Differential Diagnosis and Management of Intra-articular Hip Pathology

Four Questions to Begin

- Why are you here?
  - What do you hope to achieve?
- What type of dx/patients do you see?
- What has been successful for you in the past?
- Frustrations?

Hip Pain: “The Challenge”

- The non-arthritic hip poses a diagnostic dilemma
  - Extraarticular vs. intraarticular
  - Pain is difficult to localize
  - 60% of patients are initially misdiagnosed

Inaccurate Diagnosis

- Misdiagnosed for an average of 7 months to 3.1 years
- Patient’s evaluated by an average of 4.2 healthcare providers prior to correct diagnosis
- Goal of today is to change this !!!

Differential Diagnosis of Hip Pain

- Intra-articular
  - Osteoarthritis
  - Labral pathology
  - Chondral pathology
  - FAI
  - Capsular laxity
  - Injury to the ligamentum teres
  - Loose bodies
  - Benign intra-articular tumors
- Extra-articular
  - Hip tendinitis/avulsion injuries
  - Femoral neck stress fx
  - Snapping hip
  - Trochanteric bursitis
  - Abductor tears
  - Athletic pubalgia
  - Osteitis pubis
  - Nerve compression typologies

• Systemic Causes
  - Testicular Cancer
  - Inflammatory bowel disease
  - Endometriosis
  - Ovarian Cyst
  - Pelvic inflammatory disease
  - Appendicitis
  - Osteomyelitis
  - Septic arthritis
  - UTI

• Referred Pain
  - Sacroiliac
  - Lumbar Spine
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CPTA Annual Conference 2011
Long Beach, CA

Differential Diagnosis of Hip Pain

- Age of the patient
- Prior trauma
  - direct-impact activities
- Duration and location of symptoms
- Morning stiffness
  - less than 1 hour
- Childhood or family hx
  - Developmental Disorders
  - Dad had a THR @ 50 years of age

Age of the Patient

- Adolescent
- 15-50 y/o
- 60-77 y/o
- Extraarticular
- Systemic

Clinical Signs of SCFE

- Onset of limp
- Hip pain referred to the knee
- Limited Hip Abd and IR
- Progressive adduction and ER with shortening of the leg
- Bilateral cases yield “waddling” gait

Slipped Capital Femoral Epiphysis

- Occurs during adolescent rapid growth period (10-15 years)
- More common in obese males @ age 13
  - Females @ age 12
- Most common disorder of the adolescent hip

Legg-Calve-Perthes (LCP)

- AVN of the femoral capital epiphysis
- Occurs age 3 to 12
- 5:1 male predominance
- Short history of
  - Painful limp: Flex, Abd, ER
  - Reduced mobility
  - Muscle atrophy
  - Trendelenburg test positive
- Leads to adult DJD

Ankylosing Spondylitis

- Chronic progressive inflammatory arthritis
- More frequently seen in men than women
- Age of onset is usually between 15 and 35 years of age (average of 26)
- 95% positive for HLAB-27
- Primarily affects synovial joints of the spine and sacroiliac joints

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Clinical Presentation

- Gradual onset of pain and morning stiffness in the spine
  - improves with exercise
- Referred pain to the buttock or posterior thigh
- Generalized fatigue, nausea and iritis
- Reduced chest expansion
  - Less than 2.5 cm

Ankylosing Spondylitis

- Sacroiliac involvement is the hallmark of AS
  - Pseudowidening of the joint space
  - Loss of the articular cortical bone
  - Erosive and sclerotic changes
  - Irregular joint margins
  - Ankylosis

Normal A/P of Pelvis

![Normal A/P of Pelvis](image)

2 Major Schools of Thought

- Regarding the cause and pathogenesis of athletic pubalgia/sports hernia
  1. Muscular injury and disruption from chronic stress to pubic joint
     - Rectus abdominis
     - Adductor longus
     - External oblique aponeurosis
     - Conjoined tendon
     - Inguinal ligament

Athletic Pubalgia/Sports Hernia

![Athletic Pubalgia/Sports Hernia](image)

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Anatomy of Athletic Pubalgia

Athletic Pubalgia/Sports Hernia

• Encompasses a wide variety of injuries to the anterior pelvis outside of the hip joint
  – Term sports hernia is inaccurate
  – Need to understand the “pubic bone” joint
    • Complex rotational joint of both pubic bones and the entire anterior pelvic musculo-skeleton
  • 2008 recognize at least 17 different nonhip, soft-tissue structures as causes of primary pain.

Meyers WC: Oper Tech Sports Med. 2005

Athletic Pubalgia

• Primary mechanism involves hyper extension of the abdomen and/or hyper abduction of the thigh

• Resulting in multiple areas of fraying on the lateral and anterior aspects of the fascia of the muscles

2 Major Schools of Thought

• Regarding the cause and pathogenesis of athletic pubalgia/sports hernia
  1. Described as an occult hernia process
    – Major abnormality is a defect in the posterior wall of the inguinal canal
    – Involvement of the genital branch of the genito-femoral nerve
    – Often concurrent muscular dysfunction
**History and Prevalence**

- Athletic pubalgia affects both professional and recreational athletes
- Involved in activities such as running, kicking, cutting an explosive change of direction
  - Soccer, football and hockey
- More common in men than women
  - Pelvic shape and force distribution

**Presentation**

- Complaint of exercise induced lower abdomen and groin pain
- May radiate to the inner thigh and scrotum
- Pain relieved by rest but returns upon activity
  - Describes deep and intense pain in the unilateral
  - Insidious onset and or distinct injury

**Athletic Pubalgia**

- Cluster of 5 signs and symptoms
  - Subjective complaint of deep groin/lower abdominal pain
    - Localized tenderness pubic tubercle, inguinal canal, rectus insertion and adductor origin
  - Pain that is exacerbated with sport-specific activities and relieved with rest
  - Palpable tenderness over the pubic ramus
  - Pain with resisted hip adduction, flexion or abdominal curl-up

