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Changes in Neuromuscular Coordination with Jump Training After ACL Reconstruction

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Of the nearly 200,000 young athletes who undergo anterior cruciate ligament (ACL) reconstructive surgery every year in the United States, approximately half will be diagnosed with early-onset osteoarthritis within 10-15 years. Chronic impairments in mechanics and neuromuscular coordination are thought to decrease the ability of the knee to attenuate forces and accept weight during high-demand activities such as landing from a jump or hop. Specifically, decreased knee bending and a concomitant increase in co-contraction of the anterior and posterior thigh musculature are thought to increase compressive forces during landing. While brief instruction has been found to elicit a transient improvement in mechanical and neuromuscular behaviors in landing, there has been limited research into the effect of extended jump training in this population. No research has been done into the extent to which co-contraction can be modified with training, thereby ameliorating the risk of early-onset osteoarthritis.

PURPOSE: To determine the effects of a best-practice jump training program on mechanical and neuromuscular behaviors in people with impaired weight acceptance following ACL reconstruction.

METHODS: Twenty-five subjects completed a biomechanical screening evaluation (Wk0) of a single leg land from a 20 cm platform utilizing an 8-camera motion capture system with dual force plates. Peak vertical ground reaction force (VGRF) and peak internal extension moment during landing were both normalized to body weight (BW). They and peak knee bending in degrees served as a measure of performance. Quadriceps and hamstring recruitment were analyzed using surface electromyography (sEMG) and normalized to maximum voluntary isometric contraction. Instantaneous hamstring/quadriceps co-contraction was defined as the ratio of the two muscles multiplied by the sum of their activations with a minimum of 0 and maximum of 1. The instantaneous co-contraction was integrated over the weight acceptance phase of landing to generate a co-contraction index (CoI) with a minimum of 0 and maximum of 100. Fifteen subjects were found to have deficits in mechanical function and were enrolled in an 8-week training program. These subjects underwent twice-weekly jump training sessions, with re-testing utilizing the same protocols at mid-training (Wk4), immediately post-training (Wk8), and two months after training (Wk16). The change in kinematic and kinetic variables as well as CoI were analyzed with paired t-tests with a priori significance set to $p=0.05$.

RESULTS: As of this writing, 14 subjects had completed Wk4 and Wk8 testing. One subject left the study after Wk4. Six had completed Wk16 testing. CoI decreased significantly with training (mean±SD; Wk0: 38.3±16.1; Wk4: 24.4±14.9 ($p=0.003$); Wk8: 21.3±11.3 (Wk0-Wk8 $p=0.0003$)). Peak knee flexion increased significantly with training as well (Wk0: 58.0°±10.9°; Wk4: 68.0°±10.1° ($p=0.0004$); Wk8: 73.3°±7.9° (Wk4-Wk8: $p=0.037$; Wk0-Wk8: $p<0.0001$)). Peak knee moment did not change significantly, but peak VGRF decreased significantly over the training period (Wk0: 3.6±0.4 BW; Wk4: 3.4±0.3 BW ($p=0.08$); Wk8: 3.2±0.3 BW (Wk4-Wk8: $p=0.007$; Wk0-Wk8: $p<0.0001$)).

DISCUSSION: All mechanical and neuromuscular variables responded to training as expected. While jump training following ACL reconstruction has been recommended, only one other study has demonstrated its effectiveness in ameliorating mechanical risk factors for re-injury and osteoarthritis in this

population. We are unaware of another study demonstrating effectiveness in changing neuromuscular behaviors that can increase compressive loads and thereby increase the risk of osteoarthritis. At this time, extensive jump training following ACL reconstruction is uncommon, with most athletes released to practice based on time from surgery or strength symmetry. These results underscore the need for more extensive rehabilitation to improve long-term outcomes for these young athletes.