THE CORRELATION BETWEEN HAMSTRING TIGHTNESS AND LOW BACK PAIN IN SEATED WORKERS

Ahmed Radwan, PT, DPT, Ph.D., Thomas A. Crist, Ph.D.

Abstract

Sitting is now the most common posture in the American workplace. Seated workers are at especially high risk for Low Back Pain (LBP). Potential correlations between muscle impairments and LBP have not been well documented and may lead to more effective prevention strategies to reduce LBP in seated workers. In this presentation, the anatomical relationships between the hamstring muscles, pelvis, and spine will be reviewed and the association between hamstring tightness and sacroiliac/lumbar spine pathology will be described. The results of a published study that confirms this clinical association will be shared during this presentation. Upon examining hamstring flexibility among 72 office workers with a history of mechanical LBP, we found that all participants had abnormal hamstring tightness and that the extent of their disability scores as measured by the Oswestry Disability Index were significantly and positively correlated with the degree of their hamstring tightness. These results confirm the importance of maintaining hamstring flexibility in seated workers to decrease the incidence of LBP and its pathomechanical consequences. Effective strategies to maintain hamstring flexibility in seated workers utilizing the creep phenomenon of the body’s soft tissues should be implemented in ergonomics programs that targets management of lower back discomfort.

Key words: Hamstring tightness, Low back pain, Creep phenomenon

Introduction

Low back pain (LBP) is the second leading cause of missed work in United States (Hall, 2007) and almost 50% of working individuals experience back pain annually (Patel & Ogle, 2000). Although LBP has many causative reasons, a correlation has been found between hamstrings flexibility and LBP (Halbertsma, Goeken, Hof, Groothoff & Eisma, 2001; Kennedy, Kassab, Gilkey, Linnel & Morris, 2008; Radwan et al., 2014; Rodriguez et al., 2008). However, the exact contribution of hamstring tightness (as a primary cause) to LBP is still unclear and is difficult to determine due to the multifactorial breadth of the problem.

In this article, the authors will explain hamstring muscle anatomy and the possible pathophysiologival issues related to hamstring tightness. The extent of correlation between such tightness and frequency of LBP will be emphasized as well. Finally, appropriate methods of stretching the hamstring muscles in seated workers will be demonstrated.

Anatomy

The hamstrings are a group of three long muscles that run along the posterior surface of each thigh (Figure 1). From medial to lateral, they are the semimembranous, semitendinosus, and the biceps femoris (which includes a long and a short tendon). Proximally, the three hamstrings attach via one tendon to the ischial tuberosity of the innominate deep to the gluteus maximus muscle. The three long hamstring tendons then emerge from beneath the lower border of the gluteal maximus and attach distally below the knee to the medial surface of the proximal tibia (semimembranosus and semitendinosus) and the lateral side of the head of the fibula (biceps femoris). One part of one of the medial thigh muscles, the adductor magnus, also originates from the ischial tuberosity and is often considered to be part of the hamstrings group.
Previous studies describe the proximal attachments of the hamstrings to the ischial tuberosities of the innominates but often overlook the important continuities of the muscle fibers with the ligamentous and fascial tissues that span the gluteal region, lower back, and the diaphragm and psoas major muscles anteriorly.

In addition to the group of sacroiliac ligaments, the two sacrotuberous ligaments anchor the sacrum to the innominates. These two ligaments lie immediately superficial to the dorsal sacroiliac ligaments (laterally) and the interosseous sacroiliac ligaments (medially). Each sacrotuberous ligament fans out as it moves superiorly and attaches to the lower lateral corner of the sacrum, the coccyx, and the posterior margin of the iliac crest along the base of the auricular surface (sacroiliac joint surface) up to the posterior superior iliac spine. These attachments allow the sacrotuberous ligaments to work with the sacrospinous ligaments to resist anterior displacement of the sacrum relative to the innominates when the weight of the thorax is placed on its base.

