Meniscal Tears/Deficiency in Athletes

A. Amendola MD
Professor of Orthopaedic Surgery
Director of Sports Medicine
Duke University
Meniscal tears

Introduction

- Meniscal tears are one of the most frequent injuries of the knee

Surgical management options

- Total meniscectomy
- Partial meniscectomy
- Repair of meniscus
- Meniscal allograft/replacement

Meniscus Function

- Load transmission
- Shock absorption
- Knee stability
- Proprioception
- Chondrocyte nutrition
- Joint lubrication

Source: mendmyknee.com
Meniscal Anatomy

Lesions within 2-3mm of periphery or with vascular access heal.

Total/ Subtotal Meniscectomy

- Poor results following total meniscectomy

Johnson et al 1974
- 57.5% (all ages) unsatisfactory at 17.5 yrs

Post Meniscectomy

What do we do now?
Arthroscopic Partial Meniscectomy

- **Traditional Indications**
  - Unstable tear in avascular zone
  - Degenerative tears: Medial vs lateral

Partial Meniscectomy

**Long-term Follow-up**

- **Burks et al, 1997**
  - 146 patients /15 years
  - 88% good/excellent in ACL stable knees
  - Age, medial vs lateral not factors
  - Poorer radiographic results in varus knees
  - ACL deficient knees significantly poorer

- “...the result of partial meniscectomy in a stable knee is good enough that the morbidity of heroic measures to save complex tears may need close scrutiny.”
  - Burks et al
**Partial Meniscectomy**

**Long-term Follow-up**

- Schimmer et al 1998
  - 119 patients /12 years
  - Articular cartilage lesions untreated
  - 78% good/excellent in ACL stable knees
  - ACL disruption, articular cartilage status - increased symptoms at 5+ years
  - Additional pathology a limiting factor

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**Arthroscopic Partial Meniscectomy**

- Low morbidity
- Easy rehabilitation
- Early return to activity

One of the most common procedures in athletes and active patients

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**Meniscal resection: What Matters?**

**Factors to consider:**

- Medial vs lateral
- Root tears
- Morphology of tear:
  - degenerative vs acute
  - Radial vs longitudinal
- Limb alignment
- Knee instability
- Activity level
- BMI, sex, age of patient
1. Medial vs lateral

- Lateral Meniscus normally carries more load than medial
- Convex femur on convex tibial plateau
- Lateral meniscus more mobile
- Lateral compartment more mobile than medial

Medial vs lateral

Why Lateral Meniscectomy Is More Dangerous Than Medial Meniscectomy. A Finite Element Study

Estheria Pola, Rogelio Calvo, Miguel Angel Martinez, Daniel Palanca, Manuel Delcandi
JOR , 2005

- Pena et al con’t
- Maximum shear stress from Normal
  - Partial med: 98%
  - Total med: 177%
  - Partial lat: 415%
  - Total lat: 687%
Medial vs lateral

Risk Factors and Predictors of Significant Chondral Surface Change From Primary to Revision Anterior Cruciate Ligament Reconstruction

A MOON and MARS Cohort Study

![Graph showing Medial vs lateral comparison]

2. Posterior root tears

Meniscal root tears: a silent epidemic

Mark E Cinque, Jorge Chahla, Gilbert Moatshe, Scott C Fauchett, Aaron J Krych, Robert F LuPree

![Diagram of Meniscal Root Tears]

2. Posterior root tears

Posterior meniscal root injuries
A comprehensive review from anatomy to surgical treatment

Gilbert Moatshe, Jorge Chahla, Scott C Fauchett, Aaron Krych, and Robert F LuPree
3. Morphology of the tear

- Longitudinal tears better than radial tears
- Degenerative tears do worse than traumatic tears
- Better outcomes with less resection, rim intact

4. Knee alignment

- Abnormal knee alignment will lead to progression of arthritic changes following partial meniscectomy (ref 1,2)

