Additional Centralization Procedure Further Controls Pivot Shift After ACL Reconstruction and Lateral Meniscus Repair

Hideyuki Koga, Ryota Seki and Tomomasa Nakamura

Tokyo Medical and Dental University, Japan

Background

- Residual Anterolateral rotatory instability (**ALRI**) after ACL reconstruction (**ACLR**)
  - 8% ~ 25%

Chambat et al. Int Orthop 2013

Kim et al. AJSM 2018

- Worse outcomes with residual ALRI
  - Lower patients' subjective satisfaction
  - Lower functional outcomes
  - Progression of OA

Kocher et al. JBJS 2002

Ayeni et al. KSSTA 2012

- Importance of performing ACLR without residual ALRI

Lateral meniscus (**LM**) injuries increase **ALRI**

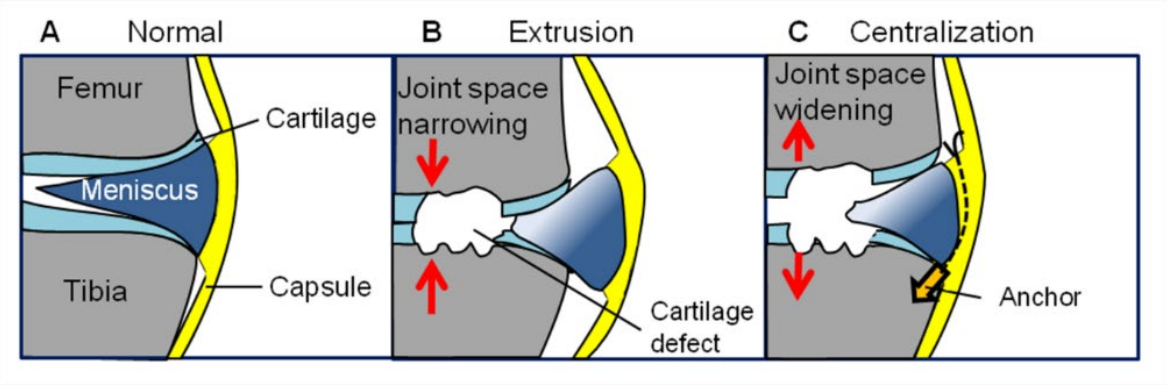
- LM contributes to controlling pivot shift — *Musahl et al. AJSM 2010*
- LM posterior root tear (LMPRT) increases ALRI — *Forkel et al. KSSTA 2018*; *Minami, Koga et al. KSSTA 2018*
- LM repair reduces pivot shift in ACL-injured knees — *Katakura M, Koga H et al. Knee 2019*
- Residual pivot shift after ACLR with LM resection — *Hoshino et al. KSSTA 2020*

▶ LM is considered as a secondary restraint against ALRI

Arthroscopic **centralization** procedure for extrusion

Koga et al. Arthroscopy Techniques 2012, Arthroscopy 2016

- Centralize extruded LM by anchoring meniscotibial capsule anterior to popliteal hiatus



- Improve load distributing function by reducing extrusion

Ozeki, Koga J Orthop Sci 2019, Amano Koga Arthroscopy 2024

- Improve **rotational stability** during ACLR by anchoring meniscotibial capsule

Nakamura, Koga, Fu AJSM 2021

Objectives

- To investigate effects of **LM repair** and additional **centralization** on ALRI during ACLR

Hypotheses

- There are several cases with residual ALRI even after ACLR and LM repair
- Additional centralization further controls ALRI

Materials and Methods

Primary ACLR between February 2022－June 2023

Inclusion criteria

- Primary double-bundle ACLR using hamstrings
- LM injury confirmed by arthroscopy

