The Role of the Hip Abductor to Adductor Ratio in Increasing Braking Impulse Asymmetry: A Field Study in Female Athletes

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INTRODUCTION

Braking impulse refers to the cumulative force applied over time to slow the body during high-speed actions such as sprinting, jumping, cutting, and landing. It plays a key role in athletic performance and injury prevention, especially in sports that demand quick changes of direction and explosive movements. Efficient braking requires coordinated eccentric control from the hip, knee, and ankle to properly absorb ground reaction forces. Research by McLean et al. (2004) indicates that improper absorption of these forces may lead to non-contact injuries. More recent findings by Donelon et al. (2020) further associate poor braking mechanics with increased knee joint stress and higher knee abduction moments—risk factors linked to ACL and other lower limb injuries.

OBJECTIVE

This study investigates how the balance between hip abductor to adductor strength relates to braking impulse asymmetries in collegiate women's soccer players. Considering the sport's physical demands, identifying how hip strength imbalances influence deceleration strategies may provide valuable insights into performance and injury risk. By analyzing the correlation between the ABD:ADD ratio and braking asymmetry, this research explores whether hip muscle imbalances contribute to uneven braking forces. The findings aim to inform strength and conditioning practices, emphasizing individualized approaches to reduce injury risk and enhance biomechanical efficiency in female athletes.

METHODS

This study used preseason sports testing data from the Division II Women's Soccer team at Point Loma Nazarene University. Female participants (age: 22.5 ± 1.5 years, height: 166.7 ± 8.8 cm, body mass: 60 ± 10.5 kg) completed a countermovement jump (CMJ) and isometric strength tests for hip abduction (ABD) and adduction (ADD). BI asymmetry was measured during a CMJ on force plates (Hawkin Dynamics, USA) sampling at 1000 Hz. Hip abductor and adductor strength were assessed with the VALD ForceFrame. The ABD:ADD ratio was calculated for both the left and right legs, along with overall asymmetries for abduction and adduction strength. Pearson correlation analysis was used to explore potential relationships between hip strength metrics and eccentric force metrics from the CMJ test. ABD:ADD strength asymmetry showed the strongest relationship to L/R BI.

RESULTS

The ABD:ADD ratio was calculated for both legs. BI asymmetry was classified as above or below the 50th percentile to distinguish between greater and lesser asymmetry. Directionality was standardized so that positive BI values represented right-leg dominance and negative values indicated left-leg dominance. A strong inverse correlation was found between the ABD:ADD ratio and BI asymmetry ($r = -0.82$; $p < 0.01$), with an R^2 value of 0.67.

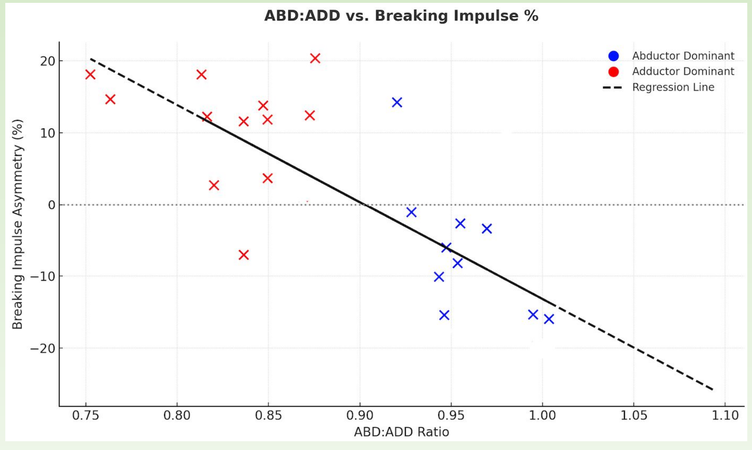

Figure 1: Relationship Between Hip ABD:ADD Ratio and Braking Impulse Asymmetry (%)

CONCLUSION

These findings suggest that a lower ABD:ADD ratio is linked to greater BI asymmetry, which may increase injury risk. Monitoring strength imbalances and braking mechanics throughout the season could provide insights into their relationship to injuries. Since braking impulse is influenced by kinetic variables, targeted strength training can help optimize deceleration mechanics and reduce injury risk. By training athletes to decelerate efficiently, control landing forces, and execute safer cutting mechanics, the risk of knee and lower extremity injuries can be minimized.

PRACTICAL APPLICATIONS

- Coaches and sports performance staff can use ABD:ADD ratio screening to identify athletes with hip strength imbalances and implement individualized strengthening programs,
- Targeted abductor strengthening may reduce braking impulse asymmetry and improve landing/cutting mechanics.
- Future research could incorporate force plates and agility or change-of-direction drills to evaluate braking impulse to understand of how hip strength imbalances affect deceleration and cutting mechanics during game-like scenarios.

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