A large medial posterior tibial slope leads to worse anteroposterior and rotational instability after anterior cruciate ligament reconstruction over time

Kensaku Abe, Masahiro Nozaki, Hiroaki Fukushima,
Shunta Hanaki, Kyohei Ota, Makoto Kobayashi
Yusuke Kawanishi, Jiro Kato, Hideki Murakami

Department of Orthopaedic Surgery, Nagoya City University
Graduate School of Medical Sciences, Nagoya, Japan

Faculty Disclosure Information

Nothing to disclosure

Introduction

Large posterior tibial slope (PTS)

➡ **Risk factor of the anterior cruciate ligament (ACL) injury or reinjury**

(Dean RS, et al. Orthop J Sports Med. 2022)

Anterior tibial translation(ATT)

- ✓ PTS > 12° → ATT ↑
  (Dejour H, et al. J Bone Joint Surg Br. 1994)
- ✓ Pre- and post-operative ATT ↑
  (Dejour D, et al. Knee Surg Sports Traumatol Arthrosc. 2019)
- ✓ Standing phase of gait: ATT ↑, shear force on ACL ↑
  (Marouane H, et al. J Biomech. 2015)

Rotational instability

- ✓ Lateral PTS (LPTS) ↑ → instability ↑
  (Rahnemai-Azar AA, et al. Knee Surg Sports Traumatol Arthrosc. 2017)
- ✓ Medial PTS (MPTS) ↑ → instability ↑
  (Yoshida R, et al. J Exp Orthop. 2024)
- ✓ Difference between LPTS and MPTS ↑ → instability ↑
  (Kataoka K, et al. J Exp Orthop. 2022)

This study aims to evaluate the impact of PTS on preoperative and postoperative instability and to assess the changes in instability following surgery.

Materials

2016.2～2022.9
Primary ACLR 614 knees

Exclusion criteria
- with other ligament injuries
- with osteotomies
- luck of data
- no hardware removal

After hardware removal 151 knees

Exclusion criteria
- Tegner activity scale < 7

High sports level → laxity ↑ → risk of reinjury

(Zhao D, et al. Am J Sports Med. 2023)
(Grindem H, et al. Br J Sports Med. 2016)

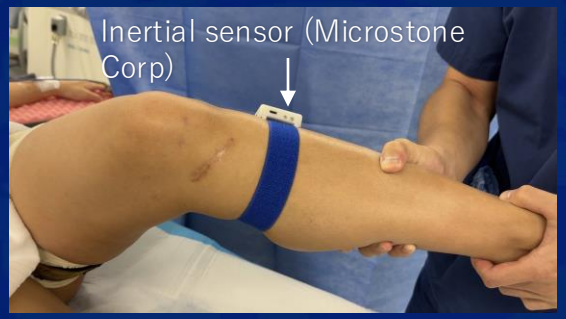
Tegner activity scale ≥7

100 knees

Evaluation items

Objective variable＝knee instability under general anesthesia

- ATT using Rolimeter: side-to-side difference (**SSD**)
- Pivot shift test ⟶
  - ✓ Subjective evaluation using IKDC grade
  - ✓ Objective (quantitative) evaluation using inertial sensor



- Inertial sensor: side-to-side ratio (**SSR**)
  - ✓ **Acceleration** (m/s^2)
  - ✓ External rotational angular velocity **(ERAV)** (deg/s)

(Murase A, Nozaki M, et al. J Orthop Sci. 2017)

4. Changes over time (difference between 2 and 3)

1. preoperation　2. during temporary fixation＝time zero ⟶ 3. hardware removal

Temporary fixation on time zero

Evaluation items

Explanatory variables: age, gender, height, weight, BMI, injury ~ ACLR (months),
ACLR ~ hardware removal (years), MM repair, LM repair, meniscal repair

