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The Role of the Back Squat as a Hamstring Training Stimulus

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THE BACK SQUAT IS AN IMPORTANT training stimulus for the development of the knee and hip extensors (1) (Figure 1). The back squat may be performed to a variety of depths. One recommendation includes performing back squats until the upper thigh is parallel to the floor or slightly lower than parallel to the floor; there are no known disadvantages to squatting to parallel or slightly below (1). However, questions remain about the role of the back squat as a hamstring training stimulus and whether or not depth is a determining factor in hamstring activation.

Figure 1. **Volleyball players training with the squat.**

The role of the Hamstrings During the Squat

During the back squat, the primary movers are the quadricep and gluteal muscles, with the hamstrings functioning as a synergist (6). Training the agonist (i.e., quadriceps) without training the antagonist can result in undesirable muscle imbalance and may increase the likelihood of injury (6). Unfortunately, agonist-antagonist strength ratios do not exist for isotonic exercises. However, a desirable isokinetic agonist-antagonist strength ratios of 3:2 has been suggested for quadriceps/hamstring (6). The further this muscle balance ratio is from 1:1, the greater the concern about muscle imbalance and possible injury (6).

In addition to the hamstrings' role as a knee flexor and synergistic cocontractor during knee extension, they may also play a role as a hip extensor, since the long head of the biceps femoris, semitendinosus, and semimembranosus all cross the hip joint and originate at the ischial tuberosity (5). Theoretically, the depth of the squat may play a role in hamstring activation as a concentric hip extensor, in addition to its role as a cocontracting stabilizer.

Research: Activation of Hamstrings During the Squat

During squats, the cocontraction hypothesis suggests the hamstrings provide a stabilizing force at the knee by producing a posteriorly directed force on the tibia in opposition to the anterior tibial force generated by the quadriceps (3). Isear et al. (3) assessed hamstring coactivation during unloaded squats, determining that there is minimal hamstring activity. They suggested that the role of

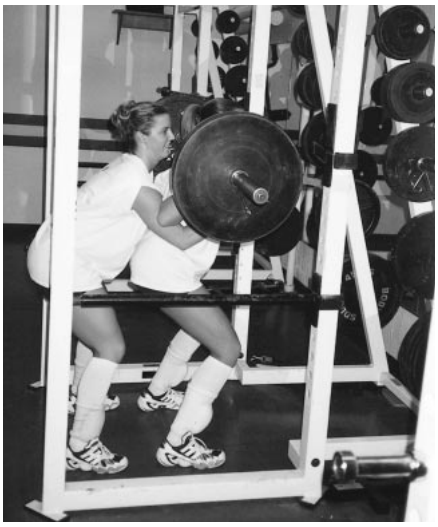

Figure 2. **Squat at 120 degrees of knee flexion.**

Figure 3. **Leg curl.**

Figure 4. **Stiff-leg deadlift.**

the hamstrings seems to be more significant with loaded squats.

Escamilla et al. (2) compared hamstring activity of squats, leg press, and knee extension exercises. Results reveal that the squat generated twice as much hamstring electromyographic (EMG) activity as the leg press and knee extension. Thus, squats seem to be a superior hamstring training stimulus compared with other lower-body exercises that include knee extension.

Jensen and Ebben (4) examined the relationship between squat depth and hamstring motor unit activation as assessed by surface EMG. Results revealed that hamstring motor unit activity did not change as a function of depth during the concentric portion of the back squat. During the eccentric portion of the back squat, hamstring activity did change as a function of squat depth. Hamstring activity was greatest at 120 degrees or less of knee flexion (Figure 2). Results suggest that during the back squat, the eccentric role of the hamstring is greater than the concentric, and that the eccentric activity increases to a degree as a function of squat depth. It was not possible to determine if the EMG activity during the concentric phase is a result of the hamstring functioning as a cocontractor and stabilizer or if the hamstring plays a role as an agonist assisting hip extension.

Wright et al. (7) compared hamstring-integrated and peak EMG of subjects performing the back squat, leg curl, and stiff-leg deadlift. These findings indicated that performing the back squat resulted in approximately half of the motor unit activity compared with the leg curl (Figure 3) and stiff-leg deadlift (Figure 4). Results suggest that back squats are limited as an exercise for training the hamstrings.

Summary

Hamstring development is important to ensure muscle balance between the quadriceps and hamstrings and to prevent injury. Some observers suggest that performing the back squat to parallel to the floor or deeper is necessary to optimally activate the hamstrings. Jensen and Ebben (4), however, suggest that during the concentric portion of the back squat, depth is an insignificant determinant of hamstring activity. During the eccentric phase, depth dictated hamstring activity as hamstring EMG was greatest at 120 degrees and beyond (somewhat above parallel to the floor and continuing down to parallel). Furthermore, findings by Wright et al. (7) reported that exercises such as the stiff-leg deadlift and leg curl offer a significantly greater hamstring training stimulus than the back squat. Consequently, back squat depth should be dictated by factors such as the need for biomechanical specificity. Although the back squat plays some role in hamstring activation, exercises such as the leg curl and stiff-leg deadlift are recommended to ensure hamstring development.

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