BIOMECANICS OF THE LOWER LIMBS IN RELRVÉ EN POINTÉ OF CLASSIC BALLET

Akiko Imura and Takeji Kojima

Department of Life Sciences, Graduate School of Arts and Sciences, The University of Tokyo, Tokyo, Japan

KEY WORDS: ballet, pointé, kinetics, electromyogram

INTRODUCTION: Relevé en pointé of classic ballet is a technique of standing on tiptoe with hard ballet shoes (Fig.1). Foot and ankle injuries caused by the motion have troubled dancers (Keryl, 2006). Though mechanics of the ankle joint have been investigated, lower limb mechanics have not been analyzed yet (Lin et al., 2005). In addition, muscle activities of the lower limbs have not been focused on. The purpose of this study was to investigate mechanics of the hip and knee joints besides the ankle joint in relevé en pointé.

METHOD: Relevé en pointé was performed by eight healthy female classic ballet dancers with markers, and it was recorded using five high speed video-cameras (Fig.1). The ground reaction forces acting on both feet and the surface electromyograms (EMGs) from some muscles of the right leg were recorded simultaneously. Then, joint angular velocities and torques of both hip, knee and ankle joints were determined. Activation level of each muscle during the motion was estimated from the EMG in maximum voluntary contraction.

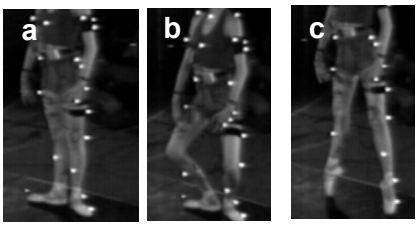

Fig.1 Sequential views of the relevé en pointé. a: standing in the first position of the legs in ballet. b: bending of the legs. c: standing on tiptoe (relevé en pointé).

RESULTS AND DISCUSSION: The kinematics of the ankle joint and the peak plantarflexion torque were comparable with those of the previous study (Lin et al., 2005). The peak hip extension and adduction torques were about 2 times larger than those of the knee extension and plantarflexion torques. This result is not comparable with the torque exertion in submaximal vertical jumps where the hip extension torque was less than the knee extension and plantarflexion torques (Vanrenterghem et al., 2004). This might be due to the difference in lower limb configuration between relevé en pointé and the vertical jump. The activation of the biceps femoris through the motion would contribute to the hip extension and adduction. Co-contraction was observed around the knee joint. The quadriceps would contribute to the push off of the floor, and then would contribute to keeping the lower limb straight during the pointé (Fig.1c) while the knee flexors, the hip extensors and adductors would prevent a lateral sliding of both legs. The maximal activation of the medial head of the gastrocnemius through the motion would also contribute to the push off and the prevention while the activity of the soleus began to decrease before the start of upward motion. Further study is needed to clarify the role of the soleus in relevé en pointé.

CONCLUSION: The hip extensors and adductors largely contributed to the upward motion in relevé en pointé. The knee extensors would keep the alignment of the lower limbs. The biceps femoris and medial head of the gastrocnemius would contribute to both movements.

REFERENCES:

Keryl, M.V. (2006). Dance-related injury. *Physical Medicine and Rehabilitation Clinics of North America*, 17, 697-723.

Lin, C.F., Su, F.C., & Wu, H.W. (2005). Ankle biomechanics of ballet dancers in relevé en pointé dance. *Research in Sports Medicine*, 13, 23-35.

Vanrenterghem, J., Lees, A., Lenoir, M., Aerts, P., & DeClercq, D. (2004). Performing the vertical jump : Movement adaptations for submaximal jumping. *Human Movement Science*, 22, 713-727.