Advancements in Patellofemoral Pain Syndrome & MPFL Reconstruction & Rehab

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Objectives

• Review of Anatomy of the knee
• Review of biomechanics of the knee
• Identify and Palpate MPFL
• Understand the biomechanics of MPFL failure
• Understand MPFL pathogenesis and reconstruction procedure
• Identify and implement a rehabilitation protocol
• Identify and evaluate based on the cross diagonal principle
• Return the athlete to their sport through specific testing
The Knee Joint

- Knee Joint (tibiofemoral joint)
  - Largest joint in body
  - Complex
  - Primarily hinge joint (Ginglymus joint)

- Patellofemoral Joint
  - Arthrodial classification
  - Gliding of patella on femoral condyles

Bones

- Enlarged Femoral Condyles articulate with respective med. & lat. Tibial condyles on the plateau
- Tibia bears most of the weight

- Fibula: lateral
  - Attachment for knee joint structures
  - Does not articulate on femur or patella
  - Not considered officially part of the knee joint**
Bones

- Patella
- Sesmoid
  - Imbedded in quadriceps and patella tendon
  - Pulley system for mechanical advantage in knee extension

Meniscus

- Medial meniscus
  - Larger more open C
- Lateral meniscus
  - Thicker on outside border
  - Can slip
  - Closed C
- Both connected by arcuate fibers
- Radicular blood supply

Meniscus

- Functions
  - Protection of articular cartilage
  - Joint Stability
  - Relieve joint incongruity
  - Increase joint mobility

- Load Transmission
  - In Extension
    - Lateral: 70%
    - Medial: 30%
  - Compressive Load
    - 50% of compression load at 0°
    - 85% at 90° of flexion
Ligaments/Capsule

Ligaments: Major

- **Tibial Collateral Ligament (MCL):** Originates on Medial aspect of upper medial femoral condyle and inserts on medial tibial surface
- **Fibular Collateral Ligament (LCL):** Originates on Lateral femoral condyle close to popliteus origin; inserts on fibular head
- **Anterior Cruciate Ligament (ACL):** Originates PM corner of Femur; inserts via collagen fibers via transitional zone to tibia
  - Resists anterior translation of tibia and rotational forces
- **Posterior Cruciate Ligament (PCL):** Originates AL corner of Femur; inserts posterior tibia
  - Resists posterior translation of tibia and tibial external rotation

Ligaments: Major

- **Tibial Collateral Ligament (MCL):**
  - Superficial: two separate tibial attachments
  - Deep: meniscofemoral: longer proximal to distal
  - Deep: Meniscotibial: shorter and thicker attached to edge of articular cartilage of medial tibial plateau
Ligaments: Minor (maybe not so much)

- Medial Patellofemoral Ligament (MPFL)
- Posterior Oblique Ligament (POL)
- Oblique Popliteal Ligament (OPL)
- Popliteofibular ligament (PFL)
- Arcuate Ligament (AL)
- Fabellofibular ligament (FFL)
- Anterolateral Ligament (ALL)

Ligaments

- Medial Patellofemoral Ligament (MPFL)
  - O: Medial epicondyle (adductor tubercle and adductor tendon) as well as MCL
  - I: Runs transversely deep to the VMQ and inserts on superomedial aspect of the patella
  - F: Resists lateral migration of the patella
    - 50-80% of restraining force of lateral patella dislocation
    - Most effective between 0° and 30° of flexion
Ligaments: Minor

- Posterior Oblique Ligament (POL)
  - O: adductor tubercle
  - I: tibia and posterior aspect of the capsule
  - F: provides static resistance to valgus loads as knee moves into full extension

- Oblique Popliteal Ligament (OPL)
  - O: arises from semimembranosus tendon and POL
  - I: lateral head of the gastrocnemius and the arcuate ligament
  - F: assists with lateral capsular stability

