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The Influence of Exercise on Single Leg Jump-Cut and Double Leg Jump Landing Biomechanics

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Background

- Anterior cruciate ligament ruptures are frequently noncontact in nature and most commonly occur during deceleration motions.[1]
- It is estimated that there are over 200,000 anterior cruciate ligament (ACL) tears in the U.S. each year with an estimated cost of $4 billion in reconstruction and rehab costs combined.[2,3]
- Neuromuscular fatigue is thought to contribute to the higher incidence of lower extremity injuries that occur during the later stages of sporting events[4], and is associated with changes in lower extremity landing biomechanics that likely increase ACL injury risk[5]
- In the frontal plane specifically, greater knee valgus angle at initial contact and greater peak knee valgus angle and knee varus moment have been shown prospectively to predict ACL injury.[6]
- While these factors are important with respect to injury risk, the type of task (i.e., single vs. double leg landing) used has been shown to influence frontal plane landing biomechanics.[7]
- It is not known whether any potential changes in frontal plane biomechanics caused by neuromuscular fatigue are the same for each type of task.
- Therefore, the purpose of this study was to compare single leg jump-cut and double leg jump landing biomechanics before and after the completion of a standardized exercise protocol.

Materials and Methods

Participants

- 31 Female Volunteers between the ages of 18-30 years old
  - No current injuries or illness that limits their ability to perform regular physical activity
  - No history of lower extremity or back surgery in the last 6 months
  - No history of low back, hip, knee, or ankle surgery
  - No previous ACL injury
  - Physically active a minimum of 150 minutes of moderate to vigorous physical activity a week
  - Previously has participated in a physical activity involving cutting or jumping motion in the last 6 months

Instrumentation

- Kinematics
  - Nine camera motion capture system (Vicon, Inc.) using a standard retroreflective marker set (25 static, 21 dynamic) sampled at 120 Hz
- Kinetics
  - Two type 4060-08 force plates (Bertec Corp.) sampled at 1,560 Hz

Procedures

Participants performed 2 different landing tasks:

1. Double leg landing from a 30 cm high box placed at a distance of 50% of the subject's height from the edge of two force platforms.
2. Single Leg jump-cut over a small hurdle from a distance equal to 50% of the subject's height.

- Participants completed 5 jump landing trials for each task before completing a standardized exercise protocol lasting 30 minutes. The protocol consisted of 6 cycles of treadmill walking at self-selected speed between 3.0-3.5 mph for 5 minutes followed by a minute of jumping activities.
- Following the exercise protocol, participants immediately repeated the two landing tasks.

Outcome measures and statistical analyses

- Peak internal knee varus moment, peak knee valgus angle, and frontal plane hop and knee angles at initial contact
- Mean values across trials during the Pre and Post-exercise conditions were calculated for each dependent measure
- Paired-samples *t*-tests were used to compare landing biomechanics between conditions

Results

	Double Leg Jump			Single Leg Cut-Jump		
	Pre	Post	P-value	Pre	Post	P-value
Peak Internal Knee Varus (Nm)	20.9±15.3	21.4±14.7	0.336	9.7±11.5	9.9±13.6	0.426
Frontal Plane Knee Angle (°)	-1.9±2.9	-2.0±2.9	0.315	-2.5±3.4	-2.7±3.3	0.309
Peak Knee Valgus Angle (°)	-7.3±6.9	8.1±6.2	0.127	-6.6±5.6	-7.2±5.5	0.174
Frontal Plane Hip Angle at Initial Contact (°)	-7.1±3.7	6.9±3.7	0.366	-11.3±4.0	-11.7±4.9	0.274

Table 1. Means ± SDs for frontal plane biomechanical variables of interest Pre- and Post-Exercise. There were no significant changes in any of these landing biomechanics for either task ($p > 0.05$).

