The Conservative Management of Hamstring Strains

by Thomas C. Michaud, DC

Published June 16, 2012 by Dynamic Chiropractic Magazine

Of all the gait-related muscle injuries, hamstring strains have the highest rate of recurrence, with as many as one third of injured athletes suffering reinjury within the first few weeks following return to sport (1). Because their stride lengths may exceed 3.5 meters, sprinters are especially vulnerable to this injury, and it can take up to 4 months of aggressive rehabilitative exercises before return to sport is possible (2).

The hamstrings are comprised of 4 separate muscles: semitendinosus, semimembranosus, and the long and short heads of the bicep femoris muscle. Semitendinosus and semimembranosus originate from the medial aspect of the ischial tuberosity, while the long head of the bicep femoris originates from the lateral ischial tuberosity and the sacrotuberous ligament (Fig. 1). The short head of the bicep femoris originates from the lateral intermuscular septum and the distal one third of the lateral femoral cortex. Distally, the semitendinosus attaches to the medial tibia on the lower portion of the pes anserine muscle group, where it is thought to play a role in assisting gastrocnemius with knee flexion during propulsion. The semimembranosus is a much more complicated muscle, as it possesses 5 separate attachments that allow it to play an important role in decelerating anterior tibial translation and valgus collapse of the knee during stance phase. Because it has a direct attachment to the posterior horn of the medial meniscus, the semimembranosus muscle protects the meniscus by displacing it posteriorly upon knee flexion.

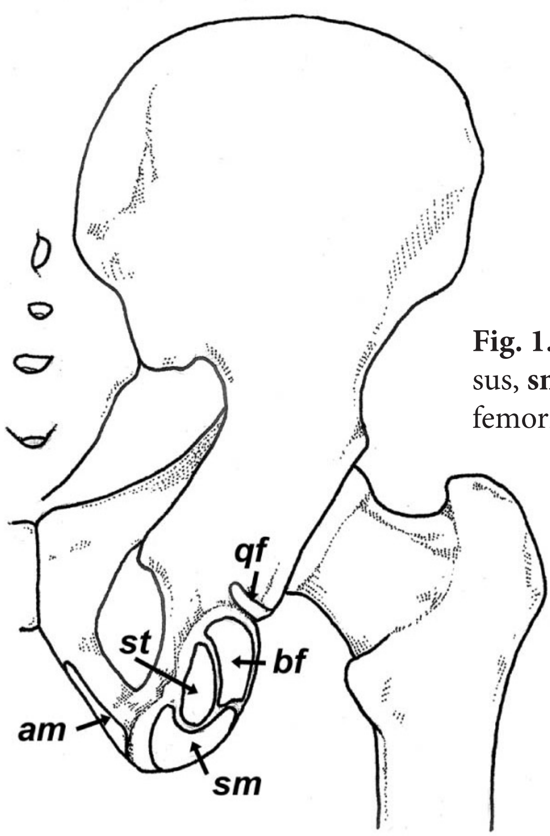

Fig. 1. Muscle attachments: bf=bicep femoris; **st**=semitendinosus, **sm**=semimembranosus, **am**=adductor magnus, **qf**=quadratus femoris.

While the semimembranosus and semitendinosus are important stance phase stabilizers, the long and short heads of the bicep femoris muscle, owing to their more distal attachment on the proximal fibula, are important decelerators of forward motion of the swing phase leg (Fig. 2). The long head of the bicep femoris also plays an important role in stabilizing the sacroiliac joint, and in lessening bony/soft tissue vibrations during contact.

