

### The Influence of Pelvis Position on Hamstring Injuries: To Stretch or To Strengthen?



*NSATA Summer Education Conference  
June 9, 2017  
Jennifer Platt, DPT, ATC, PRC*

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### Clinical Questions

- With hamstring injuries being one of the most prevalent injuries in athletics, what should be considered to evaluate potential risk for hamstring strains or tears?
- To prevent hamstring injury (or reoccurrence) in athletics, should emphasis be placed on stretching or strengthening of this two joint muscle?

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### Objectives

- The attendee will recognize the importance in assessing pelvic position in athletes who have endured or are prone to hamstring strain injuries
- The attendee will be introduced to assessment tools to identify pelvic instability and position
- The attendee will understand the clinical importance of restoring optimal pelvic position in treatment and prevention of hamstring strain injuries.
- The attendee will be able to implement lumbo-pelvic repositioning techniques to restore optimal pelvic position and hamstring length.

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### Conflict of Interest

- While I am employed by the Postural Restoration Institute® as Director of Education and Credentialing, the purpose of this presentation is educational in nature, and not intended to promote a particular brand/product/technique, but to reflect the literature.

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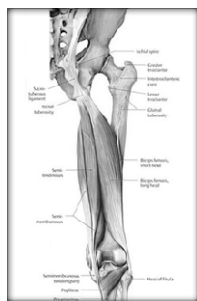
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### Anatomy Review

Hamstring muscle group consists of:

- Semitendinosus
- Semimembranosus
- Biceps Femoris (long and short head)



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### Attachment Sites

Semitendinosus

- **Ischial tuberosity**
- Pes anserinus (tibia)

Semimembranosus

- **Ischial tuberosity**
- Medial condyle of the tibia

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### Attachment Sites

Biceps Femoris (long head)

- **Ischial tuberosity**
- Lateral side of the head of the fibula and lateral condyle of the tibia

Biceps Femoris (short head)

- Linea aspera of the femur
- Lateral side of the head of the fibula and lateral condyle of the tibia

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### Review of the Literature

- Many studies have focused on stretching of the hamstrings to improve straight-leg raise measurements (Bohannon 1982, Bohannon 1985, Boone 1979, Gajdosik 1990, Gajdosik 1983, Gajdosik 1985, Gajdosik 1993, Lopez-Minarro 2012)
- The long head of the biceps femoris is the most commonly injured (Woods 2004, Battermann 2011)

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### Review of the Literature

- The late phase of swing (terminal swing) is the most common phase of running when hamstring strains occur (Thelen 2006, Chumanov 2007, Chumanov 2012, Heiderscheit 2010, Daly 2015)
- Hamstring injuries are also common with kicking motions that involve hip flexion combined with knee extension (Heiderscheit 2010)

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### Review of the Literature

- Hamstring muscle length can be measured many different ways, however rarely is the position of the pelvis taken into account.
- Congdon, et al (2005) and Herrington (2013) both concluded that the position of the pelvis has a great influence on hamstring muscle length

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### Mechanism of Injury

- “The occurrence of hamstring strain injuries during high-speed running is generally believed to occur during terminal swing phase of the gait cycle. During the second half of swing, the hamstrings are active, lengthening and absorbing energy from the decelerating limb in preparation for foot contact.”

Heiderscheit BC, et al. *Hamstring strain injuries: Recommendations for diagnosis, rehabilitation, and injury prevention.* JOSPT. 2010; 40(2): 67-76.

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### Mechanism of Injury

- “During this phase (late phase of swing), the muscle is rapidly increasing in length while performing a high level of eccentric work in order to decelerate the shank for foot strike.”

Daly C, Persson M, et al. *The biomechanics of running in athletes with previous hamstring injury: A case control study.* Scand J Med Sci Sports. Published online Apr 27, 2015.

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THEREFORE.....