- Arcuate Ligament (AL)
  - O: lateral femoral condyle: two heads for the triangular shape
  - I: traverses over the popliteal tendon and inserts into the fibular head
  - F: posterolateral stabilizer of the knee
Ligaments: Minor

- **Fabellofibular ligament (FFL)**
  - Part of the acruate complex; may be absent or present depending on size of ligament itself and arcuate ligament
  - O: lateral head of the gastrocnemius
  - I: fibular styloid process
  - F: reinforces posterolateral aspect of the capsule

Ligaments: Minor

- **Anterolateral Ligament (ALL)**
  - O: lateral femoral epicondyle; congruous with the LCL
  - I: Gerdy's tubercle, fibular head and lateral meniscus
  - F: anterolateral rotational stability
Posterolateral Corner Ligaments

Anterior Musculature

Anterior Knee Musculature

- Three Vasti Muscles originate at proximal femur; insert on patellar superior pole
  - To Tibial Tuberosity via the patella tendon (ligament)
- Tensor Fascia Latae inserts on Gerdy’s Tubercle via Iliotibial Band
- Sartorius, gracilis, semitendinosus insert Ant. Med. tibial surface
- Iliacus
- Iliopsoas
**Medial Knee musculature**

- **Sartorius**: Inserts: medial condyle; hip flexion, weak abductor, external rotator and mild knee flexor
- **Adductor Longus**: Inserts: Medial Femur; Adducts femur
- **Adductor Magnus**: Two portions: adductor and hamstring portion: Inserts: medial femur: adductor portion: adducts, Hamstring portion medially rotates
- **Gracilis**: Inserts: Proximal medial tibia; Adducts the hip; secondary flexion and medial rotation

**Posterior Musculature**

**Posterior Knee Musculature**

- **Semimembranosus**: inserts PM on medial tibial condyle
- **Semitendinosus**: inserts on medial tibial condyle
- **Biceps Femoris**: inserts primarily on Fibular Head
- **Popliteus**: Originates on lateral aspect of lateral femoral condyle
- **Triceps Surae**: gastrocnemius, soleus and plantaris
  - **Plantaris**: arises from the oblique popliteal ligament and inserts along the lateral head of the gastrocnemius
  - **Gastrocnemius**: Medial Head: medial femoral condyle Lateral Head: lateral femoral condyle
  - **Soleus**: proximal soleal line of posterior tibia and proximal 1/3 of fibula
Posterior Hip Musculature

- Gluteus Maximus: Posterior Femur: Hip extension
- Gluteus Medius: Inserts: lesser trochanter: Abducts and Internally Rotates
- Gluteus Minimus: Inserts: Lesser trochanter: Abducts and Internally rotates
- Pectineus: Pubis to pectinal line: hip flexor and internal rotator
- Piriformis: Inserts: greater trochanter; External rotator
- Inferior gemelli: Inserts: medial surface of greater trochanter: External rotator

Palpation

- Bony Landmarks:
  - Femoral Epicondyles (Med./Lat.)
  - Fibular Head
  - Patella poles (Sup./Inf./Med./Lat.)
  - Tibial Tuberosity
  - Gerdy’s Tubercle
  - Adductor Tubercle
- Musculature
  - Quadriceps (all 4)
  - Hamstrings and Adductors
  - Quadriceps Tendon
  - Patella tendon (some call it a ligament now)
  - Gastrocnemius
  - Popliteus
  - Plantaris

Palpation

- Ligaments:
  - MPFL
  - MCL
  - LCL
  - POL
- Joint Line
  - Medial
  - Lateral
**Current Knee Injuries: Layer Approach**

- Layer 1: Osteochondral
  - Patella, Femoral condyles, tibia, tibial plateau, Osteochondral lesions

- Layer 2: Inert
  - Capsule, ACL, MCL, PCL, LCL, MPFL, PDL, ALL, Meniscus

- Layer 3: Contractile
  - Musculature crossing the knee, musculature crossing the hip