**Imaging Findings**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubic symphysis</td>
<td>97</td>
</tr>
<tr>
<td>RA</td>
<td>76</td>
</tr>
<tr>
<td>Adductor longus</td>
<td>46</td>
</tr>
<tr>
<td>Rectus</td>
<td>38</td>
</tr>
<tr>
<td>Adductor brevis</td>
<td>28</td>
</tr>
<tr>
<td>Iliacus</td>
<td>6</td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>2</td>
</tr>
<tr>
<td>Iliacus</td>
<td>1</td>
</tr>
<tr>
<td>Pubic ramus</td>
<td>1</td>
</tr>
<tr>
<td>Obturator extern</td>
<td>1</td>
</tr>
<tr>
<td>Groin</td>
<td>1</td>
</tr>
<tr>
<td>Hamstring</td>
<td>1</td>
</tr>
<tr>
<td>Adductor magnus</td>
<td>1</td>
</tr>
<tr>
<td>Hip</td>
<td>1</td>
</tr>
</tbody>
</table>


Meyers WC: Oper Tech Sports Med. 2005
Various Surgical Findings

Conservative Treatment Tips

- Look for adductor dysfunction and address with aggressive soft tissue strategies.
- Balance forces on the pelvis
- Teach the patient to control the hip and trunk eccentrically
- Train pelvic and thoracic disassociation
- Avoid traditional concentric core work

Underlying Hip Dysfunction

- Always screen for underlying hip FAI in cases of athletic pubalgia
- Asymmetrical hip flexion and IR creates shearing and abnormal movement at the pubic joint
  - Cam lesion with Flex/IR
  - Symphysis motion occurred primarily in the transverse plane opening the joint anteriorly
- Can also lead to lumbopelvic compensatory movements and added pelvic stress

FEMORAL STRESS FX

- Relatively uncommon etiology of hip pain
- If not dx in a timely fashion serious complications can occur
- 7% of all stress fractures involve the femoral neck
  - 50% of these occur in the femoral shaft
    - Medial aspect of the proximal third being the most common

Presentation

- Thigh and hip pain from a femoral stress fracture is generally vague
- Location of pain may not correlate with location of fracture
- Clinical findings are often variable
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Risk Factors

- Previous history of stress fracture
- Increases in training volume
  - Recreational runners > 35 miles per week
  - Marathon runners > 45 miles per week
  - Competitive runners > 70 miles per week
- Corticosteroids
- Restrictive eating patterns
- History of amenorrhea

Clinical Findings

- Often insidious onset
  - Deep aching pain in the hip or groin region
  - Can radiate to a knee
- Worse with activity improves with rest
  - Night pain is not uncommon
- Mild pain at the extremes of hip range of motion
- Lack of local bone tenderness with palpation
- Positive hop test?
- Positive fulcrum test?

Imaging & Diagnosis

- Average delay in diagnosis 14 weeks
- Sensitivity of radiographs for diagnosis as low as 15%
- 1-3 week window before bony changes are visualized
- MRI is the gold standard for diagnosis
  - ↓ signal intensity of fracture line on T1 images
  - ↑ signal intensity on T2 images

Snapping Hip

- Internal snapping hip
  - Iliopsoas over the ilipectineal eminence???
  - Characterized by an audible snap or pop
  - Usually occurs during hip ext. from a flexed position
  - Often accompanied by pain and generally occurs during physical activity
  - Dynamic Sonography gives us new info
    - the snapping was provoked by the sudden flipping of the iliopsoas tendon around the iliac muscle, allowing abrupt contact of the tendon against the pubic bone and producing an audible snap

Fulcrum Test

Hop Test

Approximately 70% of patients with a positive hop test have a femoral stress fracture

Internal Snapping Hip

External Snapping Hip

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Snapping Hip

- Internal snapping hip
  - ? Labral tear, loose bodies, lig teres disruption
- Nonoperative management is often adequate to relieve symptoms
  - Refractory cases may require surgical intervention

“Snapping Hip”

- External snapping hip
  - Iliotibial band over the greater trochanter or
  - Anterior border of the gluteus maximus over the greater trochanter
  - Occurs when the hip is flexed from an extended position
  - Most common
  - “Can be heard across the room”

“Snapping Hip”

- Contributing factors
  - Leg length discrepancy
  - Coxa Vara
  - Poor posture
  - Decreased core stability
  - Changes in training or exercise
  - Recent adolescent growth spurt

Avascular Necrosis

- Typically affects relatively young active patients
- Results in considerable loss of function
- Estimated 20,000 to 30,000 new cases of osteonecrosis diagnosed annually

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**AVN**

- Etiology remains unknown
  - alcohol use
  - high-dose corticosteroid administration
  - coagulation abnormalities
- Pathophysiology of AVN points toward
  - alterations in intravascular blood flow
  - direct cellular toxicity
  - impaired mesenchymal cellular differentiation

**Lateral Hip Pain**

- Frequently assigned a diagnosis of trochanteric bursitis
  - Postmenopausal women
- Injection into the site of maximal tenderness can provide relief
- Recurrence of symptoms after injection often occur

**Lateral Hip Pain**

- Correlation demonstrated in the literature between
  - lumbar degenerative disease
  - gluteus medius tendinopathy or tears
  - trochanteric bursitis
- Major predictor of relapse of pain:
  - lumbar degenerative disease
- Must effectively screen the lumbar spine

**Osteoarthritis**

- Hip pain associated with OA is the most common cause of the pain in older adults
- Prevalence studies have shown the rates of adult hip OA range from .4% to 27%
- The most common predisposing factor for hip OA is age

**Clinical Criteria for OA**

- Moderate lateral or anterior hip pain
- Pain with weight bearing
- > 50 y/o
- Morning stiffness < 1 hour
- Limited Hip Flexion & IR > 15°
- Pain with Hip IR
- Hip Abductor Weakness

