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Effect of Slope Squat on Lower-extremity Muscle Activity

Yi Wan[1], Jianqiao Wang[2], Jennifer L Davies[1,3], Kate Button[1,3] and Mohammad Al-Amri[1,3]

[1]School of Healthcare Sciences, College of Biomedical and Life Sciences, Cardiff University, UK.
[2] China Rehabilitation Research Center, Beijing, China.
[3]Arthritis Research UK Biomechanics and Bioengineering Centre, Cardiff University, UK.

BACKGROUND AND AIM: Squat is a common multi-joint close-kinetic exercise used by clinicians and sport coaches to strengthen the lower-extremity (LE) muscles and enhance the posture and balance control of the lower limb. However, squatting on level ground with inappropriate load and posture may cause ligament, meniscus, and muscle injuries. Excessive shear and compressive forces at the knee are the main risk factors for injuries during squatting. These forces are produced by cross-joint muscles (quadriceps, hamstrings, and gastrocnemius) during contraction. Previous studies indicate that exercise on a decline surface can decrease force generation and tension of the LE muscles, and allow better isolation of the knee extensor mechanism. Therefore, squatting on a decline slope might reduce the load on the knee joint by reducing LE muscle activation compared to level squat. Most previous studies have evaluated the effect of slope on LE muscles during walking, and few have studied the effect during squatting. Furthermore, previous squat studies did not have a unified squat depth, which is essential for a valid comparison of muscle activity. Therefore, this study aimed to explore the effects of a decline surface on LE muscle activity during double-leg squats in healthy subjects. **METHODS:** Fifteen participants (age 24.5 ± 3.2 years) performed five squats on both 5-degree slope and level ground. Surface electromyography (EMG) was recorded from three muscles of the dominant leg: rectus femoris, biceps femoris, and gastrocnemius. Participants were instructed to squat to a depth at which their thighs were parallel to the treadmill surface, which is around a 70-degree squat. A GoPro camera recorded the squat performance, and the peak knee joint angle (PKJA) was measured by Kinovea software. The rectified and smoothed EMG at PKJA was used for statistical analysis, including Shapiro-Wilk test and paired t-test. **RESULTS:** There was no significant difference in PKJA between squats on a 5-degree slope and on level ground (70 ± 2.6° and 72 ± 4.6° respectively, $P = 0.095$), which laid a valid foundation for the muscle activation comparison. For biceps femoris, EMG at PKJA was significantly lower on the 5-degree slope than on level ground (54 ± 36.4 μV and 60 ± 32.9 μV respectively, $P = 0.016$). For rectus femoris and gastrocnemius, there was no significant difference in EMG at PKJA. **CONCLUSIONS:** Less activity in biceps femoris is required to perform squat on a 5-degree decline than on level ground. In clinical rehabilitation, patients with knee injury who have LE muscle weakness may benefit from performing squats on a decline surface. In addition, athletes and body builders who use progressive strength-gain programs may benefit from decline squat.