Friday March 10, 2023
12:30 PM – 2:30 PM Pacific Time

2023

Meniscus Transplantation Study Group Meeting

Virtual Attendance:

Zoom Meeting ID:

824 2190 1204

Zoom Passcode:

443023

2023 Meeting Agenda

12:30 **Welcome**
Kevin R. Stone, MD – Chairman, MTSG

12:35 **Introduction**
Stefano Zaffagnini, MD – Program Chair, MTSG Annual Meeting 2023

Presentations *Moderated by Stefano Zaffagnini, MD*

12:40 **Predictors of Long-Term Patient-Reported Outcome Measures (PROMs) After Collagen Meniscus Implant (CMI) for Partial Meniscus Defects**
Stefano Zaffagnini, MD

12:50 **Temporal and Sex-Dependent Effect of Short-term Simulated Microgravity on Human Meniscus Tissue Model**
Zhiyao Ma, PhD

1:00 **All-Soft-Tissue Meniscus Allograft Transplantation with Circumferential Suture Tape to Mitigate Hoop Stress: A Novel Technique**
Jarod Richards, MD

1:10 **Meniscus Allograft Transplantation Delays Arthroplasty in Patients Over 50 Years of Age**
Kevin R. Stone, MD

1:20 **MRI Evaluation of Meniscus Allograft Transplantation Patients at a Minimum Two Year Follow Up**
Natasha Honda, MD

1:30 **First Clinical Results with the Second Version of the Artificial Meniscus Prosthesis**
Tony van Tienen, MD

1:40 **Midterm Outcomes of Meniscal Allograft Transplantation in the Adolescent Population**
Joshua Kaiser, BS

1:50 **A Systematic Review of Preoperative Risk Factors for Meniscal Allograft Transplantation Failure**
Adam B. Yanke, MD PhD

2:00 **No Clinical Differences Between Isolated Meniscal Transplantation and Combined Meniscal Transplantation and Anterior Cruciate Ligament Reconstruction**
Michael Hantes, MD

2:10 **Minimum 10-Year Clinical Outcomes and Survivorship of Meniscal Allograft Transplantation with Bone Fixation**
Kyle Wagner, BS

2:20 **Discussion**
Refer to the suggested topics for group discussion

2:30 **Close**

1 Industry

- Turner Imaging Systems Smart-C® Viewing Booth and Demo

Suggested Topics for Discussion

Moderators: Kevin R. Stone, MD & Stefano Zaffagnini, MD

- Biologics for MAT
- Imaging of MAT
- Tissue processing and preparation of MAT
- Preventing MAT extrusion
- Prophylactic MAT
- Return to play after MAT
- MAT + concomitant procedures (cartilage + MAT, ligament + MAT, multiple MATs, osteotomy)

Predictors of Long-Term Patient-Reported Outcome Measures (PROMs) After Collagen Meniscus Implant (CMI) for Partial Meniscus Defects.

Grassi Alberto, Lucidi Gian Andrea, Di Paolo Stefano, Pierangeli Andrea, Agostinone Piero, Dal Fabbro Giacomo, Pizza Nicola, Zaffagnini Stefano (PRESENTER)*

Clinica Ortopedica e Traumatologica II, IRCCS Istituto Ortopedico Rizzoli, Bologna, Italy

Background: Collagen Meniscus Implant (CMI) is considered an effective procedure for reducing knee pain and improving knee function after previous meniscectomy. Nevertheless, the current knowledge regarding long-term patient reported outcomes measures (PROMS) after CMI is limited. The goal of the present study was to evaluate clinical outcomes, reoperations, and failures of CMI at a minimum 10 years of follow-up.

Methods: Consecutive patients who underwent CMI at a single institution were screened for elegibility. Inclusion criteria for the present study were (1) Medial or Lateral CMI, (2) Isolated or combined procedure with ACL reconstruction, knee osteotomy or cartilage treatment, (3) follow-up between 10 and 15 years. Demographics and surgical details were obtained via chart review. Patients were asked if they were satisfied with the procedure and were evaluated with the Lysholm score, Knee injury and Osteoarthritis Outcome Score (KOOS), visual analog scale (VAS) for pain, and Tegner score at the final follow-up. Survival analysis was performed with Kaplan-Meier curve, and clinical scores were analyzed based on the Patient Acceptable Symptom State (PASS).