With deceleration during terminal swing phase of gait being one of the most common mechanisms of injury for hamstrings, we need to remember that the hamstrings are not only needed to decelerate the forward movement of the leg, but also because of its attachment to the ischial tuberosity, they are trying to stabilize the pelvis in preparation for initial foot contact (heel strike).

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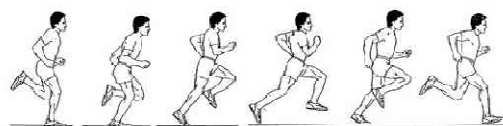
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### Gait/Running Cycle



<http://www.oandplibrary.org>

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### Review of the Literature

“Clinical cases that we have observed indicate that an anterior tilt of the innominate bones could stretch the hamstring muscles and shorten the rectus femoris muscle. The hamstring muscles that are stretched could then be predisposed to injury.”

Cibulka MT et al. *Changes in innominate tilt after manipulation of sacroiliac joint in patients with low back pain: An experimental study.* Phys Ther. 1988; 68:1359-1363.

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### Review of the Literature

“Suggested modifiable risk factors include hamstring weakness, fatigue, and lack of flexibility, with a strength imbalance between the hamstrings (eccentric) and quadriceps (concentric) being most supported by evidence. In addition, limited quadriceps flexibility and strength and coordination deficits of the pelvic and trunk muscles may contribute to hamstring injury risk.”

Heiderscheit BC, et al. *Hamstring strain injuries: Recommendations for diagnosis, rehabilitation, and injury prevention.* JOSPT. 2010; 40(2): 67-76.

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### Review of the Literature

“The pelvis is a key area for load transfer between the lower extremity and the spine and a stable “platform” is essential for optimal function of the lower extremity. Non-optimal strategies for load transfer and movement can result in poor control of the joints of the pelvis and consequently an “unstable” or poorly controlled platform. This can result in apparent weakness and loss of power in one or both lower extremities during multiple tasks. For the athlete involved in sports requiring running, this is particularly evident during hip extension task.”

Lee D, Lee LJ. *The role of the pelvis in hamstring injuries & posterior thigh pain.* <http://physicaltherapyweb.com/role-pelvis-hamstring-injuries-posterior-thigh-pain/> Article originally published in In Touch, Summer 2009, No. 127.

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### Review of the Literature

“In conclusion, significant electromyographic and kinematic differences were identified during running in athletes with previous hamstring injury. Significant late swing phase asymmetries in sagittal plane pelvic and hip movement were detected on the injured limb, likely placing the hamstring complex at increased length during this crucial phase of running gait.”

Daly C, Persson M, et al. *The biomechanics of running in athletes with previous hamstring injury: A case control study.* Scand J Med Sci Sports. Published online Apr 27, 2015.

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### Review of the Literature

- This recent study also found that transverse plane asymmetry at the knee joint was detected during terminal swing and early stance phase of running in the previously injured group

Daly C, Persson M, et al. *The biomechanics of running in athletes with previous hamstring injury: A case control study.* Scand J Med Sci Sports. Published online Apr 27, 2015.

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### Review of the Literature

“The combined movement asymmetries of increased anterior tilt, increased hip flexion, and increased medial knee rotation on the injured side are likely to place the long head of the BF under increased strain to a greater extent than the medial hamstrings.”

Daly C, Persson M, et al. *The biomechanics of running in athletes with previous hamstring injury: A case control study.* Scand J Med Sci Sports. Published online Apr 27, 2015.

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### Mechanism of Injury

- “Hamstring injuries that occur during activities such as dancing or kicking can occur during either slow or fast movements that involve simultaneous hip flexion and knee extension.”

Heiderscheit BC, et al. *Hamstring strain injuries: Recommendations for diagnosis, rehabilitation, and injury prevention.* JOSPT. 2010; 40(2): 67-76.

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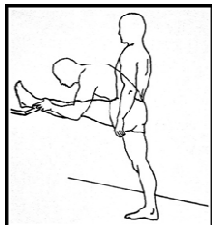
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### Food for thought...

