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Association of Quadriceps and Hamstrings Cocontraction Patterns With Knee Joint Loading

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Context: Sex differences in neuromuscular control of the lower extremity have been identified as a potential cause for the greater incidence of anterior cruciate ligament (ACL) injuries in female athletes compared with male athletes. Women tend to land in greater knee valgus with higher abduction loads than men. Because knee abduction loads increase ACL strain, the inability to minimize these loads may lead to ACL failure.

Objective: To investigate the activation patterns of the quadriceps and hamstrings muscles with respect to the peak knee abduction moment.

Design: Cross-sectional study.

Setting: Neuromuscular research laboratory.

Patients or Other Participants: Twenty-one recreationally active adults (11 women, 10 men).

Main Outcome Measure(s): Volunteers performed 3 trials of a 100-cm forward hop. During the hop task, we recorded surface electromyographic data from the medial and lateral hamstrings and quadriceps and recorded lower extremity kinematics and kinetics. Lateral and medial quadriceps-to-hamstrings (Q:H) cocontraction indices, the ratio of medial-to-lateral Q:H cocontraction, normalized root mean square electromyographic data for medial and lateral quadriceps and hamstrings, and peak knee abduction moment were calculated and used in data analyses.

Results: Overall cocontraction was lower in women than in men, whereas activation was lower in the medial than in the lateral musculature in both sexes ($P < .05$). The medial Q:H cocontraction index ($R^2 = 0.792$) accounted for a significant portion of the variance in the peak knee abduction moment in women ($P = .001$). Women demonstrated less activation in the vastus medialis than in the vastus lateralis ($P = .49$) and less activation in the medial hamstrings than in the lateral hamstrings ($P = .01$).

Conclusions: Medial-to-lateral Q:H cocontraction appears to be unbalanced in women, which may limit their ability to resist abduction loads. Because higher abduction loads increase strain on the ACL, restoring medial-to-lateral Q:H cocontraction balance in women may help reduce ACL injury risk.

Key Words: neuromuscular system, biomechanics, landings, anterior cruciate ligament, coactivation

Key Points

- The medial-to-lateral quadriceps-to-hamstrings cocontraction ratio was unbalanced in women, which may have contributed to their higher knee abduction loads.
- The women in our study had larger external peak abduction moments than their male counterparts during the forward hop task.
- Balancing medial-to-lateral quadriceps-to-hamstrings activation in women may help resist the abduction loads about the knee and may help to diminish the risk of anterior cruciate ligament injury.

CONCLUSIONS

Medial-to-lateral Q:H cocontraction was unbalanced in women, which may contribute to higher knee abduction loads in this population. Because higher abduction loads increase strain on the ACL, restoring medial-to-lateral Q:H cocontraction balance in women may help to reduce ACL injury risk.