



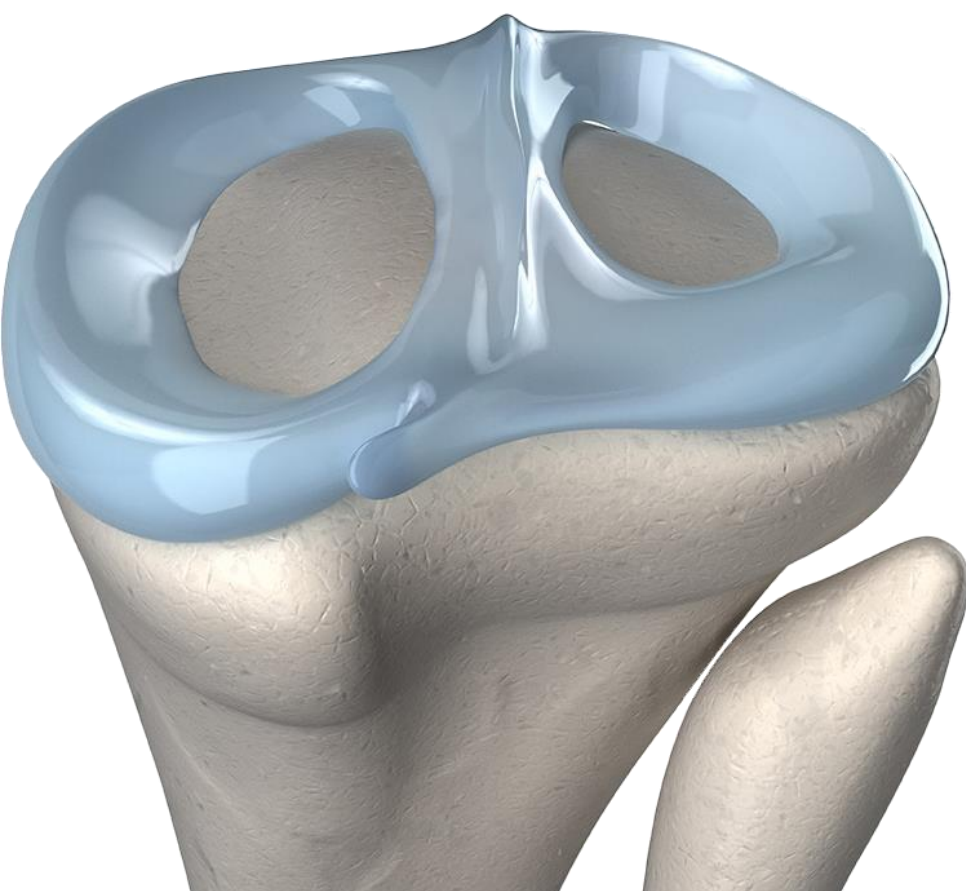
ICRS Summit Porto 2026

Thursday, October 8th, 2026

11:00am - 12:30pm PM GMT+1/West

Meniscus Transplantation Study Group Meeting

Sharing the Science and Practice of Meniscus Replacement



Location:

**Pestana Douro Riverside
Congress Center**

Douro V

**Avenida Escritor Costa
Barreto, 60**

4420-445 Porto, Portugal

Virtual Location:

Zoom Meeting ID: **872 9005
6233**

Zoom Passcode: **900121**

MTSG Mission

The Meniscus Transplantation Study Group (MTSG) was founded in 1986 by a combination of orthopaedic surgeons, veterinary surgeons, and scientists to help promote the science of meniscus cartilage transplantation and to evaluate its transfer from basic science research to clinical practice. The study group meets every year at the American Academy of Orthopaedic Surgeons. Scientists, clinicians, and industry partners are encouraged to share papers, research, and videos at the annual meeting. The 2024 meeting will be held in person and virtually.

Presentations

The presentations at the annual meeting of the Meniscus Transplantation Study Group (MTSG) are a mixture of basic science and clinical evaluations. Topics have ranged from cellular behavior, biomechanics of meniscus cartilage, growth factors, and DNA research, to animal and human studies using allograft meniscus cartilage and meniscus scaffolds.

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SRF Mission

Our mission is to pioneer new orthopaedic treatments that accelerate healing, enabling people to stay active through research, development, innovation, and education.