5. Knee Instability

—ACL instability will lead to more rapid progression of arthritic changes following partial meniscectomy
  • Increased shear stress
  • Increased meniscal loading
  • Increased motion

6. Knee Arthrosis and meniscectomy

—Poorer results following partial meniscectomy in the presence of arthrosis
  • Schimmer et al
    —62% good or excellent with degenerative changes
    —95% good or excellent with normal articular cartilage

7. Activity level post meniscectomy

—Poorer results following partial meniscectomy in the presence of significant stressful activity
  • 286 soccer players
    —the rate of arthrosis
      1.6% in controls
      4.2% in non-elite
      15.5% in elite

Other factors
- BMI
- Sex
- Patient age

- No significant impact on outcomes

Meniscal Resection: What Matters?
- Beware:
  - Lateral tears
  - Root tears
  - Radial/ degenerative tears with disruption of the rim
  - Tears associated with instability or with mechanical overload
  - Tears in the presence of arthrosis

Do All tears need repair?

The Fate of Meniscus Tears Left in situ at the time of Anterior Cruciate Ligament Reconstruction: A 5-year Follow-up Study from the MOON Cohort

Kyle R. Duchman, MD1, Robert W. Westermann, MD1, Kurt P. Spindler, MD2, Emily K. Reinke, PhD3, Laura J. Huston, MS3, Annmarie Amendola, MD1, MOON Knee Group1, and Brian R. Wulf, MD, MS1

- 208 tears: 71 medial, 137 lateral
- 97.8% medial and 94.4% lateral required no re-operation
- 7.7% (16 tears) required re-operation
  - Younger age
  - Tear > 10mm
Meniscal Repair - Type of Tears

Repair:
- Root tears
- Acute, vertical, longitudinal
- In vascular zone (3mm of meniscosynovial junction)
- Isolated (no other significant tears)
- Radial tears
- 3 - 5mm of periphery
- Some complex tears

USE CLINICAL JUDGEMENT

Meniscal Repair - Techniques

- Open
  - More anatomic
  - Better suture placement
  - (DeHaven)
- Arthroscopic
  - Inside-out
  - Outside-in
  - All-inside

Inside-out Meniscal Repair

- Accessory incisions
- Single/double lumen cannulas
- Sutures on long needles tied outside capsule
- Needle advanced just past cannula tip to “spear” and reduce tear
- Spoons (retractors)
  - Protect neurovascular structures
  - Visualize needles
Evolution of Meniscus Surgery

- Total Meniscectomy
- Partial meniscectomy
- Meniscal repair
- Meniscus transplantation

Rationale for Meniscus Transplantation

- Relieve pain, swelling
- Improve knee stability
- Prevent progression of arthrosis (?)
Considerations for Transplantation

- Age
- Pain (localized)
- Status of articular cartilage
  - x-ray / MRI
  - Arthroscopic findings
- alignment
- stability

Indications for Meniscus Transplantation

- Unicompartmental pain in the presence of total or subtotal meniscectomy
- As a concomitant procedure to revision ACL reconstruction to aid in joint stability when meniscus deficiency is felt to have been contributory to failure
- As a concomitant procedure with articular cartilage repair procedures in a meniscus-deficient compartment

Knee OSTEOTOMY: Indications

<table>
<thead>
<tr>
<th>Malalignment</th>
<th>Malalignment</th>
<th>Malalignment</th>
<th>Malalignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Arthritis</td>
<td>Instability</td>
<td>Arthritis</td>
<td>Meniscal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+</td>
<td>Transplantation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carilage</td>
<td>Resurfacing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resurfacing</td>
<td>Instability</td>
</tr>
</tbody>
</table>
Contraindications

- Diffuse arthritic changes throughout the knee
- Presence of severe cartilage loss in the compartment of interest
- Lower limb malalignment or ligamentous instability (untreated)

Literature review

- No level 1 or 2 studies
- Variable outcome measures
- Variable techniques
- Variable concomitant surgery
- No control group in any study
- ~70% survivorship
- Subgroup (MRI/xray) preservation of joint
Meniscal transplant

