

Differences in Frontal Plane Knee Kinematics by Grip, Load, and Concentric Subphase in the Front Squat

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ABSTRACT

Although the back squat is one of few exercises that has been extensively analyzed, the body of literature examining its counterpart, the front squat, is not as robust. The front squat is a vital exercise known for its quadriceps development capabilities and unique front-rack positioning. This grip position renders the front squat more difficult, and thus proper form is more vital to prevent injury. **PURPOSE:** To evaluate the association between grip (standard front-rack, cross-grip, and strap-assisted), load (50% and 80% of 1-RM), and subphases of the concentric portion of the squat on frontal plane knee varus and valgus movement in the front squat. **METHODS:** Data was gathered from eight participants. Inclusion criteria were at least 60% on the Lower Extremity Functional Scale, self-report of performing front squats at least every two weeks for the past six months, and squatting below parallel. Two sessions were completed. First, consent, anthropometrics, and a 1-RM were obtained. Next, each subject was randomized to perform four repetitions of each grip at 50% and 80% of their 1-RM. During this session, a 29-marker set for 3D motion capture was used to collect joint angle data for each squat. We used data from knee frontal plane angles to analyze the concentric portion of the squat which we broke into subphases (1: 25%, 2: 50%, 3: 75% and 4: 100%) by frame. Only the second repetition from the left leg was analyzed. We performed a three-way repeated measures ANOVA for within-subject factors of grip technique (front-rack, cross-grip, strap-assisted), load (50%, 80%), and sub-phase of the concentric part of the squat (1, 2, 3, 4). We performed a sensitivity analysis with data from the second repetition of the right leg. Analyses were performed using R, version 4.0.3. Significance was set at $p < 0.05$. **RESULTS:** The eight participants (6 males, 2 females) were 173.10 ± 8.00 cm (mean \pm sd) in height, 78.20 ± 12.30 kg in mass, 25 ± 3 yrs of age, reported 6 ± 4 yrs of training experience, and had a 1-RM of 114.10 ± 31.00 kg. There were no significant main effects for grip or load on knee varus/valgus movement in the frontal plane. However, there was a significant main effect for subphases of the concentric portion of the squat ($p < 0.001$). Except for between phases 3 and 4, there were significant differences between all pairwise comparisons of phases ($p < 0.001$ for all remaining except between 2 and 3, $p = 0.002$); whereas varus movement was found in phase 1, valgus movement was found in phase 2. Sensitivity analyses on the right leg yielded similar results. **CONCLUSION:** Our findings suggest that the subphases of the concentric portion of the front squat, but not grip or load, were significantly associated with varus/valgus movement of the knee. Therefore, strength coaches can choose a grip and load that is most appropriate for the specific athlete without significant impact on varus/valgus movement. However, regardless of grip or load, strength coaches should tune in closely to the concentric subphases of the front squat. In particular, to better prevent injury, strength coaches should focus on the first and second subphases phases where significant frontal plane movement may occur.