The upper fibers of the sacrotuberous ligaments connect with the lumbodorsal fascia that is attached to the erector spinae muscles and the deeper multifidus muscles located in the lower back. The fibers of the hamstring muscles that attach to the ischial tuberosity, particularly the biceps femoris, are continuous with the sacrotuberous ligament and thereby indirectly connect to the lower back structures. The hamstrings also are indirectly connected to the diaphragm and the two psoas major muscles. The diaphragm extends across the inferior aperture of the thorax and is responsible for breathing. The two psoas major muscles are the chief flexors of the hips. These are the key relationships through which tight hamstrings are implicated in low back pain.

Mechanics of the hamstring muscles

Together, each set of hamstring muscles cross and consequently move two joints – the hip and the knee. The semimembranosus and semitendinosus extend the hip when the trunk is fixed and also flex and medially rotate the leg when the knee is bent. The long head of the biceps femoris extends the hip at the beginning of each step and both heads of this muscle work together to flex the knee and laterally rotate the leg when the knee is bent.

In the normal standing position, the vertebrae of the lower back naturally form an anterior curve (called lordosis), the sacrum curves posteriorly, and the pelvis tilts anteriorly at the sacroiliac joints. Biomechanical research indicates that lumbar lordosis when sitting is 50% less on average than while standing (Long et al. 1997). When sitting down, the curve in the lower back flattens out and the pelvis tilts posteriorly as the femora move superoanteriorly. In an MRI examination of spinal curvature when seated in three different positions, Baumgartner et al. (2012) found that all of the vertebrae from T10 to S1 were involved in positional changes and that the range of motion was greatest in the lower lumbar vertebrae. As described by Tenney et al. (2013:9), the hamstrings and abdominal muscles inhibit the spinal erector muscles “via a posterior pelvic tilt/hip extension, a decrease in lumbar extension, and an increase in lumbar flexion.” Through their direct and indirect connections, then, tight hamstrings can exacerbate lumbar flattening when seated by pulling the pelvis and lumbar
vertebrae downward and forward, causing low back pain.

**Pathomechanics**

Sound relationships between the pelvis and the lumbar spine are needed to allow proper function of these two regions and to enable individuals to maximize human performance while minimizing energy expenditure (Neumann, 2010). Bending forward involves lumbar spine flexion and is accompanied by anterior tilting of the pelvis. In order for the pelvis to participate appropriately, individuals need flexible hamstrings that are long enough to permit such anterior tilt and healthy sacroiliac joints that will not interfere with the anterior pelvis movement. Figure 3 exemplifies the relationships between the lumbar spine and pelvis.

Tight hamstrings may not actively tilt the pelvis posteriorly, but might interfere with its anterior tilting. This will overload the lumbar spine and impose unnecessary stresses, possibly predisposing individuals to mechanical low back pain. Currently, to our knowledge, there is not sufficient published evidence to support this hypothesis. A well-designed study that tracks pelvic movements, degrees of freedom, and the effects of hamstring tightness and flexibility is highly needed.

![Figure 3: Figure representing normal lumbar-pelvic relationships that include anterior tilting of the pelvis accompanied by lumbar flexion (A); stiff pelvis secondary to tight hamstrings (B); and stiff lumbar spine (C).](image)

**How hamstring tightness may affect low back pain:**

Radwan et al. (2014) performed an exploratory study to evaluate the relationship between hamstring tightness and LBP. The authors examined hamstring flexibility in 72 participants that spent more than eight hours per day seated and had experienced at least one episode of mechanical LBP prior to data collection. Hamstring flexibility was measured in the 90-90 position as recommended in the literature. Normally in that test an individual with flexible hamstrings should score in the range between 160-180 degrees of knee extension (20-0 degrees of full extension) if the ankle is dorsiflexed and as close to zero as possible if the ankle is plantarflexed. All participants in the study scored less than that with a mean of 150-153 degrees despite the fact that they all had their ankles in plantarflexion. The results demonstrate evident tightness in their hamstring muscles. Additionally, participants presented significant intra-subject differences in hamstring flexibility. All dominant lower extremities were significantly more flexible than the non-dominant sides. The mean difference was two degrees.