Indications
• compartment overload / pain
• stable knee
• limb alignment - neutral or better
• age < 40 years
• no inflammatory disease
Meniscal Transplantation

26 yo f lateral meniscectomy age 15

2nd look 6 yr

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Graft Choice

- Fresh
- Frozen, irradiated
- Fresh-frozen, non-irradiated allografts

Graft Choice

- Fresh-frozen, non-irradiated allografts (donor age 15 - 35)
- recognized tissue bank
- Size match
Meniscal Transplantation

Sizing

- pre-op AP and lateral measure
  - AP view, m-l width
  - lateral view, a-p depth
- Too large or too small: Not acceptable
- Slightly larger is better than slightly smaller

Sizing techniques

From Rijk et al
techniques

Table 3: Differences in Prevalence of Meniscal Tissue Exusion Between Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>A</th>
<th>B</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>26.2 ± 16.7</td>
<td>26.2 ± 10.0</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Medial compartment</td>
<td>23.8 ± 16.4</td>
<td>13.3 ± 16.2</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Lateral compartment</td>
<td>30.2 ± 21.4</td>
<td>30.1 ± 22.5</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Values expressed as mean ± standard deviation.

Suture-only fixation technique leads to a higher degree of extrusion than bone fixation in meniscus transplantation.

The Anterior Horn of the Medial Meniscus
An Anatomic Study of Its Insertion

Type IV

Technique
Arthroscopic preparation rim, identify posterior root

identify posterior root
drill 6 mm tunnel for posterior root
Operative technique
Medial meniscus + HTO

- Preoperative sizing, osteotomy planning
- Arthroscopy prep
- Perform osteotomy
- Meniscal transplant as per technique
Operative technique
Lateral meniscus + DFO

• Preoperative sizing, osteotomy planning
• Arthroscopy
• Meniscal transplant as per technique
• Perform osteotomy

Lateral meniscal deficiency
Valgus overload

Arthroscopic exam
rim preparation; trough
LM transplant
prepare the rim

LM transplant
graft preparation

LM transplant
trough preparation
LM transplant preparation for insertion/shuttle

LM transplant insert/position the meniscus

LM transplant meniscal suture
Duke University Medical Center

LM transplant

anterior sutures

Duke University Medical Center

LM transplant

final check

Study

• Single surgeon series
• With and without osteotomy
• Bone trough LM
• Bone plugs MM
Demographics

91 Patients
93 knees
Medial MAT: 34
Lateral MAT: 58
Lateral + Medial: 1

Males 49, Females 44. Age 25.9 yrs (14-49)
Right Knee 48, Left Knee 45
Mean Follow-up Time: 3.7 ± 3.5 years (range 1-13.6)

Associated procedures

Table 1
Associated Procedures with the Meniscus Allograft Transplantation

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Tibial Osteotomy</td>
<td>13</td>
</tr>
<tr>
<td>Distal Femoral Osteotomy</td>
<td>6</td>
</tr>
<tr>
<td>Anterior Cruciate Ligament Reconstruction</td>
<td>6</td>
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<tr>
<td>Osteochondral Allograft Transplantation</td>
<td>4/1</td>
</tr>
<tr>
<td>Microfracture</td>
<td>11</td>
</tr>
<tr>
<td>Chondroplasty</td>
<td>13</td>
</tr>
<tr>
<td>Meniscus Repair</td>
<td>1</td>
</tr>
</tbody>
</table>

