Meniscus Injuries: Strategies for Treatment

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Treatment of Meniscus Injuries

Disclosure

- I do have consulting and speaking relationship with
  - Smith Nephew Endoscopy
  - Zimmer

Treatment of Meniscus Injuries

Objectives

- Anatomy
- Function
- Biology
- Imaging
- Tears and their treatment
- Discoid meniscus
- Meniscus transplantation

Meniscus Anatomy

- Medial
  - large posterior horn
  - sits on concave tibia
  - firmly attached to deep MCL/POL
  - roots far apart

- Lateral
  - uniform size
  - sits on convex tibia
  - very mobile
  - roots close to ACL

Compliments of Freddie Fu, MD

Meniscus Anatomy

- Lateral meniscus more C-shaped
- Meniscofemoral ligaments
  - Humphrey anterior (~50%)
  - Wrisberg posterior (~76%)
  - DeMeo (> 90%)
- Differences in mobility
  - Medial meniscus translates 2 – 5 mm
  - Lateral meniscus translates 9 – 11 mm

Compliments of Freddie Fu, MD
Meniscus Anatomy

Werner Mueller, MD
Basel, Switzerland

Meniscus Microstructure
Structure and composition account for viscoelastic properties

- Circumferential collagen fibers
- Circumferential fibers are “anchored” by small number of radial fibers
- Development of “hoop stresses” under axial loading
- Requires root attachment to tibia (Paletta/Parker 1997)

Meniscus Vascularity

- Medial: peripheral 20-30%
- Lateral: peripheral 10-25%
- Originates from geniculate arteries
- Vascular synovial fringe extends 1-3 mm over surface does not contribute vascularity
- Majority avascular—nutrition from synovial fluid diffusion

Meniscus Biology

- Healing occurs more predictably in vascular zone
- Healing proceeds by classic wound healing pathway
  - Inflammation
  - Granulation tissue
  - Undifferentiated mesenchymal cells

Meniscus Microstructure

- Neural elements in periphery and at horn attachment sites and felt to contribute to proprioception?
- Contribute to functional knee stability??
- Probing meniscus in awake patient:
  - Central: no pain
  - Peripheral: + pain awareness
**Meniscus Biology**

- Lesion in vascular zone—dog
- Healing by fibrovascular scar
- Vessels from perimeniscal capillary plexus proliferate
- Proliferation of mesenchymal cells
- Healed by 10 weeks

*The Microvasculature of the Meniscus and Its Response to Injury*  
Arnoczky & Warren *AJSM, 1983*

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**Meniscus Function: Load Transmission**

- Improve congruency & surface area
- Medial 50% & Lateral 70% of compartment load
- Transmit 50% of load in extension, 85% of load in flexion
- Partial meniscectomy:  
  - contact area 10%
  - peak load 65%

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**Meniscus Function:**

- Total LM: ~ 50% decrease contact area
- Allograft Transplant increase in contact area by 65% compared to Total LM
- If roots not attached contact area equal to Total LM

*Paletta, G., Parker RD., et al. The Effect of Allograft Meniscal Replacement on Intraarticular Contact Area and Pressures in the Human Knee: AJSM 1997*

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**Meniscus Function:**

- Total LM: ~ 300% increase in peak contact pressure (PCP)
- Allograft Transplant decrease PCP by ~ 65% compared to Total LM
- If roots not attached PCP equal to Total LM

*Paletta, G., Parker RD., et al. The Effect of Allograft Meniscal Replacement on Intraarticular Contact Area and Pressures in the Human Knee: AJSM 1997*
**Meniscus Function:**  
*Stability*

- Biomechanical interdependence between ACL and medial meniscus
- Medial meniscus is 2° restraint to anterior tibial translation in ACL-deficient knee
- Supports clinical finding of high prevalence of meniscus tears in chronic ACL insufficiency
- Lateral meniscus: no contribution

Levy et al, JBJS 1982  
Allen et al, JOR 2000

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**Load Sharing Between Medial Meniscus and ACL**

- Increased forces in medial meniscus in ACL-deficient knee (126% at 30°, 115% at 90° flexion)

Papageorgiou et al, AJSM 2001

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**Load Sharing Between Medial Meniscus and ACL**

- Increase in the in-situ force in ACL graft in medial meniscus-deficient knee compared to meniscus-intact knee

Papageorgiou et al, AJSM 2001

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**Consideration of Meniscus Function Explains Natural History of Meniscus-Deficient Knee**

- Clinical studies support experimental models
- Progressive degenerative changes following meniscectomy
- Rate/degree of degeneration proportional to magnitude of meniscus deficiency

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**Natural History of Meniscus-Deficient Knee**

- Meniscectomy outcomes affected by:
  - Concomitant degenerative changes
  - Partial vs total meniscectomy
  - Medial vs lateral
  - Status of ACL
  - Type of tear (especially degenerative tear)
  - Alignment
  - BMI
  - Genetic

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**Imaging**

- Plain Radiographs
- EWB Hip to Ankle Radiographs
- Bone Scan
- MRI
- Diagnostic Arthroscopy
Plain Radiographs

- Weight bearing views to evaluate weight bearing parts of the knee
- Supine is for ER

Ahlback AP EWB View
30° Flexion Lateral View
45° PA FWB View

Supine View
45° PA FWB View

Fairbank’s Changes (1948)
1) Ridge on condyle
2) Flattening of condyle
3) Joint space narrowing
(Sclerosis is not a Fairbank Change!)

