Meniscal Repair Using Resorbable Materials

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Fairbank’s Signs

Clinical Symptoms of Meniscal Pathology

- Joint Line Pain
- Catching
- Locking
- Swelling
Degenerative Changes Post Meniscectomy

- Gear, Br J Surg, 1967
- Tapper, JBJS, 1969
- Johnson, JBJS 1974
- Cox, CORR 1975
- Krause, JBJS 1976
- Casscells, CORR 1978
- Allen, JBJS 1984
- Veth, CORR 1985
Function

- Load Transmission
- Shock Absorption
- Stability

- Joint Lubrication
- Joint Nutrition
- Proprioception?
Basic Science Meniscal Function

Load Transmission

- Degenerative arthritis in canine model directly related to amount of meniscus excised.
  
  Cox, CORR 1977

- Remove 16% to 34% meniscus increase contact force 350%
  
  Seedham, NEJM 1979

- Complete menisectomy peak loads increase up to 235% of normal vs. partial menisctomy peak loads increase 65% of normal
Principle of Partial Meniscectomy

• Remove as much unstable torn tissue as possible, **but**—
• Leave behind as much normal tissue as possible!
Principle of Partial Meniscectomy

- Partial meniscectomies are not equal
  - Segmental worse than circumferential

- Need to keep hoop stresses
Partial Meniscectomy

Less Arthritis...

Burkes, R.T., Arthroscopy, 1987
Anderson; Arthroscopy 2002
Why Not Repair!?
Partial Meniscectomy

- Quick procedure
- Unrestricted rehab
- Excellent short term results
Meniscal Repair

- Increased surgery time
- Slower rehabilitation
- Complications
- Indications?
- Non Healing/Retear
Meniscal Repair Techniques

• Open Meniscal Repair
• Inside-Out Meniscal Repair
• Outside In Meniscal Repair
  - Suture Based
  - Implant Based
• All Inside Meniscal Repair
Meniscal Repair Rates 80-95%

- Kristensen, Acta Orthop Scand 1994
- Stone, Arthroscopy 1993
- Cannon, AJSM, 1992
- Morgan, AJSM 1991
- Hanks, Arthroscopy, 1991
- Henning, 1990
- Warren, CORR 1990
- Miller, DD, AJSM 1988
- Ryunk, Arthroscopy 1988
- Scott, JBJS, 1986
- Stone, Arthroscopy, 1986
- Rosenberg, Arthroscopy, 1986
- Cabaud, AJSM 1981
Criteria for Healing

- Clinical
- Objective
Criteria for Healing

Clinical

• No Symptoms
  – Joint Line Pain
  – Clicking
  – Locking
  – Swelling
Criteria for Healing

Objective

- Arthrography
- MRI
  - Bronstein, Orthopedics, 1992
  - Farley, Radiology, 1991
- Second Look Arthroscopy (Gold Standard)
  - Henning, CORR, 1990
  - Cannon, Arthroscopy, 1991
Second Look Arthroscopy

Repair Rates

- Completely Healed 75 – 80%
- Partially Healed 15 – 20%
- Failure to Heal 5 – 10%
Follow Up

- Need Long Term Studies
- Most Studies Published at 2 Year Follow Up
Long Term Follow Up Studies

- Follow Up 11 Years/100% Patients
- 33 Meniscal Repairs
- Retear—Average at 4 years!

DeHaven, AJSM, 1995
General Principles of Mensical Repair

• Vascularity
• Stability
• Rehabilitation
• Selection

Need blood to heal.
Vascularity

• Red on Red
• Red on White
• White on White
Prepare Tissue

- Abrasion
- Trephination
“At Risk Repair”
Exogenousous Fibrin Clot

Henning, CORR 1990
Cooper, Clin Sports Med 1990
General Principles of Mensical Repair

- Vascularity
- Stability
- Rehabilitation
- Selection

The more stable the repair, the better.
Stability: Principle

- Reconstruct ACL when possible.

ACL Tear with Associated Meniscal Tear

- Cannon, AJSM 1992
- Warren, CORR 1990
- Rosenberg, Arthroscopy 1986
- Barber, Arthroscopy 1988
- DeHaven, AJSM 1989
Second Look Arthroscopy
—Cannon

Overall (15%)

ACL & Repair (83%)

Isolated Repair (48%)
Meniscus Repair Rates

Rule of Thirds

• ACL Deficient Knee 30%
• ACL Stable Knee 60%
• ACL Reconstructed Knee 80-90%

Yamamoto, Arthroscopy, 1996
Why Better Results?

