PATELLOFEMORAL PAIN & DISORDERS:
Evidence Based Treatment for Non-Operative Rehabilitation

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“the 2013 Edition”

"If you always do what you always did, you’ll always get what you always got."
PATELLOFEMORAL DISORDERS
Suggested Treatments – 1980 & 90’s

- VMO strengthening
- Patellar taping
- Activation VMO
- Patellar bracing
- Foot orthotics
- Stretching / flexibility

PATELLOFEMORAL DISORDERS
Suggested Treatments – 2013

- Hip strengthening
- Pelvic control
- Core strength
- Knee joint proprioception
- Stretching / flexibility
- Orthotics ??

PATELLOFEMORAL DISORDERS
Introduction

- Vexing clinical challenge
- “Black hole of Orthopaedics”
- No single explanation has clarified this problem
- No single surgery or therapeutic approach solves all PF dysfunctions

Patellofemoral Pain
Common Clinical Problem

- Most common problem in sports medicine
- 80% improved with conservative Rx
- Multiple disorders: diagnosis
  - Tibiofemoral malalignment
  - PF instability - ligaments
  - PF dysplasia - congruity
  - PF arthrosis
  - Lat patellar compression

PATELLOFEMORAL DISORDERS
Common Clinical Problem

- Most common problem in sports medicine
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PATELLOFEMORAL DISORDERS

Introduction

• Most common knee pathology encountered by orthopaedic / sports clinicians

• In the general population, 1 out of 4 experience patellofemoral pain at some time in their lives

Walczak, ...Cole: J Knee Surg ’08

• 14 asymptomatic knee MRI
• Performed 2 mos prior to season
• 11/28 right knees, 16/28 left knees
✓ 27/28 (96%) had articular cartilage lesions
✓ 44% patella
✓ 26% trochlea

Diagnosis: “Anterior knee pain”

• Has become an accepted diagnosis
• Non-specific term
• Vague diagnosis
• Adds to confusion

PATELLOFEMORAL DISORDERS

Introduction

• Perhaps one of the reasons is there are many subtle variations of patellofemoral pain

• “Not all patellofemoral pain / dysfunction is the same”

Malalignment of the Lower Extremity

Great Alignment – Winning Hand !!!
PATELLOFEMORAL DISORDERS

- The ability to evaluate and differentiate these subtle variations / differences in pathophysiology will allow the clinician to formulate an effective treatment approach
  - History
  - Physical exam
  - Functional assessment
  - Imaging studies

What is the source of patellofemoral pain?

Where’s the patellofemoral pain coming from? Structure?

Dye, Vaupel, Dye AJSM 1998

- Conscious neurosensory mapping of internal structures without anesthesia
- Subjectively graded sensation:
  0 (none) – 4 (severe)
- Spatial localization:
  A (accurate localization) – B (poor localization)

- Small nerve injuries in the lateral retinaculum
- Nerve fibers appeared enlarged & inflammation present
- Potential source of PF pain – long lasting PF pain


- 13 patients underwent PF surgery
- At the time of surgery, retinaculum biopsy for neural tissue change
- Relationship between clinical and histologic findings
- Moderate - severe pain group: highest number of nerves and neural area
- Loss of proprioception due to neural damage

PATELLOFEMORAL DISORDERS

Initial Treatment

- “Well-designed” treatment program
- Mainstay of treatment
- Numerous therapies and exercises advocated and suggested:
  - Taping, VMO strengthening, orthotics,
  - What is the best treatment?
  - What does the evidence indicate

Classification System for Non-operative Rehabilitation

Wilk, Davies, Mangine, Malone: JOSPT ’98
**Patellofemoral Pain Syndrome**

*Clinical Differential Diagnosis*

- **Patellar Compression Syndrome**
  - ELPS
  - GPPS
- **Patellar instability**
  - Chronic instability
  - Recurrent dislocation
  - Acute dislocation
- **Mechanical dysfunction**
- **Osteochondritis dissicans**
- **Direct patellar trauma**
  - Fracture
  - Fracture / dislocation
- **Soft tissue lesion**
  - Suprapatellar plica
  - Fat pad syndrome
  - IT band friction
- **Overuse syndrome**
  - Tendinitis
- **Neurologic disorders**
  - (RSD) Regional Pain Syndrome

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**Principles of Treatment: Cases**

4. Exam, Dx All Components EMM

- **Ligaments**
  - Patellofemoral
    - Medial laxity: > 50%
    - Lateral sublux: < 10 mm
  - Hypermobility
- **Muscle**
  - VMO deficiency
  - Q angle, 0 & 30 deg

