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Anterior tibial subluxation measured with the bone axis method on preoperative MRI may reflect the pivot shift test under anesthesia in ACL injury cases: Multi-center study

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Faculty Disclosure Information

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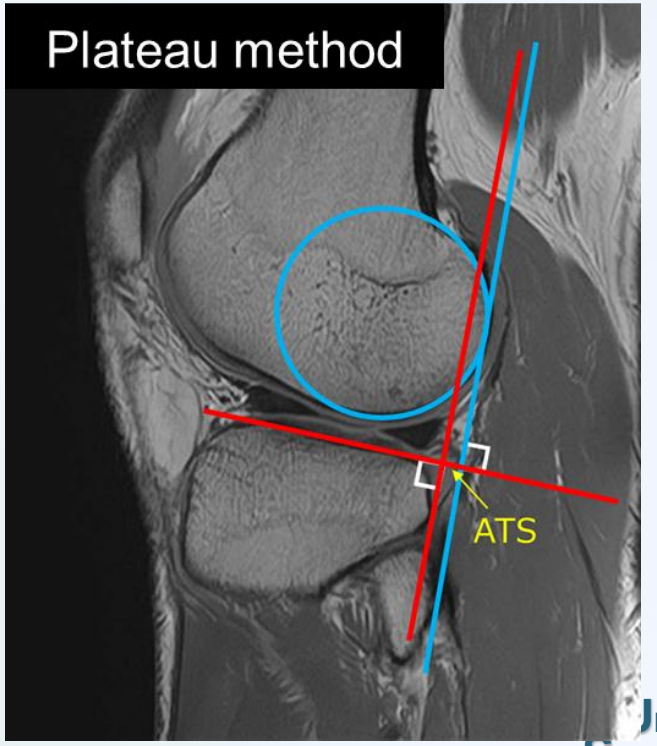
Pivot Shift test (PS)

- is associated with the incidence of graft failure and persistent rotational laxity.

Firth AD. Am J Sports Med. 2022.
Gupta R. Phys Sportsmed. 2022.

- under anesthesia can be evaluated only on the day of surgery.
- has been reported to be associated with anterior tibial subluxation (ATS) measured with the plateau method

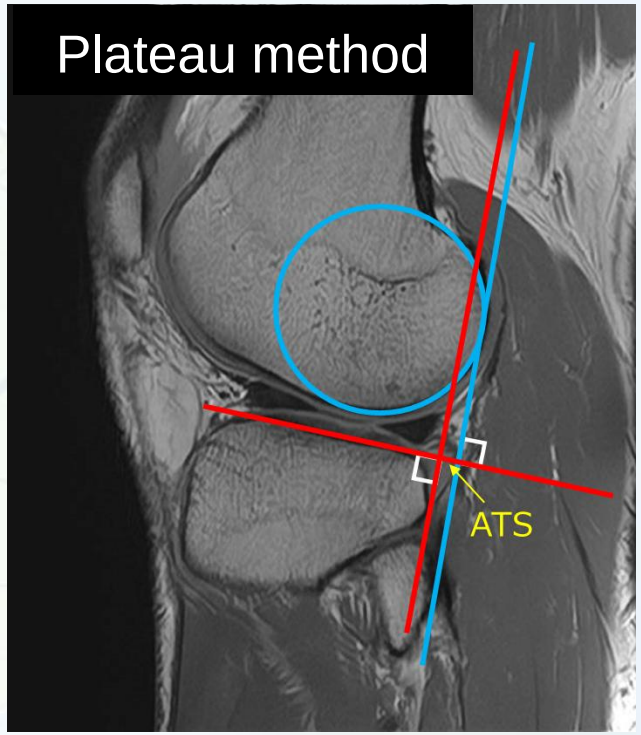
Lian J. Am J Sports Med. 2019.
Liu A. Arthroscopy. 2022.
Ni QK. KSSTA. 2022.
Ye Z. Am J Sports Med. 2023.

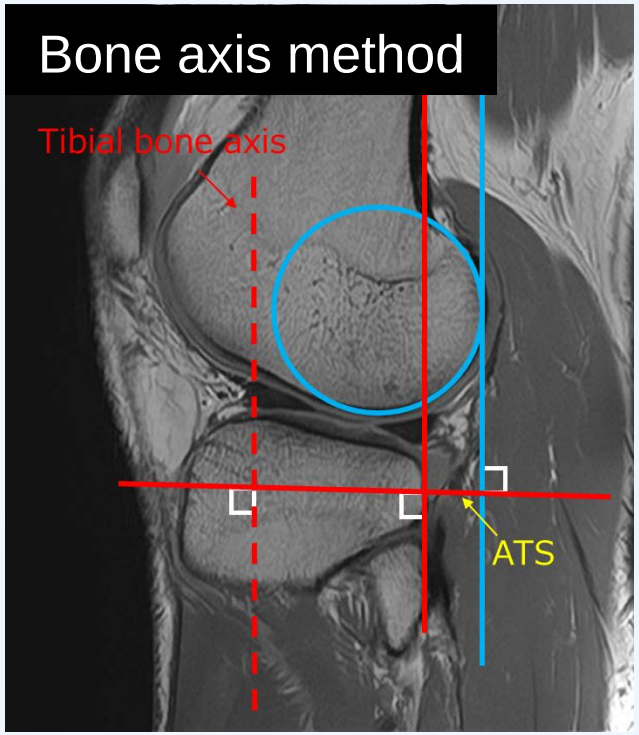


Anterior tibial subluxation (ATS)

