Physical Exam of the Hip

Layered Anatomical Approach to the Hip

Layer 1: Osteochondral Layer
Mechanics of joint

Layer 2: Inert Layer

Layer 3: Dynamic Layer

Layer 4: Neural Layer


Hip Differential Diagnosis

Is the hip the SOURCE of the problem?
Is the hip the SITE of the problem?
Is the hip the SOLUTION of the problem?
Layer 1: Osteochondral Layer

- Structures: Femur, Pelvis, Acetabulum
- Purpose: Joint congruence and normal osteo / arthrokinematics

Static Overload
- Acetabular Dysplasia
- Acetabular Protrusio
- Femoral Anteversion
- Femoral Valgus

Dynamic Impingement
- Cam Impingement
- Rim Impingement
- Femoral Retroversion
- Femoral Varus

What is Dysplasia?

Pre- and Post-Op

Klaue 1955 & 1991
Layer 2: Inert Layer

Structures: Labrum, joint capsule, ligamentous complex, ligamentum teres

Purpose: Static stability of the joint

Labral Injury
Cartilage Injury
Capsular Injury
  - Instability
  - Adhesive capsulitis

Acetabular Labrum

Deepens the socket allowing for greater coverage of the femoral head
  - Maintain stability
  - Decrease contact pressure

Provides a fluid seal for the hip joint

**Most common area of injury is at the capsulolabral junction

Parvizi et al. JAAOS 2012.

Microscopic Structure

3 Layers by SEM
  - First: 10 μm without distinct orientation
  - Second: 40 μm with lamellar orientation
  - Third: 200-300 μm with circumferential orientation

**Microscopic Structure**
- Physiologic cleft at the chondro-labral junction
  - Chondral: hyaline cartilage
- Histology
  - Articular side: fibrocartilage with chondrocytes
  - Capsular side: dense connective tissue with fibroblasts

**Vasculature**
- Increased vascularity at the capsular side
- Anastomosis between Medial/lateral circumflex, deep branch of superior gluteal, inferior gluteal arteries to provide branches to the capsule and synovium

**Innervation**
- Hip pain related to labral injury
  - Torn
  - Impingement
- Originates from the nerve to the quadratus femoris and obturator nerve
  - **Pain**: unmyelinated nerve endings in the anterosuperior labrum
  - **Pressure**: corpuscles (Vater-Pacini, Golgi-Mazzoni, Ruffini, Krause)
  - **Proprioception**: mechanoreceptors

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*Kim YT et al. CORR 1995.*
Anterior Hip Capsule and Ligamentous Support

Anterior Static Stabilizers: restrains extension & external rotation
- Iliofemoral ligament (Y Ligament of Bigelow): strongest hip ligaments
  - Originates from AIIS and inserts on the intertrochanteric line of femur.
  - Terminal fibers form zona orbicularis
  - “Screw home” mechanism with hip extension / ER
- Pubofemoral ligament
  - Originates from the pubic rami and inserts on the intertrochanteric crest

Posterior Hip Capsule and Ligamentous Support

Posterior Static Stabilizers: restrains internal rotation in flexion and extension
- Ischiofemoral ligament:
  - Originates from the ischial rim and inserts on the posterosuperior base of the GT
  - Blends with zona orbicularis posteriorly

Zona Orbicularis
- Encircles entire femoral neck
- Functions as locking ring around the femoral neck and provides stability with distraction

Ligamentum Teres

Ligamentum Teres
- Travels from the inferior aspect of the acetabulum at the transverse acetabular ligament to fovea of the femoral head (fovea capitis)
- Tension with adduction and ER
- May serve as a secondary stabilizing structure
- Torn LT has been described as a source of hip pain (Byrd & Jones. Arthroscopy 2004).
  - Some have recommended debridement (Haviv & O’Donnell. KISTA 2011)
  - Some have recommended LT reconstruction (Amenabar et al. Arth Tech 2012; Lindner Arth Tech 2012; Philippon et al. JBU Br 2015)
Layer 3: Contractile Layer

Structures: All musculature including lumbosacral musculature
Purpose: Dynamic stability

Enthesopathies / Tendinopathy:
Anterior: Hip flexor tendonitis or Psoas dysfunction or subspine impingement
Posterior: Deep Gluteal Syndrome (Proximal Hamstring Syndrome or Paraspinal dysfunction)
* SI Joint & Lumbar Spine
Medial: Athletic Pubalgia or Osteitis Pubis
Lateral: GTPS / ITB

27 Muscles Cross the Hip Joint

Muscles supporting and stabilizing the lumbo-pelvic complex
• Core “canister”: Transversus abdominis, multifidi, pelvic floor, diaphragm
• All other muscles with direct or fascial attachments to the pelvis