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**Increased Femoral Anteversion**

- Femoral torsion
- Forces patellofemoral joint

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**Lower limb alignment & lateral forces on the patella**

*Q-angle: 15°*
Dynamic Q-Angle

- **Proximal factors**
  - Femoral adduction
  - Femoral internal rotation

- **Distal factors**
  - Pronation
  - Tibial internal rotation

ACL REHABILITATION

- “Stabilization of the knee - occurs from above & below”
  - Hip & core stabilization
  - Foot & ankle control

Powers et al: JOSPT '03
Wilk et al: J Athl Trn '99

Patellofemoral Assessment

**Step Down Test**
Stabilization From ABOVE & BELOW

ACL REHABILITATION
Rehab Concepts

- “Stabilization of the knee - occurs from above & below”
  » Hip & core stabilization
  » Foot & ankle control
  Wilk et al: Ortho Clin No Am ’03
  Powers et al: JOSPT ’03
  Wilk et al: J Athl Trn ’99

Nakagawa et al: JOSPT 2012 (Brazil)

- Determine if there are differences in the sexes between hips, core, knee kinematics, hip strength and hip activation in subjects with & without PF pain
- 80 subjects (females vs males, PFPS vs No PFPS
  ✔ Compared to normals – PFPS had more trunk lean, contralateral pelvic drop, hip adduction & knee abduction during single leg squat
  ✔ Subjects PFPS: 18% less hip abd & 17% less ER
  ✔ Females with PFPS: poorer glut med activ, ↑ hip IR

Nakagawa et al: Int J Spts Med 2013 (Brazil)

- Hip & knee kinematics associated with patellofemoral joint pain & functional status
- Compared male & female subjects with PFPS
  ✔ Altered knee & hip kinematics appear to be associated with altered knee function & PF pain
  ✔ Pain was associated with hip adduction, hip IR and knee abduction
  ✔ Modest correlation regarding function & hip & knee kinematics
Lee, Souza, Powers: Gait Posture 2012

- Postural stability & hip abductor performance in females with patellofemoral pain
- 20 females with PFPS & 19 controls
- Step down balance task on a force platform (COP)
  - Hip abductor strength significantly lower in PFPS group
  - Medial-lateral displacements were greater in PFPS group (39mm vs 24mm (p<0.001))
  - Females with PFPS exhibited impaired M-L stability when compared to control subjects

Baldon, Nakagawa, Muniz, et al: JAT ’09

- Compare eccentric hip muscle function between females with PFPS & female control group
- PFPS (n=10), control group (n=10)
  - PFPS participants exhibited much lower eccentric hip abduction & hip adduction
  - No difference in hip ER or IR torque ratios

Patellofemoral Joint

- NWB: Patella moves over intercondylar groove
  - Patella glides distal to proximal during extension
  - Patella glides proximal to distal during flexion
- WB: Femur moves under the patella
Patellofemoral Joint

- **Biomechanics**

WB knee extension, femur rotates under the patella
NWB knee extension, patella moves over femur

Powers et al: JOSPT '03

Patellofemoral Joint

- **Gluteus Medius**
  - Functions:
  - Abduction
  - Anterior fibers: IR & flexor
  - Posterior fibers: ER & ext

Gluteus Maximus: Tri-Planar Muscle
- Extensor
- Abductor
- ER

Gluteus Maximus: Tri-Planar Muscle
- Extensor
- Abductor
- ER

Gluteus Medius
- Functions:
- Abduction
- Anterior fibers: IR & flexor
- Posterior fibers: ER & ext
Diagonal Lunges

- Functional movement
- Hip muscles as a rotator
- Eccentrics back leg
- Control body weight

Hip Rotation Strengthening

Instant Replay
Train the hip – Eliminate the foot

Philippon: AJSM ’11

Distefano: JOSPT ’09

Philippon et al: AJSM ’11

Distefano: JOSPT ’09
**Boren, Conrey, LeCogue, Paprocki, Voight, Robinson: IJSPT ‘11**

- 26 healthy subjects – SEMG placed on gluteus medius & gluteus maximus 18 exercises
- 5 exercises produced 70%> MVIC
  - Gluteus medius:
    - Side plank abduction (103% MVIC)  bottom
    - Side plank abduction (89% MVIC)  top
    - Single leg squat (82% MVICC)
    - Clam shell (77% MVIC)
    - Front plank w/ hip extension (75% MVIC)

