Inside-Out Meniscal Repair — Still the Gold Standard?

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Disclosures

Neither I nor my spouse/partner has a relevant financial relationship with a commercial interest to disclose.
Type of Meniscal Repairs

Inside - Out

All Inside

Outside - In

Rodeo Orthop Clinic North Am 2000
Inside Out Meniscal Repair

Long considered gold-standard to pass sutures in tight knee compartment in variety of zones
Inside-Out Method

Arthroscopic Repair meniscal Tears Extending into the Avascular Zone in Patients Younger Than Twenty Years of Age

Noyes AJSM 2002

71 inside-out repairs in patients less than 20 – extending into avascular zone

• Multiple divergent suture technique
• 75% without symptoms at average 4 years
Multiple Divergent Technique

A

B

Longitudinal tear

Superior vertical divergent suture

Inferior vertical divergent suture

EVALUATION & TREATMENT OF THE INJURED ATHLETE
ADVANCED TOPICS IN SURGERY AND REHABILITATION
Vertical over Horizontal Suture

Load at failure vertical sutures superior to horizontal suture in cadaver meniscus

Success of Inside-out meniscal repair

Meniscal repair rates 60-80% at 2-3 years; 90% in setting of ACL
- Horibe 1995: 73% healing (2nd look arthroscopy)
- Noyes 2002: 75% using multiple divergent suture technique
- Steenbrugge 2004: 100% success (20 vertical sutures)

Ease of passing multiple sutures
Safety of passing sutures posteriorly
Versatile for multiple tear configurations
Drawbacks of Inside Out

Need separate medial or lateral incision

Time/ Difficulty
◦ Need for extra assistant passing sutures

Neurovascular risk
◦ Injury to saphenous vein medially / peroneal nerve or popliteal neurovascular bundle
◦ Increased risk of lateral geniculate
Outline

Inside out meniscal repair

Biomechanical Comparisons
  ◦ Inside Out vs All Inside

Clinical Comparisons
  ◦ Inside Out vs All Inside

Modern algorithm
  ◦ Better recognition, visualization and understanding of tears
  ◦ Best tool for job
  ◦ Don’t forget the basics
All-inside repairs

Multiple generations of repairs
  ◦ First 3 generation results mixed
    ◦ Rigid implants did not do well over time
  ◦ Modern generation all-inside
    ◦ Biomechanical similar to inside out
    ◦ Anchored posteriorly behind capsule or all-suture

Quicker procedure
Less invasive
Lower morbidity
Decreased vascular complications
All-inside repairs

Drawbacks

- Technically difficult to get implants where you want
  - Horizontal versus vertical
  - Multiply divergent technique usually not possible
- Breakage or misfire
- Iatrogenic meniscus damage
  - Larger diameter holes within meniscus
  - Repairs difficult or more damage
- Up-front expense
- Vascular injury
- Biomechanical integrity?
  - Absent peripheral rim?
All-inside repairs

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- Biomechanical integrity?
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Biomechanical Comparisons

Long-term outcome after all-inside meniscal repair using the RapidLoc system.

Solheim KSSTA 2015

82 patients at 10 years post-op

- Failure rate 48%
- Re-rupture occurred several years after repair
- Questions integrity of all-inside meniscal repairs
Biomechanical Comparisons (Next Generation)

Biomechanical comparison of the FasT-Fix meniscal repair suture system with vertical mattress sutures and meniscus arrows.

Borden AJSM 2003

Fast-Fix / Vertical Mattress sutures / Meniscal arrows

First generation Mensical Arrows performed statistically worse

Comparable displacement and load to failures of vertical mattress

- FasT-Fix 104.0 ± 31
- Vertical Suture 102 ± 11
Biomechanical Comparisons

Biomechanical Testing of New Meniscal Repair Techniques Containing Ultra High–Molecular Weight Polyethylene Suture
Barber Arthroscopy 2009

UHMWPE suture-containing meniscal repair devices compared to suture
- Load to failure and cyclic loading
- Fail by pulling through meniscus – not failing at knot
- No significant difference
Biomechanical Comparisons

Comparison of all-inside meniscal repair devices with matched inside-out suture repair.

Rosso AJSM 2011 (Ramappa)

Cyclic testing meniscal repair in 66 porcine menisci

Inside-out suture repair
Lowest initial displacement
Response to cyclic loading
Highest load to failure
Biomechanical Comparison

Biomechanical Evaluation of an All-Inside Suture-Based Device for Repairing Longitudinal Meniscal Tears

Masoudi Arthroscopy 2014

Single suture in 36 porcine menisci

All-inside all-suture device showed similar load to failure as in-side out

Fast-Fix with lower load to failure

All with similar stiffness
Single suture in 36 porcine menisci

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Biomechanical testing of transcapsular meniscal repair

Luchi 2017

70 porcine specimens: longitudinal tears load to failure, cyclic loading
- Inside-out or all-inside
- Vertical or horizontal
- Number of sutures (1 versus 2)
Biomechanical Comparisons

Biomechanical testing of transcapsular meniscal repair
Luchi 2017

70 porcine specimens: longitudinal tears load to failure, cyclic loading

- Inside-out or all-inside
- Vertical or horizontal
- Number of sutures (1 versus 2)

All-inside LARGER WIDENING 0.88 ± 0.38 mm than inside-out 0.51 ± 0.38 mm (p=0.035)

Horizontal LOWER FAILURE 62.5 ± 15.5 N than vertical 79.7 ± 13 N (p=0.018)
Biomechanical Comparisons

