A Continuous and Discrete Analysis of Jump Landing Ground Reaction Forces After Anterior Cruciate Ligament Reconstruction

Arjun Parmar, BA, Jessica E. Tolzman, MS, Corey D. Grozier, MS, Ian C. Frederick, BS, Matthew S. Harkey, ATC, PHD
Michigan State University

AIR LABS
ATHLETIC INJURY AND REHABILITATION

BACKGROUND

Biomechanical variables are often oversimplified to discrete unidirectional values. However, this practice limits movement analyses to specific moments in time, greatly undervaluing potentially important waveform features associated with injury. Often after anterior ligament reconstruction (ACLR), only the peak vertical ground reaction force is analyzed, which may not capture the full complexity of kinematic changes after ACLR.

PURPOSE

This study assesses vertical (V), antero-posterior (AP), and medio-lateral (ML) GRF components during jump landing post-ACLR using multivariate analysis of both discrete and continuous GRF measurements.

METHODS

1. 45 participants with history of primary unilateral ACLR performed five drop vertical jump tasks.
2. GRF was captured using force plates at 1,200 Hz.
3. Bodyweight normalized GRF components were time normalized to 101 points of jump landing (0–100%, from initial contact to final push-off).

STATISTICS

- *Discrete: Peak GRF component magnitude.*
- *Continuous: Time normalized GRF component waveforms. Statistical Parametric Mapping (SPM).*

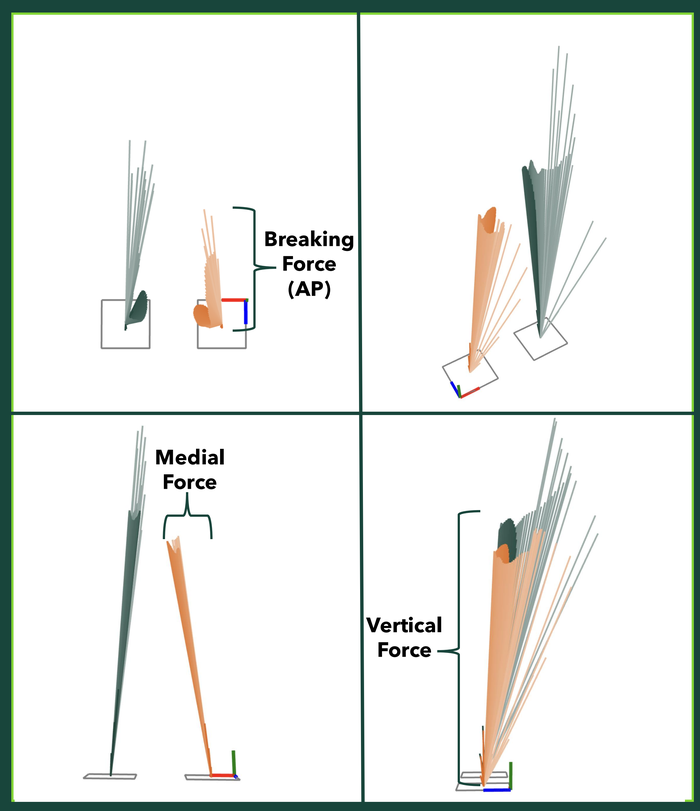
1. GRF was compared using a pairwise permutation Hotelling's T^2 tests across all components.
2. Post-hoc paired permutation t-tests were performed if the overall test was significant.
3. Alpha level = 0.05 and was Bonferroni corrected for all post-hoc tests.

RESULTS

Table 1. Participant Demographics

n	45
Age (years)	19.3 (5.6)
Gender (% Female)	42.2%
Height (cm)	173.1 (8.3)
Mass (kg)	75.4 (13.3)
Time Since Surgery (months)	7.5 (2.0)

Continuous multivariate analyses show complex widespread **underloading** and distinct **overloading** patterns of the ACLR limb during landings.



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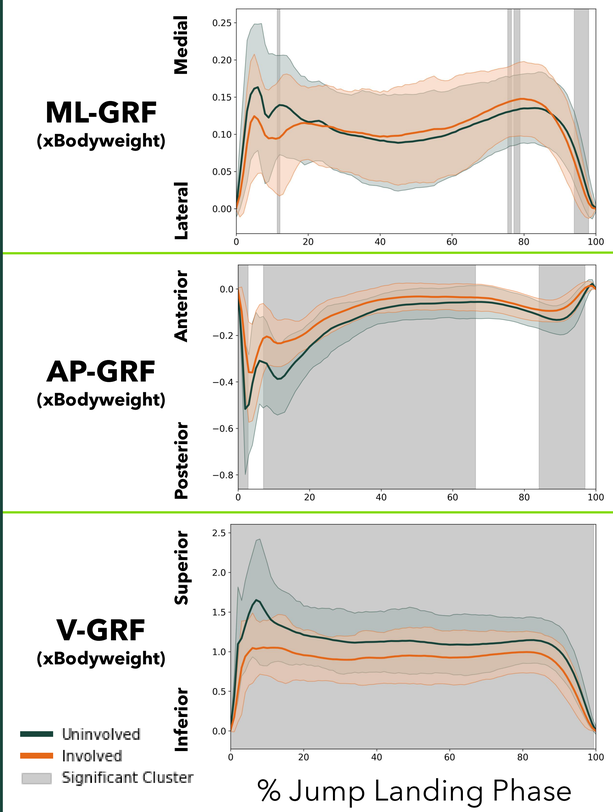
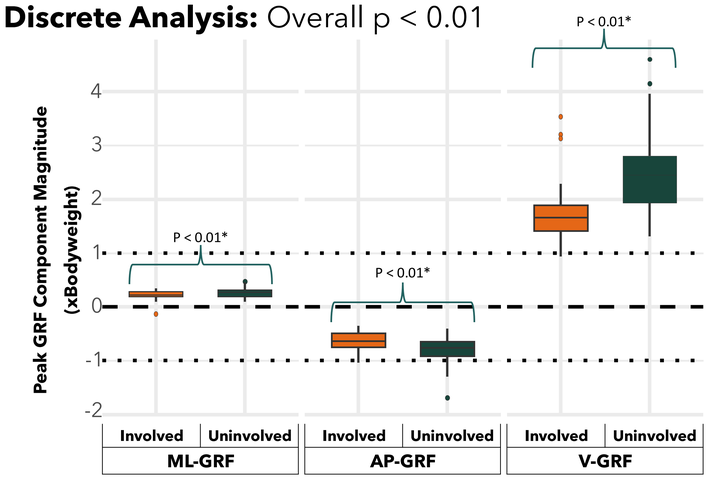
Continuous Analysis: Overall $p < 0.05$ [0.05 – 99.4%]



Discrete Analysis: Overall $p < 0.01$



DISCUSSION

- Multi-directional underloading of the ACLR limb.
- ACLR limb experiences higher ML-GRF during push-off.
- Traditional discrete analyses may miss significant kinetic differences post-ACLR.