The Meniscus

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History

- Meniscus originally thought to represent vestigial tissue
- 1883 first reported meniscal repair (Annandale)
- Total meniscectomy treatment of choice for nearly a century
- 1948 radiographic changes following total meniscectomy first described
- Over the last 30 years abundant literature documenting functional importance of meniscus and degenerative changes which follow its removal

Anatomy

- Blood supply enters from the periphery during fetal development
- By 9th month inner one third is avascular
- Densely cellular at birth
- Cellularity decreases with age
- Fibrochondrocyte major matrix producer
- Type I collagen predominates but II, III, V, and VI also present
- Most fibrils arranged circumferentially
- Some radial, oblique and vertical fibers as well

- Medial meniscus covers greater than half of the weight bearing articular surface of the medial tibial plateau
- Lateral meniscus covers greater than three fourths
- Both firmly anchored to the tibial surface both anteriorly and posteriorly

Blood Supply

- 30% medial meniscus vascularized
- 10-25% lateral meniscus vascularized
- Small synovial fringe of 2-3 mm extending over peripheral rim does NOT contribute blood supply
- Popliteus hiatus region in posterior lateral meniscus area of decreased blood supply
- Commonly referred to as zones:
  - red zone
  - red/white zone
  - white zone

Attachments

- Menisci anchored via meniscotibial ligaments (coronary ligaments)
- Medial meniscus connected anteriorly to lateral meniscus via transverse ligament
- Middle aspect of medial meniscus attached to deep fibers of the MCL
- Lateral meniscus not attached to LCL
- Lateral meniscus attaches to PCL posteriorly via the posterior meniscofemoral ligament (ligament of Wrisberg)
- Attaches to PCL anteriorly via the anterior meniscofemoral ligament (ligament of Humphrey)
- 70% of knees one will be present
- Only about 6% will be both be present
Physiology

- May contribute to nutrition of articular cartilage by enhancing synovial fluid distribution
- Secondary restraint for knee stability
- Share load bearing
- ? Proprioceptive function
- Increases the articular contact area
  - Lowers the load/unit area
  - Circumferential fiber orientation increases ability to support hoop stresses
  - Menisci transmit 30-55% of the load across the joint in the standing position
  - After meniscectomy contact stress may increase by 235%

Role as a Stabilizer

- Medial meniscus stabilizes against anterior translation of the tibia (particularly in ACL deficient knee)
- Medial meniscus thus subject to greater shear forces in ACL deficient knee
- Lateral meniscus more mobile and less likely to experience shear forces

Mean movement of the meniscus during flexion

- Erect and weight bearing
- Sitting, non-weight bearing

MR image in the sagittal plane of a knee a) in extension b) in 40 degrees of flexion and c) in 75 degrees of flexion. The arrows show the position of the anterior and posterior horns of the lateral meniscus.
Diagnosis
- History of twisting injury
- +/- ligamentous injury
- Effusion
- Mechanical Sx’s
- Joint line tenderness
- Provocative tests

McMurray Test
- 58% true positives
- 5% false positives
- forced tibial rotation with flexion and varus/valgus stress
- results:
  - negative
  - joint line pain
  - both pain and clunk (painless clunk not truly “positive”)

Steinman Test
- knee flexed at 90 degrees (sitting or lying)
- external rotation produces pain at medial joint line
- internal rotation produces pain at lateral joint line
- perform test at various degrees of flexion (pain which moves posteriorly with increasing flexion distinguishes meniscal injury from ligamentous injury and injury to osteophytes)

Apley Test
- patient prone
- knee flexed 90 degrees
- compression/distractor rotation
- pain with compression suggestive of meniscal pathology
- pain with distraction suggestive of ligamentous injury
“Duck Waddling”

Locked Bucket Handle Tear

Surgical Treatment (Arthroscopy)

- Partial Menisectomy
- Meniscal Repair

Tears

Surgical Treatment

Partial Menisectomy

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Meniscal Repair

Indications for Repair
- Recommended for longitudinal tears in the peripheral 10-30%
- Tears which displace more than 3mm
- Tears which may be left to heal:
  - peripheral tears < 10 mm
  - small radial tears < 3mm
  - (fenestration, rasping, or debridement of freed edges may expedite healing)