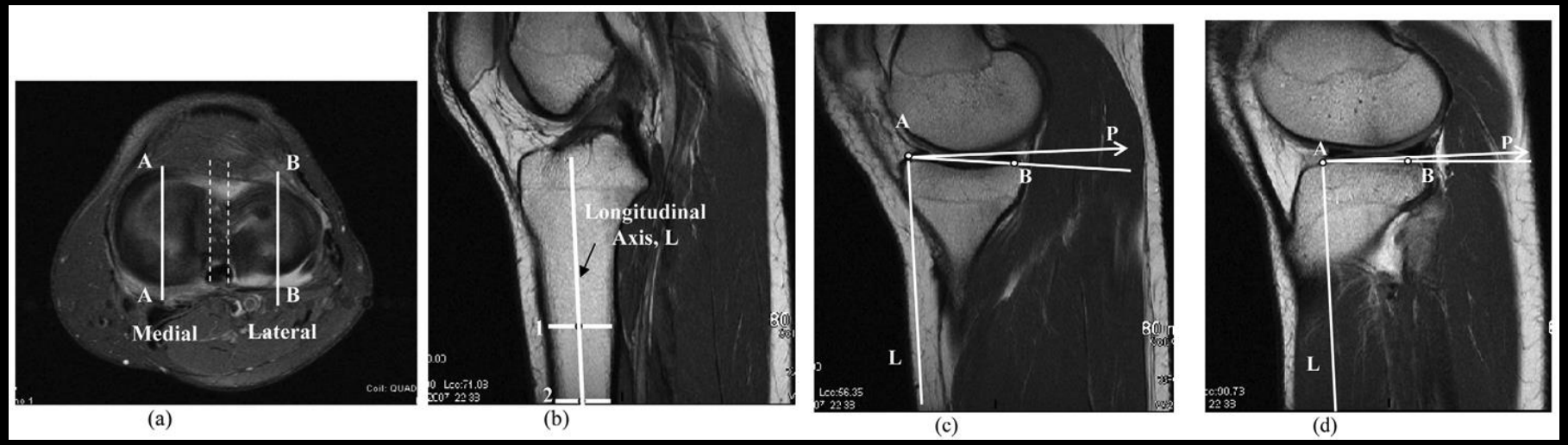
LPTS, **MPTS**, **LPTS – MPTS**, **|LPTS – MPTS|**

The measurements were performed according to Hashemi J, et al. *(Hashemi J, et al. J Bone Joint Surg Am, 2008)*

Statistical analysis: Fisher's exact test → $p < 0.2$ → **Binary logistic regression analysis**

- ✓ Based on a previous review, **MPTS was divided into 9.05°** and **LPTS into 9.55°** . *(Dean RS, et al. Orthop J Sports Med. 2022)*
- ✓ Pivot shift grade was divided into 0, 1 and 2, 3 before surgery and 0, 1 at the time of hardware removal.
- ✓ Other continuous variables were divided by median to reduce the difference in n between the two groups.

The measurements of PTS



(Hashemi J, et al. J Bone Joint Surg Am, 2008)

Representative examples

Acceleration (SSR)		pre-operation		Fisher's exact test	Logistic analysis	time zero		Fisher's exact test	Logistic analysis
		<3.8	≥3.8			<1.1	≥1.1		
		56	44	p-value		41	59	p-value	
Age (years)	<22.5 / ≥22.5	32/24	32/12	0.14	0.43	28/13	36/23	0.53	
Gender	female / male	28/28	31/13	0.044	0.48	26/15	33/26	0.54	
Height (cm)	<162 / ≥162	18/38	20/24	0.22		18/23	20/39	0.40	
Weight (kg)	<58 / ≥58	20/36	26/18	0.026	0.53	22/19	24/35	0.23	
BMI (kg/m^2)	<22.3 / ≥22.3	23/33	28/16	0.029	0.30	22/19	29/30	0.69	
meniscal repair	no / yes	21/35	10/34	0.13	0.34	12/29	19/40	0.83	
medial meniscal repair	no / yes	31/25	18/26	0.17	0.68	17/24	32/27	0.23	
lateral meniscal repair	no / yes	37/19	31/13	0.67		30/11	38/21	0.39	
LPTS (°)	<9.55 / ≥9.55	52/4	39/5	0.50		40/1	51/8	0.078	
MPTS (°)	<9.05 / ≥9.05	50/6	40/4	1.00		35/6	55/4	0.31	
LPTS - MPTS (°)	<0.3 / ≥0.3	30/26	20/24	0.55		24/17	26/33	0.22	
|LPTS – MPTS| (°)	≤2.0 / >2.0	27/29	24/20	0.55		18/23	33/26	0.31	
injury ~ ACLR (months)	<3.5 / ≥3.5	32/24	19/25	0.23		21/20	30/29	1.00	
ACLR ~ Hardware removal (years)	<1.48 / ≥1.48	N/A	N/A	N/A		N/A	N/A	N/A	