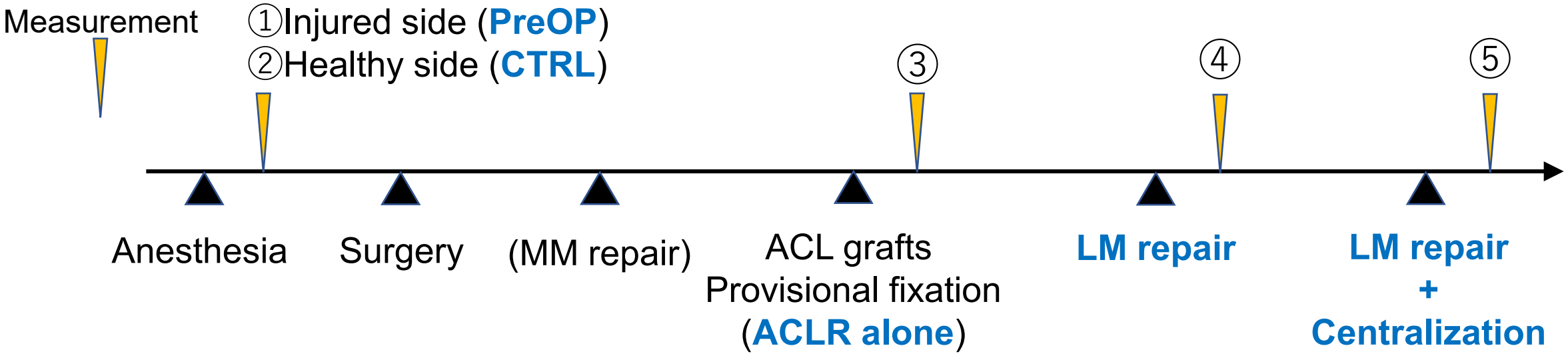
Exclusion criteria

- Multi-ligament injury
- Past history of knee injuries
- OA (Kellgren-Lawrence grade > 2)
- Open physis

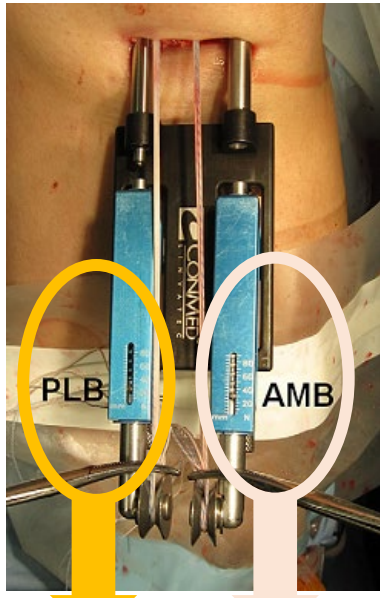
Measurement protocol

Measure **tibial acceleration** during pivot shift using triaxial accelerometer (**KiRA**)

Nakamura, Koga et al. KSSTA 2017



ACL graft provisional fixation



5N	5N
10N	10N

- Grafts provisionally fixed to graft tensioning system at 20˚
- Pivot shift measurement in 2 conditions
  - AMB and PLB fixed at 5N each (total 10N, A5P5)
  - AMB and PLB fixed at 10N each (total 20N, A10P10)