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2026 Meeting Agenda

11:00 Welcome

Kevin R. Stone, MD – Stone Research Foundation

11:05 Introduction

Fabio Sciarretta, MD – Orthopaedics and Trauma Surgery Specialist, ICRS Board Member

Presentations

11:10

Meniscus Scaffolds Update

René Verdonk, MD, PhD

11:20

Meniscal Allograft Transplantation: Are We Hitting the Target Yet

Rene Verdonk, MD, PhD

11:30

Cellular and Molecular Mechanisms Underlying Meniscal Allograft Degeneration: A Triple-Hit Model Derived from Public Single-Cell Atlases

Shiyu Ren, MD

11:40

Meniscus Preservation in the Gray-Zone Knee: Repair and Centralization as the Foundation of Joint Preservation in Kellgren-Lawrence Grade 3 Osteoarthritis

Ali Ghasemi, MD

11:50

Medial Meniscus Allograft Transplantation Using a Bone Bridge Trough Technique: Long-Term Clinical Outcomes and the Role of Staged ACL Reconstruction

Ali Ghasemi, MD

12:00

Bicompartmental Meniscus Transplantation

Kevin R. Stone, MD

12:10

Embryology of the Meniscus

Pedro Guillén García, MD

12:20

Discussion

Suggested Topics for Discussion

Moderator: Fabio Sciarretta

- Biologics and concomitant procedures for MAT
- Imaging of MAT
- Tissue processing and preparation of MAT
- Preventing MAT extrusion
- Prophylactic MAT

MENISCUS SCAFFOLDS UPDATE

Indication , longer term results in literature and future directions

Em. Prof. René Verdonk¹ MD, PhD, Matthias Schurhoff, MD⁵ Theofylaktos Kyriakidis^{1,2,3}, MD, MSc, PhD,, Peter Verdonk⁴ MD, PhD

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Abstract

Meniscal tears are some of the most frequently encountered knee injuries in orthopaedic practice and their surgical management results in one of the highest procedure volumes in orthopaedic surgery. Primary repair has been advocated by international consensus as imperative, however, partial meniscectomy and associated meniscal tissue loss remains a global challenge in patients, who develop symptoms from meniscal insufficiency. The risk of degenerative consequences remains and meniscus restoration constitutes a treatment goal for long-term knee health. Meniscal scaffolds have shown promising results with short-, mid-, and long-term benefits reported in a significant body of evidence.

Results are robust and comparable to other meniscus procedures. The use of synthetic or biologic scaffold widens the treatment spectrum within a meniscus-preservation algorithm and provides solutions for symptomatic mid-substance meniscus tissue loss with the goal to prevent or delay the need for future arthroplasty. Support is needed from Medical societies and Educational programs that play an important role in clinical adoption , institutional acceptance, regulatory approval and reimbursement.

MENISCAL ALLOGRAFT TRANSPLANTATION

Are we hitting the target yet

Em. Prof. René Verdonk MD, PhD, Theofylaktos Kyriakidis³ MD, MSc, PhD,, Peter Verdonk

MD, PhD, Tim Spalding MD.

Purpose: This study evaluates the mid- to long-term survival outcome of MAT (meniscal allograft transplantation). Potential prognosticators, with particular focus on chondral status and age of the patient at the time of transplantation, were also analysed.

Methods: An online database search was performed using following search string: “meniscal allograft transplantation” and “outcome”. A total of 65 articles were analysed for a total of 3157 performed MAT with a mean follow-up of 5.4 years. Subjective and clinical data was analysed.

Results: The subjective and objective results of 2977 patients (3157 allografts) were analysed; 70% were male, 30% were female. Thirty-eight percent received an isolated MAT. All other patients underwent at least one concomitant procedure. Lysholm, Knee injury and Osteoarthritis Outcome (KOOS), International Knee Documentation Committee (IKDC) and Visual Analogue Scale (VAS) scores were analysed. All scores showed a good patient satisfaction at long-term follow-up. The mean overall survival rate was 80.9%. Complication rates were comparable to standard meniscal repair surgery. There was a degenerative evolution in osteoarthritis with at least one grade in 1760 radiographically analysed patients. Concomitant procedures seem to have no effect on the outcome. Age at transplantation is a negative prognosticator. The body mass index (BMI) of the patient shows a slightly negative correlation with the outcome of MAT.

