KINETIC EFFECTS ON THE LOWER EXTREMITY DURING PLYOMETRIC JUMP

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INTRODUCTION: Plyometric exercises are a series of cyclical activities of muscle stretch and shortening. Jumping and landing are the major movements of plyometric exercises. Previous researches reported that the plyometric training can increase the proprioception in lower extremities. It also reported that plyometric jump exercise has great assistance to increase muscle strength of lower limbs. However, a few of published researches had studied the joint loading of lower limbs in each movement of plyimetric jump. Understanding of the loading on the lower limbs is greatly helpful to decide the proper exercise prescription for the subjects who had suffered musculoskeletal injury and in the period of rehabilitation. The purpose of this study is to estimate the joint kinetics of lower limbs in depth jump.

METHOD: Twenty-four healthy subjects (age: 21.7±1.0 years; body height: 167.0±7.0 cm; body weight: 61.5±13.5 kgw) were recruited in this study. Each subject was asked to perform the movement of depth jump in the motion analysis laboratory. The subject was asked to step off a 15-cm box, landing on the floor with both feet. As rapidly as possible, the patient should jump upward as high as he/she can. Twenty-one reflective markers (modify from Helen Hayes Marker Set) were placed on bilaterally of the lower limbs. The VICON612 motion analysis system was used to collect the trajectories of the markers at 250 Hz. Two AMTI force plate were used to record the ground reaction forces and moments at 1000 Hz sampling rates. Five useful repetitions were collected for each testing condition at least. Euler angles are used to describe the orientation of a distal segment reference frame relative to a proximal segment reference frame. Inverse dynamic method was used to calculate the joint forces and joint moments of the lower limbs.

RESULTS:

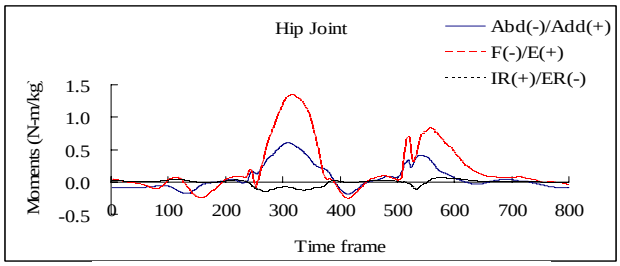

Figure 1a: The joint moments of hip

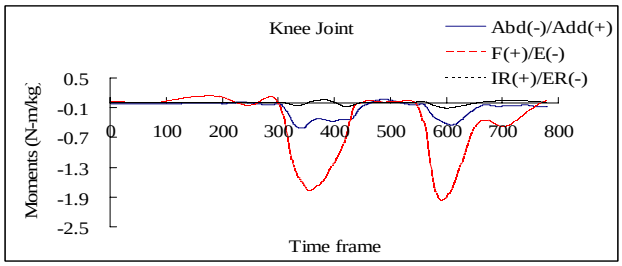

Figure 1b: The joint moments of knee

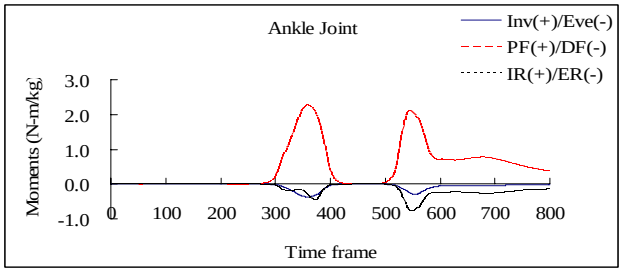

Figure 1c: The joint moments of ankle

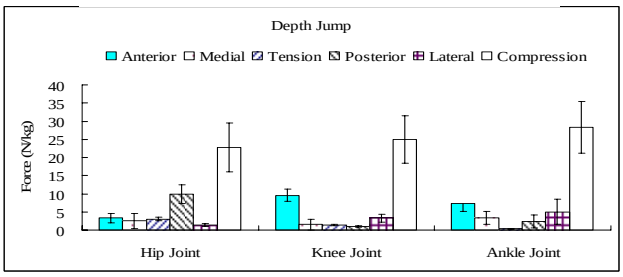

Figure 2: The maximum joint forces of hip, knee and ankle joints during depth jump

DISCUSSION: During the first and second landing, the hip extensor, knee extensor and ankle plantarflexor are dominant muscle groups (fig.1a-c). The compression forces of hip, knee, and ankle joints reached 23~30 N/kg. Also, the knee joint forces in anterior direction and hip joint forces in posterior direction reached 10 N/kg. (fig.2) It implies that the anterior cruciate ligament (ACL) suffers large tension during landing if the strength of hamstring is not enough to maintain knee joint's stability. In clinical situations, the non-contact ACL injury is also one of the most common knee injuries in landing (Boden, et al., 2000).

CONCLUSION: Hip extensor, knee extensor and ankle plantarflexor are the major training muscle groups in depth jump of plyometric exercise. The anterior cruciate ligament suffers large tension during landing if the strength of hamstring is not enough to balance external loading and maintain knee joint's stability.

REFERENCES:

Boden, B.P., Dean, G.S., Feagin, J.A. &Garrett, W.E. (2000). Mechanisms of injury in the anterior cruciate ligament. *Orthopedics.* 23, 573-8.