Anterior Enthesopathy: Hip Flexors

Primary:
• Iliopsoas
• Sartorius
• Tensor fascia lata
• Rectus femoris
• Adductor longus
• Pectineus

Secondary:
Adductor brevis, gracilis, anterior fibers of gluteus minimus
Medial Enthesopathy: Hip Adductors

Primary:
- Pectineus
- Adductor longus
- Gracilis
- Adductor brevis
- Adductor magnus

Secondary:
- Biceps femoris, gluteus maximus, quadratus femoris

Medial Enthesopathy: Hip Adductors

Athletic pubalgia
Weakeness or tear of the posterior inguinal wall (injury to rectus abdominus, avulsion of internal oblique muscle
FAI associated with AP (Larson et al. Arthroscopy 2011)
- 25% RTP with AP alone
- 50% RTP with HA alone
- 89% RTP with HA and AP surgery

Lateral Enthesopathy: Hip Abductors

Primary:
- Gluteus medius
- Gluteus minimus
- Tensor fascia lata

Secondary:
- Piriformis, sartorius
Lateral Enthesopathy: Greater Trochanteric Pain Syndrome

GTPS: disorders of the peritrochanteric space of the hip
- Trochanteric bursitis
- Gluteus medius and minimus tears ("rotator cuff tear" of the hip)
- External coxa saltans

10-25% General population \(^2,^4,^8\)
- Middle aged population
- Females > males \(^4,^9-^12\)
- Association with low back pain \(^4,^9-^12\)

20-22% of Gluteus Medius tears are found incidentally at time of THA

Lateral Enthesopathy: Peritrochanteric Space

Peritrochanteric Space
Lateral: Tensor fascia lata and ITB
Medial: Abductor tendons and vastus lateralis
Superior: Gluteus maximus muscle
Posterior: Gluteus maximus tendon

Anatomy
Anatomy

2 Distinct Footprints
- Lateral: 438 mm² (34.8mm x 11.2mm)
- Superoposterior: 196.5 mm² (17mm diameter)

Robertson WR & Kelly BT. Arthroscopy 2008.

Posterior Enthesopathy: Hip Extensors

Primary:
- Gluteus maximus
- Hamstrings
- Posterior head of the adductor magnus

Secondary:
Posterior fibers of the gluteus medius, anterior fibers of the adductor magnus
Proximal Hamstring Anatomy


Endoscopic HS Repair

Posterior Enthesopathy: Deep Gluteal Space Syndrome

Sciatic Nerve (L4 to S3) exits through sciatic notch inferior to the piriformis muscle

Covered by the G. Max and passes between the ischial tuberosity and greater trochanter

- 28mm of excursion with hip flexion
- Nerve is able to stretch and glide with joint movement

Deep gluteal syndrome (DGS) can be caused by fibrous bands, gluteal, piriformis, or HS muscles

Physical Examination of the Hip

Critical for accurate diagnosis of hip pain

Can help to differentiate intra-articular and extra-articular etiologies of symptoms

Laxity

Asymptomatic passive translation of the femoral head relative to the acetabulum

Beighton criteria:
- Placing flat hands on the floor with straight legs
- Left knee bending backward
- Right knee bending backward
- Left elbow bending backward
- Right elbow bending backward
- Left thumb touching the forearm
- Right thumb touching the forearm
- Left little finger bending backward past 90 degrees
- Right little finger bending backward past 90 degrees

Physical Exam

Gait:
- Trendelenburg
- Abductor lurch
- Antalgic
- Foot progression angle
  - Excessive ER
  - Excessive IR
- Short leg limp
20 patients with FAI underwent gait analysis

- Alpha Angle neg correlated with peak hip abd and IR moment
- CEA correlated with hip flexion moment

FAI produces characteristic gait deviations including gluteus weakness and HF hypertonicity
Hip and pelvis dysfunction can be a challenging diagnostic dilemma.
Understand the pathomorphology of the hip joint as well as the surrounding neuromuscular anatomy.
Failure to recognize and treat compensatory injury patterns may result in continued pain and dysfunction.
FAI generally produces characteristic gait deviations due to gluteal weakness and hip flexor hypertonicity.
Conclusions

Recognition of the detrimental mechanical overload from alterations in layers 1 & 2 is important in both the treatment and prevention of these injuries.