- Younger Patient
- Acute Tear (Less Deformity, Less Degeneration)
- “Normal” Meniscus That Tore Secondary to an Instability Episode
- Longitudinal Peripheral Type Tear (Red/White or Red/Red Zone)
- Hemarthrosis (Chemotatic and Growth Factors)
- Protected Rehab Secondary to Reconstruction (Pain, Slower Motion)
Biomechanics

Stability of Repair

- Vertical Suture
- Horizontal Suture/Resorbable Anchors
- Mulberry Knot

- Better
- Vertical Suture 80 N
- Horizontal Suture 50 N
- Resorbable Anchors 40 N
- Mulberry Knot 30 N

- Worse
Biomechanics
Stability of Repair

- Nonabsorbable sutures
- More sutures
- Stack sutures

- Kohn, Arthroscopy 1989
- Barber, Arthroscopy 1988
General Principles of Mensical Repair

- Vascularity
- Stability
- Rehabilitation

Tears heal at variable rates.
Unknown…

• Length of time for maturation of vascular seam?
Meniscal Repair Rehabilitation

• **Individualize Rehab**
  - Type of tear
  - Associated injury
  - Type of repair

• **“At Risk Repair”**
  - Protect weightbearing
  - Limit motion
  - Brace in extension
Meniscal Repair with ACL Reconstruction

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM 0-90°</td>
<td>4 – 6 wks</td>
</tr>
<tr>
<td>Partial Weight Bearing In Brace in Extension</td>
<td>4 – 6 wks</td>
</tr>
<tr>
<td>Straight In-line Running</td>
<td>6 mos.</td>
</tr>
<tr>
<td>Unrestricted sports</td>
<td>9 mos.</td>
</tr>
</tbody>
</table>

Healing of Meniscus at Second Look Arthroscopy

- Conservative Rehab  85% Healed
- Full Weight Bearing and Unrestricted Motion  57% Healed

Meniscal Repair Rehabilitation

• General Principles
  – No sports 6 - 9 months
  – No squatting 6 - 9 months
General Principles of Meniscal Repair

- Vascularity
- Stability
- Rehabilitation
- Selection

Need right patient and the right tear.
Selection

Summary of General Principles

• Young
• Acute Tear (Less Deformity)
• Compliant with Rehabilitation
• ACL Reconstruction in Conjunction with Repair
• Small Tear (<2cm)
• Good Vascularity
• Lateral Meniscus?
Open Meniscal Repair

- Dehaven
- Cassidy
- Lysholm
“Inside-Out Meniscal Repair”
- Cannon
- Stone
- Henning
- Rosenberg
- Clancy
Inside-Out Meniscal Repair

- Most popular
- Best Studied (Most Data)
- Good Visualization
- Good Suture Placement
  - Vertical
  - Horizontal
- Zone Specific Cannulas
- Fibrin Clot?
Disadvantages

- Need Exposure (Ancillary Incision)
- Need “Assistant Expertise” for Needle Passage
- Possible Complications
  - Needle Stick to Surgeon or Assistant
Complication

• Neurovascular Compromise
  – Saphenous Nerve
  – Peroneal Nerve
  – Tibial Nerve
  – Popliteal Artery
Complication

- Arthrofibrosis
  - Particularly with Medial Meniscus
  - High with ACL Surgery
Outside-In Meniscal Repair

• Access for Anterior Horn Tears
• Lower Neurovascular Risk
• Fewer Instruments
  – Spinal Needle
  – Suture (PDS)
Disadvantages

• Oblique Suture
• Difficult to Get Posterior
• Stable to Unstable
• Midrandge Strength
• All inside technique
• Bioabsorbable material
“Bioresorbables”
Confusing New Vocabulary

- Allergic Response
- Polyglycolic Acid
- Biocompatibility
- Strength to Failure
- PLA
- Poly-C-Capralacton
- Polydioxanone
- PLLA/PGA
- Poly-L-Lactic Acid
- Amorphous
- Hyloisis
- Resorption
- Polymers
- 96L/4D PLA
- Copolymers
- L-PGA
- PGA
- PDS
Resorbable Material

• Polyglycolic Acid PGA
  – Loses strength quickly after 1 month
  – Resorbs completely within 12 months

• Poly-L-Lactic Acid PLLA
  – Loses strength at 6 - 12 months
  – Totally resorbed at 2 -4 years
Balance Act

• Need to have implant resorb as quickly as possible
  BUT
  retain strength as long as possible.
The Bionix Enthusiasm—1996

- Kristensen, Acta Ortho Scand, 1994 Repair of buckethandle tears
- 50% of vertical suture in human cadaveric meniscus
  - Devin, Arthroscopy, 1997
- Equal to horizontal suture in bovine meniscus
  - Albreck & Olsen, Arthroscopy, 1997
Advantages

• Less O.R. time
• Less need for trained assistants
• Less morbidity
  – No ancillary incision
  – Neurovascular compromise
Clinical Studies

- 2 Yr. Follow-Up/29 Patients
  - 15% Local Soft Tissue Complications
  - 94% Clinical Success
  - 7% Failures
  