- Layer 4: Neuromechanical or Neurokinetic
  - Movement deficits, Tib-fib mechanics, Tib-Femur mechanics, neurovascular structures, regional mechanoreceptors, kinetic chain

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**Treatment Pearls:**

- Delineate which layer the knee injury is in
- Remember tissue healing time
- Implement treatment guidelines
- Proximal stability before distal mobility
- Phases of rehabilitation

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**Patellofemoral Pain Syndrome**
Patellofemoral Pain Syndrome

- General anterior knee pain
- Diagnosis code M22.2X1 (R) M22.2X2 (L)
- Affects 15-33% of population; 21-45% adolescent population
- Females > Males
- Lower Extremity Malalignment
  - Pronation
  - Genu valgum
  - Excessive Ext. Tib. Torsion
  - > 15°Q angle
  - Excessive hip IR
  - Patella Alta
- Altered kinematics
- Over training/under training

PFPS: Etiology

- Compressive and shearing forces to undersurface of patella
- Excessive lateral pressure to patella
- Lateral maltracking or displacement of the patella
  - Tight lateral retinacular attachments
  - MPFL sprain
  - Tight/inflexible sartorius, rectus femoris, biceps femoris, vastus lateralis
    or ITB
  - Weak medial tracking forces (VMO) vs stronger lateral (vastus lateralis
    and ITB)
  - Weak hip abductors and external rotators
- Recurrent lateral subluxation
  - MPFL

PFPS: Pathogenesis

- Softening, thinning and fibrillation of the retropatellar articular cartilage
- MPFL length tension failure
PFPS: Clinical Presentation and Evaluation

- Subjective Intake is Key
  - H/O subluxation or dislocation
  - Mechanism of Injury
  - Where is the pain located
  - Movie goers sign
  - Ascend/descend stairs

PFPS: Pearls of Evaluation

- ROM
  - Knee Flexion and extension
  - Hip flexion, extension, abduction, adduction, ER, IR
  - Ankle dorsiflexion in standing

- MMT
  - Keys:
    - Hip
    - Core

- Palpation
- Special Tests
  - Patellar Tilt Test and Lateral Pull test
  - POOR interrater and FAIR intrarater reliability
  - Ober’s
  - Thomas (preferred for even ITB)
  - J Sign Test

PFPS: Pearls of Evaluation

- Special Tests Cont.
  - Q angle
  - Craig’s test
  - Ely’s Test
  - McMurray’s for patella tracking
  - Tibial torsion
  - SLR and Popliteal angle

- Gait
  - Barefoot
  - Shoes
  - Orthotics

- Functional Tests
  - OH Squat
  - Single Limb Squat
  - Step downs
PFPS: Pearls of Treatment

- Manual:
  - DFM/STM distal ITB, MPFL
- Foam Rolling:
  - ART; don’t just roll
- Dynamic Stretching
- Decrease inflammation
- Proximal Stability before distal mobility
- Posterior chain strengthening
- Prevention of Dynamic valgus
- Improve functional movement

Review Strengthening and Taping

Videos 1 - 8
MPFL Reconstruction

Patella Dislocation Classification*:

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syndromic</td>
<td>Genetic Predisposition</td>
</tr>
<tr>
<td>Obligatory</td>
<td>Dislocates with every episode of knee flexion, self-reduces with extension</td>
</tr>
<tr>
<td>Fixed Lateral</td>
<td>Remains laterally dislocated, irreducible</td>
</tr>
<tr>
<td>Traumatic</td>
<td>Initial dislocation due to traumatic event, repeated traumatic dislocations, less energy required with subsequent episodes</td>
</tr>
</tbody>
</table>

Literature Review: Natural History Following Primary Patella Dislocation as Reported in Literature*

