SWACSM Abstract

The Impact of Squat Velocity on Force, Power, and Muscle Activity

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ABSTRACT

The squat is a thoroughly examined movement pattern and commonly used in sport performance training protocols, rehabilitation programs, and recreational exercise. Previous research measuring absolute strength has shown hamstring muscle activity in a six-repetition max barbell back squats. **PURPOSE:** The purpose of this study is to examine the effects of varying squat velocities (25, 50, 75 deg/s) on force, power, and the activation of the quadricep and hamstring muscles. Using a single-blind randomized research design, we hypothesized that hamstring muscle activity will increase at faster squat velocities. Our secondary hypothesis is that peak power will occur at 50 deg/s and peak force will occur at 25 deg/s. Muscle activity for both the hamstring and quadriceps was measured as root mean square (RMS) electromyography (EMG) and expressed as a percentage of the maximum voluntary contraction (MVC). Muscle activity, force output, and power output were measured over five consecutive repetitions of each velocity in a randomized order. **METHODS:** Twelve healthy adults (10 males, 2 females) participated in this investigation. Three Delsys Trigno EMG electrodes were placed on the right leg of all participants as they performed the MVC and squat trials on the isokinetic machine. One was placed on the posterior side (biceps femoris [BF]) to measure hamstring activity and two were placed on the anterior side (vastus medialis [VM] and vastus lateralis [VL]) to measure quadricep activity. An isokinetic training machine was used to test the participant's squat performance at pre-set velocities (Ariel Computerized Exercise System, CA). These machines have been used to measure force and power relationships. MVC was found using an adjustable bench with a padded immovable leg extension attachment. For the quadriceps, the participant sat on the bench in an upright position with the leg extended to approximately 110 degrees against the attachment. Hamstring MVC was measured in a standing position with the leg of interest flexed to approximately 110 degrees with the leg extension attachment behind the lower leg. Three trials of MVC were performed for both knee flexion and extension so results during squat trials can be expressed as a percentage of MVC. Following the MVC, participants then underwent experimental trials. The squat movement pattern was standardized to a depth of 90 degrees of knee flexion measured via goniometry and maintained during each trial using an adjustable height box, set to a predetermined height. Feet were instructed to remain at approximately shoulder width with knees tracking along the same line as the feet to avoid knee misalignment to avoid injury and potentially alter muscle activity. Five consecutive repetitions at each velocity (25, 50, and 75 deg/s) were performed with at least two minutes of rest between trials. For each trial, repetitions two, three, and four were used to determine average and peak power and force. **RESULTS:** To determine the magnitude of BF muscle activity, we compared it to the degree of quadricep muscle activity (VL:BF and VM:BF) for each squat velocity and analyzed using a one-way ANOVA. This relative hamstring muscle activity was highest at 75 deg/s for VL:BF at 3.84% and at 50 deg/s for VM:BF at 4.59% However, the difference in BF activity involved at each squat velocity was not statistically significant ($p = 0.2973$). The highest average peak power was achieved at a velocity of 50 deg/s with a value of 1538.19 ± 717.2 W. The greatest average peak force was found at a velocity of 25 deg/s with a value of 1574.08 N ± 605.8 W. When analyzing the peak force within the three velocity groups, a statistically significant difference was found with a $p < 0.0001$. This was also seen with the average force within the three velocity groups with a $p < 0.0001$. No statistically significant difference was found for either peak or average power among the three velocity groups. **CONCLUSION:** When comparing the degree of BF involved during the squat movement, the 25 deg/s had the lowest relative to the quadricep musculature, while both the 50 deg/s and 75 deg/s had higher relative BF activity. As expected, a U-trend was observed with average peak power observed at 50 deg/s, with a decrease at both 25 and 75 deg/s – further confirming the established power-velocity relationship. However, this difference was not statistically significant with our participant size. As velocity increased, force decreased – further confirming the established force-velocity relationship. These results proved to be statistically significant.