Articular Cartilage Lesions of the Knee

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Articular Cartilage

"a troublesome thing and once destroyed, it is not repaired"
Hunter W. On the structures and diseases of articulating cartilage.

"There are, I believe, NO instances in which a lost portion of cartilage has been restored, or a wounded portion repaired, with new and well formed permanent cartilage, in the human subject."
Written in 1851

Normal Articular Cartilage

- Should be as slick as two ice cubes gliding across one another
- Normal articular cartilage should function like a teflon-coated sponge

Articular Cartilage is subject to the process of aging

Disclosure Statement

Neither I, Edward P. Mulligan, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation
Unfortunately, it can happen earlier in life as well...

- Microtrauma
- Macrotrauma
- Congenital

How common is this?

- High frequency in athletes
  - 30% overall prevalence (much higher in basketball and running)
  - 16% full thickness (DB R/L) vs 5% in general population

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of</th>
<th>High-Grade RCTs</th>
<th>Low-Grade RCTs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patellar</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Talar</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Medial</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lateral</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Patellar tendon</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

- 27 articular cartilage lesions in 28 asymptomatic NBA knees
  - Walczak BB et al., J Knee Surg, 2008
  - 20% prevalence in NFL
  - Flanagan DC et al., Med Sci Sport Exer, 2010

Algorithm when traditional conservative measures fail....

You see the patient post-operatively

Evidence for Management Strategies

<table>
<thead>
<tr>
<th>Grades of Recommendation</th>
<th>Strength of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strong evidence (conclusive)</td>
</tr>
<tr>
<td>B</td>
<td>Moderate evidence (acceptable)</td>
</tr>
<tr>
<td>C</td>
<td>Weak evidence</td>
</tr>
<tr>
<td>D</td>
<td>Conflicting evidence</td>
</tr>
<tr>
<td>E</td>
<td>Theoretical/Prandial evidence</td>
</tr>
<tr>
<td>F</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

Ten Commandments

1. Each Patient is Unique
2. Arthrokinematic Potholes
3. Weight Bearing Considerations
4. Swelling Sucks
5. Healthy Tissue Healing
6. Unloading
7. Prevent Nightmare Knees
8. Know Pain – Know Gain
9. Exercise Patience
10. Surgical Familiarity

and we only have 45 minutes
**Post-Op Management of Knee Articular Cartilage Lesions**

**September 23, 2104**

**North Texas Physical Therapy District Meeting**

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**General Rules of Rehabilitation**

**Individualized Expectations**

- Unwavering protocols are designed for the uniformed technician.

**Rehab Influences**

- Individual variables that will influence the rehabilitation design and progression include:
  - Lesion location, size, depth, and containment
  - Patient age, size, cartilage health, goals, and motivation
  - Co-morbidities
  - Concomitant surgical interventions

**Articular Cartilage Rehab Considerations**


**Factors and Implications**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Slower cartilage repair with increased age (&lt;40)</td>
</tr>
<tr>
<td>BMI</td>
<td>Slower progression with BMI &gt; 30</td>
</tr>
<tr>
<td>Sport Goal</td>
<td>Higher demand for impact sports</td>
</tr>
<tr>
<td>Lesion Defect</td>
<td>Faster improvement with smaller defects (1-2.5 cm)</td>
</tr>
<tr>
<td>Surgical Technique</td>
<td>More rapid improvement with restorative techniques</td>
</tr>
<tr>
<td>Defect Location</td>
<td>Immediate walking for PF defects (knee locked in full extension)</td>
</tr>
<tr>
<td>Symptom Duration</td>
<td>Slower recovery in injury &gt; one year old</td>
</tr>
<tr>
<td>Concomitant Injuries</td>
<td>Modified protocol if ACL, osteotomy, meniscal repair, etc</td>
</tr>
<tr>
<td>Meniscal Health</td>
<td>Slower rehab after menisectomy (especially lateral)</td>
</tr>
</tbody>
</table>

**Knee Arthrokinematics**

- As the knee flexes at the *tibiofemoral* joint - articular contact moves from anterior to posterior
- As the knee flexes at the *patellofemoral* joint - articular contact moves from distal to proximal beginning at about 20° of flexion