<table>
<thead>
<tr>
<th>Study</th>
<th>No.</th>
<th>Recurrent Instability %</th>
<th>Included Adults?</th>
<th>Risk Factors Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cofield and Bryan, 1977</td>
<td>48</td>
<td>44</td>
<td>Yes</td>
<td>No risk factors identified; 13 patients later underwent surgical intervention</td>
</tr>
<tr>
<td>Hawkins et al, 1986</td>
<td>27</td>
<td>71</td>
<td>No</td>
<td>Patellofemoral malalignment; abnormal patella configuration</td>
</tr>
<tr>
<td>Fithian et al, 2004</td>
<td>110</td>
<td>17</td>
<td>Yes</td>
<td>Younger age at initial dislocation; history of developmental hip dysplasia</td>
</tr>
<tr>
<td>Palmu et al, 2008</td>
<td>28</td>
<td>44</td>
<td>Yes</td>
<td>Positive family history of recurrent patellofemoral instability</td>
</tr>
<tr>
<td>Sillanpää et al, 2008</td>
<td>21</td>
<td>48</td>
<td>Yes</td>
<td>No associated risk factors identified</td>
</tr>
<tr>
<td>Lewallen et al, 2013</td>
<td>188</td>
<td>38</td>
<td>No</td>
<td>Trochlear dysplasia; immature physes</td>
</tr>
</tbody>
</table>

*Rousseau et al. Medial Patellofemoral Reconstruction in Children and Adolescents. JBJS Reviews 2013; 3(10): 8

Risk Factors for Patella Dislocation

- Patella alta
- Trochlear Dysplasia
- Increased Q angle
- Increased Tibial tubercle-trochlear groove (TT-TG) distance
  - Index > 0.23 is pathological
- Genu valgum
- Excessive femoral anteversion
- Ligamentous laxity
- Excessive Tibial torsion

MPFL Pathology

- Typically avulses from the medial femoral epicondyle
- Inconsistent healing capacity which increases risk of reinjury with recurrent instability

*Guasden et al. Medial Patellofemoral Reconstruction in Children and Adolescents. JBJS Reviews 2013; 3(10): 8
**Indications for MPFL Reconstruction Surgery**

- Recurrent lateral instability and laxity of the MPFL resulting in incompetent medial restraint
- Excessive lateral patella translation

**Contraindications for MPFL Reconstruction Surgery**

- Patellofemoral arthritis
- Patellofemoral pain unrelated to instability
- Patellofemoral malalignment ***
  - Requires a tibial tubercle transfer or osteotomy
  - Most surgeries require both a TTO and an MPFL reconstruction
  - MPFL reconstruction NOT usually done without a TTO
  - Unless within the appropriate Q angle confirmed on x-ray film measurements

**Surgical Procedure**

- MPFL Reconstruction with grafting WITH:
  - Tibial tubercle osteotomy/transfer
  - Lateral retinacular release
- MPFL Reconstruction Alone

**Graft Options for MPFL Reconstruction**

- Semitendonosis tendon graft
- Quadriceps tendon graft
- Gracilis tendon graft **
  - Usually combined with semitendonosis tendon
- Tibialis anterior tendon graft
- Artificial graft
MPFL Reconstruction Surgical Techniques

- 3.5 mm titanium anchor
- Transosseous 1-mm braided polyester suture
- Interference screw fixation
- Medial bone bridge
- Transpatellar tunnels

Procedure:

- Reference: https://www.youtube.com/watch?v=rmPhjuE7MFQ

Procedure:

- Video of TTO with AMZ and MPFL reconstruction

- Reference: https://www.youtube.com/watch?v=dyuiuZvJtTU
Post-operative rehabilitation of MPFL Reconstruction - **WITHOUT TTO**

- Phase I: (weeks 0-2)
  - Full WBAT with crutches
  - Hinged brace
  - Locked 0-20° when ambulating
  - Passive ROM 0-60°
- Phase II: (weeks 2-6)
  - Hinged brace 0-90° when ambulating until quad control regained
  - Full Passive ROM progression
  - Formal Physical Therapy Initiated
- Phase III: (2-3 months)
  - Return to running
- Phase IV: (4-6 months)
  - Return to sport