Therefore, consider the influence that a forwardly rotated (anterior tilt) hemi-pelvis will have on the hamstrings during hip flexion and knee extension.....



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### Pelvic Position and it's Influence on Hamstring Length

- "During hamstring stretching, with the pelvis maintained in an anterior pelvic tilt position, we postulate that the ischial tuberosity (hamstring origin) is displaced superiorly and posteriorly to a position farther from the proximal tibia and fibular hamstring insertions. Thus, greater tension would occur within the hamstring musculotendinous structure."

Sullivan MK et al. Effect of pelvic position and stretching method on hamstring muscle flexibility. *Medicine and Science in Sports and Exercise*. 1992: 1383-1389.

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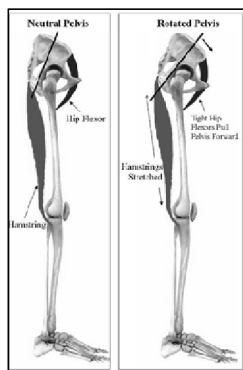
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<http://movement-as-medicine.com/training-to-prevent-hamstring-injury/>

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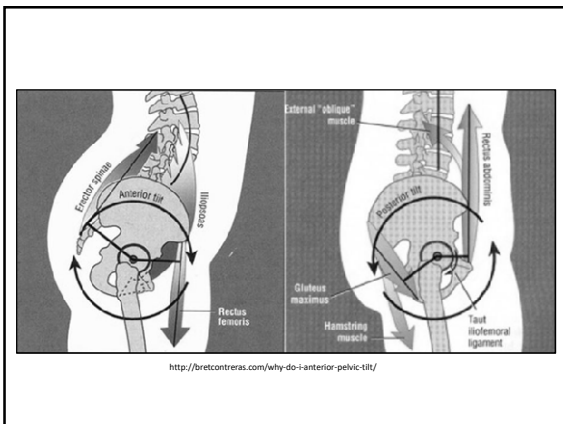
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### Dynamic Motion of the Pelvis

“Loss of motion control of the lumbopelvic-hip complex is a common finding in patients/athletes presenting with single or recurrent hamstring injuries and/or posterior thigh pain.”

Lee D, Lee LJ. *The role of the pelvis in hamstring injuries & posterior thigh pain.*  
<http://physicaltherapyweb.com/role-pelvis-hamstring-injuries-posterior-thigh-pain/>  
Article originally published in In Touch, Summer 2009, No. 127.

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Often times, athletes will present with unilateral or bilateral **lumbopelvic dysfunction**, which places increased strain across the muscles of the lumbopelvic complex, including the hamstrings in attempt to control sagittal plane stability of the pelvis, hip and knee.

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When running, the pelvis should be alternating and reciprocal in nature. Often times, you will have athletes who are “stuck” in an anterior pelvic tilt position, and are unable to move alternating and reciprocally throughout the different phases of the gait (running) cycle.

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Sacral Motion Through the Gait Cycle

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## The Role of the Adductor Magnus

- The adductor magnus is located in close proximity to the semimembranosus tendon at the ischial tuberosity, functions like a “mini hamstring”.

Broski SM, Murthy NS, et al. *The adductor magnus “mini hamstring”: MRI appearance and potential pitfalls.* Skeletal Radiol. 2016;45:213-219.

Obey, MT, Broski SM, et al. *Anatomy of the adductor magnus origin: Implications for proximal hamstring injuries.* The Orthopaedic Journal of Sports Medicine. 2016;4(1). Accessed online January 2016 ahead of publishing.

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### Methods to Assess Hamstring “Length”

- \*Straight Leg Raise (SLR) – active or passive
- Active Knee Extension (AKE)
- Standing Reach Test
- Sit and Reach Test

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### Straight Leg Raise



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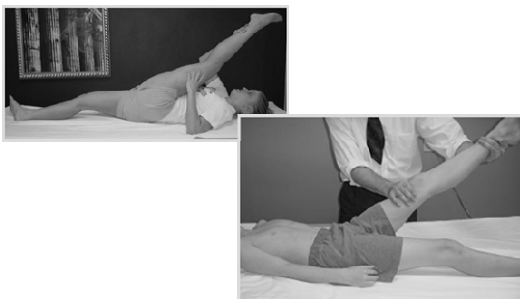
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### So, what does this tell me?