Results: A total of 92 patients (mean age, 42.8 years) were included in the analysis. A significant improvement in all the clinical scores was reported between the preoperative evaluation and the last follow-up. A chondropaty with outerbridge grade ≥III was associated with significantly overall lower clinical score, while a timing from meniscectomy to CMI to ≥5 years determined more pain at rest and reduced quality of life in the KOOS subscale.
Overall, 25% of patients did not achieved the PASS for Lysholm score and a percentage variable from 19% (KOOS Pain) and 40% (KOOS Symptoms) did not achieved the PASS in the KOOS subscales. Chondropaty with outerbridge grade ≥III was associated with an higher risk for not achieving the PASS in all the KOOS subscales, while an age at surgery ≥45 years was resulted in a lower risk of not achieving PASS in the pain subscale.
At the last follow-up 63% of patients returned to sport practice after CMI, with 41% at the same or higher level. Finally, 80% of the patients were satisfied with the procedure.

Conclusion: Up to 10 years after surgery, around 70% of the patients who underwent CMI reported satisfactory clinical results, with clinical scores still higher compared to the preoperative evaluation. In addition, the cartilage status and the time from meniscectomy have been shown to impact negatively on the outcomes, while an age >45 years was associated with less pain. There was no clinical difference between patients who underwent isolated CMI or combined procedures, and this further demonstrated the effect of the CMI as a standalone procedure.

Temporal and Sex-Dependent Effect of Short-term Simulated Microgravity on Human Meniscus Tissue Model

Zhiyao Ma, PhD

Purpose: Osteoarthritis (OA) is a debilitating condition that affects millions of people globally, with knee osteoarthritis (KOA) being one of the most common forms. Despite extensive research, the underlying causes of KOA are still not fully understood, and its prevalence and severity are disproportionately higher in females. While hormones play a role, they do not account for the entire disproportion. The molecular mechanisms behind the development of KOA are complex and not yet fully understood. It has been observed that the cellular characteristics of articular chondrocytes within KOA joints resemble the enlarged chondrocytes during normal endochondral bone formation. The genes *COL10A1* and *MMP13*, as well as the WNT and NF-kappa B signaling pathways, have been found to be activated in chondrocytes in joints affected by KOA. Mechanical unloading of spaceflight microgravity has been shown to induce OA-like gene changes and cartilage breakdown in mouse knee joints, leading to the idea that mechanical unloading may play a role in the development of KOA. In fact, a study of ten healthy individuals without a history of KOA found that unloading their knee joints resulted in MRI parameters resembling KOA. To date, the effects of mechanical unloading on articular chondrocytes have been studied by simulated microgravity (SMG) in laboratory settings. Our previous research showed that SMG enhanced the expression of *COL10A1* and *MMP13* in human meniscus models developed from *in vitro* monolayer culture expanded human meniscus fibrochondrocytes (MFC) over several weeks in a sex-dependent manner. However, the short-term effects of SMG on the gene expression profile of similar models but developed from primary human MFC have not been explored. The aim of this study is to investigate the short-term, sex-dependent gene expression profile of human meniscus models developed from primary human MFC exposed to SMG. Understanding the molecular changes that occur in response to mechanical unloading may provide insights into the development and sex differences of KOA and inform potential therapeutic strategies.

Methods and Materials: Specimens of human meniscus were obtained from 5 male and 5 female donors undergoing partial meniscectomy who had no history of KOA. The primary MFC from each donor were isolated, recovered for 48 hours on human tissue extracellular matrix-coated plates, and then seeded in 3D porous type I collagen cylindrical scaffolds for 48 hours in a defined medium to allow cell attachment and initial matrix production. After the pre-culture period, the engineered models were divided into two groups and cultured under static gravity and SMG conditions for 7 days. The scaffolds were collected on day 0, 1, 3, and 7 and the expression levels of selected markers were determined using RT-qPCR and RNA sequencing.

Results: The transcriptomic profile of the engineered tissue models were assessed by RNA sequencing. For all donors combined, principal component analysis (PCA) showed a converging transcriptional trajectory for all donors over 7 days of SMG culture, with 1383 genes significantly regulated on day 7. Among all the significantly regulated genes, several key OA-related markers (*COL10A1*, *MMP13*, *SPP1*) were highly upregulated. Gene set enrichment analysis indicated that inflammation-related pathways (IL-17 signaling pathway and complement cascades) dominated the initial changes along the trajectory, whereas calcification-related pathways (calcium signaling pathway and mineral absorption pathway) and PPAR signaling pathway were heightened at later stages. Sex-related transcriptional differences were observed, with females and males responding differently to SMG at each RNA sequencing time point. Hub protein interaction networks were constructed from the up- and down-regulated gene panels for both sexes to establish mechanistic targets. For females, the hub components of upregulations on both day 3 and day 7 were mainly involved in Wnt signaling (*CTSK, IRAK1, JUN, PIK3R1, LEF1, MMP7, NFATC4, ROR2, WNT11*), VEGF signaling (*KDR, PIK3R1, SPHK1*), and NF-kappa B signaling pathways (*BIRC3, CXCL12, DDX58, GADD45A, IRAK1, RELB, TRAF1, TRAF5*). Whereas for males, the hub components of upregulations were ECM components and matrix remodeling enzymes.

