Hamstring Injuries and Avulsions

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Hamstring Injuries: Objectives

- Mechanism and incidence of hamstring injuries
- Diagnostic work-up
- Treatment decision making
- Surgical Anatomy/Techniques
- Rehabilitation
- Treatment Outcomes
Hamstring Anatomy:

- Semimembranosus
- Semitendinososis
- Biceps Femoris
  - Long head
  - Short head
Epidemiology

- Hamstrings are the most commonly strained muscles in the body (two-joint muscle). Most common injury in professional soccer.
  - 25-30% of muscle strains (majority myotendinous)
- 12% of all hamstring injuries involve a tear or avulsion of the proximal hamstrings
  - 9% are complete avulsions

Most commonly associated with water-skiing, low energy falls, soccer, sprinters, gymnastics and martial arts
Risk Factors

• Age, higher body weight, hip flexor and hamstring flexibility, previous strain, and strength imbalances

• Typically occur early in season suggesting preventative interventions (Elliot AJSM 2011)

• EMG/Gait studies peak musculotendinous force occurs in terminal swing (hip flexion/knee extension)
Prevention Strategies:

- Prevention training techniques: Eccentric strengthening at high loads and longer tendon lengths may be beneficial but no randomized trials have confirmed true prevention strategy! (Petersen AJSM 2011)
Prevention Strategies: Eccentric Training – Nordic Curl
Low /Mid Grade Injuries

• Present with pain, spasm, and varying ecchymosis (indicates fascial injury)
• Typically injuries are myotendinous with local tenderness and knee flexion weakness
Low /Mid Grade Injuries: Imaging

MRI Grading (Peetrons)

Grade I – Fluid signal without macroscopic tear

Grade II – Partial tear

Grade III – Complete muscle or tendon rupture

Ekstrand, Br J Sports med 2012
Low /Mid Grade Injuries: Imaging

- MRI degree of myofascial involvement or perimuscular edema swelling predictive of length of recovery (NFL data)
  - < 50% 1-2 games
  - >75% 3-4 games
  - Fiber retraction/tear missed > 5 games
Low / Mid Grade Injuries: Fibrosis

Healing patterns
24-48 hrs - Clot formation
2-14 days - Connective tissue scar
2-8 weeks – Muscle fiber regeneration

Can we speed up the process?
Is excessive fibrosis a risk for re-injury?
Low /Mid Grade Injuries: Management

- Compression, protected weight bearing, modalities, and progressive mobilization
- Anecdotal reports of steroid and ‘PRP’ injections to speed recovery (Hamilton, CORR 2011)
- No single objective finding predictive of return to play
- Decadron/Losartan???
- Rettig, OJSM, 2013, NFL players
  - No evidence in faster recovery
- Ruerink, Br J Sports Med, 2012:
  - No evidence for specific treatment modalities
Low / Mid Grade Injuries: Injection Rx

2013 Dutch Trial (NEJM 2014): 108 pts
Double-blinded RCT
3 cc PRP v saline ultrasound guided injections
Identical rehab program

No difference in RTP time
No difference in re-injury
Low/Mid Grade Injuries: Fibrosis

Reurink AJSM 2015

108 patients, 96% occurred in biceps

38% of all patients with MRI fibrosis at RTP (ave. 28 days)

Re-injury (26 pts.) occurred independent of presence of fibrosis
Insertional Injuries:

- Tendon avulsions
  - Complete detachment
  - Partial thickness injuries
- Avulsion Injuries
  - Boney (adolescents)
    - Non-displaced
    - Displaced (>2 cm)
Hamstring Injuries: Boney Avulsions

- Non-operative
  - Minimal displacement
- Operative
  - Near skeletal maturity
  - Larger boney fragment
  - < 2 cm displacement with chronic pain/weakness
Hamstring Injuries:

• Chronic attritional partial tears
  – Endurance athletes
  – Typically present with 12-24 months of symptoms
  – Non-operative measures including PRP injections
  – Rare surgical repair of “partial rotator cuff tear”
Hamstring Injuries: Tendon Avulsion

- Single tendon
  - Conservative
- 2 tendon
  - Non displaced
  - Retracted
- 3 tendon
  - Minimal displacement (< 2cm)
  - Retracted
Hamstring Injuries: Acute Repair

Active healthy patients
Acute time frame (< 6 weeks)
Compliant individuals

Current Practice < 50% surgical
Chronic Injuries:

- Pain, weakness, gait dysfunction, spasm
- Deformity does not correlate with function
- Complete avulsion may have no symptoms with low level activity
- Some may return to high level function (Clarke, CORR 2011)
Proximal Hamstring Avulsion: Conservative Rx

- Hofmann et al: JBJS 2014
  - 19 pts, 10 functional testing
  - Mean age 59, mean f/u 2.5 yrs
  - LEFS scores 70/80
  - Hamstring strength 62% of contralateral side
  - 12/17 returned to recreational sports
Hamstring Injuries: Surgical Indications

