Anterior Cruciate Ligament Reconstruction with Biologic & Suture Tape Augmentation

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Lavender et al. | Arthroscopy (2025)

(Level II Randomized Controlled Trial

Why Augment??

- Re-tear rates remain high 6-10%
  - Even higher in High-Risk Populations
- Tunnel widening remains a common postoperative finding
- 9-12 Months Standard Recovery

Wiggins AJ et al. *Am J Sports Med.* 2016
Webster KE, Feller JA. *Sports Med.* 2019
Magnussen RA et al. *Am J Sports Med.* 2011

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Study Purpose

- Compare outcomes of ACL reconstruction with BMAC, DBM, and suture tape augmentation vs non-augmented ACLR
  - Evaluate functional recovery, patient-reported outcomes, and radiographic tunnel healing
  - Hypothesis: Augmented ACLR leads to improved functional recovery, and less tunnel widening without compromising long-term outcomes

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Study Design

- Prospective, single-blinded randomized controlled trial
  - Single academic institution (Marshall University)
  - Registered on ClinicalTrials.gov (NCT04178538)
  - Minimum 2-year follow-up

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Patient Population

- 59 patients included (29 augmented, 30 non-augmented)
  - Age range: 14–60 years**; mean age ~22 years**
  - Quadriceps tendon autograft (<25 years)
  - Allograft (≥25 years)
  - Concomitant meniscal pathology included

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Augmented ACLR Technique

- Bone Marrow Aspirate Concentrate (BMAC) harvested from proximal tibia
  - Demineralized Bone Matrix (DBM) combined with autograft bone
  - Composite graft injected into femoral and tibial tunnels
  - Suture Tape Augmentation (InternalBrace) for mechanical reinforcement

