Apr 21st, 1:00 PM - 3:00 PM

Influence of Holding a Lacrosse Stick on Landing Mechanics

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EXERCISE SCIENCE
SACRED HEART UNIVERSITY

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ABSTRACT

Female athletes are at an increased risk for anterior cruciate ligament (ACL) injuries by noncontact mechanisms (Beutler et al., 2009). Women's lacrosse is one of the fastest growing sports, rendering a need for increased attention to potential factors of these injuries (Dick et al., 2007). **PURPOSE:** This is the first study to use the Landing Error Scoring System (LESS) to study the effect of holding a lacrosse stick (Mihata et al., 2006) and will provide normative data. **METHODS:** The LESS was used on 20 collegiate women's lacrosse players (19.7±1.4 yo, 60.8±5.6 kg, 1.66±0.06 m) to examine jump landing mechanics with a lacrosse stick (WS) versus without (WO). Participants jumped forward off a 30-cm box to a spot on the floor 50% of their body height, and performed a maximal vertical jump upon landing. Hi-speed video (240Hz) was recorded in the sagittal and frontal planes. Sixteen biomechanical criteria were subsequently scored. **RESULTS:** There was a significant relationship between poor landing mechanics and holding a lacrosse stick reflected in the LESS scores (WS=4.6±0.63, WO=3.55±0.73, p<0.05). At initial contact, knee flexion (WS=27.6°±3.5°, WO=30.2 °±4.06°, p<.0.01), hip flexion (WS=28.8°±3.2°, WO=31.7°±3.1°, p<0.01), and trunk flexion (WS=14.1° ±5.7°, WO=17.9 °±5.5°, p<0.01) angles were significantly reduced when landing with a stick. Joint flexion displacement, however, was not significantly different (p>0.05). **CONCLUSIONS**: Holding a lacrosse stick caused participants to receive a higher LESS score and land with a less flexed knee, hip, and trunk, indicating poor landing mechanics and a potentially increased risk of a non-contact ACL injury.

How common are non-contact ACL injuries?

- Approximately 80,000 people sustain an ACL injury each year, occurring primarily in individuals 15-20 years old who participate in pivoting sports[9]
- 70% of all of these ACL injuries in sports are the result of a non-contact mechanism [8]
- High-risk mechanisms for noncontact ACL injuries are a part of most sports and include: sudden deceleration, cutting, and jumping [5]

Does arm positioning have an effect on landing mechanics?

- Landing during different sports require varied arm position, altering the loading of the lower extremities [4]
- A study on football players showed that landing with arms away from the landing limb caused decreased hip flexion and increased ankle dorsiflexion, both risk factors for ACL injury [4]
- In a different study, constraining the plant side arm during a sidestep cutting maneuver significantly influenced valgus moment on the knee [2]
- These findings suggest that preventing weight from being evenly distributed through plant side arm movement causes high risk landing patterns

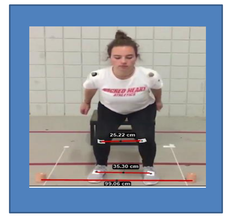
PARTICIPANTS

- 20 division 1 collegiate women's lacrosse players volunteered
  - 19.7±1.4 yo, 60.8±5.6 kg, 1.66±0.06 m
- Experienced lacrosse players (10.15 ± 2.3 yrs)
- Prior Jump Landing Training
  - Players were members of the same team, and as such received the same lifting program and instruction prior to this study

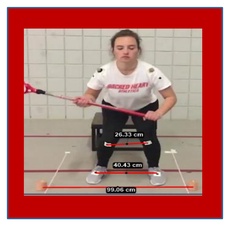
Example of a high risk cutting maneuver

METHODS

- Landing Error Scoring System (LESS) was used to evaluate two conditions
  - CONDITION 1: With a lacrosse stick
  - CONDITION 2: Without a lacrosse stick
- Participants performed a two-legged jump forward off of a 30-cm box to a spot on the floor that was exactly 50% of their body height, marked on the ground for them as a landing target. Upon landing, the participant performed a maximal vertical jump whereby they landed in approximately the same location
- Biomechanical joint angles were calculated at initial contact with the floor and at maximum flexion of the knee, hip, trunk, and ankle. Medial knee position (distance between the knees) was also measured at initial contact.