AP - EWB Hip to Ankle Radiographs

- Pre – osteotomy
- Pre – meniscal transplant
- Pre – ACR

Matava M, Wright R, Et. al: AJSM, 1999

MRI

- Helpful clinically
- Associated pathology
- Moderately reliable in predicting reparability (74 %)
- CAVEAT: Patients expect one!
MRI

- After 4 – 6 weeks of symptoms unless:
  - ACL injury
  - locked knee
  - multi-ligament injury
  - special situations
- Cyst
- Co-morbidities: chondrosis
- Worried about differential dx
- Meniscus transplant w/u

Changes vs. Tear

- MRI reports are read by:
  - ordering doctor
  - patient
  - patient’s family
  - lawyers
  - general managers
  - electronic medical record
  - etc.
- Focus on tears not changes!

Changes vs. Tear

- Changes
  - Type 1: intrasubstance
  - Type 2: intrasubstance without exiting surface
  - Type 3: same as tear

MRI

- Worried about differential diagnosis
  - Level IV EBM (Case Series)
  - Clinical spectrum of AVN of the knee
  - If insufficiency fracture then treatment is directed towards “treatment of stress fracture”

Spontaneous Osteonecrosis of the Knee Reclassified as Insufficiency Fracture

Diagnostic Arthroscopy

- Some cases prior to committing to meniscal transplant or ACR
- If clinical history and physical exam over ride imaging!

Treatment of Meniscal Injuries

Tear Types

- Classic tear types
Tear Types
• Classic tear types
• Complex tear
  - combination of tears
  - degenerative
  - horizontal changes
• Root tear (degenerative)
• Root avulsion (traumatic)

Treatments of Meniscal Injuries

Tear Types
• Classic tear types
• Complex tear
  - combination of tears
  - degenerative
  - horizontal changes
• Root tear (degenerative)

Treatment
• Always dictated by patient’s history
• Physical
• Radiographs +/- MRI
• Options
  - remove
  - leave alone
  - repair

Caveat
• A meniscus tear on MRI with or without arthrosis is only important if the patient is having meniscal mechanical symptoms!
• People can “live and die” with meniscal tears

Remove
• tears in avascular zone
• complex, flap, radial & cleavage tears
• severe damage to body/root
• degenerative meniscal cyst
• arthritis (chondrosis)
Treatment of Meniscal Injuries

• Overall, most studies report good long-term clinical and functional results following arthroscopic partial meniscectomy
• However, increasing radiographic deterioration is found with follow-up beyond 10 years

Treatment of Meniscal Injuries

Leave Alone

• Stable tear in vascular zone
• Stable tear with ACLR
• Stable degenerative components of tears
• Clinically insignificant - degenerative fraying

Shelbourne: AJSM, 1995 / Yagishita: AJSM 2004

Treatment of Meniscal Injuries

Repair

• ~ 30% of my young patient population
• greater % in ACLR and combined injuries

Treatment of Meniscal Injuries

Meniscus Repair

• Vertical/horizontal mattress sutures have:
  - highest load to failure
  - least displacement

Indications for Meniscal Repair

• Young (relative)
• Stable knee (ACL)
• Traumatic acute injury greater than 10-15 mm in length
• Longitudinal tear with one or both sides in the vascular zone (< 5 mm)
• Extend into avascular zone with ACL reconstruction
• Able to adhere to postoperative rehabilitation

Meniscus Repair

Rankin et al AJSM 2002
Meniscal Repair
Options
- Open repair
- Arthroscopic repair
  all-inside
  outside-in

8 – 18 mm length, unstable, but not a bucket - handle

Meniscal Repair
Options
- Open repair
- Arthroscopic repair
  all-inside
  outside-in
  inside-out

> 15 mm in length, unstable, bucket - handle

Meniscal Repair: Inside-Out (Sutures)
STEP I: Determine Reparability

Meniscal Repair: Inside-Out (Sutures)
STEP I: Determine Reparability
Meniscal Repair: Inside-Out (Sutures)

**STEP II: Prepare for Repair (Rasp)**

**STEP III: Medial or Lateral Incision**

A  Medial: Protecting the Saphenous Nerve

B  Lateral: Protecting the Peroneal Nerve

**STEP IV: Repair**

A

B

36

42
STEP V: Tie Sutures/Check Repair

STEP V: Check for Bleeding

Meniscal Repair: Inside-Out (Sutures)