**Questions?**

Intra-articular vs. Extra-articular
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Differential Dx of Intra-Articular Hip Pain
• A quantum leap has been made in the diagnosis and treatment of non-arthritic hip injuries
  – Improved imaging,
  – Better understanding of the anatomy and biomechanics of the hip
  – Progress in surgical technology and techniques. Among other advances, labral tears

Diagnostic Algorithm

Focus our Evaluation
• Chondral Labral Dysfunction
  – Femoral-Aacetabular Impingement
  – Tears of the Acetabular Labrum
  – Chondral Lesions

Chondral Labral Dysfunction
• Increased awareness of the condition
  – First described by Smith-Petersen 1935
  – Current literature:

“The structure of the human hip joint reflects an uneasy balance between the requirements for movement and stability”
Anatomical Understanding

- Bony Morphology of Impingement
- Function of the Labrum
  - Labro-Acetabular complex
  - Movements that strain or stress labrum
- Capsular Ligaments
  - Overlying anatomy
  - Symptoms that can fool you!

Femoralacetabular Impingement

- FAI is a morphologic condition that predisposes hip to intraarticular pathology that then becomes painful

Types Of Impingement

- Combination CAM and Pincer
- Overcoverage Pincer
- Insufficient Offset CAM

Etiology of FAI

- CAM
  - Abnormal physeal development
  - Slipped capital femoral epiphysis (SCFE)
  - Legg-Calve-Perthes disease
  - Malunited femoral neck fractures
- Pincer
  - General (coxa profunda/acetabuli protrusio)
  - Local (acetabular retroversion)

Incidence of FAI

- Copenhagen Osteoarthritis Study revealed
  - Cam deformities in 17% of men and 4% of women in a cohort of 3,202
- Reichenbach et al and Hack et al. found an incidence of
  - Cam deformities in 25% of men and 5% of women
- The combination of cam and pincer deformities is the most frequent FAI finding
  - pure cam deformities seem to be more common in men
  - pure pincer deformities are seen in women9

Function of the Labrum

- Complex fibrocartilaginous rim
- Spans entire acetabulum
- Becomes contiguous with trans. acetab lig
- Protective seal
  - Enabling increased hydrostatic fluid pressure to facilitate synovial lubrication and resistance to joint distraction
Physiologic Function

- Currently not completely defined
- Appears to serve multiple functions
  - Most important role is dissipating large forces across the hip during weight-bearing activity
  - Deepens the acetabulum to enhance stability
  - Increases the volume of the acetabulum by 33%
  - Limits extreme range of motion

Tan V: Am J Orthop 2001

Labro-Acetabular Complex

- Junctional interface
  - 7 structures
- Labral injury leads to
  - Decreased articular cartilage
  - Fluid content
  - Nutrition
  - Lubrication
  - May lead to articular cartilage degeneration

Ferguson SJ: Clin Biomech 2000

Strain Across Labrum During Hip Movements

- Flexion and adduction places the greatest strain on anterior labrum
- ER strain is > IR strain
- Lateral strain is greatest at 90° of hip flexion with abduction and external rotation

Safran et al: AJSM 2011

Strain Across Labrum During Special Test

- The impingement position increases the anterior lateral strain the most
- Posterior labrum strain is significantly increased with hip external rotation in neutral or full extension

Safran et al: AJSM 2011

Stress of Repetitive AB/ER Loading

- Strain to the labral chondral interface occurs in flexion or extension
- Greatest stress is in the anterior labrum
  - 2-3 O’clock position
- Femoral head displaces 1.3-1.6 mm anteriorly

Dy et al: JBJS 2008

Waterpolo
Stress of Repetitive Loading in AB/ER

- 22 y/o FB player
- Bilateral CAM
- Alpha angle 84/89 degrees

Capsular Ligaments

- Iliofemoral ligament
  - taut in extension & ER
  - resists anterior translation
- Pubofemoral
  - provides resistance to hyperextension & hyperabduction
- Ischiofemoral ligament
  - becomes loose with flexion and tight with extension
- Ligamentum teres

Capsular Ligaments

Extracapsular Relationships

- Iliopsoas acts as a dynamic stabilizer
- Rectus tendon close proximity to hip capsule
- Role of the iliocapsularis muscle
  
  a = anterior-inferior iliac spine
  b = origin rectus femoris
  c = origin of iliocapsularis
  d = capsule overlying femoral neck
  e = iliacus muscle
  f = iliocapsularis muscle

Iliocapsularis

- Little known stabilizer of the anterior hip
- AIIS to the lesser trochanter
  - Pincer impingement
    - atrophied & fatty infiltrated iliocapsularis
  - Acetabular dysplasia
    - large iliocapsularis muscle without fatty infiltration

Babst et al. Clin Orth Rel Res 2010

Consequences of FAI

- Cam impingement
  - Femoral head asphericity
  - Early acetabular chondral delamination
  - Progression to full thickness chondral lesions and labral detachment
- Pincer impingement
  - Labrum affected primarily, cystic changes and degeneration
  - Narrow peripheral acetabular cartilage affected

“New” hypothesis of OA in the non-dysplastic hip

Labral Tears

- Mechanism of injury
  1. Trauma: 5.3% to 15% of cases
     - Twisting/falling
  2. FAI
  3. Dysplasia
  4. Joint instability
  5. Joint degeneration

Wenger: Clin Orth Rel Res 2007
Mechanisms of Labral Injury

- Hip IR at 90° of hip flexion
  - Femoral neck impinging on acetabular margin
- Repetitive strain during ER and abduction in slight flexion or extension
  - Dy et al: JBJS 2008
  - Crawford: Clin Orth Rel Res 2010
  - Safran et al: AJSM 2011

Consequences of Labral Tears

1. Separation of the labrum from the articular margin
   - “Watershed lesion”
2. Destabilization of the hip
   - Disruption of the negative pressure seal
   - Instability

Ferguson SJ: J Biomech 2000

Consequences of Labral Tears

1. Loss of function
2. Degenerative joint disease
   - Chondral damage

McCarthy GC: Clinical Orthop Rel Res 2001

436 consecutive hip arthroscopies
261 labral tears
73% of the patients with a labral tear had chondral damage

