Effects of External Load on Joint Kinetics in the Rear-Foot-Elevated Split Squat

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Summary

The purpose of this pilot study was to investigate the effects of external load on joint kinetics in the rear-foot-elevated split squat (RFESS). Three females and three males were recruited (30.5 ± 4.3 years, 167.3 ± 5.6 cm, 64.1 ± 5.0 kg) and performed RFESS with loads of 40%, 60%, and 80% of their 1-repetition maximum. The joint moments for the ankle, knee, and hip in the front leg increased with external load, with the largest effect for the hip joint (1.93 ± 0.19 N·m/ kg at 40% versus 2.59 ± 0.33 N·m/ kg at 80% load). The magnitude of hip and knee joint moments of the rear leg were similar to the knee joint moment of the front leg. These results indicated that both the front and rear legs play an important role in performing the RFESS.

Introduction

The rear-foot-elevated split squat (RFESS) is a unilateral lower-body resistance training exercise commonly used to improve muscular strength [1]. In resistance training, the primary option to modulate the training stimulus is by changing the external load. Resistance training adaptations are specific to the imposed stimulus [2], making it important to quantify the effects of load on kinetics of the ankle, knee, and hip joints. Therefore, this pilot study aims to examine how external load affects kinetics of both the front and the rear legs - the working and the supporting legs, respectively.

Methods

This study included data from three females and three males (30.5 ± 4.3 years, 167.3 ± 5.6 cm, 64.1 ± 5.0 kg). All participants had at least one year of lower-body resistance training experience. The participants completed two separate familiarisation sessions, 1-repetition maximum (1-RM) testing, and a data collection session comprised of two sets of five repetitions at 40%, 60%, and 80% 1-RM loads with both legs as the front leg. Three minutes of rest were given between the sets. Adjustable dumbbells were used as the weight implement, and the participants were cued to descend at their own pace but perform the concentric phase as fast as possible. The order of loads and legs was randomised.

Eight Vicon T-series cameras at 100 Hz were used for motion capture with Kistler force platforms under the front and rear legs at 1000 Hz. Visual 3D was used to create a rigid body model and perform inverse dynamics analysis.

Results and Discussion

The participants achieved a 1-RM of 1.06 ± 0.21 (external load normalised by body mass). The mean net joint moments for the front and the rear legs can be seen in Figure 1. Overall, there was a slight trend in increased joint moments with heavier loads.

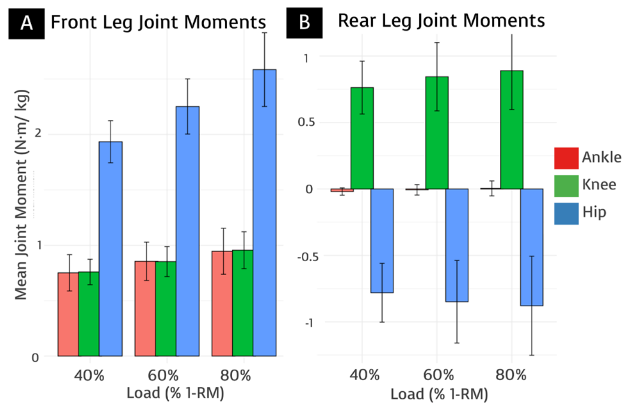

Figure 1: Mean body mass-normalised net joint moment + SD of the front and rear legs across external loads in the rear-foot-elevated split squat. Positive sign marks extension moment.

In the front leg, the hip had the largest joint moment compared with the ankle and the knee. In the rear leg, the magnitude of joint moments were similar in the knee and the hip joints. Interestingly, the knee extension moment was very similar between the front and the rear legs, despite the back leg contributing only about 16% to the total vertical ground reaction force [3].

Conclusions

External load likely increases the joint moments of the ankle, knee, and hip for both the front and the rear legs, with the largest effect for the front hip. The large hip and knee joint moments in the rear leg indicates that the rear leg, despite serving as a supporting leg in RFESS, may also experience a training stimulus.

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