Comprehensive MRI Assessment Of Femoral Tunnel Placement In Anterior Cruciate Ligament Reconstruction

ISAKOS Congress 2025

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Conflict of Interest Disclosure

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ISAKOS congress 2025

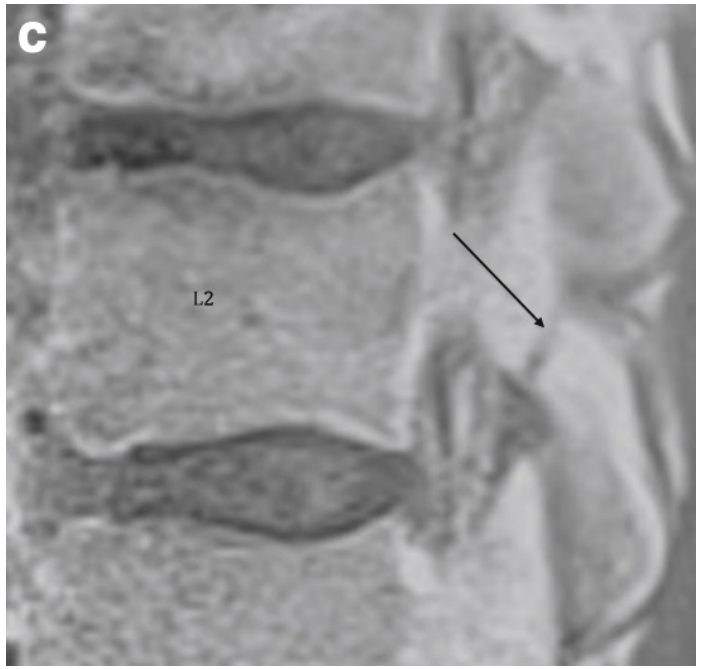
The author declares no conflicts of interest related to this presentation.

Bone-like image using MRI

MRI: Not suitable for evaluating bone morphology

2016 – **Ang et al.** reported high diagnostic accuracy for lumbar spondylolysis (*sensitivity: 96.7%, specificity: 92.0%*).

2021 – **Johnson et al.** introduced an imaging protocol called **FRACTURE** (by Philips).



Ang E.C.et al. Skeletal Radiol. *2016.*

Johnson B et al. Skeletal Radiol. *2021.*

ACL injury

- **Many adolescent patients for whom radiation exposure should be avoided**

  Younger patients have higher sensitivity to radiation

  Brener J.et al. N Engl J Med. 2007.

  Australian registry: CT scans in youth linked to higher cancer risk

  Mathews JD.et al. BMJ. 2013.

  JRS (2019): Highlights special considerations for pediatric/adolescent imaging

- **Significance of Bone Tunnel Location in Ligament Reconstruction**

  Markolf .et al. J Orthop Res. 2002.

  Fu FH.et al. CORR. 2009.

  Shino K .et al. Operative Techniques in Orthopaedics. 2008.

Bone Tunnel Evaluation Without Radiation:
Is MRI the Answer?

