The Effects of Plyometric Versus Dynamic Stabilization and Balance Training on Lower Extremity Biomechanics

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INTRODUCTION

Females who participate in pivoting and jumping sports suffer anterior cruciate ligament (ACL) injuries at a 4 to 6-fold greater rate than males participating in the same sports. Neuromuscular training protocols that combine plyometric and dynamic stabilization and balance exercise components have been shown to significantly alter potentially hazardous lower limb biomechanics and reduce ACL injury risk in female athletes [1-4]. Currently, no studies have compared the effects of plyometric and dynamic stabilization training as a means to delineate the mechanism behind the successful modification of female biomechanics linked to ACL injury risk. The purpose of the current study was to compare the effects of maximum effort plyometric training (PLYO) versus dynamic stabilization and balance training (BAL) on female lower extremity kinematics during a drop vertical jump (DVJ) and a single leg medial drop landing (MDL). Specifically, we examined the effects of each training mode on resultant frontal and sagittal plane motions during each of these tasks, which incorporate potential high-risk neuromuscular control effects[1, 3].

METHODS

Eighteen high school female athletes were randomized into one of two (BAL or PLYO) training (3 X/week) regimens for 7 weeks. The BAL (n=10) group performed dynamic stabilization and balance exercises and the PLYO (n=8) group performed maximum effort jumping and cutting tasks during training. Subjects had lower extremity (bi-lateral) three-dimensional (3D) kinematics data recorded during the execution of three DVJ and three MDL tasks, pre and post training. The 3D coordinates of external skin markers were recorded at 240 HZ during each trial using a high-speed motion analysis system (Motion Analysis, Santa Rosa CA). These data were submitted to Mocap Solver 6.17 to solve for each lower limb rotational degree of freedom. Ground reaction force data for each leg were collected at 1200Hz via AMTI force plates and used to normalize joint kinematic data to stance. Coronal and sagittal plane kinematics were calculated for the hip, knee and ankle. A mixed design ANOVA was utilized to test for the main effects of gender, task and side with alpha level of 0.05.

RESULTS AND DISCUSSION

During the DVJ, both PLYO and BAL training reduced initial contact (IC) (p=0.002), and maximum hip adduction angle (p=0.015) and maximum ankle abduction angle (p=0.02). When performing the MDL, both groups decreased IC (p=0.002) and maximum knee abduction angle during stance (p=0.038). While each training approach had a similar impact on coronal plane measures, distinct training effect differences were observed for the sagittal plane. . Specifically for PLYO training significantly increased maximum hip (p=0.041) and knee (p=0.031) flexion during DVJ tasks but not during the MDL (Figure 1A). Conversely, BAL training increased knee

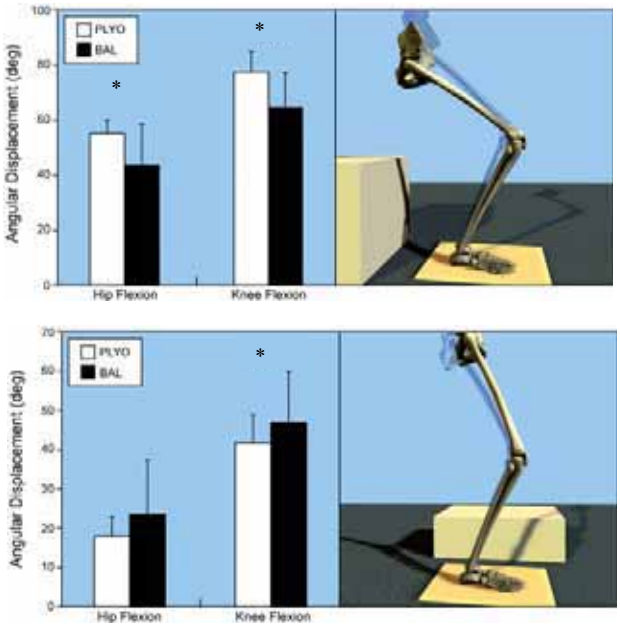

Figure 1. Effect of BAL (solid) and PLYO (transparent) training on hip and knee flexion during (A) DVJ and (B) MDL tasks.

(p=0.005) flexion during the MDL but not during the DVJ (Figure 1B). The results of the current study demonstrate that a reduction in lower limb dynamic valgus can be achieved via both PLYO and BAL training. The impact of each type of training exercise on potential sagittal plane risk factors however, appear to be most pronounced during movement tasks that incorporate similar underlying neuromuscular requirements (plyometric versus stabilization). If the ACL injury mechanisms is indeed governed by both coronal and sagittal neuromuscular factors therefore, then the inclusion of both BAL and PLYO training components appear warranted

CONCLUSIONS

The results of the current study do not support excluding either plyometrics or dynamic stabilization exercises from an ACL injury prevention protocol. Future research should evaluate whether the combinatorial effects of these training methods in more detail to maximize both risk prevention and athlete compliance. Additionally, further investigation into the role of athlete awareness of potentially dangerous positions and feedback during dynamic tasks is warranted.

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