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# THE EFFECT OF FOOT POSITION ON KINETICS OF LOWER LIMBS DURING SQUAT

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The purposes of this study were to evaluate the effects of the foot position on the joint forces and moments of lower limbs during squat. Eleven male weightlifters were recruited in this study to perform squat with different foot position (forward position and toe-out 20 degrees). The VICON motion analysis system and two KISTLER force platforms were used to record the kinematical and kinetic data during squat. The results showed that the ankle joint maximal shear force, maximal adduction moment, external rotation moment and knee external rotation moment during squat with foot forward position were significantly greater than the results in toe-out position. Squat with foot forward position could be suggested to improve the ankle stability in rehabilitative training.

**KEY WORDS:** joint force, joint moment.

**INTRODUCTION:** Squat is a strength training of lower limbs that is commonly used in personal training or athletic training. Squat is also a movement frequently adopted in the activities of daily living, such as sit-to-stand from chair (Dan & Liebenson, 2013)., Different foot positions in squat are usually used in weight training (Escamilla et al., 2001[a]; Ninos et al., 1997). However, the effect of different foot positions is not clear. Therefore, the purposes of this study were to compare the difference of the two foot positions during squat, and to investigate the effect of the foot position on the joint forces and moments of lower limbs during squat.

**METHODS:** Eleven male weightlifters of the college weightlifting team participated in this study. VICON motion analysis system with eight cameras and two Kistler force-plates were used to record kinematic and kinetic data during squat. The reflective markers were placed on the sacrum, anterior superior iliac spine, posterior superior iliac spine, greater trochanter, medial and lateral femoral condyle, medial and lateral malleolus, the 2nd metatarsal head, and heel. The stance width was 107% shoulder width. Two foot positions were used, toe forward (NS) and toe-out 20 degrees (NST). Body weight was used as the load of the squat in this study. Three repetitions were performed for each foot positions for each subject. The inverse dynamics was used to compute the maximal joint forces and moments of lower limbs. Paired-t test was used to compare the kinetics of lower limbs between two different foot positions (SPSS, V11.0).

**RESULTS:** The maximal joint forces during squat were shown in figure 1. The NST squat had a significantly greater anterior force of the knee than the NS squat ($p < .05$). However, the NS squat had a significantly greater lateral force of the ankle joint than NST squat ($p < .05$). The maximal joint moments during squat were shown in figure 2. The NS squat had a significantly greater external rotation of the knee joint, adduction of the ankle joint, and external rotation moments of the ankle than NST squat ($p < .05$).

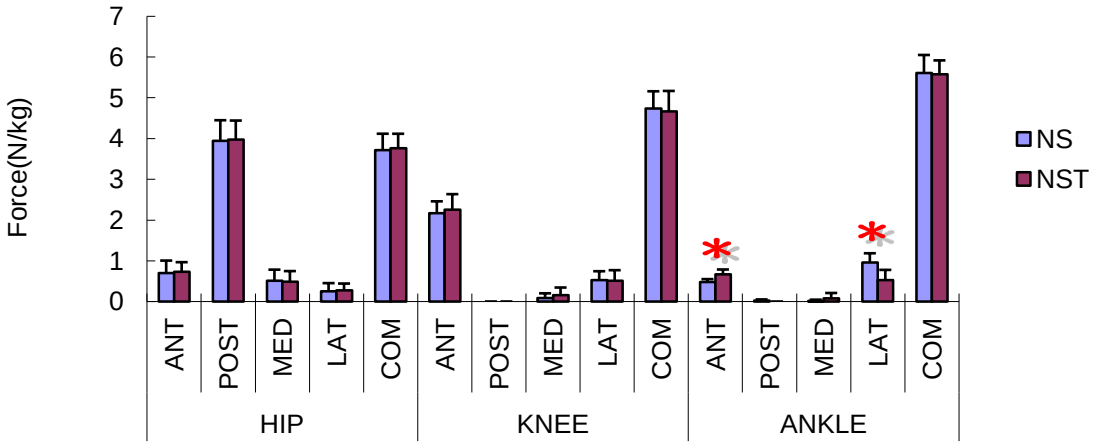


**Figure 1: The maximal joint forces between the different standing types of the lower limbs during squat (ANT: anterior force, POST: posterior force, MED: medial force, LAT: lateral force, CON: compress force, * p< .05).**

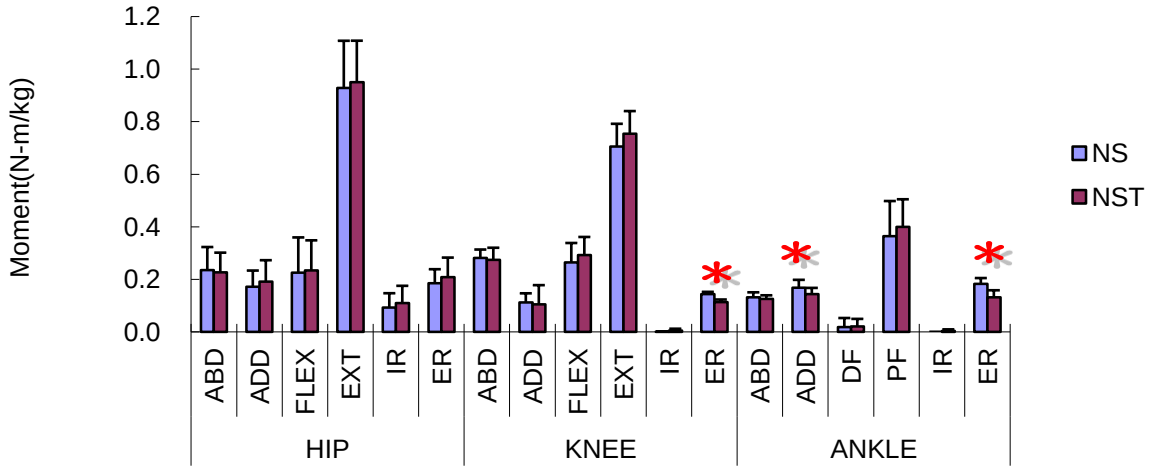


**Figure 2: The maximal joint moments between the different standing types of the lower limbs during squat (ABD: abduction moment, ADD: adduction moment, FLEX: flexion moment, EXT: extension, IR: internal rotation, ER: external rotation, * p< .05).**

**DISCUSSION:** There have been previous studies focusing on the analysis of knee kinetics of the squat (Escamilla, 2001). However, this study showed the significance of the ankle force and moment during squat. The findings showed that the ankle moments in ST squat were greater than that in NST squat. It was implied that more ankle stability might be required in NS squat than in NST squat. Toe-out position was commonly selected for the elite weightlifters (Escamilla et al., 2001[a]). It might be due to NST position needed less ankle joint moments. The athletes could then focus on performing the strength in other joints in NST position, such as hip or knee joint, to improve the competitive performance. Squat in NST position could be suggested to improve the ankle stability in rehabilitative training.

**CONCLUSION:** The effect of the foot rotation position on the joint forces and moments of lower limbs during squat was found in this study. The NST squat, with a higher ankle joint moment, has the effect for improving ankle stability compared to NST squat. In the future, the squat loads will be investigated to understand the influence of the loading effect.

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