- 2 tendon
  - Athletic patient
  - Retracted

- 3 tendon
  - Minimal displacement (< 2cm)
  - Retracted
Relevant Surgical Anatomy:
Relevant Surgical Anatomy:
Proximal Hamstring Repair:
Surgical Technique:

- Gluteal crease incision
- Avoid posterior femoral cutaneous nerves
- Identify lower border of gluteus max fascia
- Incise fascia to mobilize
- Palpate lateral ischial margin
Surgical Technique:

• Palpate or identify sciatic nerve
• Mobilize and control avulsed tendon
• Prepare lateral ischium
• Place 2-4 suture anchors
• Assess tension on the repair with hip and knee position
Surgical Technique:
Hamstring Injuries: Suture Pulley
Hamstring Injuries: Surgical Technique

- Assess suture tension with knee motion
Hamstring Injuries: Arthroscopic Technique for Partial Tears

- Prone position
- Easy to convert to open approach with poor visualization
- Find the sciatic nerve!!!
Hamstring Injuries: Arthroscopic Technique for Partial Tears

- Similar to hip abductor repair
- Gradual transition similar to shoulder arthroscopy cuff repair
Hamstring Injuries: Chronic Avulsions

- Goals less ambitious
- Extensile approach
- Sciatic nerve decompression
- More likely tension on repair site
- Occasional need for allograft tissue
Chronic Repair:
Post-operative: Repair Site Tension

- **Knee range of motion brace**
  - Limit extension to 30-45 degree
  - Increase extension 10 degrees per week

- **Hip brace**
  - Brace ROM settings -30° hyper extension to 45° flexion
  - Motions occur in 15° increments per week
Post-op Management:

• Week 0-6
  – Limited weight bearing
  – No active hamstring activity
  – Limit hip and knee motion based on repair tension
  – Allow active quadriceps and gastrocnemius muscle activity
  – DVT prophylaxis
  – Stool softeners
Post-op Management:

- **Week 6-12**
  - Resume full weight bearing
  - Restore full range of motion
  - Light hamstring concentric exercises
  - Hip/core stabilization
Post-op Management:

• **Week 12-18**
  - Aggressive concentric and begin eccentric resistance
  - Resume light jogging
  - Closed chain plyometrics
  - Wean into short light sprints
Post-op Management:

• Week 18-52
  – Resume sports specific
  – Aggressive plyometrics
  – Extended sprinting
Results:

Harris, International J Sports Med 2011

*Systematic review, 18 studies, 298 pts.*

*Operative better than non-op*

*Acute repairs better than chronic*

Birmingham, JBJS 2011 (HSS Series)

Chalal, AJSM 2012 (Rush Series)

Cohen, AOSSM 2012 (Jefferson/Pittsburg)
Results: Birmingham (HSS) AJSM 2011

23 patients: 9 acute, 14 chronic
21/23 pre-injury activity at 10 months
18/23 rated as excellent, 4/23 good
Endurance rated as 81-90% of normal
Results: Chalal (Rush) AJSM 2012

- 15 patients, 2-5 year f/u
- 13 MRI at final f/u, 100% healed
- All returned to pre-injury sports but 45% lower level of intensity
- Isokinetic strength 80% of contralateral normal (75-90%)
Results: Chalal, AJSM 2012

MRI Findings

- Post-operative MRI performed at a mean 36 months follow-up for 12/13 patients
- Hamstring muscle complex re-attached to ischial tuberosity in all cases

<table>
<thead>
<tr>
<th>Grade of Atrophy</th>
<th>Number of patients</th>
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<tbody>
<tr>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
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<tr>
<td>2</td>
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No statistically significant relationship between fatty atrophy and functional outcome scores
Results: Cohen (Pitt/Jefferson) AJSM 2012

- 52 patients, 38/52 were 3 tendon tears: questionnaire follow-up
- 3 yr average f/u, (1-6 years)
- 95% satisfied
- 60% returned to same level of sports/activity
- Patient estimated strength at 75% of normal
- Complications: 2 DVT, 1 sciatic palsy, 10% some neuritic pain and 48% some sitting difficulty
Surgical Outcomes

- Subbu et al. AJSM. 2015
  - 112 athletes comparing early, delayed and late intervention
  - 98% returned to sport
    - Early repair associated with good outcomes and quicker return to sport
    - Delayed repair associated with prolonged morbidity and increased complications
  - Complications
    - 5% superficial infections, 0 deep infections
    - 10% with residual sciatic/neural symptoms
## Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Incisional numbness</td>
<td>9%</td>
</tr>
<tr>
<td>Posterior thigh numbness</td>
<td>8%</td>
</tr>
<tr>
<td>Stiffness of operative leg</td>
<td>3%</td>
</tr>
<tr>
<td>Sciatica</td>
<td>1%</td>
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Re-operation: 3% (10 cases)

van der Made et al. AJSM. 2015

- 94 patients
- Acute: 85%
- Chronic: 15%
- Ultrasound to verify repair integrity
Pudendal Nerve:

