Massachusetts General Hospital
Founding Member, Mass General Brigham

ISAKOS CONGRESS 2023 | Boston Massachusetts June 18–June 21

Assessment of Trochlear Cartilage Thickness and Volume Using Sagittal Magnetic Resonance Images to Quantify Trochlear Dysplasia: A Matched-Cohort Study.

Nicholas Perry, MD, Maria Velasquez-Hammerle, MD,
Zachary LaPorte, BA, Varun Nukala, BS, Miho Tanaka, MD PhD

Massachusetts General Hospital, Harvard Medical School, Boston, MA

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Disclosures:
The authors have no financial disclosures

Background

- Trochlear dysplasia is a major contributing factor for patellar instability.
- Trochleoplasty procedures have become popularized to address this morphological abnormality by deepening the trochlea and avoiding perforation of the trochlear cartilage.
- The relative cartilage thickness in the dysplastic trochlea has not been well described.

Objectives

1) Assess trochlear cartilage thickness and volume in knees with and without patellar instability.

2) Compare cartilage measurements to standard measurements of trochlear dysplasia.

Methods

- 25 knees with symptomatic patellar instability were compared with 25 gender-matched, non-symptomatic knees.
- On sagittal images, trochlear cartilage thickness (TCT) and trochlear cartilage volume (TCV) were analyzed at the center, medial border, and lateral border of the trochlea.

- Statistical Analysis
  - Symptomatic and control values were compared using paired sample t-test.
  - Stepwise multivariate linear regression was performed to assess for associations with standard radiographic parameters of trochlear dysplasia.

Measurement of Trochlear Cartilage Thickness (TCT)

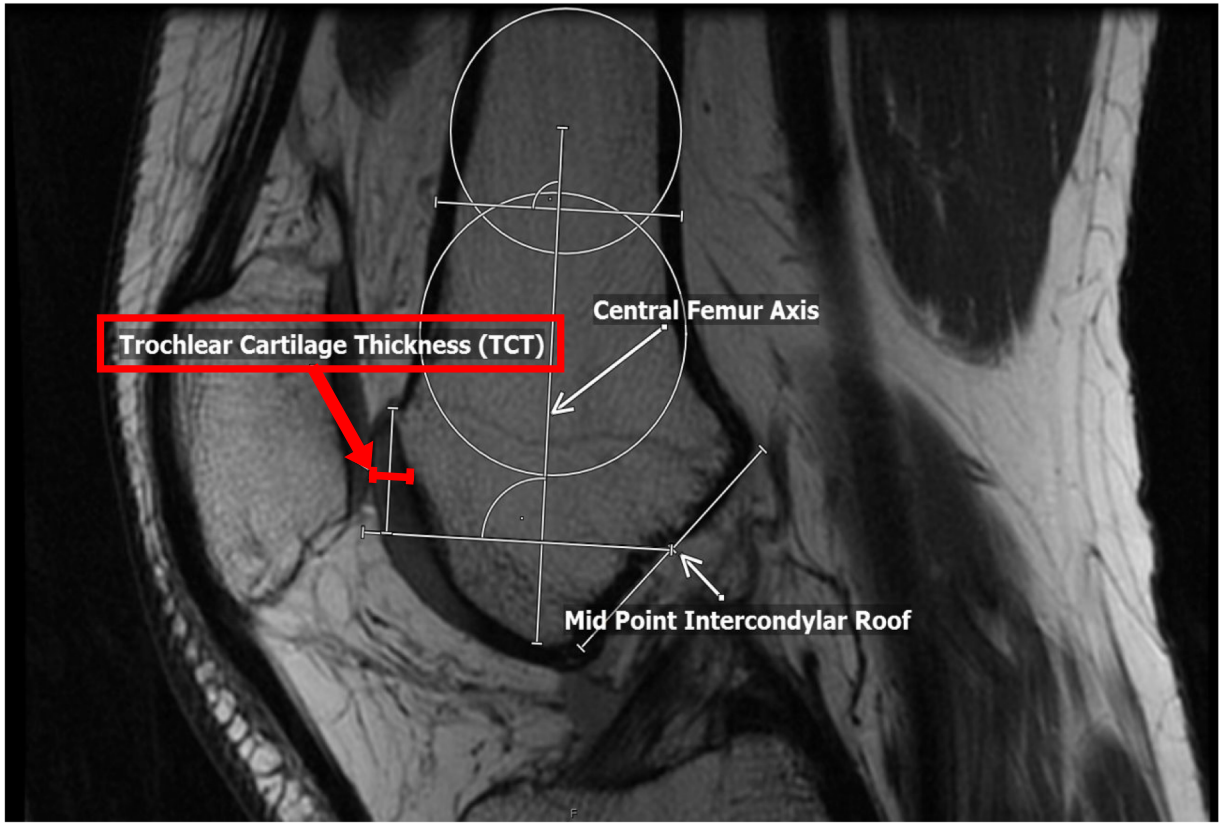

Figure 1: Left Knee MRI demonstrating position of Central Femur Axis, Mid-Point of the Intercondylar Roof, and method to find Trochlear Cartilage thickness (TCT) at the mid-point of the trochlear length.