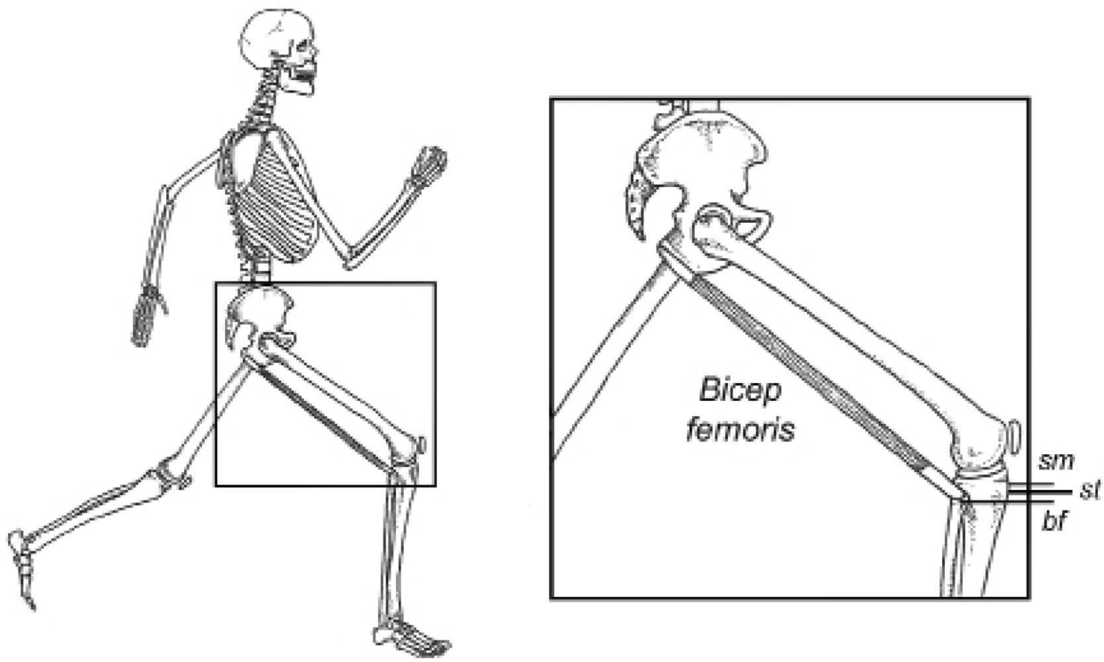

Fig. 2. Because the distal bicep femoris has a lower point of attachment than the semitendinosus (**st**) and semimembranosus (**sm**), forward motion of the leg during swing phase creates a greater tensile strain in the bicep femoris muscle. Modified and redrawn from Thelen et al. (14). The increased tension allows the bicep femoris to stabilize the sacroiliac joint during early stance phase.

Given their dissimilar functions, the various hamstring muscles are injured through different biomechanical mechanisms. Semimembranosus is more likely to be strained with activities that stretch the hamstrings through extreme ranges of motion, with the classic mechanism being a full front or side split. This injury is more likely to occur in sports like ballet, gymnastics, cheerleading and even yoga, where a slow forward or side split may overstretch and tear the medial hamstrings. Stretch injury can also occur with a fast motion, such as the rapid high kicks associated with various martial arts. As demonstrated by Askling et al. (3), stretch injuries frequently injure multiple muscles at the same time. In fact, in their detailed MRI study of 30 stretch related hamstring injuries in athletes from 21 different sports, Askling et al. (3) noted the semimembranosus muscle was injured in 83% of subjects, while the quadratus femoris, semitendinosus, bicep femoris long head, and adductor magnus muscles were also injured but at a much lower frequency. The authors correlate the severity of hamstring injury and subsequent rehabilitation time directly to the proximity of injury to the ischial tuberosity: the more proximal the injury, the more difficult it is to treat. The severity of these injuries is underscored by the fact that 47% of the injured athletes were unable to resume their sports career.

Unlike the more extensive stretch related medial hamstring injuries, runners tend to strain primarily the long head of the bicep femoris muscle. Because it possesses a longer lever arm for decelerating knee extension, this muscle is usually injured just prior to heel strike, when excessive tensile strain present in the long head results in failure of the proximal muscle tendon junction. The bicep femoris muscle is typically injured when switching from the eccentric contraction present during midswing, to the nearly isometric contraction present during late swing, when the tendons of the long head of the bicep femoris muscle are stretching in order to store and return energy. Since running related bicep femoris injuries tend to occur at the proximal muscle tendon junction, the recovery time for this injury is faster than the stretch related semimembranosus injuries, which are more likely to damage the tendon itself. A bicep femoris injury can be identified by palpating the muscle-tendon junction slightly distal to the lateral ischial tuberosity, and by having the patient gently isometrically tense the muscle. There are several modifiable and nonmodifiable risk factors responsible for bicep femoris injuries. As listed by Brooks et al. (4), nonmodifiable risk factors include previous hamstring injury, older age, and black or aboriginal ethnicity; while modifiable risk factors include quadriceps/hamstring strength imbalance, inadequate warm-up, muscle stiffness, poor lumbopelvic strength/stability, and the presence of a hyperlordotic lumbar spine with an anteriorly tilted pelvis. The latter postural factors may result in hamstring injury because a tilted pelvis shifts the ischial tuberosity superiorly, increasing tensile strain in the hamstring origin.

Fig. 3. **Stretch for the long head of the bicep femoris.** While maintaining a slight lordosis in the lumbar spine, the patient leans forward by pivoting at the hips while the lower extremity is slightly adducted and internally rotated with the knee slightly flexed.