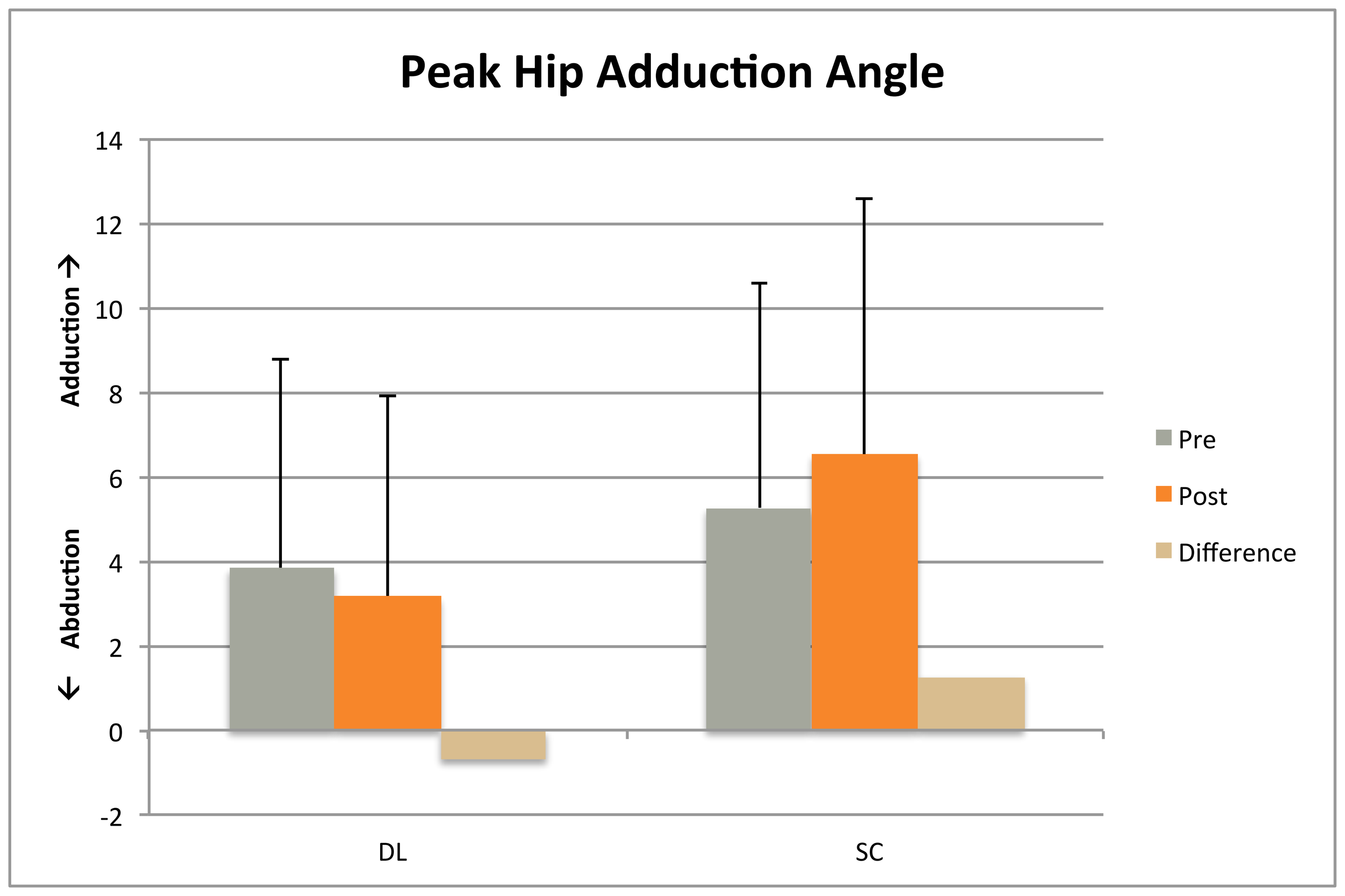

Figure 1. Peak hip adduction angle during the double leg (DL) and side-cut (SC) landing tasks. Participants were relatively less abducted following exercise during the DL task ($p = 0.042$), but were more abducted following exercise during the SC task ($p = 0.027$)