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### How do they “Appear”?

Tight? Loose? Short? Stretched? Lengthened?

\*Assessing hamstring “length” alone with these aforementioned tests is difficult without also assessing pelvic position, stability, and motion.

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### Methods to Assess Pelvic Position, Stability, Motion

- Palpation (ASIS and PSIS)
  - Often assessed in various positions (standing, seated or prone)
- Prone Knee Bend (Diane Lee)
- Leg Length
- Measuring devices such as inclinometer, caliper, Spinalmouse, etc.
- \*Adduction Drop Test (PRI) – sometimes referred to as a modified Ober’s test
- \*Extension Drop Test (PRI) – sometimes referred to as a modified Thomas test
- Pelvic Tilt Test (TPI)
- 3D kinematic motion software programs

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### Adduction Drop Test

The patient lies on his or her side with the lower leg and hip flexed (90 degrees). Stand behind the patient and passively flex, abduct and extend the hip to neutral while maintaining 90 degrees of knee flexion. Passively stabilize the pelvis from falling backward and allowing femoral internal rotation to occur. Make sure the top innominate is positioned directly over the bottom innominate so the frontal plane starting position does not give any false positives (top innominate too cephalad) or false negatives (top innominate too caudal).

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### Adduction Drop Test

A positive test is indicated by a restriction from the anterior-inferior acetabular labral rim, transverse ligament, and piriformis muscle or impact of the posterior inferior femoral neck on posterior inferior rim of acetabulum that does not allow the femur to adduct; possibly secondary to an anteriorly rotated, forward hemipelvis.

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### Adduction Drop Test



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### Adduction Drop Test

Video of this test is available at <https://www.youtube.com/watch?v=Ui1o4AtMvao>

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### An Anatomic Investigation of the Ober Test

- "No significant changes in thigh position (adduction) occurred in either version of the Ober test after ITB transection."

Willett GM, Keim SA, et al. *An anatomic investigation of the ober test.* Am J Sports Med. Published online January 11, 2016.

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### Extension Drop Test

The patient is positioned in supine with both thighs on the table. Both hips and knees are flexed to the chest. Passively lower one leg over the edge of the table while helping the patient hold the untested knee close enough to the chest to maintain the low back against the table. Do not allow hip abduction to occur past zero degrees on the tested extremity while passively dropping the FA joint into extension.

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### Extension Drop Test

A positive test is indicated when the tested lower extremity (usually the left) is restricted in hip extension because of the forward orientation of the tested side compared to the other. If both femurs do not approach the edge of the mat or table the patient is tested on, both innominates are rotated forward.

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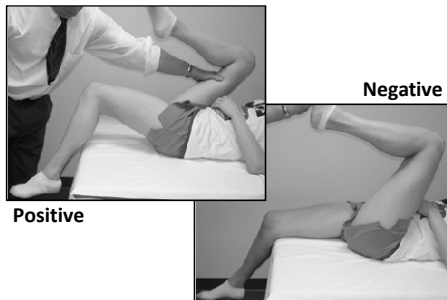
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### Extension Drop Test



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### Asymmetrical Postural Patterns

The Postural Restoration Institute® (PRI) influenced my earliest work (as a graduate assistant athletic trainer), where I first began noticing the prevalence of asymmetrical patterns with the athletes I was working with. I strongly believe that lumbopelvic dysfunction contributed to many of the injuries in the athletes I worked with early in my career, and continues to be of high prevalence today.

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### Asymmetrical Postural Patterns

Two common patterns of the lower quarter taught by the Postural Restoration Institute® are the Left Anterior Interior Chain (AIC) and the Posterior Exterior Chain (PEC).