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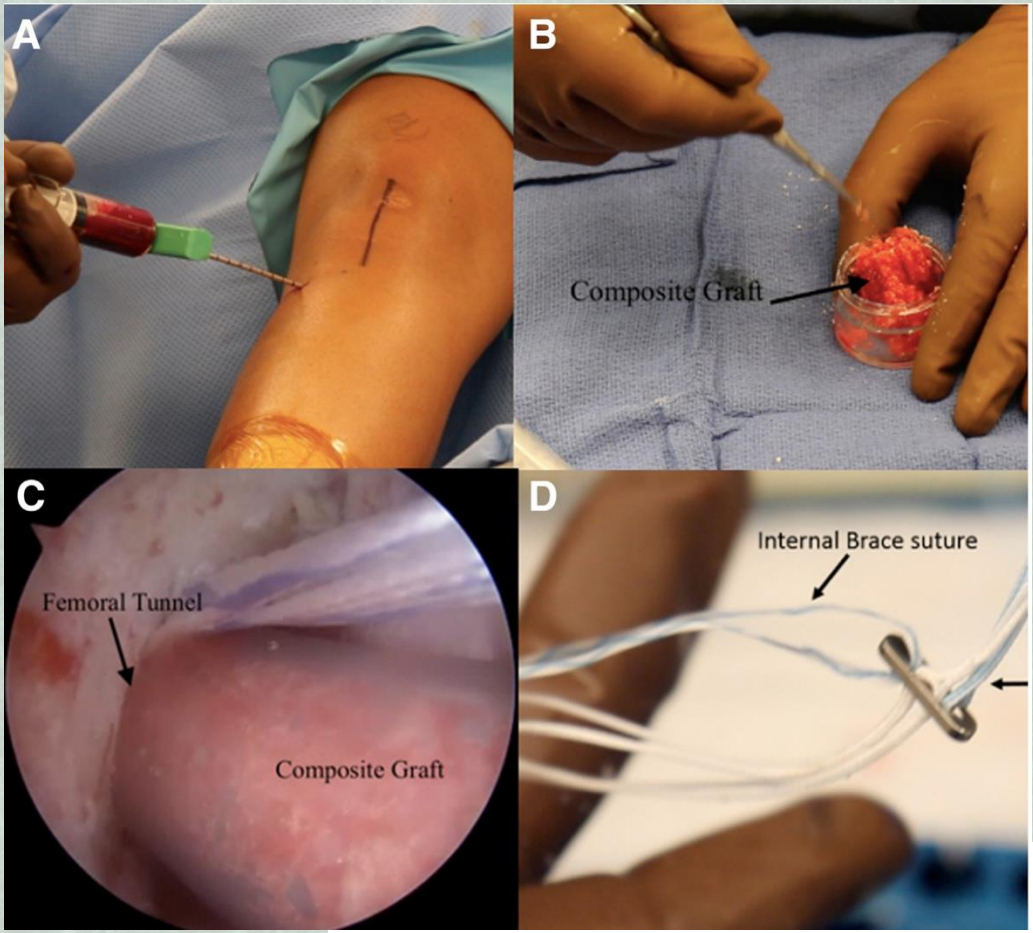
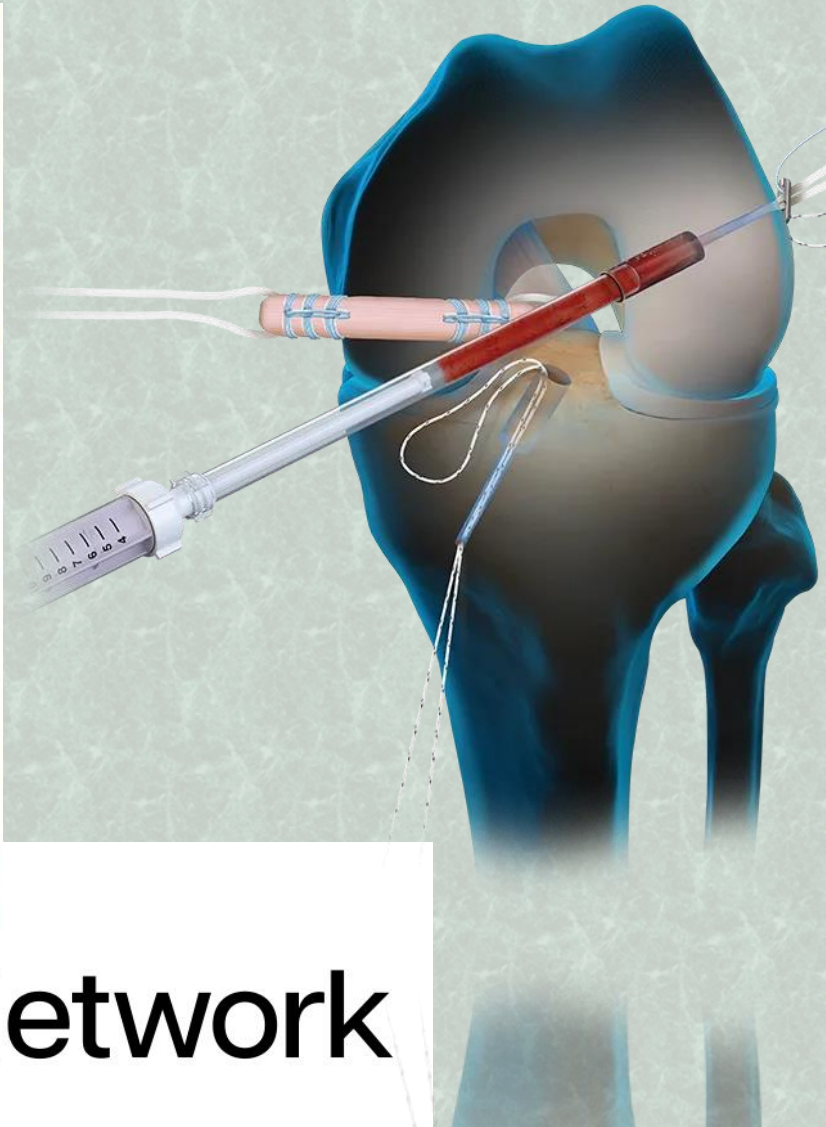
Fertilized ACL Technique





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Primary Outcomes

- Functional recovery: range of motion (ROM) and limb symmetry
  - Patient-reported outcomes (IKDC)
  - Graft rerupture and reoperation rates
- Tunnel Widening
  - Independently measured Tunnels at 6 months CT scans

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Early Functional Outcomes

- Significantly improved early **knee flexion** in augmented group
  - 6 weeks ROM: 125° vs 109° ($p < 0.0001$)
  - **12-week limb symmetry: 80.6% vs 36.7% ($p < 0.001$)**
  - Indicates faster early rehabilitation and functional recovery