Trochlear Cartilage Thickness was defined as the cartilage thickness halfway along the trochlear length at its maximum dimension.

Measurement of Trochlear Cartilage Volume (TCV)

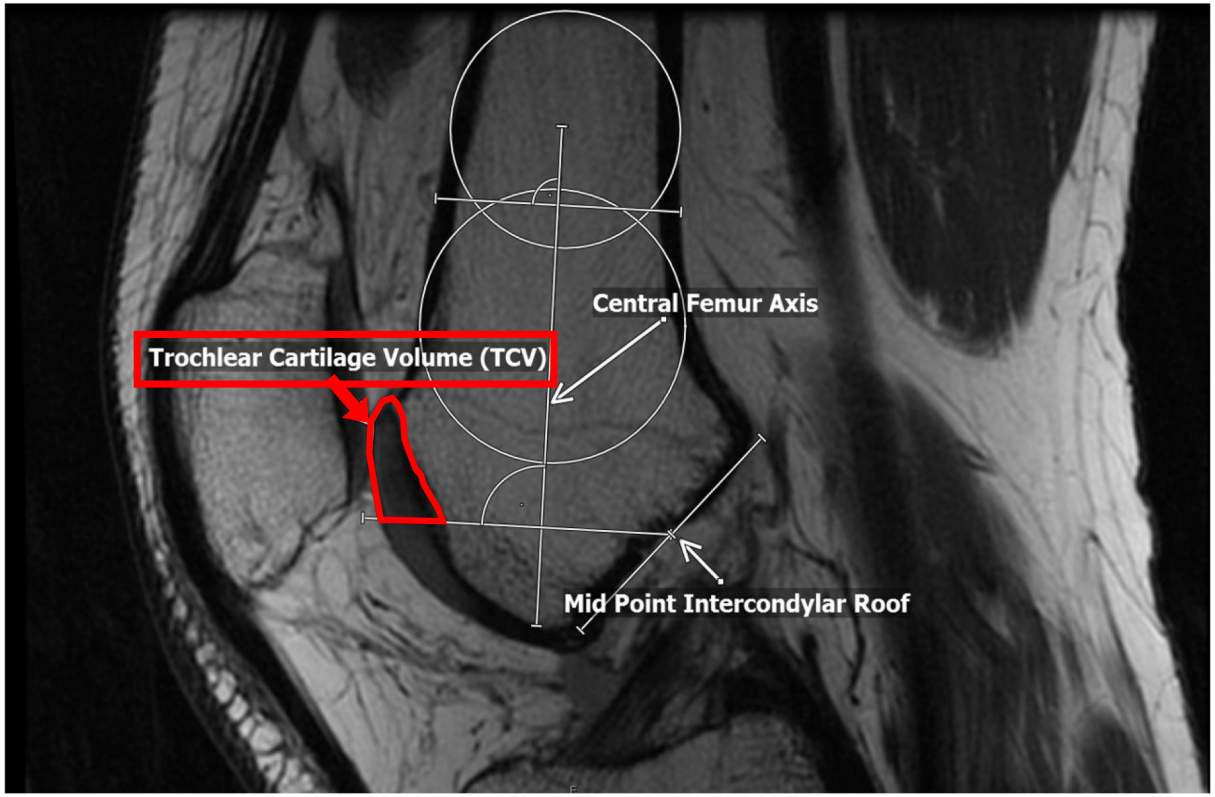

Figure 2: Left Knee MRI demonstrating position of Central Femur Axis, Mid-Point of the Intercondylar Roof, and method to approximate Trochlear Cartilage Volume (TCV). TCV uses an area measurement on a two-dimensional image to approximate volume on a three-dimensional object.

Trochlear Cartilage Volume was defined by total area of cartilage proximal to the plane of the intercondylar midpoint.

Results

- TCT was significantly different between the medial, central and lateral trochlea in both the symptomatic and control groups ($p<0.001$).
- Only lateral TCT demonstrated a significant difference between groups, which was 20.3% ($p=0.035$) thicker in the symptomatic cohort compared to controls.
- No significant differences existed in TCV between symptomatic and control groups.

