LOWER LIMB MUSCLE FORCES IN TABLE TENNIS FOOTWORK DURING TOPSPIN FOREHAND BASED ON MUSCULOSKELETAL

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Introduction

Obtaining biomechanical information about athletes' bodies through modern technology and revealing the internal mechanisms of joints and muscles during movement is significant for athletes and coaches. Musculoskeletal models used in conjunction with non-invasive measurement methods allow the strength of individual muscles to be obtained for several motor tasks [1]. To gain a thorough understanding of the muscle activity information of the table tennis footwork technique and to further reveal its intrinsic mechanisms and functions, this study aimed to create a musculoskeletal model using OpenSim software to investigate the muscle forces, joint kinematic, and joint kinetic characteristics between the chasse step and one-step during topspin forehand stroke.

Methods

Six male table tennis athletes (height: 171.98 ± 4.97 cm; weight: 68.77 ± 7.86 kg; experience: 10.67 ± 1.86 years; age: 22.50 ± 1.64 years) performed chasse step and one-step footwork to return the ball from the coach by topspin forehand stroke. The kinematics, kinetics, and muscle activity of the lower limb were recorded by the motion capture, force platform, and Electromyography (EMG) system. Statistical parametric mapping (SPM) analysis was used to investigate any difference between the chasse step and one-step footwork during the stroke.

Results

As shown in Figure 1. The muscle force of the biceps femoris long head ($p < 0.001$), lateral gastrocnemius ($p < 0.001$), vastus lateralis ($p < 0.001$), vastus medial ($p < 0.001$), rectus femoris ($p < 0.001$), and tibia anterior ($p < 0.001$) of the chasse step were significantly greater than the one-step footwork during the early stroke phase (stance). At the end of the stroke phase (push-off), the muscle force of the biceps femoris long head ($p < 0.001$), medial gastrocnemius ($p < 0.001$), lateral gastrocnemius ($p < 0.001$), rectus femoris ($p < 0.001$), and tibias anterior ($p < 0.001$) in the chasse step footwork was significantly greater than the one-step footwork. The muscle force of the ankle plantar flexor and valgus muscle groups in the one-step was significantly greater than in the chasse step. Besides, the moment and angle of hip flexion ($p = 0.001$) and axial rotation ($p = 0.009$) were significantly greater for the chasse step than the one-step footwork, as well as the ankle plantar flexion angle ($p < 0.001$) and moment ($p < 0.001$) of the one-step footwork were significantly higher than the chasse step footwork.

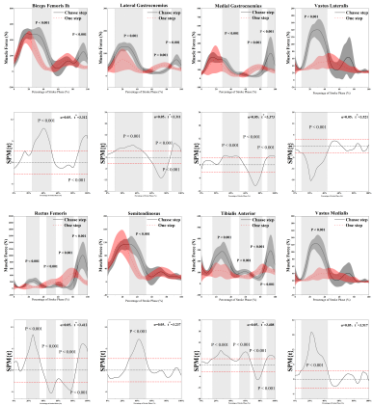

Figure 1: Lower limb muscle force results between the chasse step and one step during the stroke phase. Grey-shaded areas indicate significant differences ($p < 0.05$) between the chasse step and one step.

Discussion

The results of this study can be applied to movement control and injury prevention in table tennis footwork. Based on the results of this study, we recommend (1) strengthening the knee flexor and extensor muscle groups, such as the rectus femoris, biceps femoris, vastus lateralis, vastus medial, medial gastrocnemius, and lateral gastrocnemius, to strengthen the chasse step footwork during landing to create a stable backward phase, (2) strengthen the hip flexor/extensor muscles, brings a gain to the racket's maximum acceleration; (3) strengthen the plantar flexor muscle groups, such as the medial gastrocnemius and lateral gastrocnemius, thereby enhancing the power transfer of the one-step footwork at the end stroke phase during topspin forehand; (4) strengthen the muscle strength training of the non-dominant legs of table tennis players to reduce the risk of sports injuries.

References

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