Conclusions: MAT is a viable solution for the younger patient with chronic pain in the meniscectomised knee joint. The complications are not severe and comparable to meniscal repair. The overall failure rate at final follow-up is acceptable and the allograft heals well in most cases, but MAT cannot be seen as a definitive solution for post-menisectomy pain. The correct approach to the chronic painful total meniscectomised knee joint thus requires consideration of all pathologies including alignment, stability, meniscal abnormality and cartilage degeneration. It requires possibly combined but appropriate action in that order

Cellular and Molecular Mechanisms Underlying Meniscal Allograft Degeneration: A Triple-Hit Model Derived from Public Single-Cell Atlases

Shiyou Ren^{1,3*} (Presenting Author), Yan Wang², Siyao Guan¹, Yiyong Tang¹, Haiyang Yu³, Wentao Zhang¹

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Purpose: Meniscal allograft transplantation (MAT) is an established biological option for young patients following subtotal meniscectomy. However, even well-positioned grafts demonstrate inferior matrix quality and wear resistance over long-term follow-up. This study aimed to elucidate the cellular and molecular mechanisms driving allograft degeneration through *in silico* re-analysis of publicly available single-cell RNA sequencing (scRNA-seq) atlases.

Methods: We performed computational re-analysis of two independent scRNA-seq atlases: Swahn et al. 2022 (GSE220243, 180,488 cells across 25 donors, meniscus and cartilage) and Raut et al. 2025 (multi-tissue knee atlas including cartilage, meniscus, synovium, and subchondral bone). Data were harmonized with Harmony algorithm. Differential expression was performed using MAST. Intercellular communication was analyzed via CellChat. Senescence-associated secretory phenotype (SASP) scoring employed the SenMayo gene set.

Results: We identified three convergent mechanisms of allograft failure, termed the Triple-Hit Model:

Hit 1 - Progenitor Depletion and Niche

Silencing: Tissue-specific stem cells (TSCs) declined 28% in osteoarthritic (OA) meniscus (from 9.5% to 6.8%). Seven regenerative niche genes (CXCL12, THY1, PDGFRA, WISP2, SFRP4, LEFTY2, ANGPTL7) were coordinately silenced in OA. Cryopreservation, ischemic interval, and post-implantation inflammatory milieu amplify this depletion in the MAT setting.

Hit 2 - Senescence Pollution and Macrophage

Amplification: The C11 macrophage cluster was

76.5% OA-enriched and functioned as the dominant SASP amplifier. Ten inflammatory mediators were highly enriched (IL1B log2FC 10.6, CCL3 8.7, CXCL8 8.2, TNF 6.7). CellChat analysis revealed a 35% increase in total intercellular communication strength in OA, with CXCL12-CXCR4 regenerative signaling displaced by inflammatory chemokines.

Hit 3 - Regenerative Pathway Disruption: Recent work by Yan et al. (2024) demonstrated that endothelial cells (ECs) contribute to fibrochondrocyte regeneration via TGF-beta2-mediated endothelial-to-mesenchymal transition (EndMT). While ECs remain stable in natural OA (2.3% to 2.6%), cryopreservation selectively eliminates them with 40-80% viability loss, creating an EndMT-deficient graft unique to the MAT setting.

Conclusion: The three Hits operate as a coupled cascade linking progenitor-niche loss, inflammatory macrophage amplification, and endothelial-regenerative failure. The model leads directly to testable combinatorial intervention concepts including: (1) senolytic preconditioning of grafts prior to implantation; (2) endothelial cell-sparing cryopreservation protocols; (3) macrophage modulation via CSF1R or NLRP3 inhibitors; and (4) CXCL12-loaded biomaterial scaffolds for niche reconstruction. Single-pathway interventions are unlikely to be sufficient given the coupled architecture of the Triple-Hit cascade.

Keywords: Meniscal allograft transplantation; Single-cell RNA sequencing; Cellular senescence; Tissue-resident macrophages; Endothelial-to-mesenchymal transition

Meniscus Preservation in the Gray-Zone Knee: Repair and Centralization as the Foundation of Joint Preservation in Kellgren–Lawrence Grade 3 Osteoarthritis

Ali Ghasemi, MD

Clinical Assistant Professor of Orthopaedic Surgery
Sidney Kimmel Medical College, Thomas Jefferson University
Jefferson Einstein Philadelphia Hospital

Purpose

Meniscal extrusion and loss of meniscal function are major contributors to compartment overload and progression of knee osteoarthritis. This study evaluates whether a meniscus-centered joint preservation strategy, incorporating meniscus repair and centralization with treatment of associated cartilage and subchondral pathology, improves clinical outcomes in patients with Kellgren–Lawrence (KL) grade 3 osteoarthritis.

