P-F Biomechanics and Function
Conservative Approaches

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Function - Patella

- Increase moment arm
- Quadriceps = produces torque
- Patellectomy = 50% reduction in torque
- Protection from fall
Patellofemoral Tracking

- normal patellar tracking is influenced by:
  muscle balance
  medial and lateral ligamentous support
  joint geometry (dysplasia)
Patellofemoral Rehabilitation

• Most challenging patients
• Immediate relief possible
• Utilize concepts of biomechanics

• 2 groups: unstable, arthritic
Unstable OR Arthritic?

- Instability = use muscle forces hip/knee to improve stability, use bony anatomy to **promote stability** (120-40)
- Arthritic = **Avoid** ROM where lesions are present (30-70) trochlear groove lesion location
Normal P-F Bony Articulation

- 10 degrees = 1\textsuperscript{st} articulation
- Propagates from inferior to superior to 90 degrees
- 90-135 degrees = medial facet (odd) & lateral, quad tendon
- B=20  C=60  D=90  E=120  F=135
Leg press: PFJRF greatest where contact is greatest (60-90).

Leg extensions: PFJRF greatest where contact is least (0-30).
P-F Clinical Implication

- P-F leg extension: Pt’s have pain (0-30) because large F to minimum area.
- P-F leg press: Pt’s have less pain (90-60) because able to distribute forces to maximum area.
Not all leg presses created the same

- Deeper knee flexion = incr. PFJRF
- Increased hip flexion = incr. HS activity
  Wilk
  AJSM
Quad EMG – WB & NWB

- Wilk AJSM – knee extension = highest EMG = 25 degrees
- Wilk AJSM – leg press = highest EMG = 85 degrees
- Knee extension = requires high EMG due to lack of patellar height near extension
- Huberti = Fpt > Fquad 1st 20d, 45d Fquad > Fpt = Careful with minisquats
## Contact Forces PFJ

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated force X BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>walking</td>
<td>0.5</td>
</tr>
<tr>
<td>straight leg raise</td>
<td>0.5</td>
</tr>
<tr>
<td>cycling</td>
<td>1.3</td>
</tr>
<tr>
<td>stair climbing</td>
<td>3.3</td>
</tr>
<tr>
<td>squat</td>
<td>7.6</td>
</tr>
<tr>
<td>running</td>
<td>7 - 11</td>
</tr>
</tbody>
</table>
P-F Contact Forces ACL Def.

The Effects of Removal and Reconstruction of the Anterior Cruciate Ligament on the Contact Characteristics of the Patellofemoral Joint

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- Cutting the ACL = increased lateral tilt & unloading of medial facet
P-F Imbalance – contact & compression

- Articular deg. Changes
- Excessive compression = disruption of matrix of articular cartilage
- Peri-articular soft tissue irritation
- Scott Dye, M.D. AJSM ‘98 = graded patellar components through probing
- Results = fat pad suprapatellar pouch
Articular Cartilage Doesn’t “Hurt”

- Soft tissue overload
- Dye = Equilibrium of knee forces = balance, homeostasis
- Restore: normal muscle forces, normal flexibility, if needed, surgical alignment
Shear Forces
Ex. To avoid

- Knee extension
- Plyometric ex’s
- Quick lateral movements
Goal - Avoid Shear

HOW?

- Increase dynamic support - Quad/Hamstring strength
- Increase endurance - able to resist fatigue and maintain proper mechanics
- Increase/maintain stability = normal coupled motion = less shear
P-F Cyclic compression exercises

- Cycling - proper seat ht., 90-100 Rpm's, don’t stand on pedals
- Competitivecyclist.com
- MR leg press - allows body weight to be reduced
- Pool therapy - load, unload
- EFX?
Tilt Evaluation

- Lift laterally or press medially to determine lateral soft tissue tightness
- Displace laterally to grade degree of laxity
Testing Functional Hip Abductor Strength

- *Crossley AJSM 2011*
- A- participant demonstrates good performance
- B- participant demonstrates poor overall and trunk performance
- C- participant demonstrates poor pelvis and hip performance
- D- participant demonstrates poor hip and knee performance
• Controlling femoral position
• Hip ABDuctor, G.Max, Lateral Rotation,
• NWB routine advance – ankle wt.
Powers: Controlling Hip Internal Rotation, Knee Adduction

- WB routine
- ABD, GMAX, Lateral rotation
G.Max/Medius

- Extensor, ABD, ER of hip
- Distal control of knee through femoral rotation, adduction
- Combined hip/quad better results

Nakagawa
Clin Rehab 2009,
Fukada 2010
JOSPT
Core Strengthening = Strengthens Kinetic Chain

