Introduction

ACL injury alters knee kinematics and joint congruity, and it has been postulated but not yet proven that this increases the risk of meniscus and articular cartilage injury. Previous in vitro studies were static, required extensive knee dissection, and likely altered meniscal and cartilage contact due to insertion of pressure sensing devices.

Purpose: Develop a new cadaveric model, that is physiologically loaded, dynamic and simulates a functional activity while maintaining native knee anatomy, to investigate the effects of ACL injury on kinematics, meniscus, and cartilage properties.

Hypothesis: ACL deficiency will cause changes in knee kinematics, increase lateral meniscal translation and medial meniscal deformation, and alter cartilage contact location, strain, and area.

Methods

6 fresh human knees (ave age 44) - 6 tantalum beads in each meniscus

Dynamic loading protocol
- Custom knee rig w/ quadriceps actuator
- 100 lb axial load
- Flexion:10-60°

Trials:
- ACL-Intact
- ACL-Deficient

MRI, CT scans: anatomical modeling

Bone: Minimally invasive implantation
Meniscus: Fluoroscopic confirmation
Cartilage: Intact anatomy

Dynamic Stereo X-ray (DSX)

Outcome variables

 Bone: Knee kinematics
 Meniscus: Translation, Deformation
 Cartilage: Contact location, Strain, Contact area

ACL-deficient compared to ACL-intact

Knee kinematics:
- 2.6 mm more anterior tibial translation
- 2.2° more internal rotation

Meniscus:

Change in Meniscal Location: Medial vs. Lateral Meniscus

Cartilage:

Change in Meniscal Vertical Deformation: Medial vs. Lateral Meniscus

Cartilage:

Change in Cartilage Contact Location: Medial vs. Lateral Compartment

Cartilage Contact Area: Lateral Compartment

Conclusions

Effects of ACL-deficiency:

Knee kinematics:
- Greater anterior tibial translation
- Greater internal rotation

Meniscus:
- Increased translation, lateral more than medial meniscus
- Increased lateral meniscus vertical deformation
- Unchanged circumferential and radial deformation

Cartilage:
- More posterior contact location
- Greater change than in meniscal translation
- Decreased lateral compartment contact area
- Unchanged strain

- Greater change in translation of lateral vs. medial meniscus may explain higher incidences of acute lateral meniscus tears and chronic medial meniscus tears.
- Less cartilage contact area in lateral compartment, coupled with greater meniscal translation, may lead to early lateral compartment degeneration.
- Few cartilage changes observed may support the theory that cartilage injury occurs after meniscal degeneration.
- This new, viable, dynamic in vitro model allows the study of knee kinematics, meniscus function, and cartilage contact, and can be applied to evaluations of different pathologies and surgical techniques.

References

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