Methods

A retrospective single-center study was performed on patients with symptomatic medial compartment KL-3 osteoarthritis, medial meniscal extrusion >3 mm on MRI, medial joint line tenderness, and <5° varus malalignment. All patients underwent a comprehensive preservation procedure centered on meniscus repair and/or centralization, combined with cartilage restoration and treatment of subchondral bone pathology when indicated. Preoperative MRI findings were recorded. Clinical outcomes were assessed using the International Knee Documentation Committee (IKDC) score and Knee injury and Osteoarthritis Outcome Score (KOOS) before surgery and at final follow-up.

Results

Twenty-three patients (mean age 62.5 years; range 50–89) were evaluated at a mean follow-up of 24 months. Medial meniscal root, body, or posterior horn tears were commonly identified and repaired when indicated. Significant improvements were observed in IKDC (27.9 to 53.5), KOOS Total (39.9 to 63.6), KOOS Pain (39.5 to 68.2), KOOS Activities of Daily Living (35.4 to 63.2), and KOOS Symptoms (47.2 to 59.4) (all $P < 0.001$). Minimal clinically important difference thresholds were achieved by 87% of patients for IKDC, 65% for KOOS Pain and Activities of Daily Living, and 52% for KOOS Symptoms.

Conclusion

A meniscus-centered preservation strategy incorporating repair and centralization with treatment of associated cartilage and subchondral pathology resulted in significant short-term clinical improvement in patients with KL-3 osteoarthritis. These findings suggest that restoring meniscal function may play a pivotal role in preserving the osteoarthritic knee and support further investigation through prospective multicenter studies.

Medial Meniscus Allograft Transplantation Using a Bone Bridge Trough Technique: Long-Term Clinical Outcomes and the Role of Staged ACL Reconstruction

Ali Ghasemi, MD

Clinical Assistant Professor of Orthopaedic Surgery
Sidney Kimmel Medical College, Thomas Jefferson University
Jefferson Einstein Philadelphia Hospital

Benjamin Murray, Lawrence Miller

Purpose

Bone bridge fixation is the preferred technique for lateral meniscus allograft transplantation (MAT), whereas medial MAT is traditionally performed using separate bone plugs because of concerns regarding proximity to the anterior cruciate ligament (ACL) tibial footprint. This study evaluates long-term clinical outcomes following medial MAT using a bone bridge trough technique and reports outcomes following staged ACL reconstruction (ACLR) in patients with concomitant ACL deficiency.

Methods

A retrospective review was performed of patients undergoing MAT between 2010 and 2020. Medial and lateral MAT were performed using a bone bridge trough technique. Patients with ACL deficiency underwent staged ACL reconstruction approximately 4–6 months following MAT. Clinical outcomes were assessed using the International Knee Documentation Committee (IKDC), Lysholm, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Rates of minimal clinically important difference (MCID) achievement were calculated.

Results

Twenty-two patients underwent MAT, including 14 medial and 8 lateral transplantations. Six patients

subsequently underwent staged ACL reconstruction. Mean follow-up was 100.9 months, with a mean age of 26.4 years at surgery. Twenty patients completed a minimum of 24 months of follow-up.

Patients undergoing medial MAT demonstrated significant improvements in IKDC (42.0 to 60.1), Lysholm (26.3 to 85.2), and WOMAC (60.6 to 13.4), with $\geq 91.7\%$ achieving MCID across all patient-reported outcome measures.

Patients undergoing lateral MAT also demonstrated significant improvement, with 87.5% achieving MCID thresholds.

All patients undergoing staged ACL reconstruction experienced clinically meaningful improvement and achieved MCID thresholds for all outcome measures.

Conclusion

Medial meniscus allograft transplantation performed using a bone bridge trough technique demonstrated durable, clinically meaningful improvements at long-term follow-up comparable to lateral MAT. In patients with concomitant ACL deficiency, staged ACL reconstruction following MAT was associated with favorable outcomes, supporting this approach as a viable treatment strategy in appropriately selected patients.

Combined Medial & Lateral Meniscus Allograft Replacement

Kevin R. Stone, MD ^{1,2} & Jennifer L. Stone, MD ¹

¹Stone Clinic, San Francisco, CA, USA

²Stone Research Foundation, San Francisco, CA, USA

Purpose:

Combined medial and lateral meniscus allograft transplantation is a technique for biologic meniscus replacement that enables patients to retain meniscus tissue. Loss of both menisci leaves the knee vulnerable to pain and progressive degeneration, especially in active patients wishing to retain their native joint. This surgical technique video describes the combined medial and lateral meniscus allograft transplantation technique in a 67-year-old active patient with prior history of meniscectomy. Following the video is a series of single-surgeon clinical outcomes reports.