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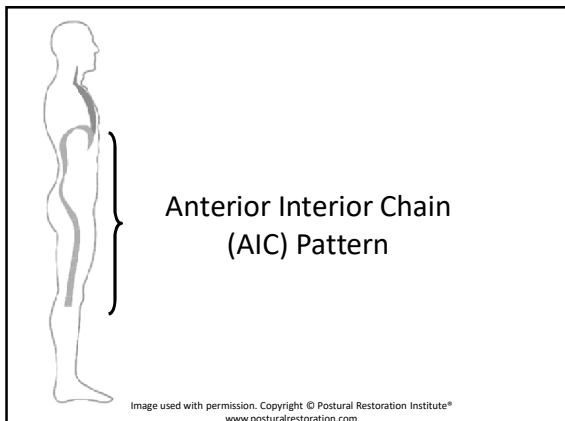
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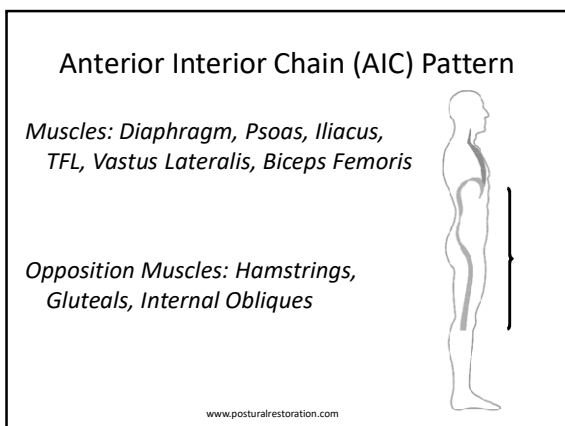
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- There are 2 anterior interior polyarticular muscular chains that have a significant influence on respiration, rotation of the trunk, rib cage, spine and lower extremities
  - Composed of muscles that attach to the costal cartilage and bone of rib 7-12 to the lateral patella, head of the fibula and lateral condyle of the tibia
  - One is on the left side of the interior thoraco-abdominal-pelvic cavity and one is on the right
  - Muscles include the diaphragm and the psoas
  - This chain provides the support and anchor for abdominal counter force, trunk rotation and flexion movement
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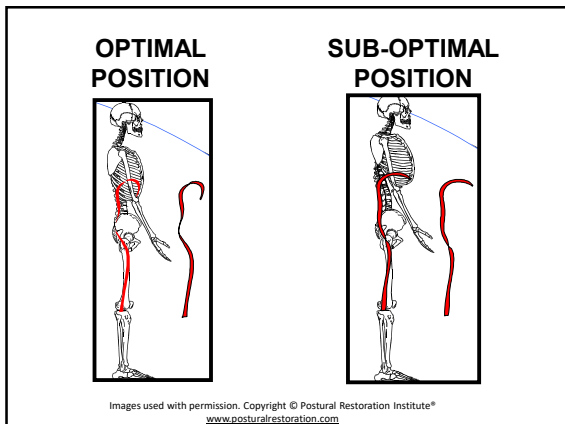
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### Left AIC Pattern

- The left pelvis is anteriorly tipped and forwardly rotated.
- The left hamstrings are lengthened due to the superior and posterior displacement of the ischial tuberosity
- The left hip flexors are short/tight

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### Posterior View of an Anterior & Forward Positioned Left Innominate with Accompanying Right Sacral Torsion

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What does the Left AIC pattern look like?



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Posterior Exterior Chain (PEC) Pattern  
(Bilateral Left AIC pattern)



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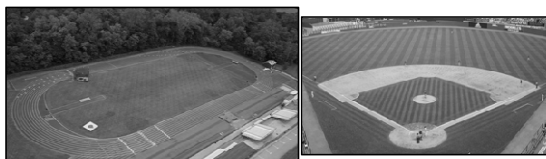
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We are all asymmetrical, but how do we manage our asymmetries? And, how do we manage asymmetrical training in sports?