Rehabilitation GUIDELINES:

- Consult with MD regarding depth of procedure and grafting type
- Remember your tissue healing time
- Phases of Rehab:
  - Phase I: Pain control and Swelling
  - Phase II: Increase ROM
  - Phase III: Increase Strength/Neuromuscular Control/Proprioception
  - Phase IV: Improve Functional Movement and Strength
  - Phase V: Return to Play
Phase I-IV Guidelines

**Rehabilitation Program: Phase I**

<table>
<thead>
<tr>
<th>Phase of Rehabilitation</th>
<th>Program Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Protect graft site, restore APROM, decrease pain &amp; inflammation, normalize gait, improve neuromuscular control and muscle performance.</td>
</tr>
<tr>
<td>Precaution</td>
<td>Avoid pivoting, or twisting the knee, full knee ROM will be restricted for the first 4 weeks. Use auxiliary device with knee flexed at 90° during ambulation until adequate quad control is appreciated. Avoid full knee and stress to surgical site.</td>
</tr>
<tr>
<td>Criteria to Advance to Phase I</td>
<td>No signs or symptoms of patellar instability, knee ROM 90° or greater (after 4 weeks), full knee extension, online quadriceps contraction, state of knee relevant with unlocked brace, no assistance of crutches, and resolution of knee effusion.</td>
</tr>
<tr>
<td>Range of Motion</td>
<td>Stationary bike with seat high, towel slides, ankle pumps.</td>
</tr>
<tr>
<td>Muscle Performance</td>
<td>NMES with quad sets, isometrics, hamstrings &amp; adductors. Full with brace, is way full flexibility, adduction, extension, standing calf raise (single and bilateral), standing donkey, esca leg bridges, OB include end range.</td>
</tr>
<tr>
<td>Proprioception</td>
<td>Single limb balance wearing brace, stable surface.</td>
</tr>
<tr>
<td>Abdominal Core</td>
<td>Transverse abdominal and stabilization exercises.</td>
</tr>
<tr>
<td>Stretching</td>
<td>Lateral Gluteal (frontal plane), hamstring, gastrocnemius.</td>
</tr>
<tr>
<td>Manual Therapy</td>
<td>STM of injured limb with emphasis on quadriceps, hamstrings, lateral quadratus tract, PROM grade I/II superior/inferior patella glide.</td>
</tr>
<tr>
<td>Modality</td>
<td>PRN, IFC, estim, cryotherapy for swelling management.</td>
</tr>
<tr>
<td>Home Program</td>
<td>Pain free A/PROM to 90°, knee flexion (after 4 weeks), basic leg strengthening with no open chain activity and knees.</td>
</tr>
</tbody>
</table>

