Managing the Musculoskeletal Mysteries of the Female Athlete

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Controversies In Women’s Health
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Title IX 1972

High School Participation Rates

The Women’s Marathon
Marathon Records

- Men’s Marathon Record Times
- Women’s Marathon Record Times
- Men’s Olympic Marathon Times
- Women’s Olympic Marathon Times

♀ at Risk: Hyponatremia

Risk factors:
- Racing time > 4 hours
- Female sex
- Low Body Mass Index < 20
- Excessive drinking > 3 liters
- Postrace weight > prerace weight
- Other mechanisms?
  - Hormonal, excessive salt loss

Female Athlete Triad

- Amenorrhea
  - (Loss of periods)
- Osteoporosis
  - (Thin Bones)
- Disordered Eating

“New” Female Athlete Triad

- Optimal Energy Availability
- Eumenorrhea
- Optimal Bone Health
- Reduced Energy Availability with or without Disordered Eating
- Low BMD
- Subclinical Menstrual Disorders
- Low Energy Availability with or without an Eating Disorder
- Functional Hypothalamic Amenorrhea
- Osteoporosis
“New” Female Athlete Triad

- Aesthetic sports
- Excessive training hours
- Win at all costs
- Steroids

Physical inactivity

- Females more inactive than males
- 27% of girls (12-14 y.o.) are inactive
- 48% of girls (15-19 y.o.) are inactive

Overview

- Cases
- Risk Factors
- Diagnosis and Treatment
- Prevention
Who? 14 year old female soccer player
When? 2 weeks ago
What? Right knee pain feels unstable especially going down stairs
How? Was cutting and felt a “pop” in the knee, developed swelling minutes after
Where? Pain over anterior and lateral right knee

Case 1
LOOK 5’6”, 140 lbs
• Moderate effusion
FEEL
• Tender over medial joint line in full flexion
MOVE
• ROM 0° to 100°
SPECIAL TESTS
• Lachman and Pivot shift tests positive
DIAGNOSIS?
Do you want to tap the knee?

Acute Hemarthrosis
The BIG THREE
1. ACL
   (almost 50% in children, >70% in adults)
2. Fracture (Patella, tibial plateau, femoral supracondylar, Physeal)
3. Patellar dislocation
More rare
• Tendon Rupture (Quadriiceps, Patellar)
• Osteochondritis dessicans
• Unlikely meniscal lesions

What you Knee’d to know
• Women have more knee problems
• Miserable malalignment syndrome
  – Femoral anteversion
  – Genu Valgum (knocked knees)
  – Pes planus (flat feet)
Anterior Cruciate Ligament (ACL) Tear

Mechanism
- Landing from a jump, pivoting or decelerating suddenly
- Foot fixed, valgus stress

Lachman’s test – test at 20°
( Sens 91.8%, Spec 96.8%)

Anterior Cruciate Ligament (ACL) Tear

Double fist sign

Rates, Age, Sex and Sports

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Rate per 1000 exposures
Women’s Gymnastics = 0.33
Men’s Spring Football = 0.33
Women’s Soccer = 0.28
Women’s Basketball = 0.23
Men’s Football = 0.18
Women’s Lacrosse = 0.17

Renstrom et al., BJSM, 2008
Anterior Cruciate Ligament (ACL) Tear

Theories
- Hormonal
- Notch size
- Alignment
- Flexibility
- Neuromuscular control *
- Women’s sports

MRI

X-rays usually non-diagnostic
- Sens 94%, Spec 84% for ACL tear

ACL tear signs
- Fibers not seen in continuity
- Edema on T2 films
- PCL – kinked or Question mark sign

ACL Tear Treatment

Conservative
- No reconstruction
- Physical therapy
  - Hamstring strengthening
  - Proprioceptive training
- ACL bracing controversial
- Patient should be asymptomatic with ADL’s

Surgery
- Reconstruction
- Depends on activity demands
- Recovery ~ 6 months

MRI

- Sens 94%, Spec 84% for ACL tear

ACL tear signs
- Lateral femoral corner bone bruise on T2
- May have meniscal tear (Lateral > medial)
To Fix or Not to Fix?

No repair
• 1/3 do well, 1/3 go on decide to get surgery, 1/3 do poorly and need surgery

Surgery
• Reconstruction is treatment of choice
  • Repair allows them to return to sports
  • Reduce chance of symptomatic meniscal tear
  • Less giving way symptoms
• Wait until patient skeletal maturity

ACL Reconstruction

• More predictive return to sports

• Grafts
  – Patellar tendon
  – Hamstring
  – Allograft (Cadaver)

How Do We Know We’re Doing a Good Job?