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### Anterior Pelvic Tilt Position

- If an athlete is stuck in an anterior pelvic tilt position unilaterally or bilaterally, the hamstrings (especially the biceps femoris) are positioned in an already lengthened state. Add in the hip flexion/knee extension position in the terminal swing phase of gait or kicking motion, and you are over-stretching the already lengthened hamstrings which could pre-dispose them to hamstring strain if they are unable to initiate posterior pelvis rotation

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If I determine an anterior pelvic tilt position of the pelvis, would I rather see....



**OR**



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I would expect and hope to see...



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If I see this, I start to get concerned that the hamstrings are overstretched, and at an even higher risk for strain...



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Therefore, we must consider....if an athlete presents with an anterior pelvic tilt position unilaterally or bilaterally, should we be stretching an already lengthened hamstring muscle group?

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- Both of these postural patterns (AIC and PEC) will contribute to a lengthened state of the hamstring muscle group as a result of anterior pelvic rotation unilaterally or bilaterally, and the hamstrings should be facilitated (strengthened) with neuromuscular retraining activities to assist in inhibiting these patterns and restore pelvic position, followed by dynamic muscle retraining activities to allow alternating and reciprocal lumbo-pelvic motion to occur with ADL's and sport activities.

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Prior to stretching the hamstrings consider....

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How FACILITATION of the hamstring muscle group can assist in....

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- Repositioning the pelvis (posterior rotation of the pelvis)
- Decreasing the “over-stretched yet tight” sensation/appearance in the hamstring
- Inhibiting overactive muscles including back extensors and hip flexors
- Allowing more reciprocal and alternating pelvic motion

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What other muscles/muscle groups could be facilitated to help the hamstrings control the lumbo-pelvic complex?

- Diaphragm
- Oblique Abdominals
- Glutes

Without these muscles, there is increased eccentric demand placed on the hamstrings (especially the biceps femoris) to stabilize the pelvis in the terminal swing phase of the gait cycle..

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What muscles should we consider inhibiting?

- Hip flexors
- Quadriceps
- Back extensors
- Calves

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What pelvis position is best?

Anterior Rotation?  
Posterior Rotation?  
Neutral?

NONE of these are an ideal position, because we do not perform statically, but rather gait and athletic performance must be a dynamic process therefore you must be able to move into each pelvic position effectively. It's when you become stuck in a static pelvic position, that it becomes problematic.

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### Lab Session

#### Assessment Tests:

- Adduction Drop Test
- Extension Drop Test
- Straight Leg Raise

#### Pelvic Repositioning Techniques:

- 90-90 Supported Hip Lift with Hemibridge
- Right Sidelying Respiratory Left Adductor Pull Back

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### Additional Clinical Considerations



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### Additional Clinical Considerations



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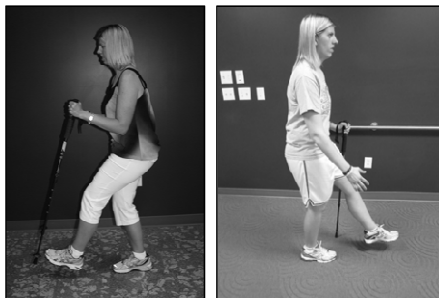
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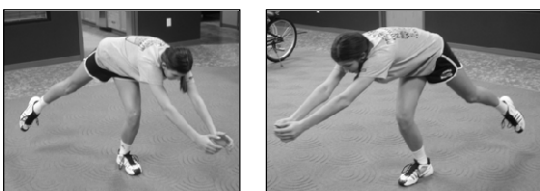
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### Additional Clinical Considerations



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### In conclusion....

The hamstring muscle group, as a two joint muscle has just as much (if not more) importance on pelvis stability as it does on the knee. Hopefully this presentation has you thinking outside the box a bit with future hamstring strain prevention and rehabilitation programs.

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**THANK YOU!!  
QUESTIONS?**

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