Two types of ATS measurement methods
- Plateau method
- Bone axis method

A steep posterior tibial slope (PTS) influenced the measurement of ATS and resulted in a reduction in the ATS value measured with the plateau method.





Which ATS method is the best for reflecting the rotational instability?

Objective

To investigate the relationship between PS under anesthesia and ATS on preoperative MRI measured with the bone axis method and the plateau method.

Methods: Participants

Oct 2022 – Apr 2024 Multicenter

156 ACLR Patients

14 Excluded

- Revision ACLR (n=8)
- Concomitant PCL or MCL injury (n=6)

142 patients remaining

High grade PS under consciousness

(n=20; All with high grade PS under anesthesia)

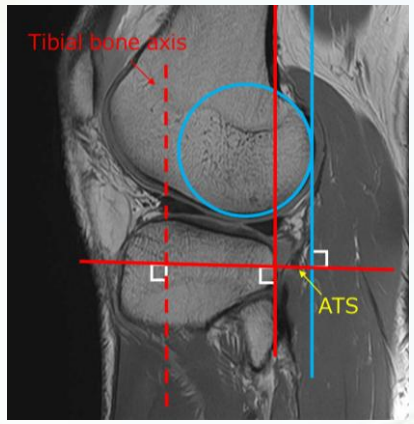
Low grade PS under consciousness (n=**122**)

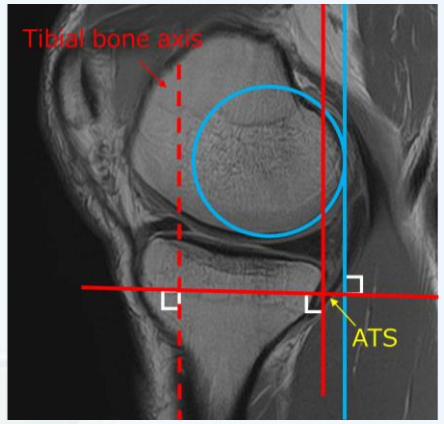
- High grade PS under anesthesia; the high group (HG) (n=**34**)
- Low grade PS under anesthesia; the low group (LG) (n=**88**)

※IKDC grade A and B were classified as low grade, IKDC grade C and D as high grade.

Methods: Comparison of ATS

for each measurement method





a) The medial ATS (**M_ATS**) b) the lateral ATS (**L_ATS**)

c) **D_ATS** (= L_ATS - M_ATS)

are **compared between HG and LG.**

(*t* test, Statistical significance was set at **P < 0.01**)

ROC analysis was performed with HG as a positive.

Results: Characteristics

	HG (n=34)	LG (n=88)	p Value
Ages (years)	25.1±2.3	29.4±1.4	0.12
Sex (male: female)	27:7	49:39	0.02
BMI (kg/m^2)	24.1±0.7	23.6±0.4	0.52
Duration between injury and surgery (months)	4.9±6.8	12.9±4.3	0.32
Medial meniscus (injury: normal)	15:18	22:65	0.03
Lateral meniscus (injury: normal)	16:17	42:45	0.98
Knee angle on MRI (°)	11.3±1.1	11.7±0.7	0.73

Male and medial meniscus injury were seen in HG more than LG.

