The Pesky Patellofemoral Joint: An Ongoing Orthopaedic Enigma

Differential Diagnosis of Patellofemoral Pain

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The presenter has no financial relationships or product endorsements to disclose

Presented at 2019 APTA Combined Sections Meeting, Washington D.C. Jan. 24th, 8-10am.

Learning Objectives
- By the end of this session, the learner will be able to:
- Choose clinically-relevant tests and measures to enhance clinical decision-making when treating individuals with PFP

Diagnosis of Patellofemoral Pain
- Challenging
  - No gold standard
  - Diagnostic tests – poor accuracy
  - Clusters of tests – no improvement to accuracy
    - Cook 2012, Nunes 2013
- Diagnosis of exclusion
  - First – rule out all other possible causes of anterior knee pain
    - Cook 2012, Witvrouw 2014, Crossley 2016

Differential Diagnosis: Anterior Knee Pain
- Medical screening: Appropriate for physical therapy?
  - Tumors, fractures, septic arthritis, slipped capital femoral epiphysis, etc.
  - Red flags – Review of Systems
    - OSPRO-ROS
  - Fractures – Ottawa Knee Rule or Pittsburgh Knee Decision Rule
  - Risk factors
  - Key red flags
    - Non-mechanical pain, insidious onset, no improvement in 4 weeks
      - Childs 2008, George 2015, Konan 2013

Differential Diagnosis
- Other musculoskeletal conditions
  - Lumbar spine
  - Hip
  - Knee – meniscus, ligaments, cartilage
  - Patellar or tibial apophysitis
  - Patellar tendinopathy

    - Patellar subluxation or dislocation
- Psychosocial issues – yellow flags
    - Noehren 2016

Symptoms
- Retropatellar or peripatellar pain
        - Papadopoulos 2015, Crossley 2016
- Functional tasks loading PFJ with flexed knee
    - Squatting
    - Stair ascent or descent
    - Running
    - Sitting with flexed knees
        - Collins 2016

Provocative Diagnostic Tests
- Squatting – most accurate
    - LR+ = 1.8, LR- = 0.20
- Stair Climbing
    - LR+ = 1.3-1.7, LR- = 0.1-0.6
- Eccentric Step-down Test
    - LR+ = 2.3, LR- = 0.7
        - Cook 2012, Nunes 2013, Papadopoulos 2015

Non-provocative Diagnostic Tests
- Patellar Tilt Test
    - LR+ = 5.4, LR- = 0.6
- Passive Gliding Patella
    - Superior/inferior
        - LR+ = 1.4, LR- = 0.7
    - Medial/lateral
        - LR+ = 1.8, LR- = 0.7
- Lateral Pull (Active Instability Test)
    - LR+ = 249 (?), LR- = 0.8
        - Cook 2012, Nunes 2013, Papadopoulos 2015

Summary: Diagnosis of Patellofemoral Pain
- Retropatellar or peripatellar pain
- Rule out other possible causes of anterior knee pain
- Reproduction of anterior knee pain with activities loading the PF joint in a flexed-knee position
    - Squatting, stair ascent/descent, prolonged sitting with flexed knees, etc.
        - Cook 2012, Nunes 2013, Papadopoulos 2015, Crossley 2016, Collins 2016

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The Pesky Patellofemoral Joint: An ongoing orthopaedic enigma

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Presented at 2019 APTA Combined Sections Meeting, Washington D.C. Jan. 24th, 8-10am.

Proposed Classification System for the Treatment of Individuals with Patellofemoral Pain

A. Overuse/Overload without other Impairment

- Loss of tissue homeostasis *(Post & Dye, 2017)*
- Moderate relationship between self-reported pain and increased patellofemoral joint metabolic activity *(Draper et al, 2012)*
- Significant relationship between pain intensity and physical activity level *(Briani et al, 2017)*
- Foot kinematics and hip strength are not predictors of injury for individuals who develop patellofemoral pain following a "start-to-run" program *(Thijs et al, 2008; Thijs et al, 2011)*
- Summary Points
  - Onset from rapid increase in patellofemoral joint loading without adequate time for tissue recovery
  - Subgroups may not necessarily exhibit other impairments like impaired muscle performance, muscle coordination or mobility
  - Supports the importance of patient education for activity modification *(Barton et al, 2015)*