Comprehensive Evaluation

Chondral Labral Dysfunction

- USC Athletic Medicine Experience
  - Prior to our initial work: 18 hip chondral labral injuries
  - 40 surgeries (4 athletes in 2005/2006 had revision arthroscopy)
    - 5 from 2000/2003
    - 16 in 2005/2006
    - 2 in 2007
    - 4 in 2008
    - 2 in 2009
    - 10 in 2010
    - 1 in 2011

Football 12, Women’s Basketball 4, Baseball 6, Water Polo 12, Soccer 2, Track 4
All athletes have returned to sport

Clinical Presentation

- Insidious onset of anterior hip & groin pain
  - Lateral hip, thigh, buttock and lumbar
- Moderate to severe at presentation
- About 35% report a specific injury
  - Describe pain as aching and sharp
  - Often a mechanical component of catching & or locking
  - C sign

Byrd T JW: NAJSPT 2007
Pain location and frequency of 51 patients with symptomatic FAI

Hip Joint Pain

- Receives innervations from branches of L2 to S1 of the lumbosacral plexus,
  - predominantly L3.
- Hip symptoms may be referred to the L3 dermatome
  - anterior and medial thigh
  - knee

Aggravating Factors

- Symptoms worse with activities
- Twisting, turning or changing directions is difficult
- Seated position may be uncomfortable, especially with > hip flexion
- Rising from seated position often painful (catching)
- Difficulty ascending and descending stairs
- Symptoms with entering / exiting an automobile

Functional Limitations

<table>
<thead>
<tr>
<th>Component</th>
<th>Nature of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep static vs dynamic symptoms</td>
<td>37 (75%)</td>
</tr>
<tr>
<td>Severity of hip flexion</td>
<td>High (60%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>7 (15%)</td>
</tr>
<tr>
<td>Seated vs standing</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>Use of cane, walker, or seated devices</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Extends to where you place your feet</td>
<td>8 (17%)</td>
</tr>
<tr>
<td>Exceeds to where you place your feet</td>
<td>8 (17%)</td>
</tr>
<tr>
<td>Exceeds to where you place your feet</td>
<td>8 (17%)</td>
</tr>
<tr>
<td>Hemi stance use of hammer</td>
<td>26 (54%)</td>
</tr>
<tr>
<td>Treadle</td>
<td>4 (9%)</td>
</tr>
<tr>
<td>Hip flexion:</td>
<td></td>
</tr>
<tr>
<td>&gt; 90 degrees</td>
<td>19 (38%)</td>
</tr>
<tr>
<td>&gt; 90 degrees</td>
<td>19 (38%)</td>
</tr>
<tr>
<td>&lt; 90 degrees</td>
<td>33 (68%)</td>
</tr>
<tr>
<td>Drawing chair and table</td>
<td></td>
</tr>
<tr>
<td>Engaged</td>
<td>33 (68%)</td>
</tr>
<tr>
<td>Treadle</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Treadle or use public transportation</td>
<td>3 (6%)</td>
</tr>
</tbody>
</table>

Components of Eval

Posture

- Slouching & listing to the uninvolved side
  - Decreases hip flexion
  - Abduction and ER
    - relaxes the capsule
- Stand with the hip and knee joint slightly flexed

Byrd T JW: NAJSPT 2007
Gait Examination

- Assess hip mobility with gait alterations
- Focus on hip extension, adduction, IR, hip flexion and ankle dorsiflexion
- Look for change in hip pain symptoms and at the quality of the movement

Long Stride

- Assess hip extension
- The restricted side hip will rotate back towards you as the patient walks away
- Causing excessive lumbopelvic rotation or extension

Crossover Stride

- Assess hip adduction
- Looking for the smooth movement without excessive lumbar sidebend

Toe In Walking

- Assess hip IR
- Looking for symmetrical motion
  - Reproduction of symptoms
- Also looks at tri-plane iliopsoas mobility
  - Ext/IR/Abd

Crouched Walking

- Utilize to assess ankle dorsiflexion and hip flexion
- Look for asymmetries in motion and reproduction of pain

FAI and Gait

- During level gait CAM FAI patient's had significantly
  - decreased hip abduction motion
  - less total frontal hip ROM
  - decreased pelvic mobility
  - lower total sagittal hip ROM
  - Predominately decreased extension

M.J. Kennedy et al. (2009)
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1st MTP Function

- Assess NWB ROM
  - 60 degrees
- Assess WB ROM
  - Place patient in a stride stance with the lead leg elevated
  - Perform a SL heel raise
    - Assess 1st MTP ROM
    - Weight distribution
    - Rearfoot inversion

WB 1st MTP ROM

Overhead Squat

Assesses bilateral, symmetrical, and functional mobility of the hips, knees and ankles

FAI Overhead Squat

Squat

Deep Squat Breakdown

- Hands behind head
  - Removes UE component and decreases level of dynamic stability needed
- Assisted deep squat
  - Looks at true symmetric mobility without dynamic stability

SFMA: Cook 2008
Deep Squat Breakdown

- Half kneeling ankle dorsiflexion
  - Flexibility vs. mobility issue
  - Achilles and soleus complex vs. anterior talocrural joint
  - Excellent interrater and intrarater reliability
    - .82
    - .89

Krause et al: J of Sport Rehab 2011

The Effect of Cam FAI on Pelvic Motion during Maximum Squat

- The FAI group had decreased sagittal pelvic ROM
- Also had decreased maximal squat depth
- Reduced sagittal mobility may lead to impingement


The Biomechanics Associated with Squatting and FAI

Squat

CONTROL

FAI

Squat Results
Squat

- Stability
- Control
- Strength
- Range of motion

Hip Hiking & Single Leg Balance

- Screen for leg length differences
- Assess balance and glut medius strength
- Screen for stress fractures of the pubic ramus