**Selkowitz, Beneck, Powers: JOSPT ‘13**

- 20 healthy asymptomatic subjects
- Fine wire EMG Glut Med, Glut Max & TFL
- 11 different hip exercises:
  - Glut Med & Max to TFL ratio – best exercises
    - Unilateral & bilateral bridging
    - Quadruped hip extension
    - Clams
    - Side stepping
    - Squatting

**My Favorite Hip Exercises**

- Sidelying clams with manual resistance
- Seated theraband ER
- RDLs
- Single leg front step downs
- Star drill
- Single leg bosu ball catches
- Instant replay
- Unilateral plank into hip abduction
Challenge the Neuromuscular System

Co-Activation to Enhance Dynamic Stability
Co-Activation to Enhance Dynamic Stability

Hip Strengthening & PFP

• Case Series (N=2)
  – Excessive hip adduction, IR during a step down
  – 14 week intervention of hip, pelvis, trunk strengthening
  – Outcome variables
    • Pain, muscle strength, LE kinematics

Mascall et al., JOSPT, 2003

Hip Strengthening & PFP

• Results
  – ↓ Pain
  – Improved kinematics
    • ↓ hip adduction, IR
  – 70% ↑ in Glut Med strength
  – 83% ↑ in Glut Max strength

Mascall et al., JOSPT, 2003

Khayambashi, Mohammadkhani, ...Powers: JOSPT ‘12

• 24 females with PF pain
  » N=12 exercise group
  » N=12 control group
  » Exercise group- Bil hip abd & ER strengthening
• Results: assessed pain levels, quality of life & hip strength
✓ Results: pain sign reduced, quality of life improved, and hip strength improved
Wilk- Non-Operative Rehab PF Lesions -
California Physical Therapy Assoc Mtg
9/20/13 9:30am

- Risk factors for patellofemoral pain
- 282 students (131 females) age 18 17-21
- Phys Ed class 2 yr; 14 hours / week
- Evaluated 9 variables prospectively
- 24 students developed PF pain (13 F)
Witvrouw et al: AJSM ‘00

- Significant differences between PF pain group & others
  - Quadriceps / gastroc flexibility
  - Explosive strength (vertical jump)
  - Thumb – forearm flexibility
  - Reflexive EMG response time (VMO /VL)
  - Psychological “looking for social support” – …

Who Needs Core Stability ??

Chinkulprasert, Vachalathi, Powers: JOSPT ’11 (Thailand)

- “Stabilization from above & below”
- Patellofemoral Pain: is there a role for orthoses?
  - Powers, Berke, Clary, Frederickson: PMR ’10
- Gastroc-soleus flexibility
- Talocrural joint mobility
- Calcaneus position

Patellar Taping

- Patellar Taping reduces pain in 78 -92% patients
  - Lan et al: AJSM ‘10
  - Cowan et al: Br J Sports Med ’06
  - Whittingham et al: JOSPT ’04
  - Hinman, McConnell: BMJ ’03
  - Wilson et al: JOSPT ’03
  - Salsich, Powers: JOSPT ’02
  - Powers et al: JOSPT ’97

Patellofemoral Pain

Role of Orthoses & the Foot

- 3D LE kinematics & kinetics & EMG
  - Peak PFJS was sign greater during FSD 13.8 MPa, compared to LSU (11.5) to FSU (11.2).
  - Peak PFJF was sign greater FSD (51N/Kg) compared to LSU (44) to FSU (43)
Patellofemoral Pain
Treatment: Patellar Taping (Position)

Larsen et al: AJSM ‘95
» 20 healthy subjects (18-35 yrs)
» Merchant view prior & after taping
» Taping repositioned patella medially
» Ineffective at maintaining after ex.

Pfeiffer et al: AJSM ‘04
» 18 healthy females (mean age 22 yrs)
» 4 flexion plain radiographs
» Taping repositioned patella prior to exercise but after exercise did not maintain

Patellofemoral Pain
Treatment: Patellar Taping (EMG)

Cowan et al: Br J Spts Med ‘06
» Effect of patellar taping on EMG amplitude during stair stepping
» Taping no effect on EMG activity

Salsich, ...Powers: JOSPT ‘02
» Effects patellar taping on VL EMG during stair ambulation
» No change in EMG activity with tape

Cerny: Phys Ther ’95
» VMO/VL muscle ratio during exercise
» No difference in EMG activity w/ taping