B. Muscle Performance Deficits

- Subgroup of individuals with patellofemoral pain exhibit hip and knee weakness that respond favorably to strengthening exercises *(Bolgla et al, 2016)*
- Measurement considerations when assessing hip and knee muscle strength
  - Hand-held dynamometry with stabilization straps

- Use of the “make” test
- 3 trial with coefficient of variation less than 10%
- Data expressed as a percent of body mass

- Guidance for identifying muscle weakness (expressed as percent body mass) based on responders from a large-scale randomized controlled trial comparing outcomes for a hip/core- or quadriceps-based rehabilitation program *(Ferber et al, 2015; Bolgla et al, 2016)*
  - Hip abductors: 38.8% (males) and 32.2% (females)
  - Hip extensors: 27.4% (males) and 22.2% (females)
  - Hip external rotators: 13.0% (males) and 12.0% (females)
  - Knee extensors: 44.9% (males) and 37.4% (females)
- Summary Points
  - Subgroup of individuals with patellofemoral pain with hip and/or knee weakness
  - Hip weakness most likely a result, not a cause, of patellofemoral pain onset *(Rathleff et al, 2014; Herbst et al, 2015)*
  - Need for ongoing works to identify threshold values to identify hip and knee weakness
  - Identifying hip and knee weakness values will assist in the development and implementation of *individually-tailored* interventions

C. Muscle Coordination Deficits

- Subgroup of individuals without evident hip and/or knee weakness
- Based on concept of an increased dynamic Q-angle during dynamic tasks *(Powers, 2003)*
  - Contralateral pelvic drop
  - Hip adduction
  - Hip internal rotation
  - Knee abduction
- Limitations of measuring the frontal plane projection angle during a single-leg squat to identify faulty mechanics *(Räisänen et al, 2018)*
- Support for the use of the dynamic valgus index that incorporates both the hip and knee frontal plane projection angles *(Scholtes & Salsich, 2017)*
- Use of mobile devices and apps to quantify the dynamic valgus index *(unpublished data from Bolgla et al, 2018)*
- Summary Points
  - Commercially-available video cameras can be used to identify patients who exhibit altered hip and/or knee mechanics during a dynamic task *(Scholtes & Salsich, 2017; Gwynne & Curran, 2018)*

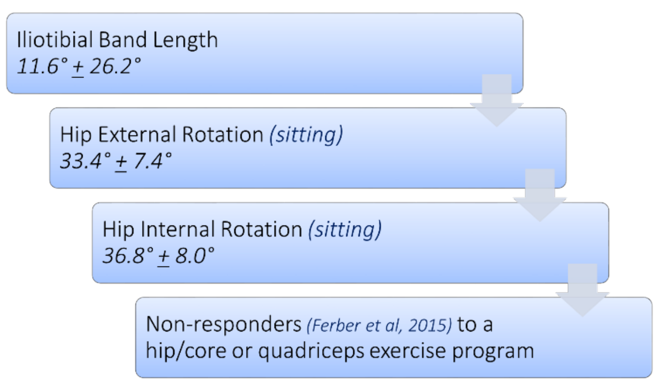
– Dynamic valgus index may provide a more comprehensive assessment of hip and knee kinematics during dynamic tasks
– Evidence supports the ability to improve hip and/or knee kinematics with movement retraining *(Willy et al, 2011; Leibbrandt & Louw, 2018; Salsich et al, 2018)*

D. Mobility Deficits

- Hypermobility (foot pronation)
  – Foot Posture Index: score ≥ 6.3 points *(Selfe et al, 2016)*
  – Midfoot Mobility: > 11.25-mm difference in midfoot width from non-weight bearing to weight bearing *(Mills et al, 2012)*
- Hypomobility *(Piva et al, 2006)*

