ALTERED KNEE MUSCLE REFLEX ACTIVITY DURING A CUTTING MANEUVER IS INFLUENCED BY MOTOR LEARNING NOT NEUROMUSCULAR TRAINING

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries may result from a lack of neuromuscular control during dynamic tasks. In particular, it has been suggested that an extended and abducted knee during dynamic movements may precipitate injury through increased strain within the ACL [1].

Despite the wide use of neuromuscular training protocols that focus on improving knee joint motions and stability during dynamic activities, the mechanisms that are associated with decreased incidence of ACL injury are not well understood [2].

Short-latency reflex activation of muscles may increase joint stability by effectively stiffening the joint, thus protecting against deleterious joint motions during dynamic movement [3]. The primary purpose of this was study was to determine if neuromuscular training affects knee joint motions and reflex activation during a dynamic landing task. A secondary purpose was to determine if changes in reflex activation could account for changes in knee joint motion.

METHODS

Twenty-three healthy un-trained young adults were randomized into one of two groups (Training and Control). Training occurred three times a week over a six-week period, for a total of 18 sessions. Successful completion of the training program required completion of at least 16 training sessions. Control subjects were asked to continue their normal daily activities during the six-week period.

Neuromuscular training included the following components: core strength and balance, plyometrics, resistance, and speed training, which were derived from previous prevention techniques touted to be effective at reducing the biomechanical measures associated with ACL injury. Each training session was composed of three specific 30-minute components. Core strength and balance training was performed first in every session. The remaining components systematically varied to limit disinterest and/or fatigue of components occurring later in the session. Early training sessions were used to develop proper technique. After establishing proper technique during the initial sessions, the training protocol progressively increased the volume, duration, and intensity.

Kinematic data and EMG were recorded during pre and post-training testing sessions. Knee joint kinematics and EMG of the medial and lateral quadriceps (MQ & LQ) and hamstring (MH & LH) muscles were quantified during subject initiated jump landings that required subjects to take-off one meter behind a force platform, jump over a 17 cm, and land on their dominant foot and then aggressively jump laterally to the side away from their landing foot. Four to five successful landing trials were collected for analysis.

Kinematic data were filtered with a fourth-order Butterworth filter at 12 Hz and processed in Visual 3D software to calculate knee flexion and abduction rotations. Peak knee joint angles between heel strike and toe-off were calculated relative to the subject's static posture. EMG data were bandwidth filter (10-500Hz), rectified, smoothed with a 50ms moving-average, and normalized to % MVIC. Short-latency stretch-reflex (SLSR) activation was calculated as the average EMG activity between 30-60 ms after heel strike.

Statistical analyses consisted of separate general linear models with repeated measures that were used to test for the effects of the training protocol on peak joint angles and short-latency stretch-reflex activations. Correlation analyses were to be used as follow-up for significant treatment interactions to establish associations between variables. The α-level was set at 0.05.

RESULTS AND DISCUSSION

No significant interaction or main effects were noted for knee joint flexion and abduction angles (Table 1). Further, no significant interactions were noted for any of the short-latency stretch reflexes. The analysis did, however, indicate significant main effects between pre and post-training sessions for all short-latency stretch reflexes (Table 1). In the absence of any significant interactions, no statistical correlation analyses were performed.

The results indicate that the neuromuscular training program used in this study did not affect knee joint kinematics during the observed landing task. Surprisingly, both groups showed greater short-latency stretch reflex activations during the post-testing session. Greater reflex activation during the impact phase immediately after landing is typically associated with higher joint stiffness [4]. Lacking any changes in knee motion it is thus likely that both groups demonstrated greater knee joint stiffness after landing.

While various levels of the central nervous system could underlie the enlargement of the short-latency stretch reflexes component, it has been shown that fast segmental spinal mechanisms can mediate long-term plasticity of the sensorimotor system in response to perturbation training [5]. It was suggested that these adaptations essentially reflect the process of motor learning [5]. Since increases in the short-latency stretch reflex components were observed in both groups, it is thus likely that a learning effect mediated changes in reflex activation levels such that upon second exposure to the landing task both groups performed the task with similar joint motions, but greater short-latency stretch reflexes to increase joint stiffness and stability.

CONCLUSIONS

The neuromuscular training program did not affect knee joint kinematics. Although we observed greater short-latency stretch reflex activations during the post-testing sessions in all muscles, the fact that this effect was noted in both groups likely indicates a learning effect.

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Table 1: Pre and post-training knee joint angles (°) and short-latency stretch reflexes (%MVIC) for the control and experimental group.

	Control Group		**Training Group**	
	Pre-training	**Post-training**	**Pre-training**	**Post-training**
Knee Flexion	54.8 ± 7.2	53.8 ± 6.6	59.2 ± 5.9	59.1 ± 7.7
Knee Abduction	13.6 ± 7.2	13.8 ± 5.0	12.6 ± 5.0	12.7 ± 4.9
LQ	2.0 ± 0.6	3.4 ± 3.3*****	2.3 ± 0.7	3.7 ± 2.1*****
MQ	2.2 ± 0.6	3.3 ± 2.3*****	2.6 ± 1.5	4.5 ± 2.9*****
LH	0.5 ± 0.4	1.2 ± 1.0*****	0.4 ± 0.2	1.0 ± 0.8*****
MH	0.4 ± 0.2	0.8 ± 0.7*****	0.4 ± 0.3	0.8 ± 0.7*****

***** $p < .05$ vs. Pre-training