Title: Neuromuscular Differences in Female Athletes Following ACL Reconstruction: Exploring Differences in Leg Dominance: A Systematic Review

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Background:
Anterior cruciate ligament (ACL) injury and subsequent re-injury after reconstructive surgery has become a popular topic of discussion in the athletic population. Female athletes have a 2-10 times greater incidence of noncontact ACL injuries to their male counterparts with nearly 68% of female soccer players injuring their nondominant side, in comparison to only 26% of male soccer players.[1,2] It was hypothesized that there are neuromuscular differences between the nondominant and dominant limb in female athletes that predispose them to an increased risk of injuring the nondominant limb compared to the dominant limb. Few studies have examined the relationship between limb dominance and ACL re-injury risk in female athletes.[3-7] These disparities are not well understood with several studies theorizing that biomechanical and neuromuscular differences are contributing factors.[1-7, 9-15]

Individuals who receive reconstructive surgery and physical rehabilitation are still at a 5-15 times greater risk of subsequent ACL re-injury.[8] These same pre-surgical biomechanical faults in conjunction with neuromuscular deficits following an anterior cruciate ligament reconstruction (ACLR) exist between the dominant and nondominant limb.[2, 6, 9] This may predispose the recurrence of an ACL injury in the female population. The purpose of this systematic review was to determine if there are existing neuromuscular differences between the dominant and nondominant limb of patients with ACLR, how these differences may impact the incidence of ACL re-injury in female athletes, and which interventions are most appropriate in addressing these neuromuscular differences.

Methods:

1. Data Sources:

The following databases were searched: PEDro, PubMed, and EBSCO which included Academic Search Premier, MEDLINE, SPORTDiscus, CINAHL, Biological Abstracts, Health Source: Nursing/Academic Edition, Professional Development Collection, and Teacher Reference Center. Research papers were identified by including search terms for neuromuscular control, ACL, and limb dominance.

2. *Inclusion Criteria:*

Studies were included if they addressed our clinical problem, included females, were written in the English language, and the articles were published within the last 10 years.

3. Study Appraisal and Synthesis Methods

A modified version of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used to rate methodological quality and PEDro was used to rate Randomized Control Trials. Articles were assessed independently by two reviewers and any discrepancies in scores were reviewed by a third party. Studies were included if they scored ≥ 7 on both the STROBE and PEDro scales.

Results:

Fourteen articles were included in the review. We found that females exhibited compensatory patterns, including increased lateral trunk flexion, femoral adduction and knee valgus as well as decreased hip and knee flexion.[3-4,10] Impaired proprioception at the tibiofemoral joint, poor postural control with aberrant movement patterns and neuromuscular control differences of the lower extremity that impacted joint kinematics following an ACLR.[10] Gait differences in the dominant and nondominant limbs are exhibited as a result of these altered lower extremity biomechanics. Five articles discussed interventions that were beneficial following an ACLR.[11-15] Neuromuscular, perturbation, and plyometric training programs were found to be effective interventions in improving knee stabilizing strategies, as well as, the overall Q:H ratio post-ACLR.[11-15] Furthermore, whole body vibration therapy has been shown to improve postural control, kinematics, and strength in people post-ACLR.[11]

Conclusion: Neuromuscular differences exist between the dominant and nondominant limb in female athletes that may predispose them to ACL re-injury following an ACLR. These neuromuscular differences include biomechanical positioning that places the ACL under greater stress, compensatory strategies to decrease stress on the ACL of the involved side, and decreased postural control and proprioception following reconstruction. Poor kinematic risk factors for ACL re-injury can be improved through various interventions and muscle re-education strategies that target increased neuromuscular control. Further investigation into defining limb dominance is necessary to stratify the direct impact of limb dominance on the recurrence of an ACL injury following an ACLR.

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