Muscle Group	Position	Instrument	Value
Hamstring	Straight Leg Raise	Goniometer	79.1° ± 11.5°
Quadriceps	Prone Knee Flexion	Inclinometer	134.0° ± 11.3°
Gastrocnemius	Ankle Dorsiflexion *(knee extended)*	Goniometer	7.4° ± 6.0°
Soleus	Ankle Dorsiflexion *(knee flexed)*	Goniometer	14.8° ± 4.8°

- Hypomobility *(Hamstra-Wright et al, 2017)*



- Summary Points
  – Clinicians should continue to assess foot mobility for those with patellofemoral pain
  – More limited data exist for the extent that reduced flexibility impacts outcomes
  – Ongoing need for works to determine "threshold" values to identify flexibility deficits
  – Future investigations should assess hip range of motion

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The Pesky Patellofemoral Joint: An ongoing orthopaedic enigma

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The presenter has no financial relationships or product endorsements to disclose

Presented at 2019 APTA Combined Sections Meeting, Washington D.C. Jan. 24th, 8-10am.

I. Slide 1: Cover slide: Best Practice Treatment Strategies for individuals with Patellofemoral Pain (PFP)
II. Slide 2: Disclosures
III. Slide 3: Outline for talk
IV. Slide 4: Case study Description
V. Slide 5: Case study: objective finding
VI. Slide 6: gait analysis
VII. Slide 7: Viewing injuries in the context of the Tissue homeostasis model and envelope of function, as per Dye 2005, can be helpful to guide the clinician and the runner.(1, 2)
VIII. Slide 8: Exercise therapy is the standard of care for the treatment of the individual with PFP(3). Absolute rest is contra-indicated.
IX. Slide 9: Quadriceps strength training has the greatest volume of research supporting its use with individuals with PFP.(4)
X. Slide 10: PFJ contact forces and stresses are higher in endrange knee extension and knee flexion for non-weight bearing and weight bearing knee extension exercises, respectively. However, constant resistance knee extension machines, which are far more common, have more moderate amounts of PFJ stress throughout the range of motion, except for endrange non-weight bearing knee extensions where PFJ stress is consistently high.(5)
XI. Slide 11: EMG biofeedback to augment quadriceps exercises is not supported(6) nor is NMES(7)
XII. Slide 12: Hip plus knee exercise therapies are associated with greater treatment effects compared with knee exercise therapy alone.(8)
XIII. Slide 14: Yet, PFJ taping is helpful but mainly in the early stages of rehabilitation.(9) Mechanism for pain reduction is likely not biomechanical as MRI evidence indicates tape does not alter PFJ alignment or contact area.(10)
XIV. Slide 13: Problems with exercise therapy literature in PFP(11):

a. very few actually describe exercise interventions in sufficient detail to replicate
b. Most interventions lack evidence-based parameters that ensure that optimal strengthening is achieved e.g., rest intervals, %1RM, number of sets

XV. Slide 14: Hip strengthening, however, does not appear to alter mechanics.(12).

XVI. Slide 15: PFJ loads of common functional tasks, including walking and running.(13-15) This large difference between walking PFJ loads and running/jumping PFJ loads illustrates why athletes have such a hard time returning to activity.

XVII. Slide 15: How much pain should we allow during exercise? What guidelines can we give our patients? Is hyperalgesia present in our patients?(16)

XVIII. Slide 16-18: Treatment plan for case study

XIX. Slide 19, 20: Gait retraining to address frontal plane mechanics in runners(17, 18) and to be used during a return to running program(1)

XX. Slide 21: Review future directions and limitations

XXI. Slide 22: Take home message

XXII. Slide 23: Acknowledgements

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Patellofemoral Pain and Patellofemoral Osteoarthritis Onset: Management Across the Life Span

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The presenter has no financial relationships or product endorsements to disclose

Presented at 2019 APTA Combined Sections Meeting, Washington D.C. Jan. 24th, 8-10am.