Rehab Patellofemoral Pain
Conclusions – stay the course

✓ Numerous causes/reasons for PF pain
✓ Not all PF pain/dysfunction is the same
✓ No one single surgery/therapy to solve
✓ Assess biomechanical factors
✓ Think hip, core, proprioception
✓ Improve pain & dysfunction
✓ Use all your tricks, skills & knowledge

Tendinopathies of the Lower Extremity:
Basic Science & Clinical Practice

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HIP
KNEE
ANKLES
Tendinopathies in Sports

Introduction

✓ Tendon problems represent a major problem in sports
✓ 30% of all injuries in runners were related to the Achilles tendon
  Lysholm et al: AJSM '87
✓ Patellar tendinopathy (jumpers knee) most frequent knee injury
  » 14% incidence in volleyball players
  » 12% incidence in basketball players
  Zwerver et al: AJSM '11

Tendon problems often become chronic – resistant to Rx

Tendinopathies in Sports

Introduction

✓ Tendinopathy:
  • Clinical syndrome – often not always implies overuse tendon injuries
    Ackermann & Renstrom: JSH '12
  • Characterized by pain, diffuse or localized swelling & impaired function
  • Pain is central factor in tendinopathies
    Kongsgaard et al: SJMSS '11
    Henrikson et al: BJSM '10

Effectiveness of Eccentrics in the Treatment of Tendinopathies

Kingma et al: Br J Spts Med '07
• Systematic literature review 9 studies
• “Effects of eccentrics promising – more studies needed”
  Woodley et al: Br J Spts Med '07
• Systematic review 11 studied included
• “Eccentric exercise limited evidence, may be no better than other treatments…”
  Wasielewski et al: J Athl Trn '07
• “Eccentrics may reduce pain & improve strength in LE tendinosis whether more effective remains questionable”

Eccentric Exercise & Tendinopathies

• Non-operative Rx with significant success
• Clinical studies illustrate 40-90% good outcomes after eccentric daily program of 6 to 12 weeks
  Alfredson et al: AJSM '98
  Ohberg et al: BJSM '04
  Langber et al: SJMSS '07
  Jonsson et al: BJSM '09
  Visnes et al: BJSM '07
  Kongsgaard et al: SJMSS '09

*Best documented Non-Op Rx for Tendinopathy
  Ackermann & Renstrom J Spts Health
**Stanish et al: CORR ’86**

- 200 patients with tendinitis treated with eccentric exercise Sx over 18 mos
- Once daily for 6 weeks of eccentric exercise
- 44% complete pain relief
- 43% marked improvement
- 9% virtually no change
- 2% were worse


- 12 Danish elite soccer players with Achilles tendinosis & 6 healthy players
- 12 week heavy resistance eccentric(2xDay) program (3 sets of 15 reps at 20% BW)
  - Collagen synthesis/formation injured area
  - VAS pain level reduced from 44 to 13
  - All players returned to play

**Jonsson & Alfredson: Br J Spts Med ’09**

- Prospective randomized study athletes (mean age 25 yrs) with jumpers knee
- Compared eccentric to concentric exercise – decline single leg squat quadriceps training
- Performed 3 sets of 15, 7 days/wk for 12 wks
  - Eccentric group: 9/10 satisfied VAS score from 73 to 23 (p<0.005)
  - Concentric group: 9/9 not satisfied, VAS 74 to 67 (p<0.34)


- Randomized controlled single blind study
- Compared corticosteroid injection (CORT) to Heavy Slow Resistance eccentrics (HSR)
  - HSR group elevated collagen turnover
  - CORT group good short term results but poor long term results
  - HSR group good short & long term results, subjective improvement, collagen synthesis

**Bernhardsson et al: Clin Rehabil ’11**

- Eccentric training for patients with RTC subacromial impingement
- Single subject research design
- 10 pts (mean age 54 yrs, Sx duration 10 mos)
  - Daily eccentric exercise for 12 weeks
  - Pain decreased in 8 of 10, improved function in all (Constant 44 to 69)
  - Mean Western Ontario RTC index from 51 to 71% (p=0.021)
Malliaras et al: Disabl Rehabil ’08

- Eccentric exercise program for patients with lateral elbow tendinopathy
- Systematic review: 4 studies included investigating a total of 248 participates
  ✓ 3 out of 4 studies reported superior results
  ✓ Duration of eccentric training (4-12 mos)

Dimitrios et al: Clin Rehabil ’11

- Eccentric training with static stretching (N=22) produced superior results to eccentric alone (N=21) in patellar tendinopathy patients (p<0.0005)