- Lower Abdominal Trunk flexion/extension using Swiss Ball
- Hewitt AJSM ‘07– Core control may be assoc. with ACL tear = pelvic control = kinetic chain = PF control
Flexibility Evaluation

- Hamstrings when tight = Incr. PFJRF
- Quad Restriction = P. Tendonitis
- Hip flexor tight = Altered pelvic position
- G-S tightness = incr. pronation
I-T Band Restriction

- O’ber’s Test
- May elicit pain over distal insertion when inflamed
IT-Band & Lateral Tilt

- Deep transverse retinaculum from ITB has dense fibrous attachment to patella
- When restricted, could produce lateral tilt
- 1995 JOSPT Winslow correlation ITB ballet
Supportive Approaches

- Excessive pronation = orthotics, reduces Q-angle and lateral tracking
- I-T band restriction = may contribute to lateral tilt, glide
- Foam roller = increased elasticity of I-T band
- Patellar taping, bracing
Supportive Approaches

- Patellar taping
- P-F bracing, Reaction Web
Active Internal Tibial Rotation
Improve Q angle

- Aleviates pain in many patients
- Can apply during SAQ, leg pressing, stepping exercises
Step One
Don’t Forget Basics

- Q.Sets: 10’
- SLR’s: 5’
- Hip ABD: Proximal Control

*JOSPT 2003 Ireland*
26% Dec. Hip ABD Str. w/ anterior knee pain
36% Dec. Hip ER may lead to pronation

*Somehow, I don’t think you thought your cunning plan all the way through.*
Hip Control Begins Immediately

- Controlling femoral position
- Hip ABDuctor, G.Max, Lateral Rotation,
- NWB routine
Step 2
Begin Gradual Loading Exercise
Leg Press Best

• MR Leg Press – supine squat low load high endurance activity 60 second contractions
• Begin with 5Kg
Step 3

Dynamic control of Valgus Force
VMO, G. Medius

• Apply valgus force above knee forcing hip/knee control

• Add unstable platform for stabilization
Control of valgus

- Heel touches: maintain proper hip ABD position decreases Q-Angle
Step 3
Body Weight Control
Functional Squat

- MR Systems Squat Control
- End stage rehab..PF pain.preparation for jump landing
- Chair Squats 3x20
Advanced Valgus Control
Slide Board

• Maintain core/spine position
• Don’t allow cg to move forward
• Control Valgus
Continued Body Weight
Ex. – Knee Muscle Force Balance

• Cone touches
• Control Valgus at all times
New Device
Primal 7

• Allows patient to assume normal body positions early using assisted strapping
Involve the core

• Late stage advanced strengthening
Avoid functional activities Until Quad Function Restored

- Altered quad mechanics = altered P-F mechanics
- Result = pain & quad inhibition
- Quad = shock absorber
Loss of Motion
Increased P-F Compression
Why?

- Pressure necrosis of articular cartilage
- Must have balance to allow perfusion of nutrients
Summary P-F Rehabilitation

- 1st = Quad strengthening
- 2nd = Hip/core control
- 3rd = Flexibility
- 4th = Dynamic P-F exercise
- Knowledge of Biomechanics = exercise progression
P-F Lab

- Assess flexibility – quads, hams, ITB
- Palpate soft tissue – Inf. Pole = patellar tendon, ITB, pes anserine bursae, quad tendon, plica, medial retinaculum medial patellar ligament?
- Lateral tilt, patella-infera, alta,
- Lateral retinaculum tightness – patellar compression test
- Crepitance – pathologic?
- Quad/VMO – dysplasia? Angle of attachment?
P-F lab

• Patellar taping – reduce soft tissue impingement – create medial tilt
• Careful not to create compression
Pt. problems PFJ

- Lateral release – 17 y/o female basketball player. Poor quad function, large effusion/hematoma, painful knee
- Treatment course
  - 1-3 weeks?
  - 3-6 weeks?
  - 6-12 weeks?
- Precautions, red flags?
Pt. problems - PFJ

- 35 y/o runner
- ACL rec. 15 y/ago
- Pain descending stairs
- Pain after running, movie goers sign
- Excellent quad function
- Advice, treatment approach, evaluation picture/tools?
Pt. Problem - PFJ

- Proximal & distal re-alignment
  - VMO reefing, medialization of tibial tubercle, lateral retinacular release
- Huge effusion, day 2 post-op – what is your initial routine? What causes swelling?
- ROM protocol, WB status?
- Indications for this type of surgery?
Q angle

- High Q angle (greater than 15 deg.) = increased chance for lateral tilt
- Functional Q angle = try to overcome with neuromuscular control