Complex Meniscal Repair: Root, Radial, and Revision

Michael B. Ellman, MD
Panorama Orthopedics
Sports Medicine

Disclosures

• Educational Consultant – Stryker Endoscopy & Sports Medicine

Meniscal Root Tears

Hot topic over past several years in sports medicine literature
Meniscal Root Tears

- Avulsion of anterior or posterior horn attachments of medial or lateral meniscal roots off tibial plateau
- Radial root tears

Meniscal Root Tears

- PH medial meniscal root / radial root tear equivalent to total medial meniscectomy → will go onto OA!
  - 70% of patients with total mx → XR OA changes within 2 years
  - 100% of patients with total mx → end-stage OA within 20 years
- PH MM root repair restores contact pressure to normal

Epidemiology
Lateral Meniscus Root Tear and Meniscus Extrusion with Anterior Cruciate Ligament Tear
Jeffrey M. Brody, MD, Mark W. Lin, MD, Michael J. Hertogs, MD, and Glenn A. Young, MD

- 264 MRIs of knees with ACL tears retrospectively reviewed
- 26/264 (9.8%) had a Lateral Meniscus Root Tear on MRI
- 8/264 (3%) had a Medial Meniscus Root Tear on MRI

Risk Factors for Root Tears:
- Female, Increased BMI, varus alignment

Meniscal Root Tears: H&P
- History
  - Atraumatic: “Pop” while descending stairs or during squat
  - Traumatic: Twisting, hyperflexion injury to knee
- Pain with deep flexion, more severe than normal meniscal tear
- Joint line TTP

Imaging
X-Ray: Meniscal ossicle
MRI: ghost sign, extrusion
Extrusion >3mm = suggests complete root tear
Find Them: Arthroscopy

Probe every root attachment, every time!

Treatment Algorithm

Bhatia, Ellman, ArS M 2015
Root Repair Surgical Technique
- Suture Anchor vs Transtibial Tunnel
- Transtibial tunnel technique most commonly used in US

Root Repairs: Pearls
- Self grasping meniscal suture passing device to pass sutures
- Transitioned from two simple sutures to mattress or luggage tag stitch
- Pass sutures through small drill hole
- Tie sutures at 90 degrees of knee flexion
- Post-op rehab:
  - Go SLOW! Bad injury with potentially tenuous repair techniques!
  - TT/WB x6 weeks
  - 0-90 ROM x6 weeks

Root Tears: Clinical Outcomes
- PMM can provide relief of mechanical sx, but does NOT alter natural history of disease
- Repair literature: 2-year outcomes promising
  - Repairs perform better than meniscectomy
  - Root repair healing rates approach 90%
  - 60% complete healing, 10% partial healing
  - However, >50% risk of recurrent extrusion
- Mid- and Long-term clinical outcomes unknown
  - Can we really stop the progression of OA???
Scenarios to Keep in Mind

SONK → Consider root tear
ACL Tear → Look for posterolateral meniscal root tear
Prior PCL reconstruction → Increase risk of iatrogenic posterior medial root tear
Prior tibial IM Nail → Increase risk of iatrogenic anterior medial root tear

(Description 1)

Scenarios to Keep in Mind

SONK → Consider root tear
ACL Tear → Look for posterolateral meniscal root tear
Prior PCL reconstruction → Increase risk of iatrogenic posterior medial root tear
Prior tibial IM Nail → Increase risk of iatrogenic anterior medial root tear

(Description 2)

Scenarios to Keep in Mind

SONK → Consider root tear
ACL Tear → Look for posterolateral meniscal root tear
Prior PCL reconstruction → Increase risk of iatrogenic posterior medial root tear
Prior tibial IM Nail → Increase risk of iatrogenic anterior medial root tear

(Description 3)
Scenarios to Keep in Mind

- SONK ➔ Consider root tear
- ACL Tear ➔ Look for posterolateral meniscal root tear
- Prior PCL reconstruction ➔ Increase risk of iatrogenic posterior medial root tear
- Prior tibial IM Nail ➔ Increase risk of iatrogenic anterior medial root tear (Laprade, Ellman AJSM 2015)

Radial Meniscal Tears

- Radial Meniscal Tears
  - Partial tears are common – 10-16% of all knee arthroscopies
  - Complete tears = BAD injuries!
    - Dramatically impede tibiofemoral load dissipation ➔ "Total mx"
    - Result in meniscal extrusion

Repairing Radial Tears

- Goal is to restore the meniscus’ ability to withstand hoop stresses
- Recommended over mx if involve red-red zone
- Current repair techniques
  - All inside horizontal mattress repair
  - Inside-out repair with single, double, or crossed horizontal mattress sutures
    - Increasing complexity ➔ Improved biomechanical strength of repair
Shortcomings of Repair Techniques

- Literature demonstrates low rate of healing

<table>
<thead>
<tr>
<th>Author</th>
<th>Repair Technique</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choi et al.</td>
<td>Inside out mattress</td>
<td>15.7% healing on follow-up MRI</td>
</tr>
<tr>
<td>Trommel et al</td>
<td>Inside out mattress</td>
<td>60% healing on second look arthroscopy</td>
</tr>
</tbody>
</table>

- Unable to restore normal contact mechanics with inside out repair or partial meniscectomy
Radial Meniscal Tears

• Key Points
  – Optimal technique still currently unknown
  – Recent literature suggests modern all-inside devices or transtibial tunnel techniques may lead to improved outcomes s/p radial repair
  – Clinical data lacking