Purpose

**To compare bone tunnel evaluation
using MRI with conventional CT-based assessment**

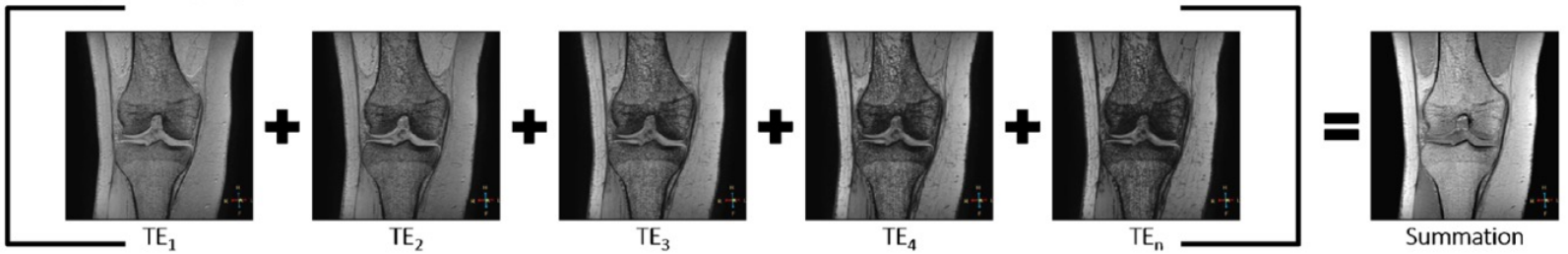
Subjects

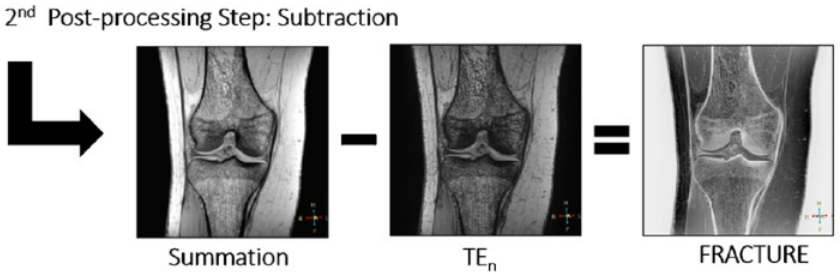
**22 cases (22 knees) after anatomical ACL reconstruction
with semitendinosus tendon,
imaged with both CT and 3.0T MRI.**

Methods～Imaging Protocol～

FRACTURE(**F**ast field echo **R**esembling **A** **C**T **U**sing **R**estricted **E**cho-spacing)

- Imaging: 3D multi-echo fast gradient echo sequence
- Echoes acquired and summed
- Final image generated by black–white inversion



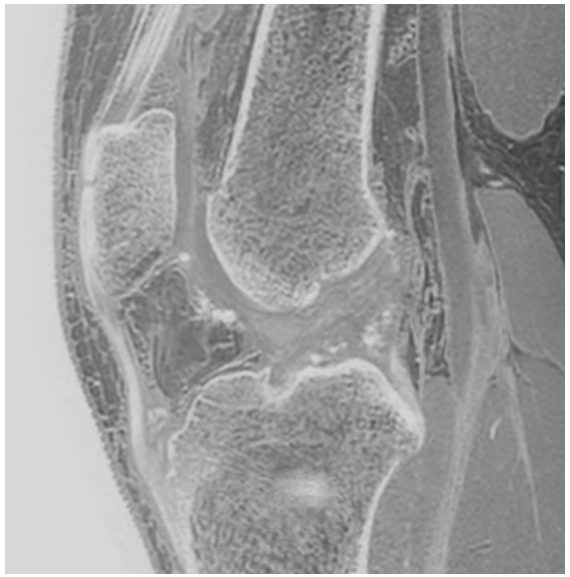


3D Image Reconstruction

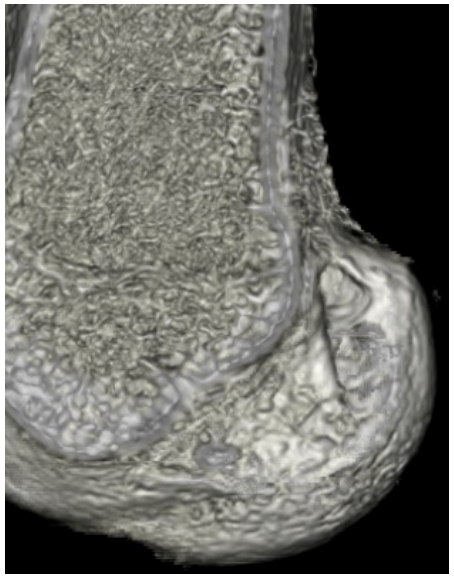
MRI System:	3.0T scanner (Ingenia, Philips)
Imaging Parameters:	TR = 30 ms, TE = 2.3 ms, ΔTE = 2.3 ms, FA = 15°
	Voxel size = 0.59 × 0.59 × 0.60 mm
	Scan time = 5 min 26 sec