As with most injuries, the single best predictor of future injury is prior injury, which may increase muscle stiffness and alter neuromotor control. Because of the extremely high rate of recurrence associated with bicep femoris strains, rehabilitation of this injury must be comprehensive and address all possible factors associated with chronicity. While hamstring inflexibility is often cited as a potential cause, there is little evidence to support this theory (5). In fact, excessive stretching is more likely to cause a hamstring injury than alleviate one, particularly during the acute phase following injury. In their detailed study of hamstring injuries in different types of athletes, the only running related hamstring strain reported by Askling et al. (3) occurred while the athlete was stretching before participating in sport. Subsequent MRI confirmed the runner tore both the semimembranosus and bicep femoris long head muscles.

The fact that stretching has not been proven to lessen the potential for developing injury does not imply that stretching should be avoided. On the contrary, since a flexible muscle is able to tolerate higher eccentric forces with less muscle damage (6), and individuals with flexible hamstrings are less prone to a variety of injuries (7), reducing muscle stiffness with gentle stretches is clinically justified.

The problem is that converting a stiff individual into a flexible individual can take months to years, and may interfere with the storage and return of elastic energy. Because of these different factors, stretching should be prescribed on an individual basis and performed in a gentle manner during the acute stages of injury. The patient should be instructed of the long-term commitment necessary to modify muscle stiffness. The stretch illustrated in figure 3 isolates the long head of the bicep femoris muscle. To reduce stiffness in the upper hamstring, this stretch should be performed with the knee flexed 45° and 90°. Since fatigue increases the potential for hamstring injury, Verral et al. (8) recommend stretching the hamstrings for 15 seconds (with the knee bent at different angles) as the muscle becomes fatigued while exercising.

Over a 2-year period, the authors demonstrated significantly reduced rates of hamstring injuries in Australian Rules football players when the stretches were performed during workouts and competition. This may also apply to marathon runners, who present with fatigue related weakness at the end of their long runs.

Because injury results in protective splinting of the hamstrings and neighboring muscles, it is important to evaluate each muscle of the hip and thigh for the presence of trigger points that might be responsible for increasing muscular stiffness. Since adhesions and/or trigger points may increase tensile strain on the hamstring origin during late swing phase, vigorous deep tissue massage along the full length of each of the affected hamstring muscles may enhance the transfer of tensile strain through the fascia and perimysium, possibly reducing the potential for muscle-tendon junction injury. Home stretches should be performed following deep tissue massage with a foam roller, with the goal being restoration of pre-injury flexibility of the entire muscle and its fascial envelope.

Additionally, since it is thought to improve arthrokinetic reflexes, several authors suggest spinal manipulation may play a role in the prevention and treatment of hamstring injuries. In the largest study to date, Hoskins et al. (9) demonstrate in a randomized controlled trial that Australian Rules footballers treated before and during a competitive season with occasional chiropractic care had reduced rates of hamstring and total lower-body muscle strains with no adverse outcomes.

While stretches and various manual therapies are helpful when treating hamstring injuries, comprehensive strengthening exercises play the most important role in the management of hamstring strains. In an impressive study comparing efficacy of different treatment regimens used in the management of acute hamstring strains, Sherry and Best (10) prove that compared to a conventional protocol of static stretching and isolated progressive hamstring resistance exercises, an exercise regimen including progressive agility and trunk stabilization exercises produces significantly better short and long-term outcomes (see Table 1 for a summary of these exercises). Compared to conventional rehabilitation, the agility and stabilization group returned to sport sooner (22 days versus 37 days), and suffered fewer reinjuries during the first two weeks after returning to sport (55% of the conventional rehab group were reinjured, compared to no reinjuries in the progressive agility and trunk stabilization group).

The beneficial effects of the agility and stabilization exercises were even present one year following return to sport, as 70% of the athletes treated with conventional stretches and exercises were reinjured, compared to only 7.7% of the athletes completing the progressive agility and trunk stabilization program. The alternate hamstring exercises illustrated in figure 4 are also helpful when treating gait-related hamstring injuries. Because nonsteroidal anti-inflammatories may result in impaired tendon healing (11), the routine use of these drugs should be reconsidered. A safer alternative to improve healing is to perform aggressive deep tissue massage directly over the damaged tendon, as this may stimulate tendon repair without adversely affecting tendon strength (12,13). If pain reduction is important, the typical runner responds well to ice packs applied in 15-minute intervals, 4-5 times per day. Given the recurrent nature and long-term disability associated with hamstring strains, it is important to treat this injury with comprehensive conservative care.

Phase 1.