  Petsche, et al, Arthroscopy 2002

- 2 Yr. Follow-Up/38 Patients
  - 31.6% Local Soft Tissue Complications
  - 93% Clinical Success
  - 7% Failures
  - 0% Failures in ACL Reconstruction Group
  
  Jones, et al, Arthroscopy, 2002

- 2 Yr. Follow-Up /32 Patients
  - 90% Success Clinical
  - Avg. 2.5 Arrows
  - 80% Medial Posterior Horn

  Arthroscopy, Aug. 2002
“Reality Check”

- Expensive
  - $110
  - 1 per pack/need many

- Stiff and Brittle
  - PLLA
  - Capsular Pain Cyst Formation

- Inflammatory Reaction

- Broken Arrow
  - Calder; Arthroscopy 1999

- Cyst Formation
  - Hecht *Arthroscopy* 1999

- Inflammatory Reaction
  - Menche *Arthroscopy* 1999

- Chondral Injury
  - Anderson *Arthroscopy* 2000
  - Ross *Arthroscopy* 2000
  - Siel; Arthroscopy 2001
Huge Market

- Over 100,000 ACL Reconstructions per year
- 800,000 Meniscal Cases Per Year
<table>
<thead>
<tr>
<th>Company</th>
<th>Name of Implant</th>
</tr>
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<tbody>
<tr>
<td>Arthrex</td>
<td>Meniscal Dart</td>
</tr>
<tr>
<td>Arthrotek</td>
<td>Mensical Staple</td>
</tr>
<tr>
<td></td>
<td>Meniscal Screw</td>
</tr>
<tr>
<td>Bionix Implant</td>
<td>Meniscus Arrow</td>
</tr>
<tr>
<td>Innovative Devices</td>
<td>Clearfix Meniscal Screw</td>
</tr>
<tr>
<td></td>
<td>Clearfix Meniscal Dart</td>
</tr>
<tr>
<td>Linvatec</td>
<td>Biostinger</td>
</tr>
<tr>
<td>Mitek</td>
<td>Meniscar Repair System</td>
</tr>
<tr>
<td>Surgical Dynamics</td>
<td>SD Sorb</td>
</tr>
<tr>
<td></td>
<td>Meniscal Stapler</td>
</tr>
</tbody>
</table>
Difference in Systems

- **Design of Instruments**
  - Cannula Delivery Systems (size, shapes, etc.)

- **Type of Fixation**
  - Dart vs Screw etc.

- **Pull out Strength**
  - Whose Data
  - How “Much is Enough”

- **Material Composition**

[Diagram showing balance between PGA and PLLA]
Arthrotek Meniscal Screw

• Headless

• Biodegradable
  – LactoSorb (82% PLLA, 18% PGA)
  – 8 wks: 75% Strength
  – 9 – 12 Months: Resorbed

• Specialized Instruments
  – Zone Specific
  – Tactile Feedback

• 1 Pack Screws or
  3 Pack Screws
Zone Specific Cannulas
• Constant Pitch of Threads of Screw Tapers for Compression
• Good Pull-Out Strength
Probe and Assess Tear (get to know it)
“Stimulate” Healing Response
Reduce Tear (Anchor Stitch)

Device Placement
Place Implants Perpendicular (Use Accessory Portals)

Assess Repair Stability
Medial and Lateral Meniscal Tear Patterns in Anterior Cruciate-Deficient Knees

• A Prospective Analysis of 575 Tears

  Smith, Barrett, AJSM 2001

• Medial (305)

• Lateral (270)

• Medial More Posterior (99.4 vs 87.8) and Peripheral (75 vs 44) than Lateral

• Conclusion
  – Peripheral Posterior horn tears of the medial meniscus were the most common type of tear (230 of 575) 40%
Motion Complications

- 25% Motion Problems with Bucket Handle Medial Meniscus Tears
  - Shelbourne AJSM, 1998

- Overall, 18%, (with ACL 20%; Isolated 14%; Arthrofibrosis 6%, Saphenous Nerve 7%)
  - 10% Arthrofibrosis when with ACL
  - Austin, Sherman, AJSM, 1993
Bioresorbable Best Indications

- Young Patients
- Longitudinal Peripheral Tears
- Mid Meniscus to Posterior Meniscus Type Tears
- ACL Tear with Reconstruction
Meniscal Repair Options

• Some ideal for resorbables

• Consider Hybrid
  – Screw or inside-out for posterior tears outside -in for anterior tear

• Isolated bucket-handle tears particularly medial meniscus
  – Formal Sutures, “Stack” “Vertical” “Non resorbable” “Many”
Conclusion:
Resorbable Meniscal Implants

• Evolving
  – Material Properties
  – Techniques
  – Indications
  – Long Term Results
Thank You!

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