Conclusion: The results of this study provide new insights into the molecular changes that occur in response to mechanical unloading and the sex differences in the development of KOA. Further understanding of these mechanisms may inform potential therapeutic strategies.

All-Soft-Tissue Meniscus Allograft Transplantation with Circumferential Suture Tape to Mitigate Hoop Stress: A Novel Technique

Jarod Richards, MD and David Caborn, MD

Meniscus allograft transplantation (MAT) is a technically challenging procedure. Bone plugs, slot techniques, and all-soft-tissue fixation techniques have been described in the past. Each technique comes with advantages and disadvantages. Native menisci have circumferential collagen fibers to help resist hoop stress during loading cycles. Although hoop stress resistance is a known function of the menisci, its recreation in MAT has only been targeted indirectly through anatomic root placement. The authors describe the use of a high tensile suture tape (i.e. InternalBrace™ construct) to directly mitigate hoop stresses by recreation of peripheral meniscus tensioning in MAT (Fig 1a-c). Posterior horn and posterior one-third junction fixation are achieved by drill tunnels with sutures tied over the anteromedial tibia. Alternatively, a TightRope™ suture button can be used for fixation at the anteromedial tibia (Fig. 1d). Anterior horn fixation can be achieved with a PEEK anchor or drill tunnel per surgeon preference. Inside-out sutures are placed in an anterior to posterior fashion between the three suture tape fixation sites. Note the internal brace construct can be independently tightened at its three fixation sites to achieve appropriate tension prior to final fixation.