Hurdle Step Over

- Assess ability to flex hip w/o L/S compensation
- Assess dynamic balance and glut medius strength

Hurdle Step

CONTROL

FAI

Hurdle Results
**At 90 Degrees Femur Flexion**

- What muscles can assist hip flexion?
  - TFL, rectus femoris & sartorius
  - Capable of hip flexion up to 90°
  - Psoas and iliacus
  - Flex hip above 90°
  - Weakness often in FAI & athletic pubalgia

**Active Hip Flexion Test**

- Patient stand with one foot on a 18” or 24” plyo box
- Hands behind the head or at side
- Attempt to lift the foot off the box and hold for 5 sec
- Inability to lift and hold is indicative of a weak psoas and or iliacus.
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**Hip Excursion Testing**
- Assess amount of motion that can be controlled within a specific plane while in unilateral stance
- “Standing hip ROM assessment”
- Document quality and quantity of motion

**Hip Flexion Excursion**
- Single leg balance hip flexion
- Evaluate quality and quantity
- Contribution from the lumbar spine
- Reproduction of pain

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**Hip Extension Excursion**
- Single leg balance hip extension
- Assess quality and quantity
- Contribution from the lumbar spine
- Reproduction of hip symptoms

**Hip IR Excursion**
- Single leg balance hip internal rotation
- Be sure the foot is kept flat
- Utilize toe touch to assess for range of motion restriction versus strength/balance deficit

---

**Hip Adduction Excursion**
- Single leg balance hip adduction/abduction
- Be sure the foot is kept flat
- Watch for lumbar spine sidebend

**Eccentric-Concentric Control of the Core**
- These tests look at the ability of the core muscle groups to control the body’s center of mass
  - Sagittal ECC SLB Posterior Reach
  - Frontal ECC SLB Medial Reach
  - Transverse ECC SLB PL Reach

Kibler, BW: Sports Medicine 2006
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**Log Roll**

- Single most specific test for hip pathology
- Moves the articular surface of the femoral head in relation to the acetabulum
- Does not stress any of the surrounding extra-articular structures

**Hip Flexion**

**FAI Hip IR**

19 y/o male water polo player right CAM lesion left Pincer lesion/retroversion

**Anterior Impingement Test**

- Combined motions of hip flexion, internal rotation and adduction
- This combined movement engages the femoral head-neck junction into the anterior superior labrum and acetabular rim

Leunig et al: Oper Tech Orthop. 2005


**FABER’s Distance Test**

An increased vertical distance between the lateral edge of the knee and the examination table has been observed in FAI patients during the FABER examination when compared with the contralateral limb


**FAI Patient**

19 y/o male water polo player right CAM lesion left Pincer lesion/retroversion

- What causes the restriction?
- Can this be improved with treatment?

Right FABER 23cm
Left FABER 16 cm
FABER Test Reliability

- Philippon: unpublished data
  - Found as FABER distance increased – alpha angle increased (r=0.2; p=0.002)
  - FABER difference ≥5cm → Alpha Angle = 72
  - FABER difference <5cm → Alpha Angle = 57
    - *p=0.001
- Growing evidence this test can be a affective part of a screening exam for FAI

Active Straight Leg Raise

- Against resistance
- Compressive forces of multiple times body weight
- Often painful when mild degree of underlying disease

FAI Hip IR

Understanding Hip IR

- Craig’s test
- 8-15° of anteversion in the adult
- Anteverted = > IR vs. ER
- Retroverted = > ER vs. IR

Patterns of Hip Muscle Weakness with FAI

- Patients with FAI (n=18) show significant muscle weakness compared to asymptomatic controls
  - Hip flexion
  - Hip adduction,
  - Hip external rotation
  - Hip abduction
  - Hip flexor muscle weakness
    - was accompanied by reduced muscle activation of TFL

Casartelli et al: Osteoarthritis and Cartilage: 2011

How do we utilize this info?

Can we prevent this cycle from occurring?
Pre-participation Physical Evaluation (PPE)

- Prior to the 2006 season screened 81 Division 1 football players
  - 9 physical exam tests
  - Video analysis of overhead squat
  - Imaging studies
  - Physician consult

9 Physical Exam Tests

- Range of Motion
  - Hip Flexion (Supine)
  - Hip IR (Prone/Seated)
  - Hip ER (Prone/Seated)
  - Thomas Test
    - Psoas, Quad, TFL
    - Van Dillen et al: JOSPT 2000
    - Straight Leg Raise (SLR)
- Provocation Tests
  - Anterior Impingement
  - FABER's
  - Log Roll
  - Lumbar Spine Flexion

Abnormal Exam

- Athletes with hip pain and an asymmetrical FABER test greater than 4 cm
- Underwent MRI examination
- Alpha angle measurements were obtained
- Suspected pathologies of the chondral labral junction were recorded

Alpha Angle

Used to quantify the degree of abnormality and cam impingement on the anterior aspect of the femoral head neck junction. An angle of 55° or greater is considered abnormal

Abnormal Alpha Angle

Results

- Thirty-three athletes (41%) had abnormal hip exams
  - Asymmetrical FABER
  - Hip Pain
- There was no difference in hip flexion between hips with normal exams (101°) and hips with abnormal exams (98°)
Results

- Hips with abnormal exams had significantly less external rotation (39° vs. 49°; p<0.01)
- And significantly less internal rotation (28° vs. 33°; p<0.05) than hips with normal exams

MRI Examination

- 27 hips were evaluated by MRI
- Average alpha angle measurements were 67° (range 44° to 83°)
  - 26 hips with alpha angle greater than 50°
  - 11 hips had suspected pathologies of the chondral labral junction
    - Higher alpha angle (73° vs. 62°; p<0.01).