Table 1: Comparison of Control and Symptomatic Trocholear Cartilage Parameters

Metric		Control		Symptomatic		Difference	
		Average	Std	Average	Std	Average	p-value
Medial	TCT (mm)	1.16	0.56	1.12	0.46	0.04	0.79
	TCV (mm^3)	6.20	5.70	6.11	4.02	0.09	0.95
Center	TCT (mm)	2.98	0.95	3.07	0.96	-0.09	0.74
	TCV (mm^3)	31.98	13.71	36.26	17.92	-4.28	0.34
Lateral	TCT (mm)	2.06	0.80	2.48	0.67	-0.42	0.03*
	TCV (mm^3)	29.41	11.69	34.65	11.15	-5.24	0.16

TCT = Trochlear Cartilage Thickness; TCV = Trochlear Cartilage Volume; Values with asterisks (*) denotes statistical significances

Results:
Gender Specific Analysis

- Female Cohort:
  - Central TCT was 28.3% thicker in the symptomatic cohort (p=0.024)
  - Medial TCV was 2.3x greater in the symptomatic cohort (p = 0.019).
- Male Cohort:
  - There were no gender specific differences identified.

Results:
Correlation with Standard Measurements of Trochlear Dysplasia

- **Central TCT** demonstrated a significant, independent relationship with:
  - **Trochlear depth**
    - Coefficient 0.38, p = 0.011

- **Central TCV** demonstrated a significant, independent relationship:
  - **Trochlear depth**
    - Coefficient 9.9, p <0.001
  - **Sulcus angle**
    - Coefficient 1.1, p <0.001
  - **Lateral trochlear inclination**
    - Coefficient -1.1, p <0.001

Conclusion

While trochlear dysplasia typically refers to abnormal bony morphology, this study demonstrates the role of differential contributions of chondral thickness and volume between knees with and without patellar instability, and that these measurements correlated with severity of dysplasia.

References

1. Ambra, L.F., et al., *Femoral Trochlear Geometry in Patients with Trochlear Dysplasia Using MRI Oblique Trochlear View.* J Knee Surg, 2021. **34**(7): p. 699-704.
2. Amis, A.A., et al., *Anatomy and biomechanics of the medial patellofemoral ligament.* Knee, 2003. **10**(3): p. 215-20.
3. Arendt, E.A., *Peterson Grooveplasty: Can we predict by imaging who will benefit from this procedure?* ESSKA Annual Meeting, 2018(Glasgow, Scotland).
4. Arendt, E.A., et al., *Risk of Redislocation After Primary Patellar Dislocation: A Clinical Prediction Model Based on Magnetic Resonance Imaging Variables.* Am J Sports Med, 2018. **46**(14): p. 3385-3390.
5. Balcarek, P., et al., *Which patellae are likely to redislocate?* Knee Surg Sports Traumatol Arthrosc, 2014. **22**(10): p. 2308-14.
6. Biedert, R.M., et al., *The lateral condyle index: a new index for assessing the length of the lateral articular trochlea as predisposing factor for patellar instability.* International Orthopaedics, 2011. **35**(9): p. 1327-1331.
7. Bollier, M. and J.P. Fulkerson, *The role of trochlear dysplasia in patellofemoral instability.* J Am Acad Orthop Surg, 2011. **19**(1): p. 8-16.
8. Carrillon, Y., et al., *Patellar instability: assessment on MR images by measuring the lateral trochlear inclination-initial experience.* Radiology, 2000. **216**(2): p. 582-5.
9. Christensen, T.C., et al., *Risk Factors and Time to Recurrent Ipsilateral and Contralateral Patellar Dislocations.* Am J Sports Med, 2017. **45**(9): p. 2105-2110.
10. Davies, A.P., et al., *The sulcus angle and malalignment of the extensor mechanism of the knee.* The Journal of Bone and Joint Surgery. British volume, 2000. **82**(8): p. 1162-6.
11. Dejour, H., et al., *[Dysplasia of the femoral trochlea].* Rev Chir Orthop Reparatrice Appar Mot, 1990. **76**(1): p. 45-54.
12. Dejour, H., et al., *Factors of patellar instability: an anatomic radiographic study.* Knee Surg Sports Traumatol Arthrosc, 1994. **2**(1): p. 19-26.
13. Dong, C., et al., *Medialization of trochlear groove was correlated with extended lateral trochlear in trochlear dysplasia: a transverse CT analysis.* J Orthop Surg Res, 2022. **17**(1): p. 276.
14. FH, A., *The bone graft wedge in the treatment of habitual dislocation of patella.* Med Rec, 1915(88): p. 257-259.
15. Fu, K., et al., *Changes in femoral trochlear morphology following surgical correction of recurrent patellar dislocation associated with trochlear dysplasia in children.* Bone Joint J, 2018. **100-b**(6): p. 811-821.
16. Fucentese, S.F., et al., *CT changes after trochleoplasty for symptomatic trochlear dysplasia.* Knee Surg Sports Traumatol Arthrosc, 2007. **15**(2): p. 168-74.

Thank you for your time and attention.

Enjoy the Conference!