There is a Difference in Preoperative Through-the-Knee Femorotibial Rotation in Pediatric Patients with Anterior Cruciate Ligament Injury Versus Patients with Patellofemoral Instability

Danielle E. Chipman, BS

Nicolas Pascual-Leone, MD

Preston W. Gross, BS

Emilie Lijesen, BS

Shae K. Simpson, BS

Roger F. Widmann, MD

Peter D. Fabricant, MD, MPH

Daniel W. Green, MD, MS

Hospital for Special Surgery, New York, NY, USA

ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

Disclosures

Presenting author: Dr. Daniel Green

- Royalties: Arthrex, Inc., Pega Medical, *Current Opinion in Pediatrics*, Wolters Kluwer Health – Lippincott Williams & Wilkins
- Paid consultant: Arthrex, Inc.
- Speakers bureau: AO Trauma International, Arthrex, Inc.
- Editorial board: *Current Opinion in Pediatrics*
- Board of Directors: AAOS, New York County Medical Society, Patellofemoral Foundation, POSNA, PRiSM

Disclosures for all authors can be found on the AAOS Disclosures page.

Background

- The risk of anterior cruciate ligament (ACL) rupture and patellofemoral instability (PFI) in pediatric and adolescent patients continues to increase, especially in those participating in sports

- Various risk factors for ACL rupture and PFI have been identified
  - Risk factors: sex, joint laxity, family history, valgus, femoral anteversion, tibial slope, variations in the intercondylar notch, patella alta, TT-TG distance, posterior cruciate ligament morphology

Purpose

Aim: Examine femorotibial rotation as a risk factor for ACL rupture and PFI in pediatric and adolescent patients

HYPOTHESIS: There will be differences in femorotibial rotation measurements between patients with ACL rupture, PFI, and a comparison cohort, with an internal femorotibial rotation for ACL rupture patients and an external femorotibial rotation for PFI patients.

Methods

- Patients aged 8-21 years who sustained an ACL rupture or PFI-related injury between 1/2015-8/2022 were identified
- Participants without a preoperative biplane hip-to-ankle EOS radiograph (EOS imaging, France), with a history of previous knee surgery in either knee, and/or >1 diagnosis of ACL rupture or PFI were excluded
- Participants were compared to a cohort of scoliosis patients with a Cobb angle <20° (Controls)
- EOS 3D reconstructions and femorotibial rotation data was acquired from preoperative radiographs
- Femorotibial rotation was compared between the three groups (ACL, PFI, Controls) using a Kruskal-Wallis test and pairwise comparisons were also analyzed

Results

Table 1. Demographics of entire cohort.

		ACL N = 60	PFI N = 92	Controls N = 45	All N = 197
Age (years) *		14.3 ± 1.8	14.3 ± 2.4	14.9 ± 2.4	14.4 ± 2.2
BMI (kg/m^2) **		21.2 (4.1)	22.2 (6.1)	20.0 (5.2)	21.1 (5.3)
		N (%)			
Sex					
	Female	26 (43.3)	54 (58.7)	20 (44.4)	100 (50.8)
	Male	34 (56.7)	38 (41.3)	25 (55.6)	97 (49.2)
Laterality					
	Left	33 (55.0)	59 (64.1)	23 (51.1)	115 (58.4)
	Right	27 (45.0)	33 (35.9)	22 (48.9)	82 (41.6)
Race					
	Asian	1 (1.7)	2 (2.2)	2 (4.4)	5 (2.5)
	Black	5 (8.3)	5 (5.4)	0	10 (5.1)
	Native Hawaiian/Pacific Islander	1 (1.7)	0	0	1 (0.5)
	White	44 (73.3)	62 (67.4)	31 (68.9)	137 (69.5)
	Other	6 (10.0)	9 (9.8)	1 (2.2)	16 (8.1)
	Unknown	3 (5.0)	14 (15.2)	11 (24.4)	28 (14.2)
Ethnicity					
	Hispanic/Latino	6 (10.0)	9 (9.8)	3 (6.7)	18 (9.1)
	Not Hispanic/Latino	49 (81.7)	74 (80.4)	33 (73.3)	156 (79.2)
	Unknown	5 (8.3)	9 (9.8)	9 (20.0)	23 (11.7)

* *Indicates Mean ± SD*

** *Indicates Median (IQR)*

Results

- 197 patients met final inclusion criteria
  - 60 ACL, 92 PFI, 45 Controls

- Median femorotibial rotation = 4.8°
  - ACL: -2.1°
  - PFI: 10.2°
  - Controls: 4.4°

Femorotibial rotation differed significantly between cohorts and pairwise comparisons between each group were also significant

- **ACL vs. Control: P<0.001**
- **ACL vs. PFI: P<0.001**
- **Control vs. PFI: P<0.001**

Table 2. Femorotibial Rotation by Cohort

	Femorotibial Rotation (°) **	P-value
ACL	–2.1 (9.1)	
PFI	10.2 (11.7)	≤ **0.001***
Control	4.4 (8.7)	

***Indicates Median (IQR)*

Positive femorotibial rotation indicates external rotation

Conclusion

- Femorotibial rotation differed significantly between patients with ACL rupture, PFI, and a comparison cohort
- The majority of ACL rupture patients had internal femorotibial rotation, while the majority of PFI patients had external femorotibial rotation
- The observed differences in femorotibial rotation suggest that femorotibial rotation may be associated with differences in knee pathology in pediatric patients

Thank you!

Contact Information: Daniel Green MD, greendw@hss.edu

References

1. Pascual-Leone N, Ellis HB, Green DW. Patellar instability: will my patella dislocate again? *Curr Opin Pediatr*. 2022;34(1):76-81. Doi:10.1097/MOP.0000000000001080

2. Lin KM, James EW, Aitchison AH, Schlichte LM, Wang G, Green DW. Increased tibiofemoral rotation on MRI with increasing clinical severity of patellar instability. Knee Surg Sports Traumatol Arthrosc. 2021 Nov;29(11):3735-3742. doi: 10.1007/s00167-020-06382-x. Epub 2021 Jan 3. PMID: 33388943.

3. Pascual-Leone N, Jahandar A, Davie R, Bram JT, Chipman DE, Imhauser CW, Green DW. Femorotibial rotation is linearly associated with tibial tubercle-trochlear groove distance: A cadaveric study. J ISAKOS. 2024 Aug;9(4):598-602. doi: 10.1016/j.jisako.2024.05.004. Epub 2024 May 11. PMID: 38735371.

4. Mitchell BC, Siow MY, Bastrom T, Bomar JD, Pennock AT, Parvaresh K, Edmonds EW. Coronal Lateral Collateral Ligament Sign: A Novel Magnetic Resonance Imaging Sign for Identifying Anterior Cruciate Ligament-Deficient Knees in Adolescents and Summarizing the Extent of Anterior Tibial Translation and Femorotibial Internal Rotation. Am J Sports Med. 2021 Mar;49(4):928-934. doi: 10.1177/0363546521988938. Epub 2021 Feb 22. PMID: 33617287.

5. Ahrens P, Kirchhoff C, Fischer F, Heinrich P, Eisenhart-Rothe Rv, Hinterwimmer S, Kirchhoff S, Imhoff AB, Lorenz SG. A novel tool for objective assessment of femorotibial rotation: a cadaver study. Int Orthop. 2011 Nov;35(11):1611-20. doi: 10.1007/s00264-010-1159-5. Epub 2010 Dec 22. PMID: 21181404; PMCID: PMC3193962.