Screening Outcomes

- Abnormal hips have reduced range of motion
- High alpha angles correlated with suspicion of chondral labral pathologies
- PPE identified athletes at risk of chondral labral dysfunction
  - A modified screening exam has continued to identify athletes at risk from 2007-2011

Alpha Angle and Chondral Labral Dysfunction

- Higher alpha angles in FAI patient’s correlate with a greater magnitude of
  - Decreased range of motion
  - Chondral damage
  - Labral injury

Johnston et al: 2008

Multifactorial Nature of Intra-articular Hip Dysfunction

- CAM and Pincer bony abnormalities
  - Chondral-labral injury
- Decreased hip ROM
- Abnormal gait
- Reduced pelvic mobility
- Hip and trunk muscle weakness
Differential Diagnosis and Management of Intra-articular Hip Pathology

Diff Diagnosis, Evaluation and Screening

Question’s Additions???

Imaging & Surgical Procedures

Rehabilitation After Hip Femoroacetabular Impingement Arthroscopy

More than 30,000 hip arthroscopies were performed in 2008. This number is expected to grow at a rate of 15% over the next 5 years, resulting in more than 70,000 hip arthroscopies performed each year by 2013


Rehabilitation Principles

- Individualized and evaluation-based (not time-based) program designed to address
  - Surgical Findings
  - Impairments
  - Functional Limitations
  - Lifestyle, work and sport requirements

Goals of Surgery

- Hip arthroscopic procedures are used
  - Correct the bony geometry
  - Provide an intact labral complex and ligamentous structure
  - Improved hip congruency
    - Femoral osteoplasty
    - Acetabular rim trimming
    - Labral repair
    - Microfracture
    - Capsular closure

Goals of Hip Rehab

- Protect the integrity of the healing tissue
- Prevent negative effects of immobilization
- Diminish pain and inflammation
- Identify the primary causes and compensations of the hip dysfunction
Differential Diagnosis and Management of Intra-articular Hip Pathology

Goals of Hip Rehab

• Normalize gait
• Restore ROM
  – Hip
  – Thoracic Spine
  – Screen
    • Lumbar spine
    • Foot and Ankle
• Promote dynamic LE mobility and stability
• Address motor control deficiencies
• Restore strength and functional capacity

Rehab Progression

• Respect differences in a
  – Patient’s age
  – Magnitude of chondral injury
    • Grade I-V
  – More severe leads to poorer prognosis
  – Nutrition and systemic health
  – Concomitant injuries or impairments
  – Goals and sport-specific demands

Components of Rehabilitation and/or Prevention Program

- Modify Training Stress Safety
- Compete Pain Free
- Reinforced Sport Movement
- Improve Hip/Trunk Stability
- Restore LE Strength
- Pain Free

Restore Hip Mobility

• Individualized specific time lines for weight bearing and ROM restrictions
  – Determined by the surgical procedure
  – Compliance with these restrictions by patients and therapists is critical
  – Error on the side of safety
  – “Don’t push hip ROM through pain”

Precautions for Hip Mobility

<table>
<thead>
<tr>
<th>Procedure</th>
<th>ROM</th>
<th>Time Line</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Repair</td>
<td>0-90°</td>
<td>12-25°</td>
<td>1-2 h, 1-2 wk</td>
</tr>
<tr>
<td>Capsule Repair and Capsule Closure</td>
<td>0-90°</td>
<td>12-25°</td>
<td>1-2 h, 1-2 wk</td>
</tr>
</tbody>
</table>

Restore Range of Motion Strategies

• Utilize
  – Passive and active range of motion
  – Bottom-Up: femur on pelvis movements
  – Top-Down: pelvis on femur movements
  – Restore range of motion in all three planes of motion while protecting the surgical repair
  – Avoid impingement symptoms
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Femur on Pelvis
- Log Roll
- Circumduction in ext
- SLR
- Circumduction @ 70° flexion
- Hip IR/ER @ 70° flexion
- Hip flexion
- Hip adduction to 45°

Pelvis on Femur
- DL pelvic circles
- DL hip rotations
- Lateral weight shift č overhead reach
  - Hip abduction
  - Hip adduction

Quadruped Rocking
- Cat Camel
- Double leg anterior tilt
- Double leg multi-directional UE reach
- Possible to do active release techniques during these movements

Abd/ER ROM
- Supine ABD/ER
- Supine Valslide Abduction
- Active FABER Supine
- Active FABER Prone
- Remember post op restrictions!!
Soft Tissue, Joint & Fascial Mobility

- Deep tissue and self soft tissue massage
- Tri-plane hip musculature stretching
  - With focus on pelvic mobility moving proximal on distal segment
  - Top-down approach
- Hip joint mobilization
  - Athlete guided mobilization with movement

Soft Tissue Work

- Often focus on iliopsoas, adductor longus, hip ext/er, gracilis and pectineus

Stress of Repetitive Loading in AB/ER

- 22 y/o Fb player
- Bilateral CAM
- Alpha angle 84/89 degrees

Stress of Repetitive AB/ER Loading

- Strain to the labral chondral interface occurs in flexion or extension
- Greatest stress is in the anterior labrum
  - 2-3 O’clock position
- Femoral head displaces 1.3-1.6 mm anteriorly

Waterpolo

Tri-plane Stretching

Adductors

Hamstrings

Dy et al: JBJS 2008
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**Tri-plane Stretching**

- Hip Flexors
- Quads

**Psoas Rectus Adductors**

- After you have restored hip flexion ROM
- Outside of timeline for precautions for hip extension ROM

**Hip Rotation**

- Swiss Ball Active IR
- Standing Hip ER Table Stretch

**Hip Joint Mobilizations**

- Caudal Glide
- Posterior Glide
- Lateral Distraction
- Anterior Glide

**Standing AP Glide**

with or without thoracic rotation

**Posterior Complex Mobilization**

with thoracic rotation
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Long Axis Hip Distraction
- Manual long axis distraction
- Self long axis distraction

Improved FABER
- 19 y/o male water polo player right CAM lesion left Pincer lesion/retroversion
  - Right FABER Before 23 cm
  - Right FABER After 19 cm

Ankle Joint Self Mobilization
- Sagittal plane
- Frontal plane invert
- Frontal plane swing
- Transverse plane

Hip Activation Exercises
- Bridge
- Bridge March
- Single Bridge
- ER
- Band work

Gait Training

Squat Progression
- Ankle mobility
- Hip ER
- L/S Flexion
  - Teach athlete to maintain spine angle to help decrease risk of impingement. Limit depth
Lots of possibilities

What to you expect to see based on their age and injury?

