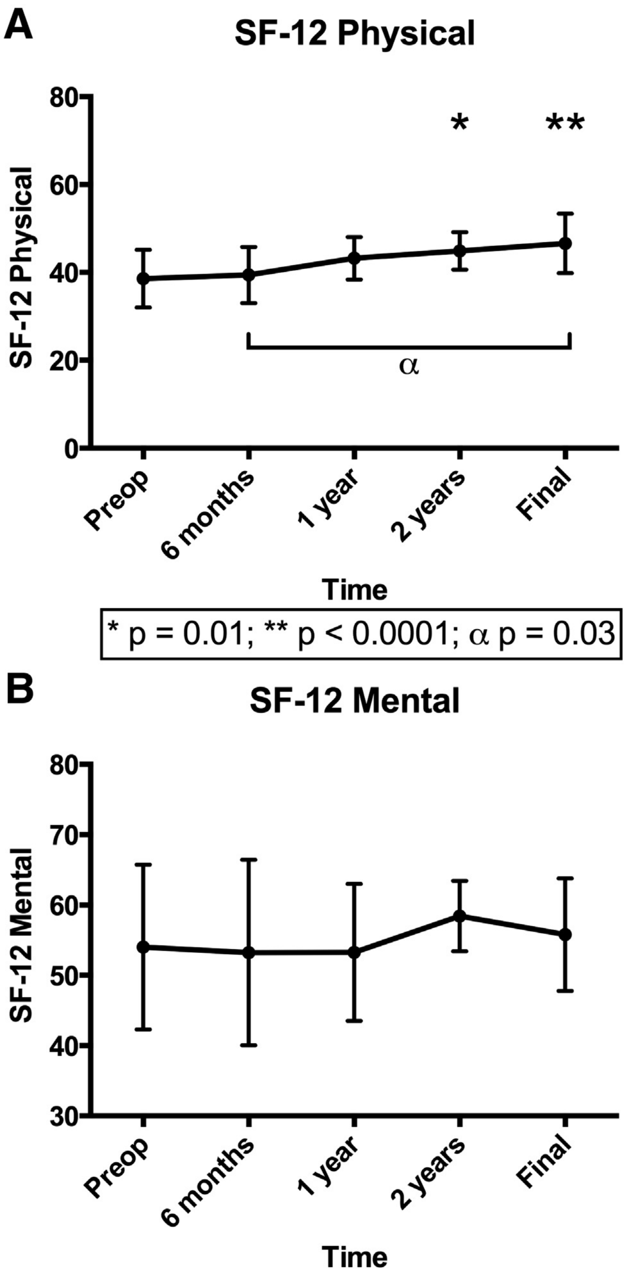

Fig 4. Short Form 12 (SF-12) (A) physical and (B) mental scores. Preoperative (Preop) and postoperative scores are reported as means with standard deviations (error bars). One or multiple asterisks confer a statistically significant difference as compared with the preoperative mean, whereas α confers a statistically significant difference between the time points indicated. Statistical significance was set at $P < .05$.

this study. Finally, the preoperative radiographs of patients in this cohort were not consistently available, largely because of the high proportion of patients coming to our tertiary facility with outside imaging scans. As a result, the effect of limb alignment on outcomes is unknown, and conclusions about the physeal safety of MAT cannot be drawn because the preoperative physeal status of several patients was unknown.

Conclusions

MAT resulted in predictable improvements in functional outcomes in the adolescent population. The meniscal reoperation rate was low (6%), no revision MAT procedures were required, and no growth complications were reported. Chondral disease remains the primary reason for reoperation after MAT.

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Appendix Table 1. Functional Outcome Data

	Preoperative	6 mo	1 yr	2 yr	Final
KOOS pain					
n	28	10	15	14	23
Mean	64.19	83.61	90.00	89.68	76.57
SD	23.20	11.67	8.71	10.47	14.91
Minimum	19.44	61.11	72.22	63.89	50.00
Maximum	97.22	97.22	100.00	100.00	97.22
KOOS symptoms					
n	29	10	15	14	23
Mean	59.73	75.36	80.00	82.40	72.36
SD	17.83	15.56	15.96	11.51	16.48
Minimum	21.43	53.57	53.57	60.71	35.71
Maximum	100.00	92.86	96.43	92.86	100.00
KOOS ADL					
n	27	10	15	14	23
Mean	75.38	93.09	96.37	97.79	90.09
SD	22.35	8.23	6.96	3.30	10.53
Minimum	7.35	72.06	73.53	89.71	61.76
Maximum	100.00	100.00	100.00	100.00	100.00
KOOS sports					
n	27	10	15	14	23
Mean	35.19	50.50	53.00	74.64	62.61
SD	22.89	30.95	31.21	17.81	25.04
Minimum	0.00	15.00	0.00	45.00	20.00
Maximum	80.00	100.00	100.00	100.00	95.00
KOOS QOL					
n	27	9	14	14	23
Mean	26.62	45.14	63.84	71.43	54.89
SD	16.86	26.66	13.24	16.02	22.77
Minimum	0.00	6.25	31.25	37.50	12.50
Maximum	68.75	87.50	81.25	100.00	100.00
Lysholm					
n	30	10	15	14	23
Mean	43.80	59.90	72.20	74.57	58.52
SD	20.37	21.87	13.18	12.31	17.92
Minimum	2.00	30.00	40.00	52.00	32.00
Maximum	89.00	84.00	90.00	90.00	86.00
IKDC					
n	27	10	15	14	23
Mean	40.19	60.80	68.58	81.77	65.02
SD	18.98	13.85	12.79	10.81	17.70
Minimum	8.05	37.93	41.38	62.07	35.63
Maximum	75.86	80.46	86.21	94.25	91.95
WOMAC pain					
n	30	10	15	14	23
Mean	5.20	1.90	0.93	0.86	3.30
SD	4.91	1.79	1.58	1.23	2.62
Minimum	0.00	0.00	0.00	0.00	0.00
Maximum	19.00	6.00	6.00	4.00	9.00
WOMAC stiffness					
n	29	10	15	14	23
Mean	3.10	2.20	1.20	1.43	1.83
SD	1.97	1.81	1.37	2.24	1.23
Minimum	0.00	0.00	0.00	0.00	0.00
Maximum	7.00	5.00	4.00	8.00	4.00
WOMAC function					
n	27	10	15	14	23
Mean	16.74	4.70	2.47	1.50	6.74
SD	15.20	5.60	4.73	2.24	7.16
Minimum	0.00	0.00	0.00	0.00	0.00
Maximum	63.00	19.00	18.00	7.00	26.00

(continued)

Appendix Table 1. Continued

	Preoperative	6 mo	1 yr	2 yr	Final
SF-12 physical					
n	29	9	15	14	23
Mean	38.56	39.41	43.21	44.89	46.59
SD	6.58	6.39	4.84	4.28	6.77
Minimum	26.60	30.94	34.09	31.32	31.32
Maximum	54.08	51.10	49.28	48.83	57.52
SF-12 mental					
n	28	9	15	14	23
Mean	54.00	53.22	53.26	58.43	55.79
SD	11.72	13.18	9.74	5.01	8.01
Minimum	23.16	25.45	29.43	42.45	35.28
Maximum	70.72	65.28	62.52	63.03	66.54

ADL, activities of daily living; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life; SF-12, Short Form 12; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.