Influence of Holding a Lacrosse Stick on Landing Mechanics

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ABSTRACT
Female athletes are at an increased risk for anterior cruciate ligament (ACL) injuries by noncontact mechanisms (Reutter et al., 2009). Women’s lacrosse is one of the fastest growing sports, rendering a need for increased awareness 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 (Mohamed et al., 2008) and will provide normative data. METHODS: The LESS was used on 30 North Carolina women’s lacrosse players (19.7±1.4 yo, 60.8±5.6 kg, 1.68±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 30% of their body height, and performed a maximal vertical jump upon landing. Kinesthetic video (40fps) was recorded in the sagittal and frontal planes. Fifteen biomechanical criteria were subsequently scored. RESULTS: There was a significant relationship between non-landing mechanics and holding a lacrosse stick reflected in the LESS scores (WS=4.6±1.63, WO=3.8±1.73, p<0.05). At initial contact, knee flexion (WS=27.6°±3.8°, WO=30.2°±4.0°, p=0.01), hip flexion (WS=28.8°±3.2°, WO=31.7°±3.1°, p=0.01), and trunk flexion (WS=14.1°±5.3°, WO=17.8°±5.9°, 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-ACL injury.

How common are noncontact ACL injuries?
Approximately 80,000 people sustain an ACL injury each year, occurring primarily in individuals 18-20 years old who participate in pivoting sports. 70% of all of these ACL injuries in sports are the result of a non-contact mechanism. High-risk mechanisms for noncontact ACL injuries are a part of most sports and include: sudden deceleration, cutting, and jumping.

Does arm positioning have an effect on landing mechanics?
Landing during different sports require varied arm position, altering the loading of the lower extremities. 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. In a different study, constraining the plant side arm during a sidestep cutting maneuver significantly influenced valgus moment on the knee. These findings suggest that preventing weight from being evenly distributed through plant side arm movement causes high risk landing patterns.

RESULTS

- Joint flexion angles at initial contact: The presence of a lacrosse stick resulted in less flexed joint angles, and a larger medial knee position.
- Joint displacement angles: There was no significant differences in joint displacement between initial contact and maximum flexion.
- LESS scores: 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 asymmetryically 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 32.0±6.9 with a stick and 30.48±5.9 without a stick in lateral displacement. This indicates increased 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. 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 impropriety, 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.

REFERENCES