Squat Variety

• Squat from a variety of foot positions to attempt to change the loading on the hip and simulate various everyday movements

Step Ups

• Step Up
  – Anterior
  – Hip demand
  – Lateral
  – Ankle and knee demand

Single Leg Mobility & Strength

• SL RDL
• SL MD Reaching RDL
• SL IR Excursion
• SL ER Excursion

Standing Hip Abduction

• Early activation minimizes hip compressive forces

Hip Flexion Progressions

• Supine Abdominal Marching
• Supine Abdominal 1 Leg Slide
• Sitting Isometric Hip Flexion
• Supine Band Hip Flexion
• Standing Box Hip Flexion
• Standing Dynamic Hip Extension to Flexion
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Single Leg Mobility & Strength
- SL overhead UE
- R/L lateral reach
  - Eccentric hip abductor control

Balance Reach Training
- Posterior UE reach - hip extension
- Medial reach - hip adduction
- Anterior lateral - hip IR
- Posterior lateral - hip ER
- Posterior medial - hip ER

Plisky et al: 2006
Gray: 1995

Single Leg Training Progression
- Split Squat
- Bench Split Squat
- T Leg Squat
- Single Leg DL

Verstegen: Rodale 2004

Glut Max Activation During Common Therapeutic Exercises

Table 1: Normalized Glutus Maximus Mean Signal Amplitude (% MVC)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Mean ± SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-legged squat</td>
<td>26.7 ± 16.4</td>
</tr>
<tr>
<td>Lunge</td>
<td>10.1 ± 11.6</td>
</tr>
<tr>
<td>Step-up and-over</td>
<td>10.9 ± 11.2</td>
</tr>
</tbody>
</table>

Distefano et al 2009 JOSPT

Glut Medius Activation During Common Therapeutic Exercises

Table 2: Normalized Glutus Medius Mean Signal Amplitude (% MVC)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Mean ± SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-legged squat</td>
<td>23.4 ± 23.5</td>
</tr>
<tr>
<td>Lunge</td>
<td>23.6 ± 36.1</td>
</tr>
<tr>
<td>Step-up and-over</td>
<td>27.2 ± 54.1</td>
</tr>
</tbody>
</table>

Distefano et al 2009 JOSPT

Hip-Muscle Activation During the Lunge, Single-Leg Squat, and Step-Up-and-Over

Table 1: Muscle Activation During Functional Exercises Represented as % RVC

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Single-leg squat</th>
<th>Lunge</th>
<th>Step-up and-over</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF</td>
<td>26.7 ± 16.4</td>
<td>10.1 ± 11.6</td>
<td>10.9 ± 11.2</td>
</tr>
<tr>
<td>ABD</td>
<td>23.4 ± 23.5</td>
<td>23.6 ± 36.1</td>
<td>27.2 ± 54.1</td>
</tr>
<tr>
<td>Gmax</td>
<td>21.7 ± 14.7</td>
<td>16.5 ± 11.7</td>
<td></td>
</tr>
<tr>
<td>Gmed_L</td>
<td>30.1 ± 29.5</td>
<td>17.7 ± 28.8</td>
<td>15.2 ± 6.9</td>
</tr>
<tr>
<td>Gmed_Nd</td>
<td>12.9 ± 7.3</td>
<td>19.0 ± 11.7</td>
<td>16.9 ± 10.4</td>
</tr>
</tbody>
</table>

Boudreau et al: JSR 2009

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Rehabilitation Exercise Progression for the Gluteus Medius Muscle With Consideration for Iliopsoas Tendinitis

An In Vivo Electromyography Study

Marc J. Phillips, MD, Michael J. Decker, MD, J. Eric Signor, MD, Michael R. Tony, MD, Michael S. Wertefelt, MD, SCS, and Robert F. LaPrade, MD, PhD
Investigation performed at the Steadman Philippon Research Institute, Vail, Colorado

Step Down

Rabin: Dec 2010 JOSPT

Dynamic Impingement

Teach athletes to decelerate flexion, adduction, IR forces as well as extension and abduction

When can I run???

Safe and appropriate loading progression of the hip

Agility Exercises

“`The state or quality of being agile or nimble``”

Train and work in all 3 planes of motion
Parameters for Agility Training

- Based on qualitative and quantitative data
  - Attributes of movement
    - Velocity, accuracy, control, rhythm, ROM
  - Numerical results
    - Time, reps per bout of agility
- Self select a work/rest interval based on the patient’s functional level
  - 3:1, 2:1, 4:1 10sec/30sec, 8 sec/16 sec
  - Adjust depending on the patient’s response

Base Front to Back

STARTING POSITION:
Stand in an athletic position, with your feet outside your hips
PROCEDURE:
Keep both feet apart jump 4 inches to the right and then to the left as if you were jumping back and fourth over a line. Repeat as rapidly as possible
TEACHING KEY:
As soon as you hit the ground spring back to the other side concentrate on quickness not height

Verstegen: Rodale 2004

Base Side to Side

STARTING POSITION:
Stand with your shoulder square, your feet at a 45 degree angle
PROCEDURE:
Rotate your hips to the right and left at a 45 degree angle. Shoulders stay stationary; use the hips only
TEACHING KEY:
Rotate from the core not the shoulders Imagine an X on the floor, rotate your hips so your feet move to the ends of the X

Verstegen: Rodale 2004

Base Side to Side

Base Rotations

STARTING POSITION:
Stand with your shoulder square, your feet at a 45 degree angle
PROCEDURE:
Rotate your hips to the left and right at a 45 degree angle. Shoulders stay stationary; use the hips only
TEACHING KEY:
Rotate from the core not the shoulders Imagine an X on the floor, rotate your hips so your feet move to the ends of the X