Complications

Table 2
Complications following Meniscus Allograft Transplantation

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Treatment</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>Meniscus Allograft Tear</td>
<td>Repair</td>
<td>4</td>
</tr>
<tr>
<td>Meniscus Allograft Tear</td>
<td>Repair</td>
<td>11</td>
</tr>
<tr>
<td>MAT Failure</td>
<td>Revision</td>
<td>3</td>
</tr>
<tr>
<td>Overload</td>
<td>HDI/DFO</td>
<td>5</td>
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<tr>
<td>ACL tear</td>
<td>SCLR</td>
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<tr>
<td>Patellar hardware</td>
<td>Removal of Implants</td>
<td>6</td>
</tr>
<tr>
<td>Femoral Nerve Palsy</td>
<td>Neurelysis</td>
<td>4</td>
</tr>
<tr>
<td>Joint infection</td>
<td>ARD MAT removal</td>
<td>2</td>
</tr>
</tbody>
</table>
Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Pre-op</th>
<th>Exp</th>
<th>Mist</th>
<th>OOT</th>
<th>MAT</th>
<th>MAT + Osteotomy</th>
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</thead>
<tbody>
<tr>
<td>MAT Tear</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MAT Repair</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MAT Failure</td>
<td>11</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Overload</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Painful Hardware Removal</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td>1</td>
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<tr>
<td>Peroneal Nerve Palsy</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Infection</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: MAT = Meniscus Allograft Transplantation.*

Outcomes

Comparison of Pre-operative and Post-operative Outcome Measures in Patients Undergoing Meniscus Allograft Transplantation

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-operative</th>
<th>Post-operative</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS</td>
<td>4.1</td>
<td>1.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS - Pain</td>
<td>59.7</td>
<td>78.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS - Symptom</td>
<td>55.2</td>
<td>68.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS - ADL</td>
<td>69.9</td>
<td>87.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS - Sports/Rec</td>
<td>32.8</td>
<td>61.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS - QOL</td>
<td>39.2</td>
<td>56.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WOMAC - Pain</td>
<td>68.5</td>
<td>84.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WOMAC - Stiffness</td>
<td>75.9</td>
<td>88.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WOMAC - Function</td>
<td>62.3</td>
<td>75.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SF-36 - Physical</td>
<td>47.7</td>
<td>56.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SF-36 - Mental</td>
<td>47.5</td>
<td>57</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

VAS = Visual Analog Scale, KOOS = Knee Injury and Osteoarthritis Outcome Score, WOMAC = Western Ontario and McMaster Universities Arthritis Index, SF-36 = Short Form 36, MAT = Meniscus Allograft Transplantation.
Pre Op Scores (MAT vs MAT + osteotomy)

<table>
<thead>
<tr>
<th></th>
<th>MAT</th>
<th>MAT + Osteotomy</th>
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</thead>
<tbody>
<tr>
<td>VAS</td>
<td>5.3</td>
<td>4.5</td>
</tr>
<tr>
<td>KOOS - Pain</td>
<td>56.8</td>
<td>58.4</td>
</tr>
<tr>
<td>KOOS -Symptom</td>
<td>51.5</td>
<td>54.9</td>
</tr>
<tr>
<td>KOOS -ADL</td>
<td>63.5</td>
<td>68.6</td>
</tr>
<tr>
<td>KOOS -Sports/Rec</td>
<td>33.3</td>
<td>41.7</td>
</tr>
<tr>
<td>KOOS -QOL</td>
<td>71.3</td>
<td>67.4</td>
</tr>
<tr>
<td>WOMAC -Pain</td>
<td>73.1</td>
<td>71.2</td>
</tr>
<tr>
<td>WOMAC -Stiffness</td>
<td>54.5</td>
<td>55.2</td>
</tr>
<tr>
<td>WOMAC -Function</td>
<td>63.4</td>
<td>62.5</td>
</tr>
<tr>
<td>SF36 -Physical</td>
<td>71.3</td>
<td>74.7</td>
</tr>
<tr>
<td>SF36 -Mental</td>
<td>63.4</td>
<td>63.6</td>
</tr>
</tbody>
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VAS = Visual Analog Scale, KOOS = Knee Injury and Osteoarthritis Outcome Score, WOMAC = Western Ontario and McMaster Universities Arthritis Index, SF-36 = Short Form 36, ADL = Activity of Daily Living, QOL = Quality of Life.