10 year post-op ACL reconstruction
KT-1000 1mm
Pivot Shift 0

Novel MRI Techniques

A healthy volunteer

An OA patient

Xiaoping Li, Musculo-skeletal Imaging Research group, Department of Radiology, UCSF. Benjamin Ma, MD
Department of Orthopaedic Surgery
ACL prevention program

- Prevent Injury and Enhance Performance (PEP) Program
- 74% reduction in anterior cruciate ligament tears over 2 years
  Mandelbaum et al., Am J Sport Med, 2005
- 1.15 injuries per team per season when trained vs 0.15 injuries per team per season (RRR=0.13)
  Caraffa et al., Knee Surg Sports Traumatol Arthrosc, 1996

Prevention Proprioception Training

- RCT (randomized by team)
- N= 765, 55 teams, M/F, high school basketball and soccer players
- At least 4 weeks, balance training program
- Training reduced the rate of ankle sprains by 38%

Week 1 - 2
- Week 2 - Eyes Closed

Week 3 - 5 + - Wobble Board
- Week 4 - eyes closed
- Week 5 - closed, functional activities
Case 2

- LOOK 5’5”, 116 lbs
- No effusions
- FEEL
  - Tender over medial and lateral patellae
  - ROM 5° ext to 140° flexion B
- SPECIAL TESTS
  - Ligament testing negative
  - Mobile patella bilateral; apprehension test +

Patellofemoral Pain

- Multifactorial
- Problems with:
  - Bending?
  - Stairs?
  - Kneeling?
- Need good muscle balance
- Quadriceps strength
- Good flexibility

Symptoms
- Too much pressure under the kneecap
- Anterior knee pain
- Worse with bending (5x body wt), stairs (3x body wt)
- Crepitus under kneecap
- May sublux if loose
PFP Syndrome

- Tender over facets of patella
- Apprehension sign suggests possible instability
- X-rays may show lateral deviation or tilt

Alignment

Ankles together (Varus/Valgus?) Ankles apart (go on toes)

Arch type

Q-angle
Too Loose?

**Hyperlaxity**
- Associated with subluxation of the patellae
- Medial facet more commonly affected

Too Tight?

- Lateral hyperpressure syndrome
- Tight hamstrings, ilotibial bands, high flexors and quadriceps

Treatment PFP

Too Loose/Weak
- Strengthen VMO
- Strengthen gluteals
- Correct alignment
- Support (Taping, Bracing)

Too Tight
- Stretch hamstring, quadriceps, hip flexor
- (Strengthen quads)
- Correct alignment
- Surgical (RARE)
- Last resort
- Lateral release
- Patellar realignment

What’s Hip?


- N=19 F with PFP, 19 controls
- Women with PFP demonstrated a 21% deficit in muscle performance when averaged across all strength testing conditions
- Decreases in hip-muscle strength (Gluteus medius and Gluteus maximus) were associated with greater degrees of average hip internal rotation
- MUSCLE PERFORMANCE more important than STRUCTURE
Functional Hip Weakness
Souza et al, JOSPT, 2008

- Females with PFP demonstrated greater peak hip internal rotation compared to the control group (mean ± SD, 7.6° ± 7.0° vs 1.2° ± 3.8°; P<0.05)
- Increased hip internal rotation, decreased hip muscle strength, and increased gluteus maximus muscle activation was observed in PFP during functional tasks.

One Leg Squat

Knee Adductor Moment

- Medial knee collapse
- Weakness of hip abductor (Gluteus medius) and hip external rotators (Gluteus maximus)
- Difficult to control knee with running, bending, jumping

Iliotibial band friction syndrome

- 10-21% of running overuse injuries
- ITB crosses the lateral femoral epicondyle at 30°
- Associated with “varus” moment at the knee
Prevention of Knee Injuries

Fix the underlying problems
• Hip abductor / gluteal muscle strengthening
• Medial quadriceps strengthening exercises
• Correct alignment
• Modify training

Stay Flexible and Strong

Key muscle groups
• Hip Flexor, ITB, Hamstring, Quadriceps, Calf / Achilles
• Hold each stretch for 30 seconds
• Core stability / Strengthening

Case 3

What? 44 year old female runner
What? Extension low back pain
When? Acute flare x 2 weeks since running, LBP on and off x 10 yrs, worse after pregnancy
How? Pain with activity, some numbness and tingling R leg
Where? Right sacroiliac joint pain with radiating pain into right buttock

Case 3

• LOOK 5’8”, 130 pounds
  – Swayback Posture (mild thoracic kyphosis, hyperlordosis lumbar spine)
• FEEL
  – Mild tenderness at R SI joint
• MOVE
  – ROM extension 30° mildly tender; Flexion 70°
  – R hip ROM internal rotation 50 external rotation 60
• SPECIAL TESTS
  – Direct and indirect SLR negative
  – March/Gillet test slight asymmetry
  – L/E 5/5, Reflexes normal
Pregnancy and Low Back Pain?