Witvrouw et al: AJSM ’01

- Prospective risk factors for patellar tendinitis
  ✓ 138 asymptomatic young athletes (mean age 18 yrs)
  ✓ 19 developed patellar tendinitis
  ✓ Risk factor: quadriceps & hamstring tightness (p<0.03)

Effects of Eccentric Exercise

- Tendon loading promotes collagen synthesis & collagen fiber cross linking – facilitation tendon remodeling
  Magnusson et al: Nat Rev Rheumatol ’10
- Eccentric produces more force by 150-300%
  Komi et al: SJRM ’74  Seling: Eur J Appl Physiol ’80
- Duration of exercise 3 months
  Visnes et al: Br J Spts Med ’07
- Same amount of time for tendon to form new fibroblasts
  Ackermann & Renstrom: JSH ’12
- Exercise may stimulate new tendon cells – fibroblasts that adapt to load

Collagen Synthesis & Degradation after Exercise

- Collagen expression peaks at 24 hrs post-exercise
- Net loss around 24-36 hrs post-exercise
- Followed by net of collagen synthesis 36-72 hrs ??

Magnusson: 2010

Effects of Eccentric Exercise

- Exercise exert mechanical effects on cells of nerve fibers & their receptors
  ✓ Seems to accelerate sensory nerve retraction
  Bring et al: J Orthop Res ’07 & ’09
  This may assist neuromodulation of pain
  Nerves alter the chemical milieu in response to load – either through release of antinoceptive substances (opioids) or by decreased production of nociceptive substances (substance P)
  Ackermann et al: Front Biosci ’09

Stanish et al: CORR ’86
Tendinopathies in Sports

How should we Rehab Tendons??

Chronic (3-100 mos) Achilles overuse (n=15)

- Eccentric training with straight/bent knee
- 12 weeks, 7 days, 3x15 rep
- Increasing load
- Pain was accepted during training
- Running activity was allowed

All 15 were back to preinjury levels with full running activity

Alfredson: AJSM ’98

MRI

Normal

Tendinosis

Tendinopathies in Sports

Introduction

Tendinitis vs Tendinosis

- Inflammation
  - Acute Hemorrhage
  - Fiber Disruption
  - Neutrophils
- Mucoid Degeneration
  - Sporadic inflammation
  - Fiber Disorganization
  - Angiofibroblastic Hyperplasia

Tendinosis Cycle

Tendon Injury

Adequate Repair

Inadequate Repair

Over-repair: Excessive scar

Increased vulnerability to injury

Further decrease in collagen and matrix

Tenocyte Metaplasia Apoptosis

Adequate Repair

Inadequate Repair

Decreased collagen and matrix production

- I: Pain only after participation
- II: Pain with participation, but doesn’t interfere with level
- III: Pain during / after participation, limits performance
- IV: Complete tendon rupture

Patellar Tendinosis

Eccentric Loading Program

II. Eccentrics (quadriceps)*
*use of pain stim
Light - Moderate - Heavy Resistance
- Slow resistance movements
- Eccentric Leg Press
- Eccentric leg extensions
- Front step downs
- Single leg decline squat
- Lateral step downs
- Single wall slides

Specific Noxious Stim Parameters:
- Frequency: 2500Hz
- Pulses: 50 pps
- Duty cycle: 10/10
- Duration: 10-12min
- Intensity: Noxious

Patellar Tendinosis

Treatment

- Heat
- Laser
- Transverse massage
- Active warm-up
- Stretch (entire LE, esp quads)
- Pain stimulation*
- Strengthening program - eccentrics
- Stretch
- HVS, compression, ice
- “level of acceptable pain” (5-6)
Witvrouw et al: AJSM ’01

- Intrinsic risk factors for patellar tendinitis (prospective study)
- 138 young adults (18 yrs) athletics
- Studied for 2 years
- 19 developed tendinitis
- Prospectively assessed anthropometric variables leg alignment, flexibility, & strength
- Positive correlation: *Quadriceps tightness*

**Tendinopathies in Sports**

**Conclusions**

- Common lesion in sports (workplace)
  - **Difficult to treatment**
- Various Rx strategies for tendinopathies
- **Eccentric appears to stimulate healing response through collagen synthesis & remodeling** – may require 12 weeks
- **HSR (E/C)** effective for LE tendinopathies
- Pain is common with this lesion
- **Noxious pain stim** may assist & allow people to exercise with minimal pain
Thank you!