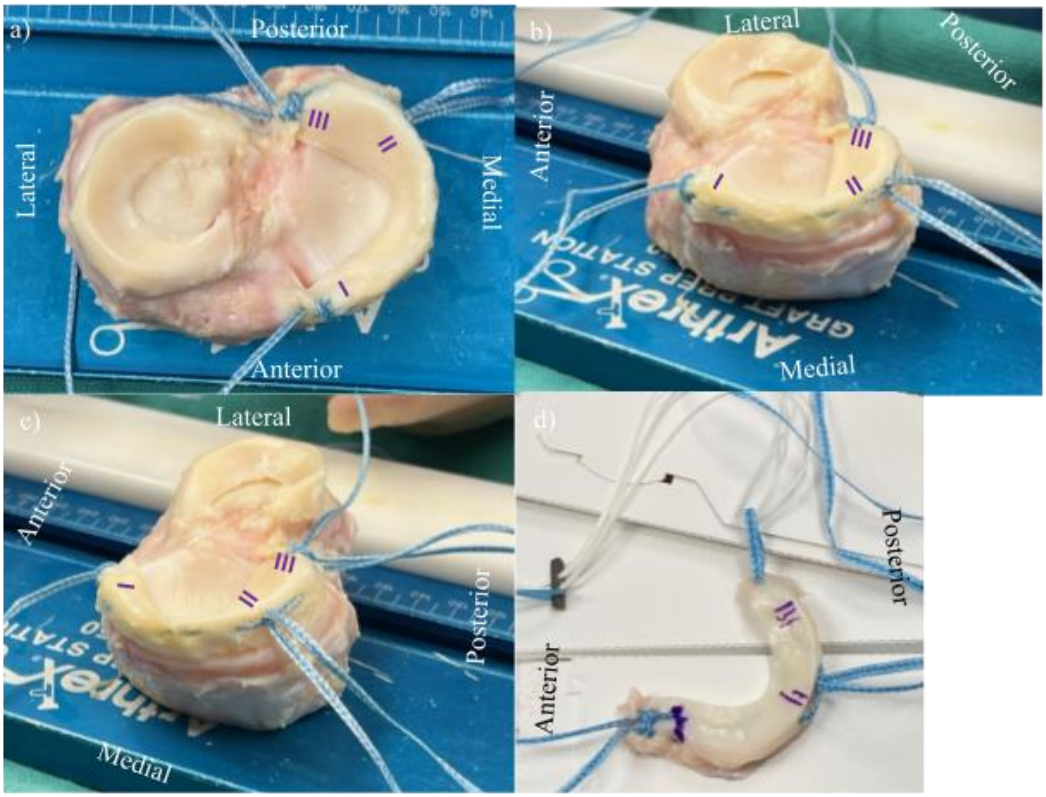

Figure 1a-c: Proximal tibia allograft with medial meniscal preparation prior to meniscal amputation from the graft. Three points of fixation coincide with a peripherally coursing InternalBrace™. The first suture tape is at the anterior horn with one exiting limb for fixation, the second at the posterior one-third junction of the meniscus with two exiting limbs for fixation, and the third at the posterior horn with three limbs exiting limbs for fixation. Note the second point of fixation with two exiting limbs of suture tape wrapped around the InternalBrace™ at the posterior one-third junction of the medial meniscus has the capacity for approximately 1.5 – 2 cm of translation for appropriate meniscal seating once inside the joint; **d:** Another meniscus allograft after removal from the proximal tibia. Note the TightRope™ suture button attached to the looped posterior horn suture line which also functions as a tensioning point for the InternalBrace™ and serves as an alternative for fixation per surgeon preference.

Meniscus Transplants Delay Arthroplasty in Patients Over 50 Years of Age

Kevin R. Stone MD[1,2], Ann W. Walgenbach RNFA[1,2], Shadera Slatter[2], Thomas. J. Turek[2], Caroline Ferguson-Dryden[2], Marie Dicker[2], Emma Miltenberger[2], Riley Horn[2], Haley Cowles[2], Vivian Liu[2], Stephanie Wu[2], Mani Vessal MA PhD[2]

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Background: Although progression from meniscus injury to knee arthroplasty is complex, a critical stage exists between 50 and 70 years of age. One topic of investigation often overlooked is the utility of meniscus allografts in combination with other arthroscopic procedures to delay knee arthroplasty for patients in this age range.

Purpose: To assess the ability of meniscus allografts in combination with other procedures to delay knee arthroplasty in patients older than 50 years of age.

Methods: 108 meniscus allograft transplants (MATs) using the arthroscopic three tunnel technique between 1997 and 2019 in patients over 50 years of age and told to have a knee arthroplasty were reviewed. Patient ages ranged from 50 to 69 years of age (mean 55.8). 86 of 108 (79%) patients met eligibility for this case series report. Inclusion criteria were patients told to consider a knee arthroplasty with pain in a meniscectomized compartment with preservation of some joint space by standing AP and PA flexion x-ray. Exclusion criteria was defined as failure to comply with rehabilitation protocol or failure to complete baseline and follow-up research questionnaires. 74 of 86 (86%) patients had Grade III or IV arthritis documented by Outerbridge findings on X-ray and direct observation. 44 of 86 (51%) patients underwent concomitant cartilage repair with the articular cartilage paste graft technique previously reported. International Knee Documentation Committee (IKDC) and Visual Analogue Pain Scale (VAS) were obtained longitudinally throughout the post-operative period. Time from meniscus transplantation to knee arthroplasty was measured with failure of the surgical procedure defined as progression to arthroplasty, no improvement in pain scores, or increased pain.

Results: Over the follow-up range of 2 to 25 years, 41 of 86 (47.6%) patients progressed to revision by arthroplasty, at a mean time of 8.5 years. 68 of 89 (76%) meniscus transplants in patients over 50 delayed joint arthroplasty by a minimum of 8.2 years (8.2-20.6). At the time of reporting, 41 of 86 (47.6%) patients had intact meniscus transplants. Significant improvements ($p<0.05$) were observed in both pain and function as assessed by VAS and IKDC. These significant improvements were sustained through ten years post-operatively, correlated to a mean age of 65.8 years of age.

Conclusions: Meniscus allografts in combination with other arthroscopic knee treatments delay knee arthroplasty, improve knee symptoms of pain and improve function in a population over 50 years who are otherwise candidates for knee arthroplasty. The individual contribution of the meniscus separate from the concomitant procedures cannot be defined.

Keywords: meniscus, allograft, meniscal transplant, cartilage, arthroplasty, arthritis, paste graft

First clinical results with the second version of the artificial meniscus prosthesis

Tony van Tienen[1] (presenting), KC Defoort[2], PJ Emans[3], Ewoud van Arkel[4], LM Jutten[3], PJC Heesterbeek[2]

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Introduction

Last year (MTSG Chicago 2022) we presented the clinical results of the first generation of the artificial meniscus prosthesis. This prosthesis had a stiff core and was fixated with screws and the polymer implant broke in 4 out of 5 patients within 6 months. This second version is much more flexible and is fixated with tape and should improve its survival. We hypothesized that the more flexible design would be more durable and lead to a faster recovery of the patients.