Acceleration (SSR)		post-operation		Fisher's exact test	Logistic analysis	changes over time		Fisher's exact test	Logistic analysis
		<1.3	≥1.3			<0.16	≥0.16		
		54	46	p-value		54	46	p-value	
Age (years)	<22.5 / ≥22.5	31/23	33/13	0.15	0.58	30/24	34/12	0.064	0.46
Gender	female / male	26/28	33/13	0.025	0.14	24/30	35/11	0.0021	0.067
Height (cm)	<162 / ≥162	17/37	21/25	0.16	0.67	15/39	23/23	0.025	0.73
Weight (kg)	<58 / ≥58	21/33	25/21	0.16	0.56	19/35	27/19	0.027	0.75
BMI (kg/m^2)	<22.3 / ≥22.3	23/31	28/18	0.075	0.29	24/30	27/19	0.17	0.85
meniscal repair	no / yes	21/33	10/36	0.084	0.30	16/38	15/31	0.83	
medial meniscal repair	no / yes	30/24	19/27	0.17	0.62	27/27	22/24	0.84	
lateral meniscal repair	no / yes	36/18	32/14	0.83		35/19	33/13	0.52	
LPTS (°)	<9.55 / ≥9.55	49/5	42/4	1.00		48/6	43/3	0.50	
MPTS (°)	<9.05 / ≥9.05	52/2	38/8	0.041	0.027	53/1	37/9	0.0051	0.025
LPTS - MPTS (°)	<0.3 / ≥0.3	27/27	23/23	1.00		24/30	26/20	0.32	
|LPTS – MPTS| (°)	≤2.0 / >2.0	28/26	23/23	1.00		30/24	21/25	0.42	
injury ~ ACLR (months)	<3.5 / ≥3.5	28/26	23/23	1.00		29/25	22/24	0.69	
ACLR ~ Hardware removal (years)	<1.48 / ≥1.48	28/26	17/29	0.16	0.22	26/28	19/27	0.55	

Correlation between PTS and instability

	1. preoperation	2. time zero	3. hardware removal	4. changes over time
ATT	large MPTS (p=0.024)	N/A	N/A	N/A
Pivot shift grade	N/A	N/A	large MPTS (p=0.013)	large MPTS (p=0.013)
Acceleration	N/A	N/A	large MPTS (p=0.027)	large MPTS (p=0.025)
ERAV	N/A	N/A	N/A	large MPTS (p=0.037)

Discussion

- Most of previous reports:

  large PTS (LPTS involvement) → ATT ↑ *(Dejour D, et al. Knee Surg Sports Traumatol Arthrosc. 2019)* *(Rahnemai-Azar AA, et al. Knee Surg Sports Traumatol Arthrosc. 2017)*

- This study:

  large **MPTS** → **pre**operative ATT ↑

  postoperative rotational instability ↑

	1. preoperation	2. time zero	3. hardware removal	4. changes over time
ATT	large MPTS (p=0.024)	N/A	N/A	N/A
Pivot shift grade	N/A	N/A	large MPTS (p=0.013)	large MPTS (p=0.013)
Acceleration	N/A	N/A	large MPTS (p=0.027)	large MPTS (p=0.025)
ERAV	N/A	N/A	N/A	large MPTS (p=0.037)

📌 Even if there was no difference at hardware removal, it got worse over time.

Conclusions

- **MPTS affected on rotational instability after ACL reconstruction and on ATT before ACL reconstruction.**
  - → Anterior closing wedge osteotomy is the best method to control. *(Pearce SL, et al. Am J Sports Med. 2023)*
  - → However, control by ALL reconstruction or LET is also possible?
  - → Next theme

- **Rotational instability worsened over time.**