**Tibiofemoral Lesions**

- Degenerative changes most common in 30-60° ROM
- Much more common in medial compartment
- Joint instability can expand this zone
  - Avoid danger zones
  - Avoid varus stress for medial compartment and valgus stress if lateral compartment involvement
  - Generally, 0-20° and 90-70° safer in most patients

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**Patellofemoral Contact Stress**

- **Movement and intermittent loading** are essential for healthy cartilage
- **Moderate compression forces and mild shear forces** are beneficial while static compression and immobilization are harmful however,
- **Shear and compression combinations** should be avoided

**General Rules of Rehabilitation**

- **Controlled weight bearing and motion**

- **Immobilization and unloading**
  - Loss of proteoglycans and weakening of articular cartilage
- **Controlled cyclic joint loading** (destructive if excessive)
  - Increases chondrocyte and synthetic activity by removing fluid and waste and matrix reabsorbing nutrient rich synovial fluid
- **Motion without loading**
  - Associated with cartilage atrophy
- **Controlled early motion**
  - Prevents degeneration, assists in cellular orientation and prevents adhesions

**Aquatic Unloading**

- **Effusion results in arthrogenic muscle inhibition of quadriceps**
  - Threshold for VM is 20-30 ml; 50-60 ml for RF and VL
  - Aspiration typically provides immediate benefit

**Total Gym Unloading**

- **Standard Glide Board**
  - $2 \times \text{incline} = \% \text{ BW}$
  - ex: $25^\circ = 50\% \text{ BW}$
- **Adjustable Glide Board**
  - use factor of 2.5

**Swelling Sucks**

- **General Rules of Rehabilitation**
  - **Manage pain and Effusion**

- **Effusion**
  - Results in arthrogenic muscle inhibition of quadriceps
  - Threshold for VM is 20-30 ml; 50-60 ml for RF and VL
  - Aspiration typically provides immediate benefit
The Bulge Sign to detect mild to moderate swelling

- Trace: Small fluid wave with superior pouch compression
- +1: Large fluid wave with superior pouch compression
- +2: Fluid wave spontaneously returns
- +3: Too much fluid to milk into pouch

Recurrent or Persistent Effusion should be treated like black smoke coming out of an engine, a clear indicator that it ain't running right.

Healthy Healing

General Rules of Rehabilitation
Rehab that Respects Chondrocyte Maturation

<table>
<thead>
<tr>
<th>Phase</th>
<th>Estimated Time</th>
<th>Biological Status</th>
<th>Rehabilitation Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I - Protection</td>
<td>0-8 weeks</td>
<td>Graft integration and cell maturation</td>
<td>Graft protection and joint activation</td>
</tr>
<tr>
<td>II - Stimulation</td>
<td>8-26 weeks</td>
<td>Matrix production and organization</td>
<td>Progressive loading and functional joint restoration</td>
</tr>
<tr>
<td>III - Challenge</td>
<td>26+ weeks</td>
<td>Cartilage maturation and adaptation</td>
<td>Activity Restoration</td>
</tr>
</tbody>
</table>

ACI Maturation Analogy

Patient must understand the maturation consistency of the "new" cartilage

- After 1 week: Like WATER
- After 3 months: Like YOGURT
- After 6 months: Like DOUGH
- After 9 months: Like CHEESE
- After one year: Like RUBBER

General Rules of Rehabilitation
Alter Applied Forces

- Orthotic therapy and insoles
  - Decrease symptoms and improve gait mechanics
- Footwear Recommendations
- Patellar Bracing
  - May not alter kinematics but may increase contact area to redistribute stress
- OA Unloader Bracing
  - To increase joint space (if knee has adequate mobility)
**Foot Orthoses**

Orthotic therapy and insoles
- Pronated feet are more likely in patients with medial compartment OA
  - Reilly K, et al, Physiotherapy, 2009
- Medial-wedge (posted) orthotic insoles decreased pain, altered the tibiofemoral angle, and improved function in patient with valgus induced knee OA
- Laterally wedged orthoses were of benefit in patients with medial compartment OA in regards to pain during a 6-min walk test, stiffness, and function (based on the WOMAC outcome tool)

**Locked extension bracing**

- Larger defects
- Kissing defects
- Poor quad control (extension lag)