Results: Comparison of ATS

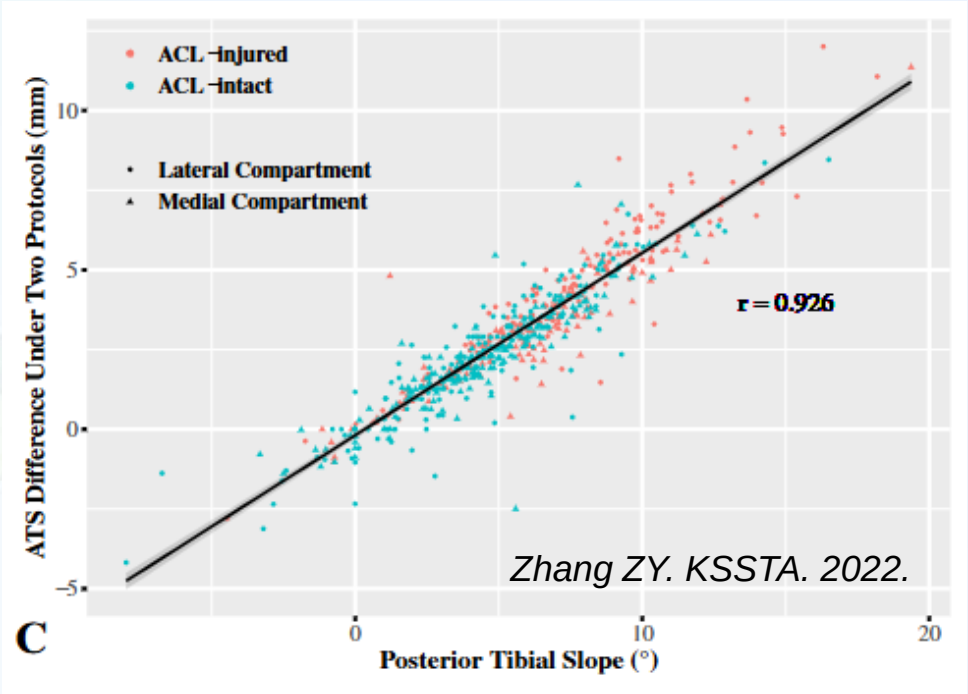
		HG (n=34)	LG (n=88)	P value	ROC-AUC
M_ATS (mm)	Plateau	0.52±0.46	1.46±0.29	0.09	0.57
	Bone axis	2.11±0.54	3.40±0.33	0.04	0.60
L_ATS (mm)	Plateau	3.29±0.67	2.75±0.42	0.50	0.53
	Bone axis	6.41±0.77	5.41±0.48	0.27	0.55
D_ATS (mm)	Plateau	2.77±0.58	1.29±0.36	0.03	0.60
	Bone axis	4.30±0.67	2.01±0.42	**0.004**	**0.65**

D_ATS was greater with the bone axis method in HG than in LG.
The ROC-AUC for D_ATS with the bone axis method was the highest.

Discussion: Plateau method and bone axis method

A strong positive correlation has been observed between the posterior tibial slope (PTS) and the ATS difference between the plateau method and the bone axis method.

Zhang ZY. KSSTA. 2022.



The ATS measured with the plateau method may underestimate rotational instability in those with a steep PTS.

Discussion: D_ATS

Rotational tibiofemoral position was determined by calculating D_ATS. Increased D_ATS in ACL-injured knees compared with ACL-intact knees showed rotated internally.

Zhang ZY. Knee. 2021.

D_ATS is one of the risk factors of having high grade PS.

Ni QK. KSSTA. 2022.

Present study:

- D_ATS measured with the bone axis method on preoperative MRI was associated with PS.
- Each ATS (M_ATS, L_ATS, D_ATS) measured with the plateau method was not associated with PS.

Conclusion

Comparing ATS between HG and LG groups,

- D_ATS measured with the bone axis method was significantly greater in HG than LG group.
- With the plateau method, there was no difference in each ATS (M_ATS, L_ATS, D_ATS).

References

Firth, A. D. et al. Predictors of Graft Failure in Young Active Patients Undergoing Hamstring Autograft Anterior Cruciate Ligament Reconstruction With or Without a Lateral Extra-articular Tenodesis: The Stability Experience. Am. J. Sports Med. 50, 384–395 (2022).

Gupta, R., Kapoor, A., Singhal, A., Patil, B. M. & Bansal, P. The presence of high-grade pivot shift test preoperatively is associated with inferior functional outcomes. Phys. Sportsmed. 50, 306–310 (2022).

Benjaminse, A., Gokeler, A. & van der Schans, C. P. Clinical diagnosis of an anterior cruciate ligament rupture: a meta-analysis. J. Orthop. Sports Phys. Ther. 36, 267–288 (2006).

Lian, J. et al. Static Lateral Tibial Plateau Subluxation Predicts High-Grade Rotatory Knee Laxity in Anterior Cruciate Ligament-Deficient Knees. Am. J. Sports Med. 47, 277–284 (2019).

Liu, A. et al. Anterior Tibial Subluxation of Lateral Compartment Is Associated With High-Grade Rotatory Instability for Acute But Not Chronic Anterior Cruciate Ligament Injuries: An Magnetic Resonance Imaging Case-Control Study. Arthroscopy 38, 2852–2860 (2022).

Ni, Q.-K. et al. High-grade pivot-shift phenomenon after anterior cruciate ligament injury is associated with asymmetry of lateral and medial compartment anterior tibial translation and lateral meniscus posterior horn tears. Knee Surg. Sports Traumatol. Arthrosc. 30, 3700–3707 (2022).

Ye, Z. et al. Association Between Anterior Tibial Subluxation of Lateral Compartment and High-Grade Knee Laxity in Patients With Anterior Cruciate Ligament Deficiency. Am. J. Sports Med. 51, 1698–1707 (2023).

Zhang, Z.-Y. et al. Anterior and rotational tibial subluxation in the setting of anterior cruciate ligament injuries: An MRI analysis. Knee 33, 365–373 (2021).