Meniscal Injury & Repair
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Epidemiology
- 60-70/100,000 per year
- Arthroscopic Meniscectomy
  - One of the most common orthopaedic procedures
  - 20% of all surgeries at some centers
- Male/Female ratio - 2:4:1
- Younger patients – acute traumatic incident
- Older patients – degenerative tears
- 1/3 of all tears associated with ACL injury
  - ACL Injury – lateral meniscus tears more frequent
  - Chronic ACL deficiency – medial meniscus injury more prevalent
- Tibial Plateau Fractures
  - Nearly 50% associated meniscal tears

Meniscus Anatomy
- Medial Meniscus
  - C-shaped
  - Posterior horn larger than anterior hom
  - Anchored to anterior and posterior bony attachments
  - Coronary Ligament
    - Remainder firmly attached to joint capsule
  - Deep MCL
    - Thickening of mid-portion of capsular attachment

- Lateral Meniscus
  - Semi-Circular configuration
  - Anchored to anterior and posterior bony attachments
  - Much closer than Med Meniscus
  - Anterior horn inserts adjacent to ACL
  - Meniscofemoral Ligaments
    - Humphrey – anterior
    - Posterior horn to femur
    - Wrisberg – posterior
    - Can be only posterior attachment in Wrisberg Variant discoid meniscus
  - Covers more tibial articular surface
  - Capsular attachments much less developed
  - Allows increased translation of lateral meniscus with ROM
**Arthroscopic Anatomy**

- Lateral
- Medial

**Microstructure**

- Type I collagen (90%)
  - Orientation mainly circumferential
  - Allows dispersion of compressive loads
  - Some radial fibers at surface and within mid-substance
  - Resist longitudinal tearing
  - Mesh orientation at surface
  - Distribution of shear stresses

**Blood Supply**

- Birth – entire meniscus is vascular
- 9 months – inner 1/3 is avascular
- Decreased vascularity until 10yo

- Adult Meniscus vascularity
  - PeriMeniscal Capillary Plexus
  - Superior and Inferior branches of Medial and Lateral Genicular Arteries
  - Lateral – outer 10-25%
  - Mostly avascular at Popliteal Hiatus
  - Medial – outer 10-30%

- Nerve Fibers
  - Concentrated in outer portion of meniscus
  - Dye et al. – conscious neurosensory mapping
  - Peripheral tissue – mild to moderate discomfort
  - Central tissue – little or no pain awareness
  - Mechanoreceptors in anterior and posterior horns
  - Proprioceptive feedback

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Meniscus Function

- 1897 Bland-Sutton
  - “the functionless remnants of the intra-articular leg muscles”

1. Load Sharing
2. Reducing Joint Contract Stresses
3. Passive Stabilization
4. Increasing Congruity/Contact Surface Area
5. Limiting Flexion/Extension Extremes
6. Proprioception

Meniscus Function

- Knee Extension
  - 50-70% of load transmitted through menisci

- Knee Flexion
  - 81% of load transmitted through menisci

- Total Medial Meniscectomy
  - 100% increase in contact stress
  - 50-70% reduction in femoral condyle contact area

- Total Lateral Meniscectomy
  - 200-300% increase in contact stress
  - 40-50% decrease in femoral condyle contact area

- ACL deficient Knee
  - Medial Meniscus is most important resistance to anterior tibial force
    - 50% increased load at full extension
    - 200% increased load at 60° flexion

History

- Twisting or Hyperflexion Injury
- Pain, swelling
- Locking, catching
- Loss of motion, extension block
- Degenerative Tears
  - Older patients
  - Chronic history of mild swelling and pain
  - Degenerative changes on Xrays

Physical Exam

- Inspection
  - Joint Effusion
  - Quadriceps Atrophy
  - Joint Line Swelling – parameniscal cyst