**General Rules of Rehabilitation**

- Avoid the “Nightmare Knee”
  - Puny quad
  - Swollen knee
  - Stuck patella

**Exercise Patience**

Patient’s must exercise while exercising patience

“the hardest part may be going easy”
General Rules of Rehabilitation

Understand the Surgical Procedures

- Debridement and Lavage
  - 1st line palliative treatment indicated in low demand patients with < 2 cm lesions

- Abrasion Chondroplasty
  - Motorized burring of subchondral bone

- Microfracture Drilling (marrow stimulation)
  - "picking" with drill (not burring) to cause bleeding and formation of "pseudocartilage"

- OATS
  - Osteochondral autograft, allograft, or substitute transfer

- ACI
  - Autologous articular cartilage implant

No Protocol is a Perfect Fit

Temporal and philosophical approach that honors the basic science of healing and adheres to sound principles of rehabilitation progression

Continuous Passive Motion

- Commonly prescribed but limited on consensus on prescription
  - Justification based on low-level evidence (basic science and level III or higher)
  - Enhance chondrocyte repair and stimulate proteoglycan metabolism to improve cartilage healing

- Most commonly – 0-30° first post-op day with 5-10° increases per day for 4-8 hours/day with 1-2 hour sessions

- Substitute 500 active assistive heel slides/TID when CPM is not available

- Necessity/Value may be influenced by fear avoidance/kinesiophobia (personal opinion)

Methods to gain full extension

- Manual therapy
- Soft tissue mobilization
- LLPD Gravity Stretch
  - Prone knee hangs vs. Ottoman Stretch

General Rehab Trends

- Acute Proliferation Phase (protection)
  - First 4-6 weeks – control inflammation and prevent arthrofibrosis
  - CPM usage
  - Immediate, controlled A/PROM (CPM) – establish full extension quickly
    - Range limiting or unloading brace prn
  - NWB to PWB
    - NWB if condyle/platuea lesion
    - WBAT if trochlear lesion
  - Regain volitional quad Control
  - Build Hip/Trunk strength

Overlapping treatment options ranging from palliative ... to reparative ... to restorative objectives
Equipment-Based Products/Devices to gain full extension

- Static Progressive Stretch – JAS
- Dynamic Progressive Stretch – Dynasplint
  - Case based evidence of efficacy
- Patient-Acuated Serial Stretch – Extensionator
  - Static and PASS generally not covered by commercial insurance

Weight-Bearing Guidelines

- Femoral Defects
  - 2 weeks NWB; with 25% increase in WB the next 4 weeks; FWB at week 6
- Patellar/Trochlear Defects
  - Immediate weight bearing with brace locked near full extension
- ACI procedures usually progress the slowest

Post-op Weight Bearing Progression

- Gradual acceleration over last 15 years in the WBing progression without any negative impact on graft healing or clinical outcomes
- Notice that the evidence-based protocols are now allowing FWB at 8 weeks (and much earlier than 15 years ago) with a much more aggressive progression during the first 6 weeks

Two scale technique to teach accurate weight-bearing load

General Rehab Trends

- SubAcute Transitional Phase (matrix & reorganization)
  - 6-12 weeks
  - Gentle, gradual PREs
  - Progress to FWB by 4-8 weeks
  - By end of this phase can introduce weight-bearing exercise

Proximal Hip Training – Gluteus Medius

- Phase I
- Phase II-III

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**Quad Training**

- Motion arc dictated by lesion location
  - Press through medial longitudinal arc
  - Keep tibial vertical (or parallel to spine)
  - Utilize UE positioning to impact COG
  - Adjust lever arm to impact A/P shear

**Quad Training Rationale**

- Steinkamp, AJSM, 1992

**STJ Control Training**

- Posterior tibialis training to control transverse plane position of tibia

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**Progression Criteria**

<table>
<thead>
<tr>
<th>Progression</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I to II</td>
<td>Full PROM</td>
</tr>
<tr>
<td>Phase II to III</td>
<td></td>
</tr>
</tbody>
</table>

- Femoral IR and adduction allowing increased knee valgus and Q angle
- Work the gluteus maximus to control the rotation and gluteus medius to control the adduction
- Excellent agreement on identifying “poor” performance indicating a need for proximal hip attention


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**Proximal Hip Training**

**Gluteus Maximus**

- Poor proximal hip control allows “Medial Collapse”
  - Femoral IR and adduction allowing increased knee valgus and Q angle
  - Work the gluteus maximus to control the rotation and gluteus medius to control the adduction
  - Excellent agreement on identifying “poor” performance indicating a need for proximal hip attention