Patients & Methods

We received approval from the Dutch Ethic Review Board (ERB) for 10 patients (ClinicalTrials.gov NCT05297175). We selected 10 patients with medial compartment post-meniscectomy pain syndrome, neutral leg alignment, and a stable joint in the age group between 18 and 70 years. The fixation tapes on the meniscus horns were pulled through two drill tunnels to the anatomical position of the anterior and posterior meniscus horns and the tapes were fixated with two interference screws. The patients had to walk on crutches with partial weight bearing for 4 weeks.

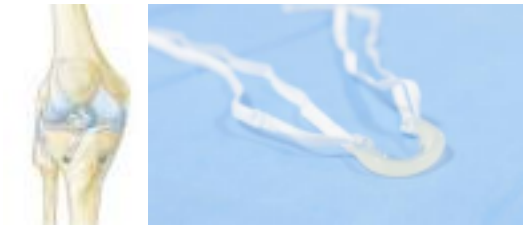

Figure 1: artificial meniscus prosthesis

Results

In 2022 10 patients received the medial artificial meniscus prosthesis. The majority has reached the 6 months follow-up. No broken polymer implants so far. They regained full range of motion within 6 weeks. The average KOOS scores significantly improved in all different subscales except for symptoms which remained on the same level. We had to remove one prosthesis because the posterior horn tape failed due to rubbing against the femoral condyle. The drill hole location on the tibia was too close to the medial compartment cartilage. In another one the drill hole was too far anteriorly which led to anterior dislocation of the implant.

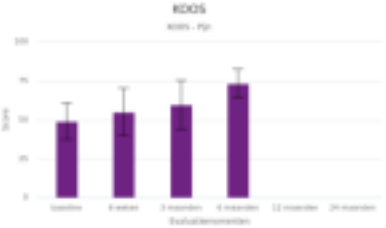

Figure 2: KOOS pain scores

Discussion

Although the follow-up of the study is short (<6 months) the meniscus prosthesis design change seems a real improvement in the early phases after the surgery. The post-op recovery of the patients was much faster, the effusion disappeared shortly after surgery and the scores significantly improved. The two failures occurred due to inaccurate location of the posterior drill hole. Contact between the fixation tape and condyle should be avoided and the posterior horn should be fixation maximal posterior to avoid anterior dislocation of the prosthesis. We changed to a different aiming device to be able to reach a more posterior and lateral drill hole outlet on the tibia plateau.

Conclusion

The design changes to a more flexible meniscus prosthesis seem to affect the durability and to improve the recovery of the patients on the shorter term.

A Systematic Review of Preoperative Risk Factors for Meniscal Allograft Transplantation Failure

Zachary Wang BS[1], Kevin Credille BSE MS[1], Hasani Swindell MD[1], Mohamad Alzein BS[1], Azad Darbandi BS[1], Johnathon R. McCormick MD[1], Dhanur Damodar MD[1], Brian J. Cole MD MBA[1], Adam B. Yanke MD PhD[1] (Presenting)

1. Rush University Medical Center, Chicago IL 60612

Introduction: The aim of this systematic review is to further identify significant factors for both surgical and clinical failure of meniscal allograft transplantation.

Methods: PRISMA guidelines were used to conduct a systematic review of scientific literature via Covidence. Twenty-one full-text studies met the following inclusion criteria: (1) clinical studies involving meniscal allograft transplantation (MAT), (2) reported clinical outcome data including failure rates defined by clinical failure (Lysholm score ≤ 65) or surgical failure (revision, removal, or conversion to knee arthroplasty), and (3) studies assessing pre-operative risk factors for failure.

Results: Overall, 2503 patients were included, and 16 risk factors were evaluated. Follow-up ranged from 1 year to 24 years, and the weighted failure rate was 23.9% with a range of 3.0% to 84.9%. For surgical failure **(Table 1),** the presence of high-grade cartilage defects (71.4%, 5/7 studies) was the only risk factor found predictive of MAT failure in the majority of studies. Four of the five studies that found high grade lesions significant did not feature treatment of all high-grade cartilage lesions. Additionally, the two studies not finding cartilage status significant treated all full thickness defects at the time of MAT. For clinical failure (**Table 2**), there were no risk factors found predictive of MAT failure in the majority of studies. Smoking, concomitant ligament procedures, and concomitant osteotomy procedures were found significant in only one study each. Risk factors studied in at least three studies that were not found significant include age, sex, BMI, and cartilage status.