Methods～Bone Tunnel Evaluation～

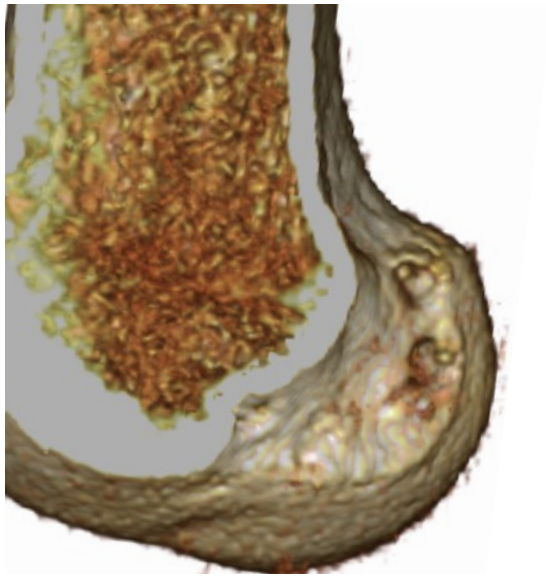
FRACTURE



MRI



CT



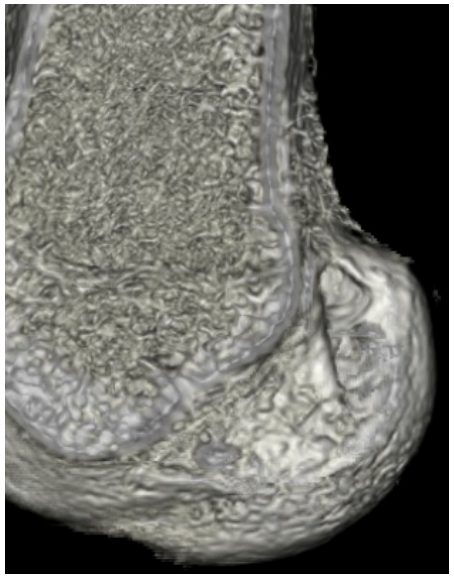
Quadrant methods

Bernand M .et al. Am J Knee Surg. 2002.

Quadrant method used to assess AM/PL bundle centers from 3D images

Methods～Reliability Assessment～

- **Evaluators:** 3 orthopedic specialists
- **Assessment:** Interrater reliability of AM/PL tunnel centers
- **Statistical method:** ICC (2,1)



Evaluators:

3 orthopedic surgeons

- **Interrater reliability:** ICC (2,1)
- **Software:** R (The R Foundation)

Results – MRI vs. CT Comparison

		MRI (%)	CT (%)	*p value*
AM	Depth（D）	**14.5** ± 2.3	**15.8** ± 2.3	*0.15*
	Height(H)	**22.9** ± 9.6	**22.8** ± 9.1	*0.44*
PL	Depth（D）	**23.1** ± 4.1	**29.1** ± 9.2	*0.14*
	Height(H)	**52.1** ± 5.8	**53.3** ± 8.2	*0.30*

(paired t test, <0.05)

No Significant Difference

Results～Reliability Assessment～

ICC (2,1) by three orthopedic specialists

AM bundle : **0.878** (95% CI : 0.696～0.965)

PL bundle : **0.961** (95% CI : 0.883～0.989)

High ICC Values

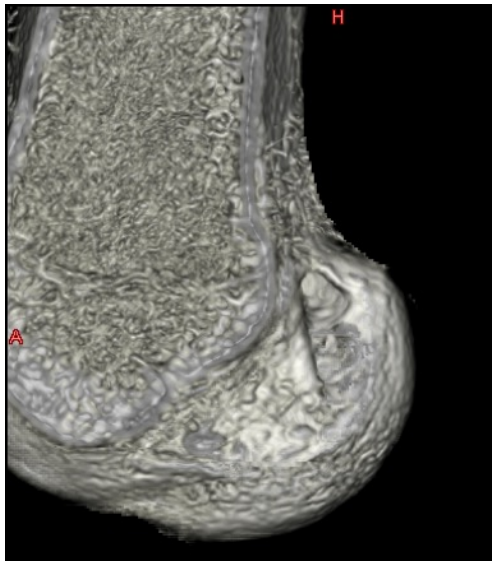
Discussion～Bone-like MRI Imaging～

Used for diagnosis (e.g., spondylolysis, avulsion fractures)

Ang E.C.et al. Skeletal Radiol. *2016.*

Johnson B et al. Skeletal Radiol. *2021.*

Rarely reported for postoperative evaluation



This study **:**

MRI enabled evaluation of bone tunnel positions
in anatomic ACL reconstruction.

The accuracy was comparable to CT-based assessment.
High interrater reliability was observed.

MRI-Based Tunnel Evaluation Is Feasible

Discussion ～Future Plan～

Key Benefit: Zero Radiation Exposure

- Applicable to adolescents with high sensitivity to radiation

- Allows for repeated imaging
  → Evaluation of tunnel **enlargement** before/after ROM exercises
  before/after weight-bearing

- Enables more detailed assessment of the relationship between graft and bone tunnel

- **Identify causes of tunnel enlargement**
- **Reconsider postoperative rehabilitation**

Conclusion

•Bone tunnel positions after anatomic ACL reconstruction (22 knees in 22 patients) were compared using 3D images derived from both MRI and CT.

•MRI and CT yielded nearly equivalent tunnel positions when evaluated with the quadrant method, and interrater reliability was very high.

•MRI-based femoral tunnel assessment, free from radiation exposure, demonstrated comparable accuracy to conventional CT evaluation.