- Range of Motion
  - Mechanical block in extension
  - Loss of flexion

- Palpation
  - Medial and Lateral joint lines, patellofemoral joint

- Ligament Stability Testing

- Specialized Testing
  - McMurry’s Test
  - Apley Grind Test

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Diagnostic Studies

- **Xrays – IMPORTANT!**
  - Helpful for bony pathology and assessing degenerative changes
- **Series**
  - PA 45deg flexion weight bearing view of both knees
  - Lateral view
  - Merchant

Diagnostic Studies

- **MRI**
  - 95% accuracy of detecting tears
  - **BUT – must correlate clinically**
    - LaPrade – 5.6% tears in asymptomatic 18-39 year olds with normal physical exam
    - Boden – MRI on asymptomatic patients
      - < 45yo – 13% positive for meniscal tear
      - > 45yo – 36% positive for meniscal tear
  - Muellner – equal effectiveness of clinical evaluation compared with MRI

Classification of Meniscal Tears

Vertical Longitudinal Tear

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Bucket Handle Tear

Oblique Parrot Beak Tear

Horizontal Cleavage Tear

Radial Tear

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Complex Degenerative Tear

Surgical Indications

1. Symptoms affect
   - Activities of daily living
   - Work
   - Sports

2. Positive physical findings:
   - Joint line tenderness
   - Joint effusion
   - Limited Range of Motion
   - Provocative signs:
     - Pain with Squatting
     - Positive McMurry’s or Apley’s

3. Failure to respond to non-surgical management

4. Absence of other causes of knee pain identified on Xray or MRI

Total Meniscectomy

- Previously a commonly performed procedure
- Considered benign

1948 – Fairbank
- Joint space narrowing
- Osteophyte formation
- Squarring of femoral condyles

1987 – Jorgensen
- 147 athletes, followed at 5 and 14.5 years
- Knee complaints - 53%, 67%
- Knee Instability - 15%, 36%
- Radiographic degenerative changes 40%, 89%
- 46% gave up or reduced sporting activity

1992 – Wroble
- 39 adolescents, 21 year follow up
- Pain - 71%
- Stiffness - 68%
- Swelling - 67%
- Instability - 41%
- 90% with abnormal signs in affected compartment
- Overall 63% unsatisfactory results

Arthroscopic Partial Meniscectomy

- 80-90% satisfactory results compared with open total meniscectomy
- Less invasive
- Decreased hospitalization
- Shorter recovery time
Arthroscopic Partial Meniscectomy
- BUT – not a completely benign procedure
- Still a progression of degenerative changes compared to untreated knees
  - Does not necessarily correlate with subjective clinical results
- Worse results with:
  1. Concomitant Articular Cartilage Damage at time of arthroscopy
  2. Chronic ACL deficiency
  3. Mal-alignment

Meniscal Repair
- 1885: Annandale documented first successful meniscus repair
- Popularized in 1970s by DeHaven and Wirth as alternative to meniscectomy (DeHaven, Orthop Trans, 1981; Wirth, CORR, 1981)
- Direct open suturing of peripheral tears

Repair Techniques
- Open
- Inside-Out
- Outside-In
- All-Inside

Meniscal Repair
- Maintain Meniscal Functions
  - Load bearing
  - Shock absorption
  - Stress distribution
- Prevent degenerative changes
- Beneficial effects of meniscus preservation
  - Partial vs Total Meniscectomy
- So, repair should be even more beneficial……

Repair vs. Partial Meniscectomy
- Difficult to compare
  - Heterogeneity of tears
  - Associated injuries
    - ACL
    - Articular Cartilage
  - Patient Factors
    - Recreational vs. professional
    - Compliance with rehab
Repair vs Partial Meniscectomy

- Paxton – systematic review 2011
  - Repair has higher re-operation rate (23% vs 4%)
    - Higher in lateral meniscus
    - Lower combined with ACL reconstruction (14%)
  - Meniscal repair has not been definitively shown to reduce osteoarthritic changes when compared with partial meniscectomies
    - BUT – higher re-operation rate may be justified if there is a potential long term benefit of repair
  - There is some evidence that meniscal repair does lead to better radiologic and subjective outcomes over the long-term.