Inside-out repairs are inherently slightly stronger

- Testing assumes 1-2 mm rim of tissue to anchor plastic anchors

Does it matter?
Clinical Comparison

Inside-Out Versus All-Inside Repair of Isolated Meniscal Tears: An Updated Systematic Review

Fillingham AJSM 2017 (RUSH)

27/481 studies
Limited to next generation implants
Quality of evidence is low (majority level 4 studies)
No significant differences in clinical or anatomic failure rates

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<thead>
<tr>
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<th>Inside-out</th>
<th>All-inside</th>
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<tr>
<td>Clinical failure</td>
<td>11%</td>
<td>vs 10%</td>
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<tr>
<td>Anatomic failure</td>
<td>13%</td>
<td>vs 16%</td>
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<tr>
<td>Lysholm</td>
<td>88.0 ± 3.5</td>
<td>vs 90.4 ± 3.7</td>
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<tr>
<td>Complications</td>
<td>5.1%</td>
<td>vs 4.6%</td>
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Complications
Inside out
• DVT
• Saphenous nerve palsy x 3
• Deep infection x 2

All-inside
• DVT
• Deep infection
• Chondral injury x 2
Clinical Comparison

Comparative Outcomes of All-Inside Versus Inside-Out Repair of Bucket-Handle Meniscal Tears: A Propensity-Matched Analysis.
Samuelsen Orthop J Sports Med 2018

Matched patients with bucket handle tears
- 20 all inside versus 20 inside out

- Mean follow up 2.7 years:
  - No difference in Tegner, IKDC, ROM
  - 2 wound complications all-inside
Clinical Comparison

Arthroscopically Repaired Bucket-Handle Meniscus Tears: Patient Demographics, Postoperative Outcomes, and a Comparison of Success and Failure Cases

Saltzman Cartilage 2018 (Cole)

75 arthroscopic bucket-handled tears
- 2 year follow-up
- **Survival**
  - 94% 6 months
  - 85% 1 year
  - 78% 2 years
  - 70% 3 years
- Reduced risk of failure once reach 15 months,
Is there still a gold standard?

- Biomechanics — Small detectable advantage
- Clinical results — No detectable advantage
- Literature is still inadequate
- Tears are not just Red-Red, Red-White or White-White anymore...
- Recognize specific Meniscal pathology
  - Radial tears
  - Root tears
  - Ramp lesions
  - Meniscopopliteal fascicle lesions
- Recognize concomitant pathology
  - ACL
Radial Tears

Tibiofemoral contact pressures in radial tears of the meniscus treated with all-inside repair, inside-out repair and partial meniscectomy

Zhang The Knee 2015
Radial Tears

Tibiofemoral contact pressures in radial tears of the meniscus treated with all-inside repair, inside-out repair and partial meniscectomy

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<table>
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<tr>
<th>1000N static load</th>
<th>0°</th>
<th>8°</th>
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- Intact
- Radial tear
- Meniscectomy
- Inside-out repair
- All-inside repair

**MPa**

- 15.00
- 0.00
Factors Influencing Successful Repair

Repair technique

Repair method
- Number of sutures
- Repair pattern

Tear pattern

Traumatic versus degenerative

Patient age, smoking (Uzun 2017)

Rehab (Stability over immobilization)

Environment: Intact ACL, alignment
Simultaneous repairs, growth factors, clot
Decision making

1. Initial indications suitability of repair
   ◦ Degenerative tear
   ◦ Presence of arthritic change
   ◦ Meniscal extrusion
   ◦ Presence of bony edema
   ◦ Patient age

2. Tear Configurations
   ◦ Vertical Peripheral tear (stable?)
   ◦ Horizontal tear
   ◦ Complexity of tearing
   ◦ Radial tears
   ◦ Meniscal Root Tears

2. Meniscus
   ◦ Ease of access meniscus
   ◦ Number of stitches
   ◦ Vertical vs Horizontal Sutures
   ◦ Need for divergent sutures

Healing environment (ACL)
Right tool for the right job

- Perform repair with surgical technique surgeon is most comfortable using
- Recognizing size, pattern, location of tear
- Stability of the construct matters

**Inside-out**
- Complex tears
- Middle one-third meniscal tears
- Tears requiring 3-4 sutures (cost)
- Consider for revisions
- Meniscocapsular separations

**All-inside**
- Posterior-horn
- More stable tears
- With ACL

**Hybrid**
Bucket Handled Tears

Hybrid approach

- All-inside posteriorly
- Inside out - body of tear
- Outside-in anteriorly
Special tears: Ramp Lesions

“tear or disruption of the peripheral meniscocapsular attachments of the posterior horn of the medial meniscus”

- Common in ACL injuries
- Not always seen on MRI
- PROBE the MENISCUS!

Laprade OJSM 2017
Special tears: Ramp lesion
Special tears: Meniscopopliteal Fascicle Tear

Diagnosis: Replicate pain in figure 4 position

Inside out repair with multiple sutures (Noyes)
Open repair on both sides LCL (LaPrade)
Meniscal Root Tears

Type 1
Partial Root Tear

Type 2
Complete Radial Root Tear

Type 3
Complete Root Tear
Bucket Handle Tear

Type 4
Oblique Tear into Root Attachment

Type 5
Root Avulsion Fracture

LaPrade AJSM 2015
Conclusions

Inside-out technique still remains the gold standard

All-inside techniques offer some advantages when appropriate
  ◦ especially in setting of concomitant ACL

Find the best tool for the job
  ◦ Identify meniscal pathology
  ◦ Consider hybrid approaches

Technique for meniscal repair less important than meticulousness of repair

Meniscal re-tear can occur > 2 years post-procedures (inform patients)
Thank You.