Learning Objectives
- By the end of this session, the learner will be able to:
- Explain how factors associated with PFP may contribute to PF OA and describe specific intervention strategies when treating individuals with PF OA

Prevalence of Patellofemoral Pain
- Varies by population
    - Annual prevalence general population: 22.7%
        - Smith 2018
- Not just a problem for young adults & adolescents
- PearlDiver Record Database - diagnosis rates
    - PFP: 1.5%-7.3% all patients seeking medical care in USA
    - Diagnosis rates increased with age – to 50-59 years
        - Glaviano 2015

Patellofemoral Osteoarthritis: Imaging
- Osteoarthritis – multifactorial disease
    - Cartilage, subchondral bone, synovial tissue, joint capsule, muscle
    - Knee: medial TF, lateral TF, PF
- Radiographic findings
    - Joint space narrowing, osteophytes
- MRI
    - Abnormal cartilage morphology, bone marrow lesions
        - Hart 2017

Patellofemoral Osteoarthritis
- Possible long-term result of PFP
    - PFP and PF OA – possible continuum
        - Lack of longitudinal studies
        - One retrospective review – persons undergoing PFJ arthroplasty
            - Crossley 2014, Thomas 2010, Utting 2005
    - PFP – frequent persistent symptoms – up to 20 years
        - Nimon 1998

    - Similar symptoms, impairments, functional limitations
        - Crossley 2016

Patellofemoral Osteoarthritis (cont.)
- Highly prevalent in adults
    - 38% (population-based)
    - 43% (symptom-based)
        - Hart 2017
- Anterior knee pain – stair climbing
    - Min-no pain – level ambulation
        - van Middelkoop 2018
- Significant cause of disability
    - Stair ascent & descent, sit-to-stand, car & bathtub transfers
        - Hoglund 2015, van Middelkoop 2018

Muscle and Static Alignment Factors Associated with PF OA
- Proximal muscle weakness:
    - Quadriceps
    - Hip abd, hip ER, hip ext
        - Hoglund 2014, Stefanik 2011, van Middelkoop 2018
- LE static malalignment
        - Elahi 2000, Cahue 2004

Biomechanics Associated with PF OA
- Faulty dynamic mechanics: inconsistent
    - Sit-to-stand: dynamic genu valgus
        - Hoglund 2014
- Gait: conflicting
    - No differences
        - Crossley 2012, Pohl 2013
    - Inc. anterior pelvic tilt
    - Late stance – inc. contralateral pelvic drop, dec. hip extension & inc. hip adduction
        - Crossley 2018
- Stair descent: inc. anterior pelvic tilt
        - Fok 2013

How should we treat the patient with PF OA?
- Limited evidence
- Patellar taping or bracing
- Multimodal approach
- Two trials
    - Hip abductor strengthening, VMO retraining, jt mobilization, patellar taping
        - van Middelkoop 2018
- Foot orthoses – prefab orthosis (6°varus wedge) and flat insole – dec. knee pain in stepdown test
        - Collins 2017

Pilot Study: Exercise Intervention
- Principles for treating patients with PFP: hip focus → hip + knee
    - Core/trunk strengthening + neuromuscular reeducation
        - Hoglund 2018

PF OA: Exercise Focus (Hoglund 2018)
- 6 weeks, 2x/week + home program
- Hip focus + abdominal strengthening/stabilization – lying
    - Decreased PFJ stress
- Progressed to standing hip, knee, pelvic/trunk stabilization
    - Neuromuscular reeducation
    - Functional ex: sit-to-stand

PF OA Exercise Intervention Results -1

PF OA Exercise Intervention Results -2

Patient-Reported Outcome Measure for PF OA
- Knee Injury and Osteoarthritis Outcome Score (KOOS)
    - Valid, reliable, and responsive for knee OA, focal cartilage lesions, meniscal tear, ACL tear, postsurgical
    - MDC: older pts 20 pts per subscale, younger pts 14.3 – 19.6 pts
        - Collins 2016
- KOOS-PF
    - Smallest detectable change: 16 pts
    - Minimal important change: 14.2 pts
        - Crossley 2018

PF OA Physical Performance Measures
- Recommended core set of PPM for pts with knee and hip OA (OARSI):
    - 30” Chair Stand Test
    - 40 meter Fast Paced Walk
    - Stair-climb Test
- Additional recommended PPM
    - TUG
        - PF OA participants – longer time vs controls
            - Hoglund 2015
    - 6-minute Walk Test
            - Dobson 2017

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