- Back pain among 18% of all women before pregnancy and among 71% during pregnancy declined to 16% after 6 years.
- Pain intensity was highest in Week 36 (VAS, 5.4) and declined markedly 6 years later (VAS, 2.5).
- Slow regression of pain post-partum correlated with:
  1) back pain history before pregnancy, \(r = 0.30; P < 0.05\)
  2) high pain intensity during pregnancy \(r = 0.45; P < 0.01\)
  3) much residual pain 3 months after pregnancy \(r = 0.41; P < 0.01\).

Mechanical low back pain

- Sort patients into:
  - Simple low back pain (mechanical low back pain)
  - Flexion vs Extension back pain
  - Nerve root vs peripheral pain
  - Red flag signs for serious spinal pathology
  - Cauda equina syndrome
- Identify which patients may benefit from specialist treatment

Intervertebral Disks

- Disc height = 20 to 25% of vertebral column height
- Shock/load absorber
- Annulus fibrosis – Concentric criss-cross collagenous rings for strength and accommodate torsion
- Tears usually occur posterolaterally
- Nucleus pulposus – 85-90% water but replaced by fibrous tissue as we age
- Minimal nerve supply except for peripheral annulus

Possible Mechanisms for Disk Degeneration

- Aging
- Genetic (extracellular matrix)
- Metabolic disease including Diabetes
- Low grade infection
- Nutritional deficiencies
- Neurogenic inflammation
- Immune reaction
- Mechanical factors
  - Vibration
  - Traction
  - Compression

Hadjipavlou et al., JBJS-BR, 2008
Sciatic Nerve

Sitting - Provocation

Indirect Straight Leg Raise
- Reproduces SLR in the sitting position
- May have "Sciatica" with sitting too long (i.e. driving)

Slump Test
- Fully flex patient’s neck chin to chest
- Examiner holds foot in dorsiflexion and passively extends leg
- Highly reliable (k=0.83-0.89)
- More sensitive than SLR (0.84 vs 0.52) but slightly less specific (0.83 vs 0.89)
  Majlesi et al, J Clin Rheumatol, 2008

Posterior elements / Facet Joints
- Superior / inferior facet joints
- Pars interarticularis
- Allow flex/ext and side bending with minimal rotational motion due to direction of facets
- Usually NWB but can WB with extension
- Facet joint asymmetry may lead to disk degeneration

Standing Examination

Extension
Single leg extension
Trendelenberg Test
Extension/rotation
Lateral flexion
Does the Sacroiliac joint move?

- Is a Diarthrodial Joint
- Synovial fluid
- Cartilage on both surfaces
- A joint capsule
- Ligamentous connections
- Articular connections allowing movement

Age Changes


Ligaments

1) Distribute the load
2) Apply tension
3) Support the vertebrae and sacrum

Superficial Muscles

- Trapezius
- Latissimus dorsi

Thoracolumbar fascia
1) Transmit force
2) Stores elastic energy
Core Stability

- Center of gravity lies anterior to spine
- Erector spinae muscles, abdominal musculature, the lumbodorsal fascia and gluteus maximus resist the body weight
- Deep Muscle stabilizers (type 1 fibers) maintain core stability
- Multifidus, TA, pelvic floor and diaphragm - affects posture
- If impairment, may get reflex inhibition due to other pain and can affect sports activity

Pelvic Girdle Pain (PGP)


- N=308, Sweden
- 62% had some pain at 12-18 weeks GA
- 33% had pain at 3 months post-partum
- One hypothesis is that pregnancy-related hormone-induced ligament laxity in combination with low muscle endurance impairs dynamic stability of the pelvis
- Combined low back pain and PGP recovered least

Pelvic Girdle Pain (PGP)


- Predictors for having persistent PGP or combined pain after delivery were (n=308):
  1. low endurance of back flexors,
  2. older age,
  3. combined pain in early pregnancy and
  4. work dissatisfaction
     (explained variance 30%)

Positional testing
Gillet Test (March Test)

Posture

- Lines: ear lobe-acromion-iliac crest
- Lordosis, kyphosis
- Pelvic inclination - ASIS lower than PSIS

Femoral Acetabular Impingement (F.A.I.)

- Cam effect
- Protrusion of femoral head neck – “bump”
- Orientation of the acetabulum – acetabular version
- Increased stress on labrum

Examination Supine - Hip

- Hip Internal and External ROM
- Labral Impingement and Stress tests
- Thomas test – for hip flexor tightness
**Posterior Hip Pain**

*Piriformis syndrome*

10% of population have sciatic nerve passing through the piriformis

Beaton et al. Anat Rec, 70, 1937.