**Rehabilitation Program: Phase II**

<table>
<thead>
<tr>
<th>Phase of Rehabilitation</th>
<th>Program Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Protect graft site, continue to restore ROM and gait, improve muscle performance by progressing CKC exercises in single planes of motion.</td>
</tr>
<tr>
<td>Precaution</td>
<td>Avoid pivoting, or twisting the knee, reversing the surgical site, multiplanar movements, CKC with deep knee flexion angles &gt; 90° and wearing the brace during activity.</td>
</tr>
<tr>
<td>Criteria to Advance to Phase II</td>
<td>No signs or symptoms of patellar instability, adequate quadriceps strength (i.e. absence of extensor lag during SLR), knee ROM 120° or greater, single limb balance 30 seconds or greater, normal gait pattern with unlocked brace, resolution of no joint effusion.</td>
</tr>
<tr>
<td>Range of Motion</td>
<td>Phase I activity continued.</td>
</tr>
<tr>
<td>Muscle Performance</td>
<td>Phase activity with the progression of CKC exercises from isometrics, side stepping, 90° range in frontal and sagittal plane, 4 inch step ups, heel walking and toe walking.</td>
</tr>
<tr>
<td>Proprioception</td>
<td>Single limb balance on unstable surface.</td>
</tr>
<tr>
<td>Abdominal Core</td>
<td>Planks, side planks, etc.</td>
</tr>
<tr>
<td>Stretching</td>
<td>Phase activity continued, adduction and hip flexion.</td>
</tr>
<tr>
<td>Cardiovascular Conditioning</td>
<td>Hip and shoulder exercises, Aquatic therapy if available.</td>
</tr>
<tr>
<td>Manual Therapy</td>
<td>STM and joint mobilizations as needed.</td>
</tr>
<tr>
<td>Modality</td>
<td>PRN, IFC, estim, cryotherapy for swelling management.</td>
</tr>
<tr>
<td>Home Program</td>
<td>Phase I activity with addition of cardiovascular conditioning with the elliptical trainer and stationary bike.</td>
</tr>
</tbody>
</table>
### Rehabilitation Program: Phase III

<table>
<thead>
<tr>
<th>Phase of Rehabilitation</th>
<th>Program Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase III</strong></td>
<td><strong>Focus</strong>: Restore full joint ROM, muscle performance, improve proprioception and introduce sport specific/functional movements. <strong>Precautions</strong>: Avoid exercises targeting the surgical site, closed chain movements with deep knee flexion angles (&gt;90°), post-exercise swelling and pain. <strong>Criteria to advance to Phase IV</strong>: No signs or symptoms of patella instability, swelling to &lt;50% of non-operative leg, normal knee ROM, clearance by surgeon, normal jogging pattern while wearing brace. <strong>Range of Motion</strong>: as needed to return full range of motion. <strong>Muscle Performance</strong>: Phase II activity with addition of multidirectional CKC exercises and hamstring strengthening. Sports specific activity including light jogging patterns with brace. <strong>Proprioception</strong>: Single limb balance on BOSU. <strong>Abdominal Core</strong>: Planks, side planks, etc. <strong>Stretching</strong>: Phase I stretching continued; self-myofascial release techniques. <strong>Cardiovascular</strong>: Elliptical, stationary bike, progression in jogging. <strong>Manual Therapy</strong>: STM and joint mobilizations as needed. <strong>Modalities</strong>: NONE. <strong>Home Program</strong>: Phase I and II activity with addition of cardiovascular conditioning with the elliptical trainer and inclined treadmill.</td>
</tr>
</tbody>
</table>

### Rehabilitation Program: Phase IV

<table>
<thead>
<tr>
<th>Phase of Rehabilitation</th>
<th>Program Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase IV</strong></td>
<td><strong>Focus</strong>: Returning to full sports activity. <strong>Precautions</strong>: Pain free activity and avoidance of post exercise joint effusion. <strong>Criteria to return to full activity</strong>: No signs or symptoms of patella instability, absence of joint effusion, symmetric movement strength, normal neuromuscular control with all sports specific testing, clearance by surgeon. <strong>Range of Motion</strong>: Phase III as needed. <strong>Muscle Performance</strong>: Phase III as needed; begin sports specific activity including low level plyometrics, multidirectional agility drills and circuit training. <strong>Abdominal Core</strong>: Progressive core strengthening exercises. <strong>Stretching</strong>: Phase III activities as needed with Dynamic/High Step. <strong>Cardiovascular</strong>: Elliptical, stationary bike, progressive jogging. <strong>Manual Therapy</strong>: STM and joint mobilizations as needed. <strong>Modalities</strong>: NONE. <strong>Home Program</strong>: Phase III and IV activity and addition of jogging for cardiovascular jogging.</td>
</tr>
</tbody>
</table>

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*time for discussion*
References


References cont.