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General Rehab Trends

Remodeling Phase
- 3-6 months
- Maximizing strength - hips/thighs
- Low impact functional activities as tolerated

Terminal Maturation Phase
- May last for another 6-12 months
- Return to preinjury levels of activity as tolerated

Functional Progressions
- Walk ⇒ run ⇒ sprint
- Aerobic ⇒ anaerobic
- Straight line ⇒ circular ⇒ zig/zag ⇒ start/stop ⇒ pivot/cut
- Predictable/ Stable ⇒ Unpredictable/Labile
- Static Balance ⇒ Dynamic Balance ⇒ Plyometrics

Miscellaneous Concepts
- Load protect affected area
  - Grass football field analogy
- Restore passive knee extension
  ASAP and gradually regain flexion ROM as tolerated
- Careful with mobilizations
  - Glides, not compressions

Prognosis: Return to Competition
- Generally, 60-90% return to sport and 2/3 to preinjury level performance
- Generally, return to sport around one year
  - Longest with ACI (18-24 months)
  - Shortest with OATS (6-9 months)

Surgical Outcomes
- Excellent short-term results with 65-80% good to excellent ratings and return to pre-injury sports levels
  - Stookey JR et al, Arthroscopy, 2009
- Seem to have high rate of sports participation decline over 5 years
  - Goble A et al, Knee Surg Sports Traumatol Arthrosc, 2005
  - 83% of NBA players return to play, however, with fewer games played and points or steals/game
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**OATS Surgical Outcomes**

- 80% (patellar lesions) - 90% (femoral lesions) of patients report good to excellent results
  
  

- Survivorship
  
  - 88-95% survival at 10 years
  
  - 74% survival at 15 years

  

- OATS 80-90% return to sports and 60% at pre-injury level performance


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**ACI Surgical Outcomes**

- Multicenter 3-year follow-up shows excellent surviviorship of graft with substantial improvement in function


- Multiple studies have shown high (80-90%) patient satisfaction with good to excellent results

  
  
  Cole, AAOO Meeting, 2003

- 2/3 can return to sport but probably < 50% return to pre-morbid high level athletic activity


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**Just Published in August**

**Functional Outcomes After Surgical Management of Articular Cartilage Lesions in the Knee: A Systematic Literature Review to Guide Postoperative Rehabilitation**

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**Long-term insights**

- Significant strength-deficits, gait deviations and deficits, or asymmetries in functional performance persist up to 5-7 years following surgical intervention

  - early avoidance of voluntary activation failure and continued attention to quadriceps atrophy throughout the first 1-2 years
  
  - Earlier weight-bearing is helpful (and not harmful) but long-term gait deficits persist in either group

  - restoration of quad performance will normalize sagittal plane moments and dampen unwanted joint loading stress

  - MFX tends to do well in performance for the first two years (then decline)

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**Post-Op Resources**


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**Protocol Resources**

- Microfracture

  

- Osteochondral Autograft Transfer

  
  - Includes considerations and alterations based on concomitant surgeries

- Autologous Articular Cartilage Implant

  
  - Includes considerations and alterations based on concomitant surgeries

- Bone Bank/Articular Cartilage Implant

  - J Ortho Sports Phys Ther. 2006;36(10):769-70

- Multicenter 3-year follow-up shows excellent surviviorship of graft with substantial improvement in function

  
  
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11
APTA Orthopedic Section’s Clinical Practice Guidelines
Knee Pain and Mobility Impairments: Meniscal and Articular Cartilage Lesions

CLINICAL GUIDELINE                      STRENGTH OF RECOMMENDATION
Clinical Course                           C
Risk Factors                              C
Progressive Weight Bearing               D
Early Knee Motion                         C
Return to Activity Criteria               C
Therapeutic Exercise                      B
NMES                                      B

Long Term Outcomes for Chronic Patellofemoral Pain
Surgery vs. Rehab

- Prospective RCT with 28 subjects in each group
  - Surgery and HEP vs. HEP alone
  - At 5-year follow-up both groups improved but no difference in function (Kujala outcome score) or pain (VAS)


www.continuing-ed.cc for copy of handout

“Surgery went well, Mr. Moore. I had a lot of fun evaluating your knee joint.”

Thank You!!