AN ANALYSIS OF PEAK VERTICAL GROUND REACTION FORCE IN PEDIATRIC PATIENTS FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION DURING DROP VERTICAL JUMP AND GAIT ASSESSMENTS

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BACKGROUND

- Average age of pediatric ACL injury is approximately 15 for males and females.[1]
- 92% of pediatric athletes return to sport following ACL Reconstruction (ACLR) despite high rates of reinjury[2]
- The drop vertical jump (DVJ) is frequently utilized in return-to-sport testing and rehabilitation.[3]
- Adults demonstrate lower peak vertical ground reaction force (vGRF) in the ACLR limb than uninjured limb during DVJ testing.[4]
- The magnitude of peak vGRF does not correlate between DVJ and gait in adult ACLR patients.[4]
- The vGRF magnitudes in both limbs during a DVJ task and the link between walking and DVJ vGRF magnitudes in pediatric ACLR patients is unknown

PURPOSE

Primary Purpose: Determine bilateral differences in peak vGRF and vGRF Limb Symmetry Index (LSI) during DVJ between pediatric ACLR patients and pediatric controls and adult ACLR patients.
Secondary Purpose: Determine the association between peak vGRF during DVJ and walking in pediatric ACLR patients
Hypotheses: Pediatric ACLR patients will exhibit lower peak vGRF in both limbs and a smaller LSI than pediatric controls while conversely demonstrating similar peak vGRF and LSI to adult ACLR patients. We also hypothesize there will be no association between peak vGRF in DVJ and gait in pediatric ACLR patients.

METHODS

- We performed a cross-sectional analysis, with a DVJ and walking biomechanics assessment completed at a single visit
- All participants were between 7 and 17 years of age and completed the Tanner Stage questionnaire by self-report
- ACLR patients were between 6-24 months post primary unilateral ACLR
- The Tanner Stage questionnaire was used to categorize the participants into the groups used for analysis
  - Tanner Stage I-IV = sexually immature
  - Tanner Stage V = sexually mature (i.e., adult)
- Pediatric controls were matched to pediatric ACLR participants based on sex, Tanner Stage (± 1), and Tegner Activity Score (±2)
- vGRF data was sampled at 1200 Hz (Bertec, Ohio, USA), time normalized to 100% of stance phase (vGRF >20N) to toe-off (vGRF <20N), and further normalized to body weight (%BW)
- LSI = Uninvolved Limb/Involved Limb

RESULTS

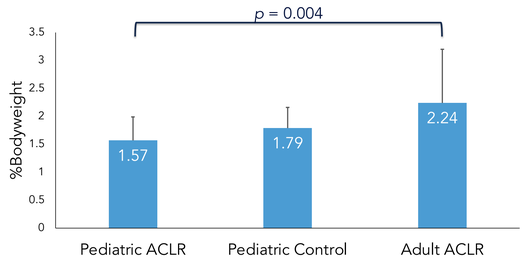

Figure 1. Involved Vertical Ground Reaction Force Magnitudes

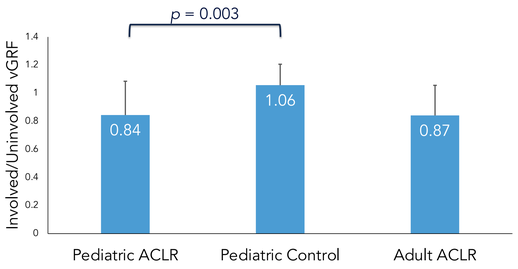

Figure 3. Vertical Ground Reaction Force Limb Symmetry Index

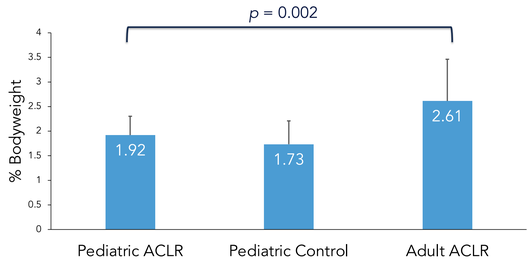

Figure 2. Uninvolved Vertical Ground Reaction Force Magnitudes

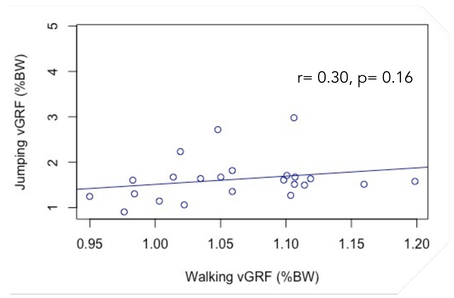

Figure 4. Association Between Drop Vertical Jumps and Gait

Table 1. Demographic Information by Group

	Pediatric ACLR (n=22)	Pediatric Control (n=22)	Adult ACLR (n=13)
Age	15.32 ± 1.21	14.59 ± 1.53	18.69 ± 3.33
% Female	59.09%	59.09%	38.46%
Height (m)	1.67 ± 0.09	1.67 ± 0.10	1.79 ± 0.13
Weight (kg)	64.75 ± 11.92	58.19 ± 9.24	78.57 ± 15.55
BMI (kg/m²)	23.01 ± 3.14	20.07 ± 2.32	24.39 ± 3.29
Months Post-ACLR	10.68 ± 4.81	NA	9.54 ± 3.17 (n=11)
% Mid/Late Puberty	100%	91%	0%

- In the involved limb, pediatric ACLR patients demonstrated a weak effect size compared to pediatric controls (*d*=0.36) and a strong effect size compared to pediatric controls (*d*=1.09).
- In the uninvolved limb, pediatric ACLR patients demonstrated a weak effect size compared to pediatric controls (*d*=0.29) and a strong effect size compared to pediatric controls (*d*=1.08)
- The LSI effect size between pediatric ACLR and adult ACLR (0.10) was weak, between pediatric ACLR and pediatric controls it was strong (0.94).

Statistical Analysis

- Separate, one-way ANOVAs were used to determine differences in peak vGRF in both limbs and LSI between groups during the DVJ task
- Tukey's *Post-Hoc* test was performed for pre-specified comparisons
  - Pediatric ACLR vs Uninjured pediatrics
  - Pediatric ACLR vs. Adult ACLR
- Alpha value established as *p*=0.05
- A Pearson Product Moment Correlation was used to determine the association between peak vGRF during a DVJ task and overground walking
- All analyses was performed in R Studio

DISCUSSION

- During the DVJ task, pediatric and adult ACLR participants showed lower vGRF in their ACLR limb, which is consistent with previous adult literature.[8]
- Pediatric participants demonstrated a trend of lower vGRF magnitudes than adult ACLR participants in both limbs.
- Pediatric ACLR participants demonstrated an LSI below the RTS threshold of 0.90.
- No association between jumping and walking peak vGRF (ρ= 0.30) in the present study aligns with previous research assessing the link in adult ACLR patients (ρ= 0.39)[4] and suggests that loading magnitudes during dynamic activities are likely task specific.

Limitations:
- Most patients were early post-ACLR (6-12 months)
- All pediatric ACLR participants were mid/late puberty (Tanner III-IV).
- Unable to directly match adult ACLR to pediatric ACLR due to sample size

Future Directions:
- Examine the influence of time post ACLR on vGRF magnitudes during DVJ
- Assess between-group differences in peak vGRF during DVJ, as stratified by Tanner Stage

REFERENCES

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