PreOp scores (MAT vs MAT + osteotomy)

Post OP Scores (MAT vs MAT + Osteotomy)
Outcomes

- Survivorship 84/93
- Xray analysis: 6 went on to grade 4 (Kellgren)
- 5 patients went on to TKA/1 medial UNI
  - (mean 3.5 years (2-11))
- 3 revision MAT
  - (5.1 years (2-11))

Discussion

- MAT resulted in satisfactory outcomes; significant improvement in pain in function
- Results are similar with and without osteotomy
- Patient Selection is the key to success
Return to High-Level Sport After Meniscal Allograft Transplantation

Peter N. Chilcote, M.D., Vasil Kazes, B.S., Seth L. Sherman, M.D., and Brian J. Colle, M.D., M.B.A.

- 13 out of 166 MAT were competitive athletes
- Min 1.9 yr FU; incomplete FU
- Lysholm, IKDC, MOOS significant improvement
- 4 reoperations (1 MAT, 1 meniscal repair, 1 pmm, 1 plica)

Return to Activity

Survivorship of Meniscal Allograft Transplantation in an Athletic Patient Population

Brian R. Reamer, M.D., Nicholas Rosing, M.D., Kenneth L. Cameron, M.D., M.P.H., Scott D. Owens, M.D., and Mark Palka, D.D.S.
Investigation performed at Wilmot Beaumont Army Medical Center, El Paso, Texas, USA

- Case series of 230 MATs performed in active duty military personnel with mean age 27.2 years
- 22% of patients underwent knee-related military discharge at a mean of 2.5 years post-op

Long-term Survivorship and Function of Meniscus Transplantation

Frank P. Noyes, M.D., and Sue D. Barber-Wadlin, M.D.
Investigation performed at the Cincinnati Sportsmedicine and Orthopedic Center – Mercy Health, Cincinnati, Ohio, USA

- 58 MATs evaluated for long-term functional outcomes at a mean of 11.2 years post-op
- Survival endpoints included reoperations, MRI failure and radiographic loss of joint space
- Significant improvements in pain, swelling, walking scores and patient knee rating scores (P<.05)
- Estimated probability of survival was 85% at 2 years, 77% at 5 years, 69% at 7 years, 45% at 10 years and 19% at 15 years
- Progression of OA in 57%
Results of Meniscus Transplantation

Meniscal Allograft Transplantation

A Systematic Review

Federico Rosato, MD, Salvatore Biaschia, MD, Davide Eduardo Bonaia, MD, and Ammunito Amendola, MD, PhD
Investigation performed at the UI Sports Medicine Center, Department of Orthopaedic Surgery, University of Iowa Health Care, Iowa City, Iowa, USA

• 2015 Systematic Review of 55 articles (2 level 2, 7 level 3, 46 level 4) with a total of 1666 MATs and average follow up of 53 months

Clinical Outcomes

• Outcome scores:
  • Lysholm score increased from 55.5 to 82.7
  • VAS pain score decreased from 6.4 to 2.4
  • 14 studies had average satisfaction rating of 82%
• Medial vs. Lateral:
  • 16/18 studies found no difference in clinical outcomes
  • Isolated MAT vs. combined procedures
  • 13 studies found no significant differences in outcomes
• Bone plugs versus suture-only fixation:
  • 1 out of 2 studies reported higher complication and failure rates with suture-only fixation

Conclusions

• MAT indicated in young-middle age patients suffering from symptomatic meniscal deficiency and who have stable, well-aligned knees without advanced arthritis
• MAT provides consistent symptomatic relief but has not been proven to prevent progression of OA
• Careful patient selection and pre-operative evaluation as well as post-operative activity modification are necessary for acceptable outcomes
Meniscus Replacement

- Nusurface Meniscus Implant
- Made from polycarbonate-urethane
- Does not require fixation to bone or soft tissue
- Requires intact meniscal rim
- Clinical trials ongoing

Source: https://activeimplants.com/products/nusurface-meniscus-implant/

Thank you