Conclusion: The presence of untreated high-grade cartilage defects at the time of surgery significantly increases the likelihood of surgical failure after initial MAT. However, there appears to be evidence that concomitant treatment of higher-grade defects mitigates their negative effect on prognosis. There is no clear risk factor that predicts clinical failure with regard to patient reported outcomes.

Table 1. Risk Factors Associated with Meniscal Allograft Transplant Surgical Failure

	Age	Sex	Compartment	Treated and Untreated Full Thickness Lesion (Cartilage Status)	BMI	Concomitant Cartilage Debridement	Concomitant High Tibial Osteotomy	Concomitant Ligament Procedure	Time From Prior Meniscectomy	Femorotibial Alignment	Laterality (Limb)	Smoking Status	Tibial Chondral Defect Grade	# of Prior Surgeries to Index Transplant	Subchondral Bone Marrow Lesion Grade	Time From Injury to Surgery	N
Van Der Straeten 2016[7]		■		Untreated		■		■				■					329
Waterman 2016[2]	■	■	■			■	■	■			■	■					230
Lee 2017[3]	■	■	■	Untreated	■					■	■						222
Park 2019[4]	■	■			■	■				■	■						28
Parkinson 2016[5]	■	■		Untreated						■							125
Mahmood 2018[6]	■	■		Untreated							■						45
Song 2020[1] **	■	■			■					■							264
Mccormick 2014[8]	■	■	■		■												200
Van der Wal 2020[9]		■	■					■									90
Stone 2015[10]	■		■			■									■	■	49
Searle 2020[11]	■	■		Treated							■						43
Bloch 2019[12]				Untreated			■	■									240
Zaffagnini 2016[13]	■		■		■												147
Kazi 2015[14]						■	■			■							84
Stone 2006[15]							■	■							■		47
Saltzman 2018 (1)[16]				Treated		■											91
Carter 2020[17]																	48
Grassi 2020[18]																	46
Saltzman 2018 (2)[19]															■		40
Jimenez-Garrido 2019[20]					■												35
	3/13 23.1%	0/12 00.0%	2/8 25.0%	5/7 71.4%	0/7 00.0%	0/6 00.0%	1/5 20.0%	0/5 00.0%	0/4 00.0%	0/3 00.0%	0/3 00.0%	0/2 00.0%	1/1 100.0%	1/1 100.0%	0/1 00.0%	0/1 00.0%	

** Definition of failure: meniscectomy of more than half of the allograft, meniscectomy to the zone of meniscocapsular junction, Lysholm score < 65, conversion to revision MAT, realignment osteotomy, or arthroplasty.

Table 1. Risk Factors Associated with Meniscal Allograft Transplant Surgical Failure

Table 2. Risk Factors Associated with Meniscal Allograft Transplant Clinical Based Failure

	Age	BMI	Sex	Treated and Untreated Full Thickness Cartilage Lesion (Cartilage Status)	Compartment	Time From Prior Meniscectomy	Femorotibial Alignment	Laterality (Limb)	Smoking Status	Concomitant Ligament Procedure	Concomitant High Tibial Osteotomy	Concomitant Cartilage Debridement	Concomitant Cartilage Debridement	N
Waterman 2016[2]	■		■		■			■				■	■	230
Lee 2017[3]		■	■	Untreated	■	■	■							222
Song 2020[1] **	■	■	■			■								264
Searle 2020[11]	■		■	Treated				■						43
Zaffagnini 2016[13]	■	■			■									140
Verdonk 2005[21]				Treated		■								100
Jimenez-Garrido 2019[20]														35
	1/5 20.0%	1/4 25.0%	0/4 00.0%	0/3 00.0%	0/3 00.0%	0/2 00.0%	0/2 00.0%	0/2 00.0%	1/1 100.0%	1/1 100.0%	1/1 100.0%	0/1 00.0%	0/1 00.0%	

** Definition of failure: meniscectomy of more than half of the allograft, meniscectomy to the zone of meniscocapsular junction, Lysholm score < 65, conversion to revision MAT, realignment osteotomy, or arthroplasty.