Muscle strain vs sciatica

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**Pregnancy and back pain**

Young, Cochrane Review, 2008

- For women with low-back pain, participating in strengthening exercises, sitting pelvic tilt exercises and water gymnastics reduced pain intensity and back pain-related sick leave (relative risk (RR) 0.40; 95% CI 0.17 to 0.92) better than usual prenatal care alone.
- Standardised mean difference (SMD) -5.34; 95% CI = -6.40 to -4.27) with

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**Case 4**

- **LOOK** 5’ 5”, 130 pounds
  - Rolled forward shoulder posture, head forward posture
- **FEEL**
  - Tender over cervical spine near R C7 facet joint
- **MOVE**
  - C-spine - ROM 45° flexion 40° extension painful; right rotation 50° left rotation 70°
  - ROM shoulder 180 flexion bilaterally
- **SPECIAL TESTS**
  - Rotator cuff strength 5/5
  - Neer and Hawkins’s negative test
  - Spurling’s test positive
  - Roos’ test positive, Adson’s positive on right
  - Elbow flexion test positive
  - Tinel’s sign negative
  - U/E 5/5, Reflexes normal, sensation intact to light touch
**Cervical Impingement**

- Spurling’s test for cervical radiculopathy
  - Sens = 64%
  - Spec = 95%
  - PPV = 58%
  - NPV = 96%

**Thoracic Outlet Syndrome tests**

- Possible compression of the subclavian artery between the scalenes and any cervical rib
- Compression of neurovascular symptoms in the upper extremity by the pectoralis minor

**Adson’s Test**

- Seated patient extends and turns head toward the tested shoulder.
- Shoulder is slightly abducted and extended. The subject inhales while the examiner palpates the ipsilateral radial pulse.
- Positive findings: Diminution or elimination of the pulse and reproduction of the paresthesias
- Studies have documented the Adson’s maneuver to have poor to good specificity and good sensitivity.

**Roos Stress Test**

- Patient holds shoulders in abduction and external rotation at 90 degrees with elbows flexed at 90 degrees and repeatedly open and close their hands for three minutes.
- Positive findings: Reproduction of their symptoms or a sensation of heaviness and fatigue.
- No studies have examined validity of the Roos stress test as it pertains to thoracic outlet syndrome.
3 Basic P/E findings for tendinopathy

1. Tenderness on direct palpation
2. Reproduction of pain with resisted contraction (eccentric loading)
3. Reproduction of pain with passive stretch

Elbow Tendinopathies

- Lateral epicondylitis
  - Tender lateral epicondyle
  - Resisted third digit extension
  - Resisted wrist extension

- Medial epicondylitis
  - Resisted pronation/wrist flexion
  - Distal biceps
  - Resisted supination

Ulnar nerve – Funny Bone

- Elbow Flexion test
- Tinel sign
- Ulnar nerve subluxation

Who? 38 year old female secretary
What? Neck pain with radiating pain to the right elbow and right arm numbness and some ulnar nerve symptoms
When? She has had worsening pain over 3 months
How? Talking on her phone is painful, sleeping is sore
Where? Numbness to 4th and 5th fingers
What is “Normal” Flexibility?

- Flexibility is the range of motion available at a joint or series of joints
- Hypermobility vs. Hypomobility
- Spectrum like hypertension

Modified Marshall Test

Micheli Score
- Look at passive thumb abduction of the right hand
- Grade 1 = 0°
- Grade 2 = 45°
- Grade 3 = 90°
- Grade 4 = 135°
- Grade 5 = thumb touches forearm
- Can use + or – for in between grades

Generalized Laxity

Common Pictures

Hyperlaxity
- OVERUSE & Postural problems
- Associations with subluxation of the hip, patella, shoulder, and proximal cervical spine, osteoarthritis, chondrocalcinosis,
- Bad sprains

Tight
- Patellofemoral syndrome, hamstring and quad strains
- Tendinopathies
- Osgood-Schlatter’s disease, Sever’s disease and peripelvic apophyseal avulsion fractures
Multidirectional instability

Case 2

Lines: ear lobe-acromion-iliac crest
Lordosis, kyphosis
Pelvic inclination - ASIS lower than PSIS

Case 3

Posture

- Lines: ear lobe-acromion-iliac crest
- Lordosis, kyphosis
- Pelvic inclination - ASIS lower than PSIS
Rehab, rehab, rehab

Strengthening
• Core stability
• Postural exercises
  – Upper Back
• Proprioception exercises
• Endurance / conditioning
• Ergonomic assessment at work

? Chronic pain

Take Home “Pointes”

• Sex is a Risk Factor
• Think Biomechanics
• Posture and core exercises are important
• Consider hypermobility syndrome
• Use physical therapy

Thank You