1. Low- to moderate-intensity sidestepping, 3 x 1 minute.
2. Low- to moderate-intensity grapevine stepping (lateral stepping with the trail leg going over the lead leg and then under the lead leg), both directions, 3 x 1 minute.
3. Low- to moderate-intensity steps forward and backward over a tape line while moving sideways, 2 x 1 minute.
4. Single-leg stand progressing from eyes open to eyes closed, 4 x 20 seconds.
5. Prone abdominal body bridge (performed by using abdominal and hip muscles to hold the body in a face-down straight-plank position with the elbows and feet as the only point of contact), 4 x 20 seconds.
6. Supine extension bridge (performed by using abdominal and hip muscles to hold the body in a supine hook-lying position with the head, upper back, arms, and feet as the points of contact), 4 x 20 seconds.
7. Side plank, 4 x 20 seconds on each side.
8. Ice in long-sitting for 20 minutes.

Phase 2.

1. Moderate- to high-intensity sidestepping, 3 x 1 minute.
2. Moderate- to high-intensity grapevine stepping, 3 x 1 minute single-leg windmill touches (Figure 8.35B).
3. Push-up stabilization with trunk rotation (performed by starting at the top of a full push-up, then maintain this position with one hand while rotating the chest toward the side of the hand that is being lifted to point toward the ceiling, pause and return to the starting position), 2 x 15 reps on each side.
4. Fast feet in place (performed by jogging in place with increasing velocity, picking the foot only a few inches off the ground), 4 x 20 seconds.
5. Proprioceptive neuromuscular facilitation trunk pull-downs with Thera-Band, 2 x 15 to the right and left.
6. Symptom-free practice without high-speed maneuvers.
7. Ice for 20 minutes if any symptoms of local fatigue or discomfort are present.

Key: Low intensity: a velocity of movement that is less than or near that of normal walking. Moderate intensity: a velocity of movement greater than normal walking but not as great as sport. High intensity: a velocity of movement similar to sport activity. Progression criteria: subjects progressed from exercises in phase 1 to exercises in phase 2 when they could walk with a normal gait pattern and do a high knee march-in-place without pain.

Table 1. Hamstring exercise protocol described by Sherry and Best (10).