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Patient-Reported Outcomes (2 Years)

- IKDC scores similar between groups at 2 years
  - Augmented: 91.1 ± 12.7 vs Non-augmented: 85.3 ± 10.8 (p = 0.109)
  - MCID and PASS achieved at high rates in both groups

KOOS Quality of Life

- Significantly higher KOOS QOL scores in augmented group
  - 6 months, 1 year, and 2 years all favored augmentation
  - **2-year KOOS QOL: 85.2 vs 72.1 (p = 0.042)**
  - Suggests meaningful long-term patient-perceived benefit

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Radiographic Outcomes (CT at 6 Months)

- Significantly less bone tunnel enlargement in augmented ACLR

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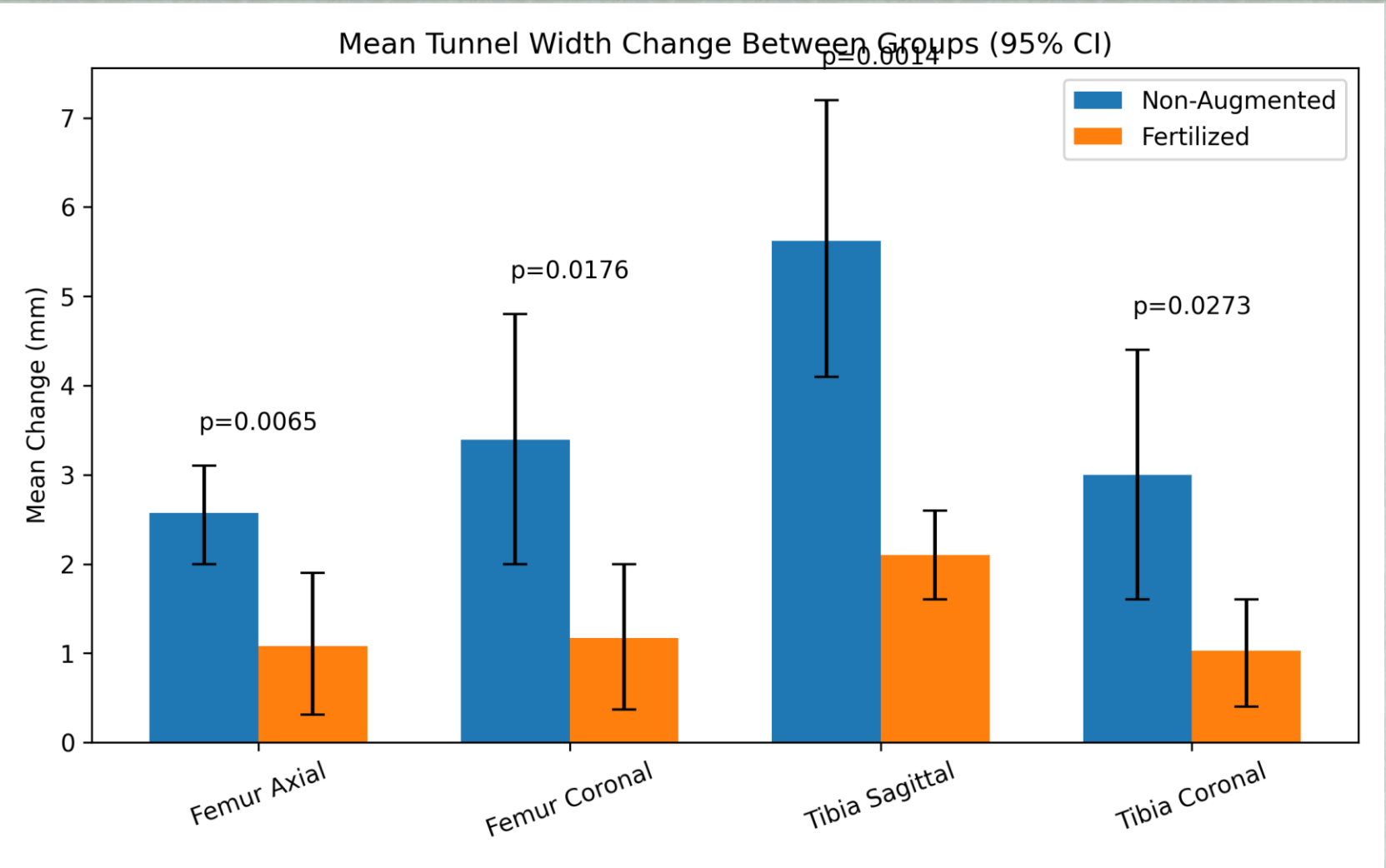