Table 2. Risk Factors Associated with Meniscal Allograft Transplant Clinical Failure

	Cartilage Status Found as Significant Predictor of MAT Failure	Overall Cartilage Treatment Rate (including low grade lesions)	High Grade/Full Thickness Lesion Treatment Rate
Bloch 2019[12]	ICRS 3b (full thickness)	N/A (unknown/240)	100%
Parkinson 2016[5]	ICRS 3b (full thickness) of both tibial and femoral surfaces	30.40% (38/125)	70% (38/54)
Van Der Straeten 2016[7]	Outerbridge Classification 3-4	18.18% (52/286)	40%** (52/130)
Lee 2017[3]	ICRS 3b (full thickness) of both tibial and femoral surfaces	11.71% (26/222)	19% (26/135)
Mahmood 2018[6]	Outerbridge Classification 3-4	6.67% (3/45)	10%** (3/31)
Saltzman 2018 (1)[16]	None	75.82% (69/91)	100%
Searle 2020[11]	None	20.93% (9/43)	100%

**These studies did not specify the number of cartilage procedures used for different cartilage grades (high grade versus low grade) and a conservative calculation was used to assume all treatments were for higher grade lesions. Therefore, the rates are potentially lower than reported.

Table 3. Sub-analysis on Concomitant Cartilage Treatment Rate with MAT

Title: Midterm Outcomes of Meniscal Allograft Transplantation in the Adolescent Population

Authors: Ryan A. Quigley MD, Joshua T. Kaiser BS, Kyle R. Wagner BS, Landon P. Frazier BS, Mario Hevesi MD PhD, Dhanur Damodar MD, Zachary D. Meeker BS, Eric J. Cotter MD, Adam B. Yanke MD PhD, Brian J. Cole MD MBA

Presenting Author: Joshua T. Kaiser BS

Purpose: To report midterm outcomes following primary meniscal allograft transplantation (MAT) with fresh-frozen allografts implanted with the bone-in-slot technique in the adolescent patient population.

Methods: Adolescent patients <18 years old at the time of primary MAT from 1999-2016 were retrospectively identified. International Knee Documentation Committee (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales, and Lysholm scores were collected preoperatively and at 1-year, 2-years, and a minimum of 5-years follow-up. Meniscus reoperation and revision rates were determined.

Results: Forty-four (female n=33; male n=11) of 62 identified patients met inclusion criteria and were followed for a mean of 9.5 ± 3.8 years (range: 5.0-17.7). Isolated MAT was performed in 27 (61%) patients. Common concomitant procedures included osteochondral allograft transplantation (OCA) (32%), autologous chondrocyte implantation (ACI) (18%), and anterior cruciate ligament reconstruction (ACLR) (14%). Eleven patients (25%) underwent reoperation at an average of 5.9 ± 4.5 years (range: 0.8 – 14.0) following MAT. Three (7%) patients met criteria for failure, requiring revision MAT an average of 3.8 ± 1.1 years (range: 2.8-4.9) post-transplant. Overall survival free from failure at 1, 2, 5, and 10 years was 100%, 100%, 93%, and 93%, respectively. When compared to preoperative scores, significant increases in Lysholm, IKDC, and KOOS subscales were observed at 1-year, 2-year, and most recent follow-up ($p < .05$). At the time of final follow-up, 90% of patients reported satisfaction with their current physical status.

Conclusion: Primary MAT in adolescent patients resulted in significant and durable functional improvements at mid- to long-term follow-up. At an average of 9.5 years postoperatively, meniscal reoperation rate was 25% while graft survival free of revision MAT was 93%. Adolescents undergoing MAT demonstrated similar functional outcomes and graft survivability when compared to available adult MAT literature.

Title: Minimum 10-Year Clinical Outcomes and Survivorship of Meniscal Allograft Transplantation with Bone Fixation

Authors: Kyle R. Wagner BS, Joshua T. Kaiser BS, Mario Hevesi MD PhD, Eric J Cotter MD, Ron Gilat MD, Zach D. Meeker BS, Landon P. Frazier BS, Ryan A. Quigley MD, Adam B. Yanke MD PhD, and Brian J. Cole MD MBA.

Presenting Author: Kyle R. Wagner BS

Purpose: The purpose of this study was to report on clinical outcomes and survivorship following primary meniscal allograft transplantation with fresh-frozen
allografts implanted with the bone-in-slot
technique in a large cohort of patients with 10-year minimum follow-up.