Verstegen: Rodale 2004
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Box Agilities

- Sagittal
- Frontal
- Transverse

Agility Ladder Foot Sagittal

Agility Ladder 2 Feet Sagittal

Agility Ladder 2 Feet Frontal

Agility Ladder 2 in 2 out
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Agility Ladder Scissor

Agility Ladder Icky Shuffle

Common Agility Tests

Common Agility Tests

CONE DRILLS

PRO AGILITY

Progressive Plyometric Program
Keys

• Exercises are taught in a progressive manner
• Progress is based on competence, not a predetermined timeline
• Teach how to summate forces using the arms and the hips
  – Teach to “Land Softly” “Quiet”
  – Must learn to absorb force with the muscles and not with the joints

Phase 1: Single Response with Stabilization

• Learn to jump and land
  – Tendon training
  – Summate forces using arms and hips
  – Land softly
• Purpose is to develop Eccentric Strength
• Generally lasts 3-4 weeks
• Most important and often overlooked phase
Phase 1: Single Response with Stabilization

- Plyometric exercises are broken down into
  - Linear drills
  - Lateral drills and Rotational drills
- Exercises performed 2-4 days per week
  - 3-5 sets of 5 jumps
  - For lateral jumps 3 sets of 5 landings on each leg

Box Jumps

- Plyometric exercises are broken down into
  - Linear drills
  - Lateral drills and Rotational drills
- Exercises performed 2-4 days per week
  - 3-5 sets of 5 jumps
  - For lateral jumps 3 sets of 5 landings on each leg

Box Height

- Range from 4-24 inches for beginners
- Criteria for evaluating box height
  1. Can the patient land quietly
  2. Does the patient land in the same position they took off in? If the landing squat is deeper than the take off squat, the box is too high
  3. Landing position should never be deeper than a parallel squat position

Lateral Hop with Stabilization

- Gravity becomes a larger component
  - Linear drills: we will now jump over an obstacle
  - Lateral drills: now jump over an object in a medial and lateral direction
- Emphasis on soft landings continues
- Exercises performed 2 days per week
  - 3-5 sets of 5 jumps
  - For lateral jumps 3 sets of 5 landings on each leg
Hurdle Hop and Stick

**STARTING POSITION:**
Stand behind a hurdle on two feet

**PROCEDURE:**
Squat and load your knee, ankle and hip and jump over the hurdle and stick the landing. Hold this position for 2 seconds and repeat over the remaining hurdles.

**TEACHING KEY:**
Land soft, stick the landing, use your arms.

---

Single Leg Lateral Hop and Stick

**STARTING POSITION:**
Stand next to the hurdle on one foot

**PROCEDURE:**
Squat and load your knee, ankle and hip and jump over the hurdle and stick the landing. Hold this position for 2 seconds and repeat.

**TEACHING KEY:**
Land soft, stick the landing, use your arms.

---

Phase 3: Multiple Jumps

- Emphasis switches from development of eccentric strength to eccentric to concentric switching
- Less emphasis on stabilization
- Introduction of elastic component
- Most injury occurs from ignoring phase 1&2

---

Hurdle Hops

**STARTING POSITION:**
Stand behind a hurdle on two feet

**PROCEDURE:**
Squat and load your knee, ankle and hip and jump over the hurdle and stick the landing. Rapidly repeat this movement over the remaining hurdles.

**TEACHING KEY:**
Land soft, stick the landing, use your arms.
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Single Leg Medial and Lateral Hurdle Hops

**STARTING POSITION:**
Stand next to a hurdle on one foot

**PROCEDURE:**
Squat and load your knee, ankle and hip and jump over the hurdle and stick the landing. Repeat over the remaining hurdles.

**TEACHING KEY:**
Land soft, stick the landing, use your arms.

Other Testing Options

- **Triple Hop**
- **Multidirectional SL Hop**
- **Drop Jump**
  - Assess landing strategy
  - Hip, knee and ankle
- **Lateral Shuffle**
  - Assess change of direction strategy
- **Cutting 45° or 90°**
  - Assess LE position & control during cutting

Drop Jump

- **Pre Training**
- **Post Training**

Lateral Shuffle

- **Pre Training**
- **Post Training**

Bad Cutting Mechanics
Cutting 45° or 90°

Training Modification

- Attempt to limit high risk angles of flexion and internal rotation
  - Modify squat ROM and step up height
  - Olympic lift from boxes or hang position
  - Increase single leg training

Squat ROM

Step Up Height

Olympic Lift Modifications

- Hang Clean
- Clean Pull from box

Training Modification

- Train LE in multiple planes to
  - Decrease sagittal plane hip loads
  - Teach athlete to decelerate flexion, extension, adduction, IR forces
- Educate the athletes to not use treadmills
  - hyperextension anterior hip joint forces
- Emphasize post workout stretching and mobility

Perform olympic lifts from a variety of foot positions to attempt to change the loading on the hip and simulate sport specific movements

Lewis et al: Jour of Biomechanics 2007

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Management of Intra-articular Hip Injuries

- Screening - Identify hip at risk
  - Early diagnosis
  - Modify training program and educate patient and family
- Importance of comprehensive evaluation and treatment
  - Total body movement assessment
  - Imaging (Extra-articular Injections: PRP)
  - Modify strength training
- Surgical intervention if necessary
  - Safe appropriate rehabilitation progressions

Components of Rehabilitation and Prevention Program

- Modify Training Stress
- Safety
- Reinforce Sport Movement
- SL LE Strength
- Compete Pain Free
- Improve Hip Stability
- Eccentric Core Training

Biomechanical Changes

Long Term Outcomes

Thanks to

- USC Athletic Medicine and Physical Therapy
  - Dr. Snibbe
  - Dr. Tibone
  - Dr. Philippon
  - Dr. Byrd
  - Dr. Sampson
- USC Athletes
- CPTA