- **Functional anatomy**
  - Exits great sciatic notch under piriformis
  - Passes anterior under sacrotuberous ligament
  - 20% motor, 50% sensory, 30% autonomic
  - 3 distal branches
    - Penis/clitoris branch
    - Perineal nerve
    - Inferior anal nerve
Hamstring Repair Complications:

- **Re-rupture** – 1%
  - (Collagen disorder at 3 years)
- **Deep Infection** – 5%
  - 3 pts (< 3 weeks)
  - 1 pt (> 3 weeks)
  - 1 pt (6 months)
- **Neurologic**
  - 0% sciatic
  - 4% PFCN
  - 3% pudendal nerve (transient 1-6 weeks)
- **DVT/PE**
  - 1 pt (1%)
Pudendal Nerve:

• Complication of fracture table traction
  – Up to 2% with IM nailing
  – 40% of hip scope nerve issues (1.4%)
  – Newer distraction devices have decreased incidence

• Nerve Injury
  – Pain
  – Sensory loss
  – Sitting discomfort
  – Sexual dysfunction
Anatomy of the Pudendal Nerve

The pudendal nerve is a sensory, autonomic, and motor nerve that carries signals to and from the genitals, anal area, and urethra. There are slight differences in the nerve branches for each person but typically there are three branches of the nerve on each side of the body: a rectal branch, a perineal branch and a clitoral/penile branch.

LEGEND (scroll down to see entire list)

Basic Pudendal Nerve Anatomy

Important Images
Female Pudendal Nerve
Male Pudendal Nerve
Comparison of Pudendal Nerve Drawings
Pudendal Nerve by Dr. Robert
Pudendal Nerve by Dr. Beco

The Pelvic Region
Body and Pelvic Region, Rear View
Pelvis and Ligaments, Rear View
Pelvis and Ligaments, Front View
Pelvis and Ligaments, Front View from Above
Pelvis and Ligaments, Cadaver, Front View
Pelvis and Ligaments, Vertical Cross Section
Pelvis Cross Section, Horizontal

The Pudendal Canal
Pudendal Canal Closeup
Male Perineum, Superficial Dissection
Pelvis and Perineum Frontal Section
Perineum with Pudendal Canal Probe
Pudendal Canal Probe Detail

Additional Images
Deep Dissection of the Gluteal Region
Schematic Anatomy of the Pudendal Nerve
Schematic Anatomy of the Pudendal Nerve in Greater Detail
Emotional Aspects of Dealing with PN and Chronic Pain

"Hope Springs Eternal" – Alexander Pope

Constant pain, no diagnosis, or treatment failure usually causes intense frustration, anger, denial, aggression, depression, anxiety and other emotions. This receipt of bad news is all part of a perfectly predictable and normal pattern. It is nothing to be ashamed of or feel guilty about. But if it's never happened to you before, you may not recognize the pattern for what it is, and become trapped in a downward spiral of inability to deal with your problems. This pattern causes the average person to begin thinking irrationally and behaving abnormally.

The pattern is called the Cycle of Acceptance, which is also sometimes referred to as the Cycle of Grief, or the Kübler-Ross grief cycle. Entering it is unavoidable upon receipt of bad news. How long it takes you to complete the cycle is critical. The longer you are in it, the less likely you will ever fully complete the cycle, the more likely you will be unable to manage your condition wisely, and the more likely you will be terribly unhappy.

BACKGROUND
For many years, people with terminal illnesses were an embarrassment for doctors. Someone who could not be cured was evidence of the doctors' fallibility, and as a result the doctors regularly shunned the dying with the excuse that there was nothing more that could be done (and that there was plenty of other demand on the doctors' time).

Elizabeth Kübler-Ross was a doctor in Switzerland who railed against this unkindness and spent a lot of time with dying people, both comforting and studying them. She wrote a book, which is now world famous, called 'On Death and Dying'...

In the ensuing years, it was noticed that this emotional cycle was not exclusive just to the terminally ill, but also other people who were affected by bad news, such as...
Pudendal Nerve:

- Anatomic study to identify safe margins
- 6 fresh frozen full-pelvic male specimens
- Average age 64 years
• **Sciatic nerve**
  - 1.1 cm lateral to hamstring origin (HO)

• **Pudendal Course**
  - Emerged 6.3 cm proximal to HO
  - Shortest distance was only 2.3 cm from medial aspect of HO
Safe Zone for Retractor Placement

- Pudendal nerve passes ~2-3 cm superomedial to hamstring footprint
- Sciatic and posterior femoral cutaneous nerves pass ~1 cm lateral to hamstring footprint
Discussion

• Excellent functional and radiological outcomes can be obtained with operative management of complete proximal hamstring ruptures

• Return to pre-operative activity level and intensity, as well as, recovery of hamstring strength is less predictable.

• There are differences in strength recovery between patients undergoing acute and chronic repair; however, no differences in functional outcomes were found
Thank You