Methods: A retrospective review of prospectively collected data was performed to identify patients undergoing primary MAT from 1999-2012. Lysholm, International Knee Documentation Committee (IKDC), and Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales were collected preoperatively and at 1-, 2-, 5-, and minimum 10-year follow-up. Cox proportional hazards modelling was utilized to identify variables associated with reoperation and failure. Failure was defined as revision MAT or conversion to unicompartmental or total knee arthroplasty (UKA and TKA, respectively).

Results: A total of 143 patients undergoing primary MAT met inclusion criteria and were followed for a mean of 12.8 ± 2.7 years (range: 10.0 - 21.0). Concomitant procedures were performed in 96 (67%) patients. Patients demonstrated statistically significant ($p \leq .037$) postoperative improvements in all patient-reported outcome measures at all time points, compared to baseline. Fifty-four patients (38%) underwent a meniscal reoperation at a mean time of 6.5 ± 5.4 years (range: 0.3 – 16.7) postoperatively. Thirty-five (24%) patients met criteria for failure at a mean time of 7.2 ± 4.9 years following MAT (range: 1.0 - 16.5). Twelve (8%) patients underwent revision MAT and 23 (16%) underwent conversion to arthroplasty. MAT survival free of meniscal reoperation and failure was 73% and 83% at 10 years and 58% and 69% at 15-years, respectively (Figure 1). At final follow-up, 88% of patients reported being satisfied with their overall postoperative condition.

Conclusion: Primary MAT demonstrates efficacy and durability with high rates of patient satisfaction at minimum 10-year follow-up. Reoperation rates may approach 42% at 15 years, overall revision rates (8%) and conversion to arthroplasty (16%) remain low at long-term follow-up.

Title: No clinical differences between isolated meniscal transplantation and combined meniscal transplantation and anterior cruciate ligament reconstruction

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Introduction: Menisci have been found to play an essential role in load sharing, shock absorption and joint stability in the knee joint [1]. Loss of the meniscus, in part or in total, significantly alters joint function and predisposes the articular cartilage to degenerative changes and progression of symptomatic osteoarthritis [2]. Their role becomes more vital in the anterior cruciate ligament (ACL) deficient knee. Meniscal allograft transplantation (MAT) is an indicated option for relatively young and active patients when all or nearly all of the native meniscus has been removed [3].Although the effectiveness of the procedure has been already established, it is unclear whether isolated meniscal allograft transplantation (MAT) procedures lead to better clinical outcomes than MAT and additional ACL reconstruction.

Methods: In total, 20 patients that were treated with a MAT procedure using a soft tissue fixation technique from 2015to 2020 were retrospectively analysed. Patients were allocated in 2 groups, the isolated MAT group (group 1) or the MAT plus (additional) ACL reconstruction group (group 2) according to the procedures they underwent. Both groups were assessed clinically and also with the following patient reported outcome measures (PROMs): the KOOS, the IKDC, the Tegner Activity Scale (difference before injury and in latest follow up - TASd) and the Lysholm Score. The health related quality of life of the patients was evaluated with the EQ-5D-5L questionnaire. A comparison between the clinical outcomes of medial versus lateral MAT was also performed.

Results: Mean follow-up was 3.2 years. Mean age of patients at surgery was 29 years. 12 patients were treated with isolated MAT and 8 patients were treated with MAT and additional ACL reconstruction. All patients had previously undergone a total or subtotal meniscectomy. Twelve medial and eight lateral MAT procedures were performed. Graft survival was 100% and re-operation rate was 0%. For group 1 and 2 mean scores in PROMs were respectively 73%(SD ±13) and 68% (SD ±17) for KOOS, 61,62% (SD ±12) and 65% (SD ±23) for IKDC, 83% (SD ±9) and 84% (SD±9) for Lysholm score, 2 (SD ±1,04) and 2,99 (SD ±0,43) for TASd and finally 72,4% (SD ±13) versus 73% (SD ±22)for EQ-5D-5L. During statistical analysis no significantly important difference was found between the two groups regarding PROMs. Regarding the comparison between patients that underwent medial (n=12) or lateral (n=8) MAT, a statistically significant difference was found only for KOOS (p=0.017) with mean scores 65% (SD ±14) for medial meniscus and 79% (SD ±11) for lateral meniscus.

Conclusion: MAT is an effective procedure either as an isolated procedure or in combination with ACL reconstruction. In cases of combined MAT and ACL reconstruction patients can benefit with one stage operation and avoid multiple surgical procedures that can lead to extended rehabilitation and prolonged time to return to normal activities and sports. Our study was tied in with current literature regarding the effectiveness of MAT procedure between medial and lateral meniscus with better KOOS score for lateral MAT.