Of most interest was that the authors identified a significant and positive correlation between the extent of hamstring tightness and the extent of LBP and dysfunction felt by the patients and reported using Oswestry Disability Index. Considering how hamstring tightness may interfere with normal lumbar pelvic rhythm, we will be able to establish a meaningful sense of how hamstring tightness predisposes to mechanical LBP. Even the two degrees of intra-subject differences in hamstring flexibility between the dominant and non-dominant sides still can have a great effect on ilio-sacral movement and impose unequal stresses on the hypomobile sacroiliac joint. Sacroiliac pain is a main contributor to the cause of patients who report LBP (Cher, Polly & Berven, 2014).

Similarly, Halbertsma et al. (2001) confirmed the presence of hamstring tightness in patients with non-specific LBP when assessed during passive straight leg raising tests. Those patients had almost 25 degrees deficiency towards full extension of the knee and 90 degrees flexion of the hip. The deficiency in flexibility was significantly higher than healthy participants in the control group.

**Effective strategies to stretch tight hamstrings:**

Creeping phenomenon is identified as the increase in the strain of tissue over time while applying constant stress (Duenwald, Vanderby & Lakes, 2009; Figure 4). At some point this strain plateaus due to some sort of stress relaxation. Creeping phenomenon is currently being used in human research to correct deformities like club foot through applying constant stretching stress and some serial casting and in operating a prosthesis to correct mal-alignment of teeth by applying prolonged stress.

Researchers also have proven that stretching tight muscles is more efficient if performed in a
sustained way than interrupted. Sustained stretching applied for 30-60 seconds on the hamstring muscles is sufficient to produce permanent change in length. Three to five sustained stretches (30-60 seconds each) per session is recommended over the course of treatment to provide the needed overall change in length (Lim, Nam, & Jung, 2014).

Figure 4: Creeping behaviors of biological tissues.

In order to effectively apply stretching to the hamstring muscles, one should attempt to lengthen both origin and insertion of the muscle through applying and emphasizing anterior tilting of the pelvis and knee flexion, respectively. For a seated worker, this is something that can be performed at the edge of his or her chair as shown in Figure 3. Leaning forward of the trunk while in the previously described position will impose the needed stress that, if applied for sustained periods of time, will provide the needed permanent change in muscle length.

This position could be performed easily by seated workers and does not need a lot of space or time to apply. As depicted in Figure 3, the subject is stretching the right hamstring by leaning forward while maintaining anterior pelvic tilt and knee extension for a continuous 30 seconds.

Figure 5: Effective method for a seated worker to stretch or maintain the flexibility of tight hamstrings.

Conclusion

Tight hamstrings have been previously linked with mechanical LBP in seated workers. Regularly stretching the hamstring muscles to regain or maintain flexibility can prevent many postural alterations and directly/indirectly guard against development of LBP. Appropriate stretching for the hamstrings can be performed while sitting at the edge of a chair and for as little as 30 continuous seconds. This is something that should be incorporated (as part of routine exercises) into ergonomics programs to minimize physical stresses on seated workers.

References


**Biographical Sketch**

Dr. Ahmed Radwan, PT, DPT, PhD, is an Assistant Professor in the Physical Therapy Program at Utica College in upstate New York. His teaching, research and clinical expertise include biomechanics, ergonomics, and rehabilitation of musculoskeletal pathologies. Dr. Radwan can be reached at aradwan@utica.edu.

Dr. Thomas A. Crist, PhD is a Professor in Utica College’s Physical Therapy Program. An anatomist and biological anthropologist, his primary expertise is in human skeletal biology and paleopathology. Dr. Crist’s email address is tcrist@utica.edu.