Meniscal Repair: Inside-Out (Sutures)

Meniscal Repair
Unusual Tears

• Root avulsion in Multiligament Injury

Root Avulsion in Multiligament Injury

Radial tear treated with partial medial meniscectomy

Meniscal Repair
Root Avulsion in Multiligament Injury

Meniscal Repair
Root Avulsion in Multiligament Injury
Meniscal Repair

**Unusual Tears**

- Complete radial tear of lateral meniscus with ACL/MCL

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Meniscal Repair

**Complete Radial Tear Lateral**

Peripheral rasping and central partial meniscectomy

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Methods to Improve Meniscus Healing

- Picking inter condylar notch
- Fibrin clot
- Platelet rich plasma evolving
- Vascular access channels
- Negative effect on meniscus collagen fiber architecture
- Synovial pedicle flap
- Cytokines?
- Gene transfer?

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Methods to Improve Meniscus Healing

- 16 yo swimmer with 1 year of mechanical symptoms especially with turns in competition
Methods to Improve Meniscus Healing

- Fibrin clot
- Platelet rich plasma evolving

Meniscal Repair

Postoperative Rehabilitation

- Controversial

Meniscal Repair

Postoperative Rehabilitation

- DeHaven: NWB 6 weeks/no sports for 6 months

Meniscal Repair

Outcomes

- Systematic review of all-inside repair
- 31 studies predominantly Level 4 case series
- Variety of techniques, settings and devices
- 0 - 43% failure rate
- Unable to find significant differences between failure and device

Lozano, Ma, Cannon. All-inside Meniscal Repair, CORR 455, 2007

Meniscal Repair

Outcomes

- Prospective evaluation of 82 repairs in 80 pts with ACLR
- 94% f/u at 2 years
- 96% success at 2 years as defined by reoperation

Success of Meniscal Repair at ACL Reconstruction. MOON Group. AJSM 37, 2009
**Tears Not Suitable for Repair**

- stable tears < 5 mm in peripheral 2/3 – leave alone
- flap, radial & cleavage tears
- severe damage to body
- arthritis (chondrosis)
- tears in avascular zone
- thickness < 3 mm – debride

**Degenerative Root Tear Medial Meniscus**

- Stabbing pain posterior medial
- Associated with “misstep”

**Degenerative Root Tear Medial Meniscus**

- Extrusion

**Lateral Meniscal Cyst**

- Usually cyst or ganglion intermittent swelling and pain associated with pressure
**Lateral Meniscal Cyst**

- Treated with partial meniscectomy and arthroscopic evacuation of cyst
- Consider open if recurrence?

**Meniscal Transplantation**

- Fresh, cryopreserved, or fresh-frozen tissue
- With or without attached bone
- Goals:
  - Relieve symptoms
  - Prevent progressive degenerative joint disease
- Favorable clinical results reported
- Long-term chondroprotection??

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**Meniscal Transplantation in Sheep**

- Sheep model
- Chondroprotective effect of meniscal transplantation, but not as good as control

Kelly BT, Potter HG, Warren RF, Rodeo SA: AJSM 2006
Meniscal Transplantation

- Meniscal transplants heal to the periphery
- Meniscal transplants may shrink

Meniscal Transplantation in Sheep: Evaluation of Chondroprotective Effects
Kelly BT, Potter HG, Warren RF, Rodeo SA: AJSM 2006

Meniscal Transplantation

- Sizing based on radiographic tibial plateau measurements
- Contraindications:
  - Advanced articular cartilage degeneration
  - Instability
  - Axial malalignment unless corrected
  - Flattening of the femoral condyle

Meniscal Transplantation

Indications

- age: 14 – 40??
- symptomatic: localized pain
- prior subtotal meniscectomy
- minimal arthritis
  (≤ Grade III or focal Grade IV)
- no architectural changes (condylar flattening)
- ligamentously stable
- alignment: favoring the involved side
- Informed patient with realistic expectations!

Meniscal Transplantation

MEDIAL: Ideal Candidate

LATERAL: Good Candidate

Post Implantation

Medial  Lateral
Meniscal Transplantation
Summary of Clinical Outcomes Data

- Predictable relief of symptoms of pain, swelling
- Knee stability & limb alignment are critical
- Frozen or cryopreserved grafts better than lyophilized due to shrinkage
- Cellular re-population is of host origin with an overall reduction in cellularity
- Grade III-IV chondromalacia has a significant negative impact on outcomes

Meniscal Transplantation
Summary of Clinical Outcomes Data

- Concomitant OATS & knee ligament reconstruction procedures may improve knee function without an increased rate of complications
- A sustained beneficial effect has been demonstrated in up to 70% of pts at 10 yr follow-up in one study
- Results deteriorate over time as demonstrated at 3 yr & 14 yr follow-Up in two separate studies

The ability of meniscal allografts to prevent degenerative arthritis & the degree of articular cartilage protection they provide has not yet been shown

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Thank you!