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## Patients Exhibit a Persistent Knee Underloading Response to Progressive Squat Demands after ACL Reconstruction

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**Abstract Text:**
***Purpose/Hypothesis:*** Progressive resistance training is standard treatment for quadriceps weakness after anterior cruciate ligament reconstruction (ACLR). It is presumed that increasing external loads will lead to increased knee loading of the ACLR limb, but maladaptive underloading of the ACLR knee may counter this assumption. We hypothesized that 1) knee underloading of the ACLR limb will be present during squatting, 2) ACLR knee underloading would be exacerbated with progressive external loads, and 3) these findings would persist over time.

**Number of Subjects:** Forty-two patients (19 men) participating in rehab for unilateral ACLR (21±5yrs of age; 74±15 kg; 1.74 ±0.09m, Tegner score=7/10±2).

***Materials and Methods***: 3- and 5-month 3D kinematic (200Hz) and kinetic (1000Hz) data were collected during 10 bilateral squats during 5 load dose conditions: full body weight, plus and minus 15% and 30% body weight. A weight vest and a custom body weight support (BWS) system were used to obtain the respective load doses. A validated musculoskeletal model estimated tibiofemoral joint contact force (TFJCF) and patellar tendon force (PTF). Repeated measures ANOVAs (LEG x LOAD DOSE x TIME; α=0.05) with Bonferroni post hoc comparisons were conducted.

**Results**: A main effect of LOAD DOSE occurred as TFJCF and PTF changed considerably between each dose (all $p<0.001$, $d>0.95$), but these forces did not change over time (all $p>0.1$). As external resistance was added, knee underloading increased for both forces (LEG x LOAD DOSE interaction, all $p\leq0.01$), with the smallest interlimb differences at -30%BW load (effect size d=0.6) and greatest at +30%BW load (effect size d= 2.4)(TABLE). There were significant LEG x TIME interactions (all $p<0.011$) for PTF and TFJCF. The ACLR TFJCF and PTF were consistently lower vs. the uninvolved leg at every load dose at 3MO and 5MO (all $p<0.001$, TABLE). Uninvolved TFJCF and PTF decreased between 3mo and 5mo for each load dose (all $p\leq0.04$), but the ACLR limb remained unchanged over time for any of the load doses (all $p>0.2$).

| Knee Variables (BW) | Limb | Time | -30%BW mean±SD | -15%BW mean±SD | 0%BW mean±SD | +15%BW mean±SD | +30%BW mean±SD |
|---|---|---|---|---|---|---|---|
| PTF | ACLR | 3mo | 1.45±0.32 | 1.96±0.40 | 2.24±0.42 | 2.53±0.47 | 2.78±0.50 |
| PTF | ACLR | 5mo | 1.47±0.27 | 2.00±0.36 | 2.35±0.42 | 2.64±0.50 | 2.90±0.49 |
| PTF | Uninv | 3mo | 1.81±0.33 | 2.59±0.40 | 3.11±0.42 | 3.68±0.50 | 4.10±0.50 |
| PTF | Uninv | 5mo | 1.65±0.36 | 2.36±0.46 | 2.87±0.50 | 3.40±0.55 | 3.80±0.59 |
| TFJCF | ACLR | 3mo | 2.26±0.47 | 2.92±0.59 | 3.42±0.60 | 3.87±0.64 | 4.29±0.65 |
| TFJCF | ACLR | 5mo | 2.28±0.39 | 2.97±0.52 | 3.55±0.56 | 3.99±0.64 | 4.42±0.61 |
| TFJCF | Uninv | 3mo | 2.78±0.46 | 3.78±0.62 | 4.63±0.64 | 5.44±0.74 | 6.02±0.77 |
| TFJCF | Uninv | 5mo | 2.51±0.53 | 3.46±0.66 | 4.29±0.73 | 5.05±0.82 | 5.64±0.87 |

**Conclusions:** Patients underload the TFJ and patellar tendon of the ACLR limb when squatting. Increasing external loads during natural squatting worsened knee underloading at each time point as the ACLR leg showed a minimal load response to changes in exercise demand.

**Clinical Relevance:** These findings indicate that movement retraining may be needed since adding more external resistance to bilateral squatting only exacerbated patients' knee underloading and their movement patterns do not resolve over time.

**Abstract Submission Type:**
Research Report

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**References:**

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**Student Category:**
Not a Student

**Sub-Section:**
Hip/Knee

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The APTA's Academy of Orthopaedic Physical Therapy Research Grant.

First Presenting Author

***Presenting Author***

Ryan L. Mizner, PT, PhD (UM- School of Physical Therapy and Rehabilitation)

**Speaker Bio:** Dr. Mizner works primarily as a clinical scientist in his role as a Professor for the School of Physical Therapy at the University of Montana. He completed his undergraduate degree in Exercise Science – Biomechanics at Montana State University. He then went on to complete his Master's in Physical Therapy and a PhD in Biomechanics and Movement Science at the

University of Delaware. Dr. Mizner has published 40 peer-reviewed scientific manuscripts and has authored more than 100 peer-reviewed presentations at national scientific meetings. His publications have been cited by other papers more than 5000 times over the span of his career. His research has been financially supported from sponsors such as the Foundation for Physical Therapy Research, the National Institutes of Health, the Academy of Orthopedic Physical Therapy. Dr. Mizner's current teaching responsibilities are clinical biomechanics, electrotherapeutics, foundational musculoskeletal practice, and orthopedic management of knee disorders. He continues to treat patients and provides consultation in outpatient orthopedics. He is a credentialed clinical instructor and he has served as faculty member and mentor in the University of Montana's Accredited Sports and Orthopedic residencies.

**Speaking Experience Level:** International conference (outside the US)

Second Author

Richard W. Willy, PT, PhD (School of Physical Therapy and Rehabilitation Science, University of Montana)

**Speaker Bio:** Dr. Rich Willy is an Associate Professor in the School of Physical Therapy, University of Montana (Missoula, MT, USA) and the Director of the Montana Running Lab. He received his PhD in Biomechanics and Movement Science from the University of Delaware and his Masters of Physical Therapy from Ohio University. Dr. Willy has been a clinician for over 20 years specializing in the treatment of the injured runner. He has presented on lower extremity injuries to multiple Olympic sports medicine staffs from around the world as well as to the National Basketball Association. He has published over 60 peer-reviewed papers primarily on two populations: endurance runners and tactical athletes. His research aims to develop clinically effective treatments for individuals with patellofemoral pain, Achilles tendon injuries, and bone stress injuries. Dr. Willy treats runners and athletes of all levels, from the new runner to the elite competitor. He has received funding to support his work from the United States Department of Defense and the Foundation for Physical Therapy.

**Speaking Experience Level:** International conference (outside the US)

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