

Background

- Rates of ACL tears are steadily increasing in the pediatric population
- In adults, ACL reconstruction (ACLR) individuals demonstrate altered gait biomechanical profiles that are not corrected in traditional rehabilitation
- Vertical ground reaction force (vGRF) is used to analyze the amount of loading the limb experiences during contact with the ground
- Adult ACLR individuals demonstrate less-dynamic vGRF profiles (i.e., lesser first and second vGRF peaks and greater midstance vGRF which has been linked to worse biological outcomes consistent with osteoarthritis development)
- vGRF profiles have not been identified in pediatric ACLR patients as stratified by maturation stage

Purpose

Purpose: To compare the vGRF profiles during walking between ACLR patients as stratified by Tanner Stages 3-5.

Hypothesis: ACLR individuals in early maturation stages (i.e., Tanner Stage 3) will elicit a larger difference in vGRF waveform than individuals in later maturation stages (i.e., Tanner Stages 4 and 5).

Methods

Design & Participants:

- We performed a cross-sectional analysis of pediatric ACLR patients, collecting gait biomechanics and self-reported Tanner Stage at a single timepoint.
- Participants were between 11-17 years old and 6-24 months post primary unilateral ACL reconstruction.

Gait Analysis:

- Participants performed 5 walking trials at a habitual self selected walking pace while looking straight ahead through a 6 meter walkway
- vGRF data was collected at 1200 Hz from two force plates cemented in the lab floor (Bertec, Ohio, USA).
- vGRF was time normalized to 100% of stance phase (vGRF >20N) to toe-off (vGRF <20N) and further normalized to body weight

Statistical Analysis:

- A functional mixed effect model was utilized to compared vGRF between groups at each 1% stance phase using R code (FunctionalMixedEffects.R)

Results

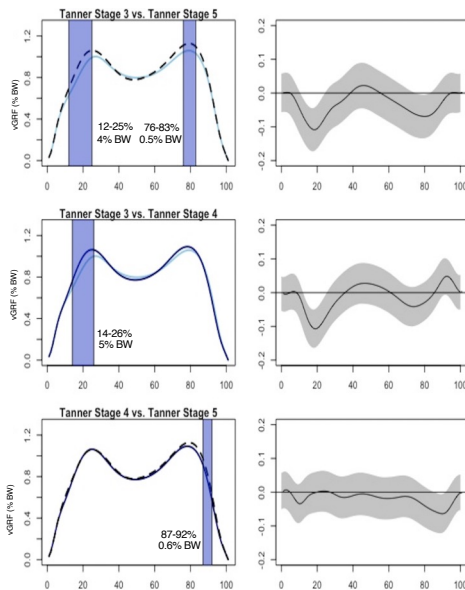


Figure 1. Group means and corresponding mean difference curves for tanner stage 3 (teal), tanner stage 4 (navy), and tanner stage 5 ACLR patients (dashed) are illustrated for vertical ground reaction force of the ACLR limb throughout the entirety of stance phase. Grey bands represent the associated 95% confidence intervals around the mean difference curves. Areas where the 95% confidence intervals did not include zero were recognized as statistically significant differences and are denoted with shaded blue bars.

Table 1: Demographic Information by Group

	Tanner Stage 3 n=9	Tanner Stage 4 n=13	Tanner Stage 5 n=8	p value
% Female	56	62	50	
Age	15.26±1.07	15.78±1.17	16.33±1.23	0.18
Gate Speed	1.23±0.08	1.26±0.14	1.29±0.15	0.68
Month Post-ACR	8.22±2.73	12.23±5.39	9.50±4.72	0.13

Discussion

Overall Findings

- Greatest vGRF profiles difference were observed between Tanner Stage 3 and 5 individuals
- vGRF profiles became more similar with increased maturation stage

Limitations:

- We did not utilize a pediatric control group; therefore, we are unable to conclude if difference in vGRF profiles by maturation stage is an effect of maturation stage or ACLR

Future Directions:

- Our analyses should be replicated with the inclusion of a healthy control group, stratified by maturation stage
- Future work should assess the link between altered vGRF loading and biological outcomes in pediatric ACLR patients

References

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- 1) Werner-Yang-Looney-Gwathmey et al. *Trends in Pediatric and Adolescent Anterior Cruciate Ligament Injury and Reconstruction*, 2016.
 - 2) Wilson-Pfleiffer-Johnston-Seely-Matthew K-Harkey-Blackburn-Fockler-Sprang-Pietrosimone et al. *Bilateral Gait 6 and 12 Months Post-Anterior Cruciate Ligament Reconstruction Compared with Controls*, 2020.
 - 3) Wilson-Pfleiffer-Johnston-Seely-Matthew K-Harkey-Blackburn-Fockler-Sprang-Pietrosimone et al. *Gait Mechanics and T1ρ MRI of Tibiofemoral Cartilage 6 Months after ACL Reconstruction*, 2019
 - 4) Pietrosimone-Blackburn-Jordan et al. *Greater Mechanical Loading During Walking Is Associated With Less Collagen Turnover in Individuals With Anterior Cruciate Ligament Reconstruction*, 2015