Meniscal Repair

- Indications
  1. Young, active patient
  2. Acute, symptomatic tears
  3. Complete vertical longitudinal tear >10mm
  4. Peripheral 10 – 30% (red-red and red-white zones)
  5. Unstable tear
  6. Stable knee
    - 30 – 70% success rate in unstable knees

Meniscal Repair

- Contraindications
  1. Degenerative tear in older patients
  2. White-white avascular tear
  3. Stable, incomplete tears
  4. Infectious, rheumatoid, collagen vascular disease
  5. Non-compliance with rehab
  - Growing Indications in young patients
    - Devices evolving
    - Techniques improving
    - Role of Biologics?
    - Sometimes an attempt to repair is better than the alternative

Meniscal Repair

- Techniques
  - ALL-INSIDE
  - Inside-out
  - Outside-in

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All-Inside

Advantages
- All arthroscopic, no open incisions
- Easy access to posterior meniscus
- Shorter operating time
- Relatively quick, easy insertion
- Implants necessary
- 4 generations:
  - 1st – suture hooks
  - 2nd – sutures attached to a peripheral bar (T-fix) – required knot tying
  - 3rd – rigid bioabsorbable devices (arrows, darts)
  - 4th – suture devices, lower profile, allow tensioning (Fix-T-Fix, RapidLoc, Viper)

4th generation suture devices show comparable biomechanical strength to open and inside-out techniques

All-Inside Suture devices

Clinical Results
- Hass 2005
  - 80-90% clinical success at 2 years
  - 91% with ACLR
  - 80% isolated tears
- Barber 2008
  - 83% clinical success at 3 years

All-Inside

Complications
- Still risk of neurovascular damage
- Implant problems
- Technical problems
- Difficult to access anterior horn

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Meniscal Repair
- Improved results combined with ACLR > 90%
- Abundance of blood and growth factors in the joint
- Relatively limited patient activity
- Less aggressive initial rehabilitation
- Intrinsic condition of the meniscus at the time of repair
- Augmenting isolated meniscal repair?
  - Iatrogenic trauma to the surrounding synovium/fat pad
  - Microfracture in the notch/notchplasty
  - Growing interest in Biologics

Stem Cells
- Animal Studies – encouraging
  - Smaller defects
    - MSCs appear to localize and remain at the repair site
  - Larger defects
    - Require a scaffold loaded with MSCs
      - Must pass through FDA regulatory pathway
- Early clinical studies
  - Show potential for
    - Increased meniscal volume after meniscectomy
    - Decreased pain after meniscectomy
    - Increased healing rate after repair

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Rehabilitation

- Partial Meniscectomy
  - Accelerated rehab
  - Immediate WBAT, FROM
  - RTP 3-6 weeks

- Meniscal repair - controversial
  - Isolated repair
    - Protected weight bearing
    - 50% PWB for 2 weeks, then advance to WBAT
    - Brace locked in extension for 4 weeks
    - Restricted hyperflexion/squatting for 4 weeks

Rehabilitation

- With ACL Reconstruction
  - No significant alteration in rehab protocol
  - ROM and Weight bearing already limited by ACL in the early post-op period

  - WBAT Immediately
    - Weight bearing helps to compress circumferential fibers
    - Reduces meniscus
    - Stabilizes tear

- BUT --- NWB for radial tears – only exception
  - Circumferential fibers disrupted
  - Weight bearing distracts tear margins

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conclusions

• A good history and physical exam with MRI can accurately diagnose meniscal injury
• Partial meniscectomy is one of the most commonly performed procedures today, but is not completely benign
• Meniscal Repair can preserve meniscal tissue and function when performed on the appropriate tear type and patient population
  • All-Inside has become the preferred method for repair
  • In combination with ACLR
  • A meniscal repair has a better chance to heal
  • Postoperative rehab protocol does not need to change with a repair
  • For isolated meniscal repairs
  • There is an increasing role for biologics
  • The repair needs to be protected postoperatively