Surgical correction of layers 1 & 2 will require a necessary Layer 3 & 4 accommodation period.
Passive ROM of both hips is critical for diagnosis
(Normal: Flexion 120°, Extension 10°, ER 50°, IR 30°, ABD 45°, ADD 30°)

Provocative Maneuvers

Impingement Test
FADDIR
Painful Arc

Posterior Impingement Test
Hip extension & ER
Provocative Maneuvers

Lateral Rim Impingement
Hyperabduction

Provocative Maneuvers

Psoas Impingement
FABER

Provocative Maneuvers

Instability Test
Extension and ER
Loss of normal recoil
**Provocative Maneuvers**

**Circumduction maneuver** for snapping psosas tendon

**Trochanteric Pain Sign**
Abduction and ER

**Peritrochanteric Space Exam**
Palpation of the anterior, lateral, and posterior trochanter
Exam of areas of bony prominence
Provocative Maneuvers

Hip Abduction strength with knee in flexion

Hip Abduction strength with knee in extension

Bicycle maneuver for snapping ITB
Femoroacetabular Impingement
CAM Type

Femoroacetabular Impingement
Pincer Type

Topographic Bony Anatomy

Anterior
- Anterior Superior Iliac Spine (ASIS)
- Pubic Tubercle

Lateral
- Iliac Crest
- Greater Trochanter

Posterior
- Posterior Superior Iliac Spine (PSIS)
- Ischial Tuberosity
Surface Anatomy

ASIS

Anterolateral Portal

Anterior Portal

Greater trochanter

DALA Portal

Hip Arthroscopy Portals

ASIS

Anterolateral Portal

Anterior Portal

Greater trochanter

DALA Portal

Neurovascular Structures

Lateral femoral cutaneous nerve

Ascending branch, lateral circumflex femoral artery

Rectus femoris muscle

Biceps muscle

Byrd. JAAOS 2006.
Neurovascular Structures

Considerations for Difficult Access: Portal Distance

Byrd. JAAOS 2006.
Capsulotomy

Interportal Capsulotomy  T-Capsulotomy

Labral Function

Labrum maintains intra-articular fluid pressurization
- Decreases with labral tear / resection
- Through-type labral repair > looped-type labral repair
- Labral reconstruction normalized IAP

Labrum stabilizes hip by maintaining suction seal at small displacement (1-2mm) but capsule has a greater role at larger displacement
- May explain microinstability in the setting of labral injury.

Neppe et al. KSSTA 2014.

Labrum Contact Mechanics

Findings: Compared to normal hips, the labrum in dysplastic hips supported a larger percentage of total load transferred to the hip

Labral Reconstruction With Iliotibial Band Autografts and Semitendinosus Allografts Improves Hip Joint Contact Area and Contact Pressure

An In Vitro Analysis

Five fresh-frozen human cadaver hemi-pelvises were analyzed utilizing thin film piezoresistive load sensors (Tekscan) within the hip joint.

3 Testing conditions: Native intact labrum; anteriorsuperior labral resection; ITB autograft labral reconstruction.

Lee et al. AJSM 2014.

Contact Area after Labral Reconstruction

After labral resection, there was a statistically significant decrease in contact area at both 20° extension (73.2%±5.38, p<0.0005) and 60° flexion (78.5%±6.93, p<0.0026).

Following reconstruction of the labrum with ITB autograft, the contact area increased significantly from the resected state at both 20° extension (87.2%±12.3, 0.0269) and 60° flexion (90.5%±8.81, p<0.0027).

Contact Pressure after Labral Reconstruction

Contact pressures significantly increased following labral resection at both 20° extension (106.7±4.15, p<0.0181) and 60° flexion (103.9%±1.15, p<0.0039).

Contact pressures significantly decreased as compared to the resected state after ITB reconstruction at both 20° extension (98.5%±5.71, p<0.0109) and 60° flexion (96.6%±1.13, p<0.0010).
Role of the Acetabular Labrum and the Iliofemoral Ligament in Hip Stability

An In Vitro Biplane Fluoroscopy Study

Casey A. Myers, MD, Bradley C. Register, MD, Paul Lettsom, MD, Leonardo Episcopo, MD, W. Mike Parcellon, MD, J. Rob Gifford, MD, Robert F. LaPrade, MD, PhD, and Marc J. Philpott, MD
Investigation performed at the Biomechanics Research Department of the Steadman Philippon Research Institute, Vail, Colorado

Myers et al. AJSM 2011.

Vascular Safe Zones
Place leg in extension and abduction
Use fluoroscopy to localize lateral aspect of greater trochanter
Patients present with sudden pain in the back of the thigh
- Waterskiing
Physical Exam
- Swelling
- Ecchymosis
- Pain
- Weakness
Treatment
- Primary Repair of Proximal HS Tendon
Layer 4: Neuromechanical Layer

Structures: TLS Plexus, Lumbopelvic structures, LE structures

Purpose: Neuromuscular linking and functional control of the entire segment as it functions within its environment

Nerve compression syndromes
Pain syndromes
Neuromuscular dysfunction
Spine referral patterns

Blood Supply


4 Vessels to the hip capsule
- Superior gluteal a.
- Inferior gluteal a.
- MFCA
- LFCA
Blood Supply

- MFCA provides primary blood supply to femoral head in most cases.
- Inferior gluteal artery provides primary blood supply in some cases.

Kalhor et al. JBJS 2009.