Volume 22, Number 6, pages 35–36

Hamstrings of Steel: Preventing the Pull, Part I—Isolated Versus Integrated Function

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ONE OF THE MOST COMMON INjuries in sports is a pulled hamstring. It is hypothesized that hamstring pulls are caused by various mechanisms, including strength imbalances between the quadriceps and hamstrings, weak hamstrings, tight hamstrings, and asynchronous firing by the nerves that innervate the hamstrings. Out of all of these proposed mechanisms, weakness in the hamstrings gets the most attention.

Traditionally, leg curls have been the exercise of choice among coaches and sport medicine specialists. This is probably due to one of the hamstrings' well described isolated functions—knee flexion. A better understanding of how muscle function was first described will enlighten us on how to better view muscle function for optimum training.

The isolated functions of muscles were first described in cadavers, obviously in horizontal, nonstanding positions. In this position, the mainline of the body is in contact with the ground. Therefore, any muscle action would pull the extremity (e.g., the leg and foot) toward the mainline of the body. Thus, the classification of origin and insertion is derived from this observation. Furthermore, in this cadaver lab condition, the eccentric component of muscle action cannot really be appreciated, especially in the transverse plane. Therefore, traditional descriptions of muscle actions have focused only on concentric muscle action. Rarely is the eccentric component and the transverse plane well documented or emphasized.

There is a tremendous difference between a muscle's isolated function and integrated function. In the case of the hamstrings, when the foot hits the ground during running, the integrated function greatly expands beyond its traditional description. During running, the foot is in contact with the ground, and the body's center of mass is moving over the foot. Because of its ground contact, the foot acts as the origin of movement, not the hips. Unlike in the cadaver lab, where the hips would be in contact with the ground (i.e., via a table), when running, the foot is in contact with the ground. Therefore, the foot does not move; the hips and body move over the foot. If viewed from this perspective, hamstring function becomes a bit easier to understand. Additionally, if the eccentric and rotational role of the hamstrings is also taken into account, a better understanding of their conditioning can be achieved. This is especially relevant since most of the hamstring pulls occur during the eccentric actions of the "blocking" and "plant" phases, with the majority occurring during the plant phase

Let's get a more detailed view of the hamstrings' major functions during running. In Figures 1C, 1D, and 1E, the left knee flexes as it goes through the "swing phase." According to the isolated function of the hamstrings, the hamstrings would perform the flexion of the left knee and the extension of the right hip. But during the swing phase, the knee is flexed by the momentum created by hip flexion, which brings the knee around to the "block position" shown in figure 1B (by the right leg). During running, the major integrated functions of the hamstrings (1) are to

- Decelerate hip flexion during the blocking swing phase (right leg; Figures 1A–1C).

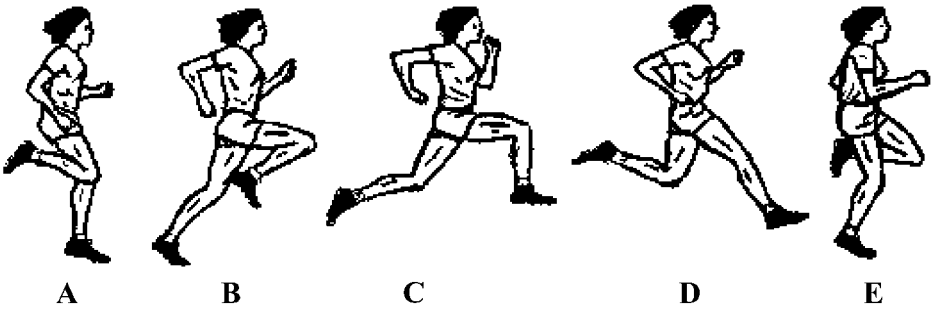

Figure 1. A–E.

- Decelerate knee extension while accelerating hip extension (right leg; Figures 1C–1E).
- Decelerate hip flexion at foot strike (left leg; Figure 1A).
- Decelerate lower leg internal rotation at midstance (left leg; Figure 1A).
- Accelerate hip extension and external rotation prior to foot strike (right leg; Figures 1C and 1D).
- Accelerate external rotation of the lower leg before foot strike and during push-off (left leg; Figures 1B and 1D).
- Provide sacroiliac stabilization through the deep longitudinal system (i.e., erectorspinae, thoracolumbar fascia, sacrotuberous ligament, and biceps femoris) after heel strike (Figure 1E).

Like other muscles that cross 2 joints, the hamstrings sometimes perform econcentrically, such as before foot strike. *Econcentric* is a term coined by physical therapist Gary Gray (2) to describe situations in which a single muscle is simultaneously working concentrically at one joint (e.g., the hip) and eccentrically at another joint (e.g., the knee); this action is illustrated by the right leg in Figures 1C and 1D.

With this basic understanding of how the hamstrings work functionally during running, a leg curl to condition or rehabilitate them would not seem prudent. The isolated and unnatural movement of the leg curl could make the hamstrings more prone to injury. Most athletes perform leg curls, yet athletic training rooms across the country are plagued by hamstring pulls. Part II of this article will illustrate a protocol that can help develop stronger and more functional hamstrings. ▲

References

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