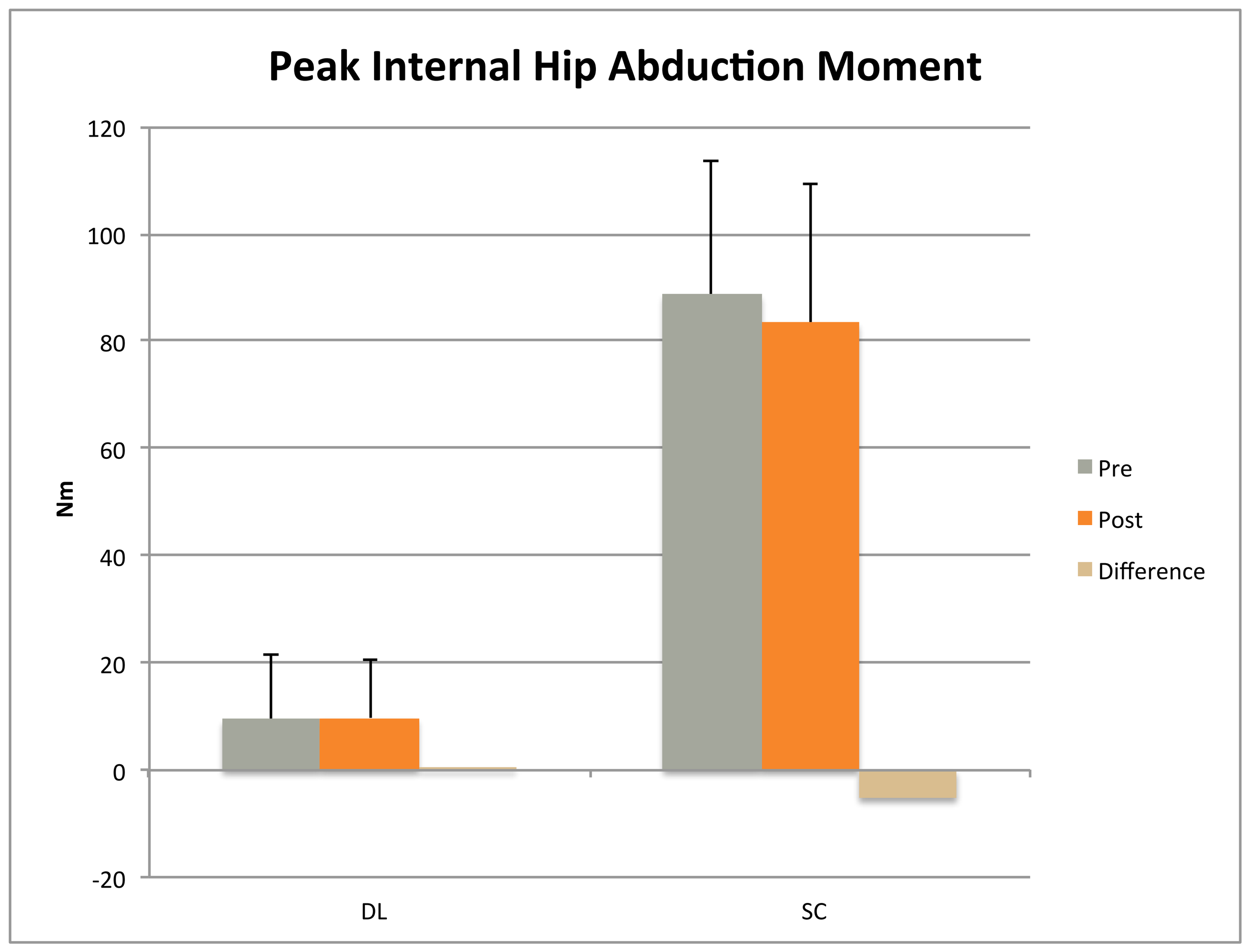

Figure 2. Peak internal hip abduction moment during the double leg (DL) and side-cut (SC) landing tasks. While the peak hip abduction moment was not different pre- and post-exercise for the DL task ($p > 0.05$), the moment requirement during SC significantly decreased post-exercise ($p = 0.04$)

Conclusions

- Contrary to our hypotheses, we observed very few changes in frontal plane landing biomechanics during either task following exercise.
- While peak hip adduction angle and internal hip abduction moment achieved statistical significance, the absolute magnitude of the changes likely has no clinical relevance with respect to ACL injury risk.
- Given previous research that has shown biomechanical changes in landing mechanics following exercise, it is possible that the lack of expected findings could be the result of:
  - Subjects not being adequately fatigued through the exercise protocol
  - Too much time elapsing between finishing the exercise protocol and the Post Exercise Testing such that any fatigue effects were mitigated, or
  - Trunk compensations by subjects following fatigue which was noticed anecdotally during testing

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