Meniscal Repair Technique
- 3 basic techniques for repair
  - inside out
  - outside in
  - all inside
  (saphenous and peroneal nerves always a concern)

Inside Out Technique
- suture passed through cannulas
- needle accepted outside via a posteromedial or posterolateral incision

Outside In Technique
- suture passed from outside through straight or curved needle
- knot is created once suture passed across the tear
- suture then pulled tight and tied to adjacent suture

Vertical suture superior to horizontal biomechanically
All Inside Suture Repair

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Repairs</th>
<th>Follow-up</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggli et al26</td>
<td>54</td>
<td>7.5 yr (average)</td>
<td>Clinical ± MRI 73% success</td>
</tr>
<tr>
<td>Albrecht-Olsen and Bak27</td>
<td>27</td>
<td>3 yr (median)</td>
<td>Clinical 63% success</td>
</tr>
<tr>
<td>Miller28</td>
<td>79</td>
<td>3.25 yr (mean)</td>
<td>Arthroscopy or arthrogram 84% healed (stable), 93% healed (recon)</td>
</tr>
<tr>
<td>Morgan et al29</td>
<td>74</td>
<td>8.5 mo (average)</td>
<td>Arthroscopy 65% healed (completely), 19% healed (incompletely), 16% failed</td>
</tr>
<tr>
<td>Cannon and Vittori30</td>
<td>90</td>
<td>10 mo (mean)</td>
<td>Arthroscopy or arthrogram 50% healed (stable), 93% healed (recon)</td>
</tr>
<tr>
<td>Buseck and Noyes31</td>
<td>66</td>
<td>1 yr (average)</td>
<td>Arthroscopy 80% healed (completely), 14% healed (partially), 6% failed</td>
</tr>
<tr>
<td>Tenuta and Arciero32</td>
<td>54</td>
<td>11 mo (average)</td>
<td>Arthroscopy 57% healed (stable), 90% healed (recon)</td>
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</tbody>
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Results of Meniscal Repair

Transplantation

- Ideal candidate:
  - young
  - active
  - pain over previously menisectomized compartment
  - normal knee alignment
  - minimal to no damage to articular cartilage

Problems

- expensive - may exceed $15,000
- disease transmission
  - irradiation damages graft
- technically demanding (fixation)
- volume loss (up to 70%)
- probably just a scaffold
  - DNA analysis shows 95% transplanted meniscus at 1 year identical to recipient
- lack of long term follow up data

What’s the latest?

A Comparative Study of Meniscectomy and Nonoperative Treatment for Degenerative Horizontal Tears of the Medial Meniscus

Background: a restudy whether a degenerative horizontal tear of the medial meniscus should be treated with surgery. Hypothesis: the clinical outcomes of arthroscopic meniscectomy will be better than those of nonoperative treatment for degenerative horizontal tear of the medial meniscus.

Methods: a total of 153 patients with knee pain and a degenerative horizontal tear of the posterior horn of the medial meniscus were included in this study between January 2007 and July 2009. The study included 77 males and 76 females with an average age of 43.4 years (range 18-72 years). The patients underwent arthroscopic experimental meniscectomy and nonoperative treatment. The patients were divided into two groups: treatment of meniscectomy and nonoperative treatment, respectively. All patients were examined using the Korean Meniscal Evaluation and Research (K-MER) scale. The mean follow-up period was 23.2 months (range 12-36 months). Results: the K-MER scale and subjective satisfaction scores were significantly different between the two groups. Although most patients showed slight improvement in pain and function, the nonoperative treatment group showed significantly better results than the meniscectomy group in terms of pain and function. Conclusions: there were no significant differences between arthroscopic meniscectomy and nonoperative treatment with strengthening exercises in terms of relief of knee pain, improved knee function, or increased satisfaction in patients after 2 years of follow-up.
In Summary

- Meniscal tissue essential to joint preservation
- Meniscus serves secondary roles in knee joint function
- Repairable tears are rare but indications should expand in younger patients
- Meniscal replacement strategies evolving

Future

Collagen Meniscal Implants