Revision Meniscal Repair

• Failure rate after primary meniscal repair = 5-43% (mean 20-25%)
  – Dependent on type of tear, chronicity, location, patient variables, repair technique, etc.
• Options s/p failed repair:
  – Partial Meniscectomy
  – Revision Meniscal Repair

Revision Meniscal Repair

• Historically, treatment of failed meniscal repair = partial meniscectomy
  – Problem: Partial meniscectomy → Increases contact stress and progression of OA
• Recent studies support revision meniscal repair if possible (ie, longitudinal tear in red-red zone)
  – Krych et al, Arthroscopy 2016: 79% success rate at 6 years in patients undergoing revision meniscal repairs with tears within 5mm of meniscocapsular junction
  – However, most failed repairs failed for a reason → if irreparable or poor tissue quality, proceed with mxml
Summary

- 4 R's = Acute Root tears, or Radial/Revision within Red-Red Zone = Repair em!
- No gold standard technique for root or radial tears; evolving understanding and techniques
- Natural history studies warranted for root and radial tears following repair: can we really prevent progression of OA or SONK?
• Two tunnel transosseous radial repair constructs demonstrated:
  - Significantly less gapping with cyclic loading
  - Significantly stronger ultimate failure loads
• No clinical data available
• Others have reported improved outcomes with modern all-inside devices for soft tissue repairs
  - Guerina Arthro Tech 2016
  - Mulhon Arthro 2016

References

Complete healing at 6 mo on Second look arthroscopy

Surgical Technique

Root Tear Classification

- Type 1: partial stable root tear
- Type 2A: 0 to <3 mm of bony root attachment
- Type 2B: 3 to <6 mm of root attachment
- Type 2C: 6 to <9 mm from bony root attachment
- Type 3: isolated bundle tear with complete root detachment
- Type 4: complex intra-articular tears
- Type 5: bony avulsion fracture of root attachment

Rootal Root Tears: A Classification System Based on Tear Morphology
Christopher M. LaFosse, Dow M. Zhou, Roy A. Gross, John A. Petre, Linda Buser, and Robert F. LaFosse
Meniscal Anatomy: Blood Supply

SONK and Root Tears
SONK and Root Tears

Spontaneous Osteonecrosis of Knee
After Arthroscopy Is Not Necessarily Related to the Procedure

Surgical Treatment Options

• PMM vs Repair
  – Indications for PMM:
    • Pre-existing OA
    • Elderly patient
    • Mechanical symptoms = discuss expectations
  – Indications for Meniscal Root Repair
    • No OA
    • Young, active patients
    • Acute injury

Anatomic Root Repairs

• Anatomic PH MM root repairs restore contact area and minimize peak contact pressures better than non-anatomic root repair (LaPrade CM, AJSM 2015)
**Summary: Complex Meniscal Repair**

- When in doubt, go Inside Out!
- 3 A’s
  - Anatomy
  - Approach
  - Anatomic Repair

**Other Types of Meniscal Tears**

- Radial Tear
Effect of Fibrin Clot at Repair Site

- Simple method for initiating bone marrow egress from the proximal humeral metaphysis during rotator cuff repair
- Discussed importance of optimizing this natural healing process made available by a robust bone marrow clot called the "Crimson Duvet"

Techniques in Shoulder & Elbow Surgery

Effect of Fibrin Clot at Repair Site

- 5/5 Radial meniscal tears fully healed at second look arthroscopy (mean 5 mo) after repair with fibrin clot incorporation
- Two-tunnel technique inherently produces fibrin clot at repair site due to transosseous tunnels

Techniques in Shoulder & Elbow Surgery 2009
Peripheral Longitudinal and Bucket Handle Tears

• Fix if you can!
• Inside out vs All inside vertical mattress = better restores hoop stresses
• Literature?

Surgical Technique

• Yanke study = all inside equiv to inside out
The microvasculature of the meniscus and its response to injury

*An experimental study in the dog*

STEVEN P. ARNOLOWSKY, DVM, ACVS, and RUSSELL E. WARRINER, MD, FACS

From the Laboratory of Comparative Orthopedics and Sports Medicine Research, The Hospital for Special Surgery affiliated with the New York University School of Medicine, New York, New York

- Meniscal vascularity study in dogs
- Created midbody medial meniscus radial tears and observed vascularity and healing response
The microvasculature of the meniscus and its response to injury

An experimental study in the dog

- Found that vascular response to midbody transection originated from peripheral tissues
- Saw complete healing of tear with fibrovascular scar by 10 weeks
Types of Meniscal Tears

- Longitudinal Tear
- Radial Tear
- Bucket Handle Tear

What about the roots?

- Meniscal Root Tears:
  - Avulsion of anterior or posterior horn attachments of medial or lateral meniscal roots off tibial plateau
  - Radial tears

Specialty Update
What's New in Sports Medicine
• PM meniscal root tear → 25% increase in medial compartment contact pressures
• Similar to total meniscectomized state

• Increased focus on surgical repair techniques
  – Transtibial Pullout
  – Suture Anchor
• Current surgical techniques only reattach the most prominent, dense portion of each root, and fail to account for supplemental fibers

• PHMM: “Shiny White Fibers” (SWFs) Anderson, JBJS 2012; Johanssen AJSM 2012
• PHLM: Supplemental medial fiber expansion
• AHMM: Supplemental fibers recently identified
• AHLM: Supplemental attachments to overlying