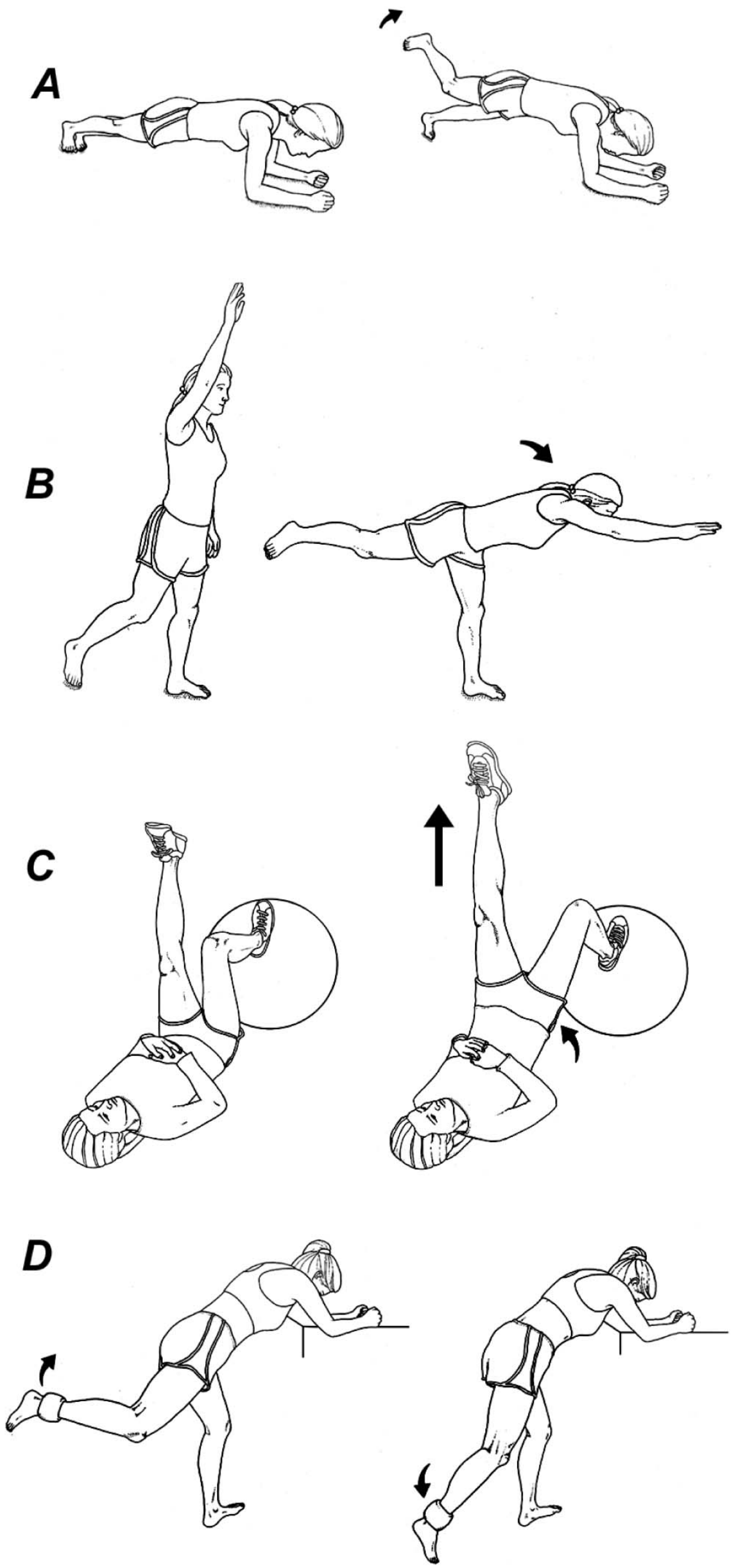

Fig. 4. Hamstring exercises.

A) Prone plank march: While maintaining a plank, alternate ankles are lifted off the ground.

B) Single-leg windmill: While standing on the involved leg, pivot at the hips while maintaining alignment of opposite arm and leg.

C) Single-leg physioball lift. While maintaining the lumbar spine in a neutral position, the involved hip extends to lift the vertical contralateral leg upwardly.

D) Lower hamstring exercise. With arms supported on a stable surface, the involved knee flexes and extends while varying the degree of internal/external rotation of the leg.

References.

1. Orchard J, Best T. The management of muscle strain injuries: an early return versus the risk of recurrence. *Clin J Sport Med.* 2002;12:3-5.
2. Askling C, Saartok T, Thorstensson A. Type of acute hamstring strain affects flexibility, strength, and time to return to pre-injury level. *Br J Sports Med*. 2006;40:40.
3. Askling C, Tengvar M, Saartok T, Thorstensson. Proximal hamstring strains of stretching type in different sports. Injury situations, clinical and magnetic resonance imaging characteristics, and return to sport. *Am J Sports Med.* 2008;36:1799.
4. Brooks J, Fuller C, Kemp S, et al. Incidence, risk, and prevention of hamstring muscle injuries in professional rugby Union. *Am J Sports Med.* 2006;34:1297.
5. McHugh M, Connolly D, Eston R, et al. The role of passive muscle stiffness and symptoms of exercise-induced muscle damage. *Am J Sports Med.* 1999;27:594.
6. McHugh M, Connolly D, Eston R, et al. The role of passive muscle stiffness and symptoms of exercise-induced muscle damage. *Am J Sports Med.* 1999;27:594.
7. Hreljac A, Marshall RN, Hume PA. Evaluation of lower extremity overuse injury potential in runners. *Med Sci Sp Exerc.* 2000;32(9):1635-1641.
8. Verrall GM, Slavotinek JP, Barnes PG. The effect of sport specific training on reducing the incidence of hamstring injuries in professional Australian rules football players. *Br J Sports Med*. 2005;39:363-368.
9. Hoskins W, Pollard H., Orchard J. The Effect of Sports Chiropractic on the Prevention of Hamstring Injuries: A Randomized Controlled Trial. *Med Sci Sports Exerc*. 2006;38:S27.
10. Sherry M, Best T. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. *J Orthop Sports Phys Ther.* 2004;34:116.
11. Cohen D, Kawamura S, Ehteshami J, Rodeo S. Indomethacin and Celecoxib impair rotator cuff tendon-to-bone healing. *Am J Sports Med.* 2006;34:362-369.
12. Davidson C, Ganion L, Gehlson G, et al. Rat tendon morphologic and functional changes resulting from soft tissue mobilization. *Med Sci Sports Exerc.* 1997;2903:313.
13. Loghmani M, Warden S. Instrument-assisted cross-fiber massage accelerates knee ligament healing. *J Orthop Sports Phys Ther.* 2009;39:506-514.
14. Thelen D, Chumanov E, Hoerth D, et al. Hamstring muscle kinematics during treadmill sprinting. *Med Sci Sports Exerc.* 2005;37:108-114.