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: meniscocapsular: 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

Figure 2 - Triangular area between the MPFL, VMQ and TMMH
MPFL: medial patellofemoral ligament, VMQ: vastus medialis obliquus
TMMH: tibial collateral muscle. F: patella, VMQ: vastus medialis muscle

Ligaments: Minor

- 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
  • Inferior arm attaches to the semimembranosus tendon
  • Superior arm with the posterior capsule and proximal part of oblique popliteal ligament
  • Femur and anterior to gastrocnemius tubercle
  • F: provides static resistance to valgus loads as knee moves into full extension
  • Dynamic stabilizer via attachment of semimembranosus to valgus force as knee moves into flexion

Ligaments: Minor

• 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

Ligaments: Minor

• 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 arcuate 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

Ligaments
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

- 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: gastronemius, 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 Knee Musculature
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

- 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

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

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/descent 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
**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>198</td>
<td>38</td>
<td>No</td>
<td>Trochlear dysplasia; immature physes</td>
</tr>
</tbody>
</table>

*Guasden et al. Medial Patellofemoral Reconstruction in Children and Adolescents JBJS Reviews 2015: 3(10) 3

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
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=rnPHjuZ7MFQ

Procedure:

- Video of TTO with AMZ and MPFL reconstruction

Reference: https://www.youtube.com/watch?v=dyuiuZvJlTU
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: Rehabilitation Program Details

**Focus**: Protect graft site, restore AP/PROM, decrease pain & inflammation, normalize gait. Improve Neuromuscular Control and muscle performance.

**Precautions**: Avoid pivoting, or twisting the knee, limit knee flexion to 90° for the first 4 weeks. Use axillary crutches with knee locked at 0° during ambulation until adequate quad control is appreciated. Avoid full quad and direct knee stress.

**Criteria to Advance to Phase II**: No signs or symptoms of patella instability, knee ROM 90° or greater (after 6 weeks), full knee extension, quadriceps contraction, heel to toe gait pattern with unlocked brace, no assistance of crutches, and return to no joint effusion. Progression is slow.

**Range of Motion**: Stationary bike with seat high, towel slides, ankle pumps

**Muscle Performance**: NMES with quad sets, Isometrics Hamstrings & Adductors, Soft with brace, 1-way Soft Abduction, adduction, external, standing calf raise (plantar and dorsal), clamming cures,Iso leg bridges, CKE inclining L/L, squats, and lunge.

**Proprioception**: Single limb balance wearing brace, stable surface

**Abdominal Core**: Transverse abdominal stabilization exercises

**Stretching**: Lateral Quad/ITB Band, Hamstrings, gastrocnemius

**Manual Therapy**: STM of injured limb: emphasis on quadriceps, hamstrings, lateral quad/ITB tract, PROM grade I/II superior/inferior patella glides

**Modalities**: PRN, IFC estim with cryotherapy for swelling management

**Home Program**: daily knee flexion to 90°, toe flexion (if weekly), basic L/L strengthening with no open chained activity at home.

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Phase II: Rehabilitation Program Details

**Focus**: Protect graft site, continue restore PROM, and gait. Improve muscle performance by progressing CKC exercises single planes of motion.

**Precautions**: Avoid pivoting, or twisting the knee, dorsiflexion of surgical site, multiple plane movements, CKC with deep knee flexion angles > 90° and wearing the brace during activity.

**Criteria to Advance to Phase III**: No signs or symptoms of patella 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, return to no joint effusion.

**Range of Motion**: Phase I activity continued

**Muscle Performance**: Phase activity with the progression of CKC exercises: from lunges, side stepping, L/L lunges in frontal and sagittal plane, 4 inch step ups, heel walking and toe walking

**Proprioception**: Single limb balance on unstable surface

**Abdominal Core**: Planks, side planks, etc.

**Stretching**: Phase activity continued, adductors and gluteus

**Cardiovascular**: Elliptical and stationary bike, Aquatic therapy if available

**Manual Therapy**: STM and joint mobilizations as needed

**Modalities**: PRN, IFC estim with cryotherapy for swelling management

**Home Program**: Phase I activity with addition of cardiovascular conditioning with the elliptical trainer and stationary bike.
## Rehabilitation Program: Phase III

**Phase III**

### Focus
- Restore full joint ROM, muscle performance, improve proprioception and introduce sport specific/functional movements.

### Program Details
- **Precautions:** Avoid stressing the surgical site, closed chain movements with deep knee flexion angles (90°) and avoid exercise causing and pain.
- **Criteria to advance to Phase IV:** No signs or symptoms of patella instability, minimal to no joint effusion, normal lower limb strength, gradual return to normal knee flexion, clearance by surgeon, gradual jogging pattern with awareness of pain.

### Range of Motion
- As needed, to restore full range of motion

### Muscle Performance
- Phase II activity with additions of multidirectional CKC exercises and hamstring strengthening. Sports specific activity including low stressed plyometric movements and agility ladder.

### Proprioception
- Single limb balance on BOSU

### Abdominal Core
- Planks, side planks, etc.

### Stretching
- Self-myofascial release techniques

### Cardiovascular
- Elliptical, stationary bike, progressive jogging

### Manual Therapy
- STM and joint mobilizations as needed

### Modalities
- NONE

### Home Program
- Phase III activity with addition of cardiovascular conditioning with the elliptical trainer and inclined treadmill

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## Rehabilitation Program: Phase IV

**Phase IV**

### Focus
- Returning to full sports activity

### Program Details
- **Precautions:** Pain-free activity, and avoid post exercise joint effusion
- **Criteria to return to full activity:** No signs or symptoms of patella instability, absence of joint effusion, symmetric lower extremity strength, normal neuromuscular control with all sports specific testing, clearance by surgeon.

### Range of Motion
- Phase I-III as needed

### Muscle Performance
- Phase I-III as needed, begin sports specific activity including low level plyometrics, multidirectional agility drills, and circuit training

### Abdominal Core
- Progressive core strengthening exercises

### Stretching
- Massage Iliotibial band with dynamic massage technique

### Cardiovascular
- Elliptical, stationary bike, progressive jogging

### Manual Therapy
- STM and joint mobilizations as needed

### Modalities
- NONE

### Home Program
- Phase IV activity and addition of jogging for cardiovascular conditioning

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**Time for discussion**
References


References cont.