NEUROMUSCULAR AND BIOMECHANICAL FACTORS

What We Know

1. The ACL is loaded by a variety of combined sagittal and nonsagittal mechanisms during dynamic sport postures considered to be high risk.1–6
2. In vivo strain of the ACL is related to maximal load and timing of ground reaction forces.7,8
3. Females typically display a more erect (upright) posture when contacting the ground during the early stages of deceleration tasks.9–12
4. Maturation influences biomechanical and neuromuscular factors.13–20
5. Fatigue alters lower limb biomechanical and neuromuscular factors suggested to increase ACL injury risk.2,21–23
   The effect of fatigue is most pronounced when combined with unanticipated landings, causing substantial central processing and central control compromise.24

6. Trunk and upper body mechanics influence lower extremity biomechanical and neuromuscular factors.12,25,26
7. Hip position and stiffness influence lower extremity biomechanical factors.2,10,27

What We Don’t Know

1. We still do not know the biomechanical and neuromuscular profiles that cause noncontact ACL rupture. An understanding of the causes is central to identifying how to prescreen at-risk individuals.
2. We do not yet understand the role of neuromuscular and biomechanical variability in the risk of indirect or noncontact ACL injury. Are there optimal levels of variability, and do deviations from these optimal levels increase the risk of injury?
3. Is noncontact ACL injury an unpreventable accident stemming from some form of cognitive dissociation
that drives central factors and the resulting neuromuscular and biomechanical patterns?

4. Is gross failure of the ACL caused by a single episode or multiple episodes?

5. Is noncontact ACL injury governed by single or potentially multiple high-risk biomechanical and neuromuscular profiles?

Where We Go From Here

1. To best understand movement patterns linked to noncontact ACL injury, authors should include comprehensive kinetic, kinematic, and neuromuscular (strength, postural stability, activation, and timing) profiles (henceforth referred to as neuromechanics).

2. We need to improve our understanding of neuromechanical variability within and between individuals as it relates to injury risk and injury mechanisms.

3. To fully appreciate joint loading profiles, we must better understand the interaction of anatomical structure, laxity, and neuromechanics.

4. Neuromechanical assessments of different tasks that mimic the mechanical demands commonly associated with sport-specific injury mechanisms should be performed with the testing methods and interpretations particular to the task demands.

5. Neuromechanical factors predicting ACL injuries need to be identified from prospective data.

6. We must develop tasks designed to stress the joint systems that mimic injury mechanisms and are realistic to the mechanistic purpose of the study. Further, musculoskeletal models describing cause-and-effect relationships need to be studied explicitly within a realistic injury scenario.

7. We should determine if a critical threshold of structural or functional weakness exists at which compensatory strategies become evident.

8. We need to continue to expand research models and analyses to include assessments of central processes (automaticity, reaction time, etc), cognitive processes (decision making, focus and attention, prior experience [expert versus novice, etc]), and metacognitive processes (monitoring psychomotor processes, etc).

9. Further understanding of the influence of the head, arms, and trunk segment on lower extremity neuromechanics is important.

10. Further understanding of the influence of the maturation process on lower extremity neuromechanics is necessary.

11. Work that translates laboratory measures to the field and field measures to the laboratory needs to be performed to help with the interpretation of field and laboratory findings. Validating commonly performed field assessment (eg, squatting, landing, etc) to known neuromechanics profiles is essential.

12. Technology must continue to advance and evolve to help us better understand in vivo mechanics, allow more precise transverse-plane measurements, and improve the accuracy and ease of use of measurement techniques in general.

REFERENCES


