Associations Between Preoperative Tibiofemoral Articular Cartilage Composition and Cumulative Loading 2 Months Following ACL Reconstruction

Banks Cisne, Elizabeth Bjornsen, Jamison Dorsey, Caroline Lisee, Brian Pietrosimone

Department of Exercise and Sport Science, University of North Carolina at Chapel Hill

**BACKGROUND**

- Lower proteoglycan density (PGD) of the tibiofemoral articular cartilage is a marker of cartilage degeneration that is of concern following ACL injury.
- Higher T1rho interlimb ratios, which indicate decreased PGD, have shown to be associated with aberrant gait mechanics at 6 months post-ACLR, including decreased vGRF.
- Cumulative joint loading is a metric characterizing both habitual loading magnitude and frequency.
- ACLR patients often display lower activity levels in comparison to healthy controls.
- Fewer steps per day after ACLR associate with a worse cartilage metabolic response to walking.
- However, it is not clear whether the initial response to ACL injury is linked to habitual loading characteristics early after ACLR.

**PURPOSE**

To determine the association between pre-operative PGD and cumulative loading 2 months post-ACLR.

**Hypothesis**

We hypothesize that higher interlimb ratios of tibiofemoral cartilage T1rho relaxation times will be associated with lower levels of cumulative loading at the 2 month timepoint following ACLR.

**METHODS**

- **Participants:** Twenty-one individuals who underwent unilateral ACLR (47.6% Female; 21.0±3.4 years old; 24.6±4.3 kg/m²).
- **Baseline T1rho MRI scans** were performed preoperatively with a Siemens Magnetom Prisma 3T PowerPack scanner using a three-dimensional fast-low angle shot T1rho sequence with a spin lock power of 500 Hz at five spin lock durations (0, 10, 40, 70 ms).
- At 2 months post-ACLR, all participants completed 5 error-free walking trials at a self-selected pace (TF100, Tractronix) across two staggered force plates (40 × 60 cm, FP406010, Bertec Corporation, Ohio, USA) embedded in the lab floor.

**Kinetic data** was sampled at 1200 Hz and low-pass filtered at 10Hz using a 4th order recursive Butterworth filter.

- **Subjects** were instructed to use a GT9 Link ActiGraph activity monitor on their right hip for 7 days at 2 months post-ACLR and the 10th day were averaged across the wear period.
- A valid wear period was identified as 3 weekdays and 1 weekend day, worn for at least 10 hours each day.

**RESULTS**

- **Table 1** presents descriptive statistics, including mean and standard deviation for each variable.
- **Figure 1** demonstrates the extraction of T1rho values from the tibiofemoral cartilage MRI scans.
- **Figure 2** illustrates weightbearing regions of the tibiofemoral articular cartilage that showed statistically significant association.
- **Figure 3** highlights the association between the T1rho ILR of the anterior LTC and cumulative loading at 2 months post-ACLR.

**DISCUSSION**

**Conclusions:**

- Greater interlimb differences in PGD in the anterior LTC are associated with lesser cumulative loading 2 months post-ACLR.
- Trends concerning the MTC appear similar to that of the LTC, but they do not exhibit statistical significance to the degree of the LTC patterns.
- Concomitant injuries and non-weightbearing status preoperatively may contribute to early compositional changes within the articular cartilage.

**Limitations:**

- The sample size was small (n=21).
- Preoperative T1rho assessments are limited in the scope of interpretation as no pre-injury scans are available to serve as a baseline measure.

**Future Research:**

- Future studies should develop interventions that address cumulative loading as a modifiable risk factor to reduce risk of post-traumatic osteoarthritis following ACLR.
- Other biomechanical metrics of interest, such as knee adduction moment, should be assessed at 2-months post-ACLR for association with preoperative T1rho relaxation times of the tibiofemoral cartilage.

**REFERENCES**


Contact Information: Banks Cisne
bcisne@live.unc.edu

Our Mission is to Explore, Educate & Engage in MUSCULAR SKELETAL INJURY PREVENTION