Methods:

Retrospective review identified 15 patients who underwent bicompartamental meniscus allograft transplantation between 1998 and 2026. Indications were meniscal loss, pain, and preserved joint space. Both menisci came from a single donor, and the tissue bank was asked to preserve the meniscotibial ligaments, so the native meniscal anatomy was maintained. The surgical technique included trephination of the MCL and lateral tissue to stimulate blood supply, preservation of the native rim, and a three-tunnel technique with a bone trough on the lateral side. The posterior horn was secured with all-inside fixation, the periphery was sutured, the horns were tied over bone, and suture anchors provided secondary fixation. In combined ACL procedures, ACL tunnels were drilled first and

the graft was passed last. The surgical video features a 67-year-old athlete with a prior meniscectomy. Outcomes were assessed with IKDC scores and pain scores.

Results:

The cohort included 9 males and 6 females, with a mean age of 42.2 years (range 22–67). Concomitant procedures included debridement (12), articular cartilage paste grafting (5), ACL revision (4), chondroplasty (4), posterolateral corner reconstruction (2), and microfracture (1). IKDC data were available for 12 patients. Mean IKDC scores rose post-operatively. Imaging also demonstrates successful meniscus repair in patients coinciding with increased activity (IKDC) scores and decreased pain scores (1-10). At latest follow-up, case patients reported low pain levels at rest and had returned to activities including running, skiing, jiu-jitsu, and beach volleyball.

Conclusion:

Combined medial and lateral meniscus transplantation from a single donor, with the meniscotibial ligaments preserved, is a feasible biologic option for patients with bicompartamental meniscal loss or injury. It improves function and lets patients return to sport. The procedure may delay the need for arthroplasty while preserving the patient's own knee in patients across a broad age range.

Identification and Characterisation of POSTN⁺ Synovial Progenitor Cells in Meniscus Regeneration

Authors: Wanting Yan, Xiaojia Huang, Zhengzheng Zhang

Presenting Author: Wanting Yan (Email: wanting.yan@postgrad.manchester.ac.uk)

Background

The meniscus exhibits limited intrinsic self-repair capacity, particularly within its avascular inner region. A central challenge in joint preservation and biological repair strategies is identifying the specific endogenous cell populations that respond to injury and drive fibrocartilage regeneration. This study aimed to identify and characterise the key injury-responsive progenitor population involved in meniscal healing and evaluate its therapeutic potential for cell-based repair.

Methods

Single-cell RNA sequencing (scRNA-seq) was performed on clinical meniscus repair tissue obtained during arthroscopy (2 weeks post-injury) and integrated with healthy control datasets. Parallel temporal studies were conducted using a full-thickness meniscal injury model in rabbits and mice. To establish the physical origin of the repair cells, selective cryoablation of the adjacent joint synovium was performed *in vivo* prior to meniscal injury. *In vivo* lineage tracing was employed to dynamically trace cell fate during spontaneous healing.

Results

Single-cell transcriptomics revealed a dramatic expansion of a distinct periostin-expressing fibroblast population (POSTN⁺ FB) in repair tissue compared to intact meniscus. *In vivo* lineage tracing confirmed that under uninjured baseline conditions,

POSTN⁺ cells reside almost exclusively in the adjacent synovial sub-lining region at the meniscus-synovium junction.

Following meniscal injury, these synovium-derived POSTN⁺ SPCs rapidly proliferated, expanded in the synovium, and migrated directly into the meniscal defect site. Devitalisation of the neighbouring synovium markedly abolished cell accumulation at the lesion site and severely impaired morphological defect healing, confirming that the synovium is the primary endogenous source of these regenerative cells.

Pseudotime trajectory analysis and *in vivo* lineage tracing demonstrated that migrated POSTN⁺ SPCs persist throughout the repair process and transition into a chondrogenic state (COL2A1⁺) in the later stages of healing. *In vitro*, isolated POSTN⁺ SPCs exhibited robust multilineage differentiation capacity. Intra-articular transplantation of POSTN⁺ SPC-enriched cells into meniscal defects enhanced cellularity, matrix deposition, and structural continuity.

Conclusion

This study identifies POSTN⁺ synovial progenitor cells as the primary endogenous effector population driving meniscal repair. Strategies aimed at preserving the synovial-meniscal junction or mobilising/transplanting POSTN⁺ SPCs represent a promising translational approach for achieving functional meniscal regeneration.

***Thank you all for attending and presenting at
the 2026 MTSG meeting!***



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