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Complications & Safety

- No ACL reruptures in either group at 2 years
  - Reoperation for stiffness: **11.9% overall**
  - No difference in stiffness rates between groups
  - Augmented procedures increased operative time **~15 minutes**

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Clinical Implications

- Biologic + suture tape augmentation improves **early function** and **tunnel widening**
  - Does not compromise 2-year patient-reported outcomes
  - Improved tunnel healing may have long-term structural benefits
  - Supports safe use in high-risk or high-demand patients

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Study Limitations

- Reduced sample size due to COVID-19 pandemic
  - Limited power to detect 2-year IKDC differences
  - Multiple augmentation variables (biologic + mechanical)
  - Single-center design with short-term radiographic follow-up

Key Takeaways

- Augmented ACLR improves early function and limb symmetry
  - No difference in 2-year IKDC outcomes
  - Superior KOOS Quality of Life and tunnel healing
  - Represents a safe, evidence-based evolution of ACL reconstruction

Citation

- Lavender CD, et al.
- **Anterior Cruciate Ligament Reconstruction Augmentation With Bone Marrow Aspirate Concentrate, Demineralized Bone Matrix, and Suture Tape Shows No Difference in Outcomes-But Faster Functional Recovery-Versus Non-augmented Anterior Cruciate Ligament Reconstruction**
  - Arthroscopy: The Journal of Arthroscopic and Related Surgery, 2025

Long Term Retrospective Review

- **High Return to Activity and Low Revision Rates after Anterior Cruciate Ligament Reconstruction with Bone Marrow Aspirate, Demineralized Bone Matrix, and Suture Tape Augmentation at Minimum 2-Year Follow-Up**
  - Lavender CD, Peterson J, Soucier C, Groves J, Schaver AL, Hewett TE, Lycans DS

- Accepted for publication (ASMAR)
  - Retrospective review of a prospectively maintained registry
  - All-inside quadriceps tendon autograft ACLR with BMAC, DBM, and suture tape augmentation
  - Single-institution study (Marshall University)
  - Minimum 2-year follow-up

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Patient Cohort & Methods

- 98 patients with ≥2-year follow-up (mean 3.4 years)
  - Mean age: **19.4 years** (range 15–31)
  - 81.7% follow-up rate
  - Primary outcomes: return to activity, IKDC, ACL-RSI, VAS pain
  - Secondary outcomes: graft re-rupture, contralateral ACL injury, reoperation, Return to previous level of sport

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Key Clinical Outcomes

- 91.8% returned to pre-injury activity level
  - Patients routinely cleared for full activity at 6 months
  - Mean IKDC: 84.0 ± 7.3
  - Mean ACL-RSI: 93.4 ± 17.2 (high psychological readiness)
  - Mean VAS pain <1

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Safety & Durability

- **Graft re-rupture rate: 3.1% (3 patients)**
  - Contralateral ACL injury rate: **9.2%**
  - Manipulation under anesthesia for stiffness: 3.1%
  - Overall reoperation rate: 4.1%
  - Low complication profile in young, high-risk athletes

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Why This Matters??

- Demonstrates reproducibility outside a randomized trial
  - Low re-rupture rate despite accelerated return-to-sport timelines
  - Supports biologic + mechanical augmentation for young athletes
  - Complements RCT data with real-world durability
  - Strengthens the Fertilized ACL evidence ecosystem

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Whats Next?

- Currently finishing enrollment in 125 patient Prospective Study
  - Young <25 years old
  - MRI at 6 months
    - 1 mm or less of widening on average
    - No evidence of synovitis or early cartilage issues
  - Functional outcomes
    - 3,4.5, 6 months
  - Long term outcomes 5-10 years for rerupture/Reoperation

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Future of ACL Surgery

- Should we augment? Yes
- How?????
  - Biologic
  - Suture Tape
  - ALL/LET/Osteotomy

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