(1) (2) (3) (4)



Phases:
(1)Initial contact with floor
(2)Maximum joint flexion
(3)Take-off
(4)Medial knee position

RESULTS

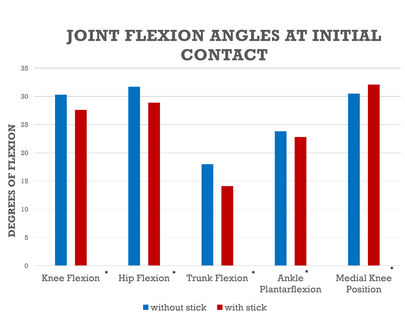


Figure 1: The presence of a lacrosse stick resulted in less flexed joint angles, and a larger medial knee position

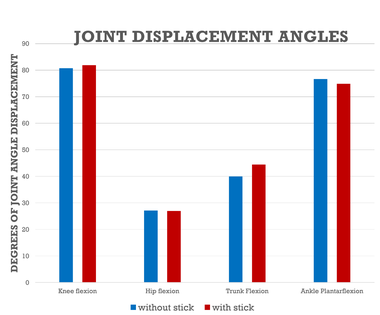


Figure 2: There was no significant differences in joint displacement between initial contact and maximum flexion

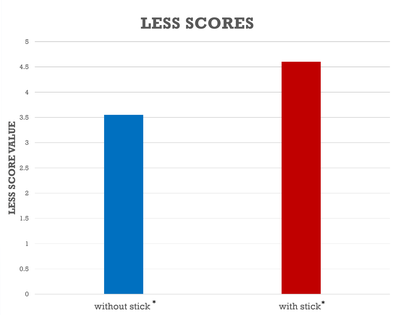


Figure 3: LESS scores were significantly higher when holding a lacrosse stick

DISCUSSION

- **Overall Landing Mechanics Score (LESS)**
  - Results when holding a lacrosse stick while landing:
    1. 12 participants landed with a **wider stance** (greater than shoulder width) in more trials while holding a stick than without
    2. 12 participants **leaned towards the dominant leg** when executing the jump, increasing loading at this knee joint
    3. **Landing asymmetrically** with the dominant foot touching first was seen in 11 participants
    4. Higher LESS scores: 1.05 higher with a stick
- **Position at Initial Contact**
  - Landed with less flexed knee, hip, and trunk joint angles with a stick, indicating poor landing technique
  - Medial knee displacement was 32.09-cm with a stick and 30.48-cm without at initial contact, indicating a wider stance upon landing, thus increasing the valgus moment at the knee
- **Joint Displacement**
  - Was not significantly different between the two conditions. Similar range of motion was achieved with both conditions
- Holding a lacrosse stick changes the arm positioning of the athlete, which may lead to riskier landing patterns at initial contact. The differences in the landing mechanics between the two conditions suggest the need for sport-specific ACL prevention programs *(i.e.* while holding a lacrosse stick).

TAKE HOME MESSAGES

In a competitive setting, the ability of athletes to land and react with proper mechanics is of utmost importance for injury prevention, as most non-contact injuries occur during the landing phase of a high risk movement[2]. This study shows that holding a lacrosse stick alters athlete's landing patterns. In these situations where the arms cannot be used for balance, athletes could compensate improperly, yielding poor landing mechanics and increasing the risk of injury.

Future research needs to be conducted on sport specific ACL prevention programs in these athletes. Lower extremity biomechanics are modifiable, and special attention should be paid to landing mechanics in sports involving arm constraints, and its effect on landing mechanics. Possible prevention plans that account for the compromised landing patterns when arm position is varied needs to be considered.

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This work was presented at the 2017 Sacred Heart University Academic Festival