Statistics

- Comparisons between all groups
  ⇒Kruskal-Wallis test

- Multiple comparison
  ⇒Steel-Dwass test with Bonferroni correction

- P-value of <0.05 was considered as statistically significant

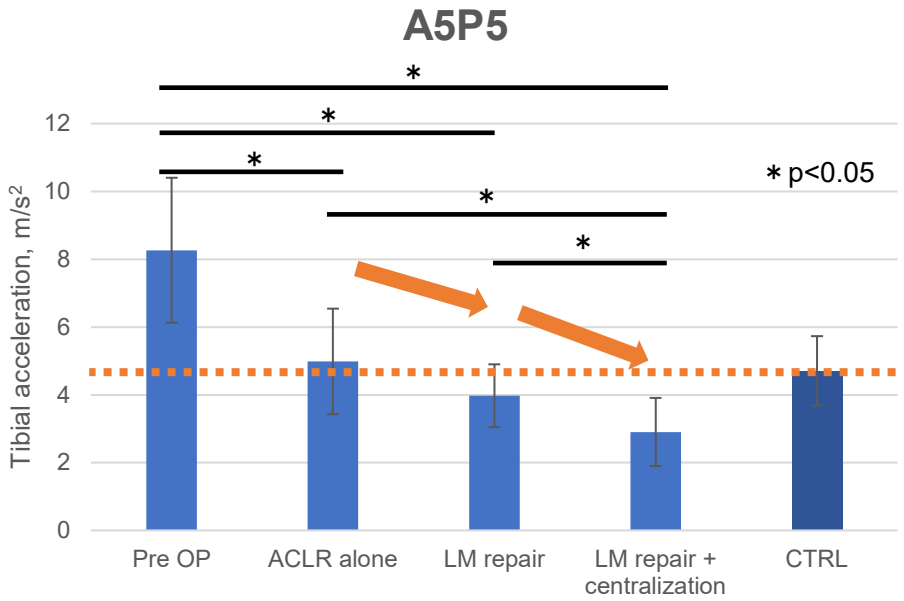
Results

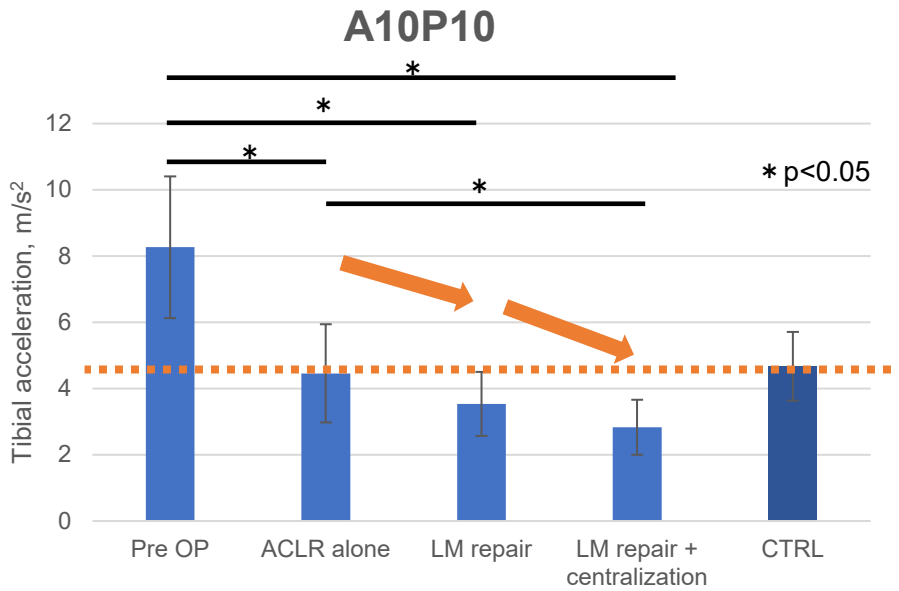
Patients' background

n=20

Age, years		28.6 (17-54)
Gender female/male, n		10/10
Preoperative period, months		3 (1-420)
MM injury, n		12 (Repair 12)
LM injury, n	Longitudinal	12
	Horizontal	1
	Flap	1
	radial	1
	PRT	5

Pivot shift acceleration





- ACLR alone was not enough for controlling pivot shift
- LM repair reduced pivot shift
- Centralization further reduced pivot shift

Pivot shift acceleration in each case

A5P5

	PreOP	ACLR alone	LM repair	LM repair + centralization	CTRL
1	9.5	5.2	3.7	1.9	4.3
2	8.6	5.2	3.2	2.5	5.2
3	6.2	5.4	4.2	2.6	5.7
4	9.2	4.2	1.9	1.1	4.5
5	8.4	5.8	5	3.2	5.5
6	7.1	5.6	**4.8**	3.6	2.8
7	9.9	4.7	4	3	5.4
8	10.1	3	3.2	2.7	4.8
9	7.4	4.7	4.9	2.1	5.4
10	7.7	5.3	2.8	2.5	4.4
11	5.3	5.4	**4.8**	3.3	3.6
12	6.4	4.8	4	3.4	5.8
13	8	3.7	**4.8**	3	4
14	11.1	4.1	3.6	2.6	4.4
15	13.4	10.4	5	4.8	6.8
16	3.2	2.5	**2.8**	2.3	2.5
17	9.9	4.3	3	2.1	4.8
18	7.7	4.4	**4.7**	2.8	4.1
19	7.5	6	5.1	4.7	5.4
20	8.7	7.5	4.7	4.2	5.2

A10P10

	PreOP	ACLR alone	LM repair	LM repair + centralization	CTRL
1	9.5	4.8	2.2	2.5	4.3
2	8.6	4.5	3.5	2.4	5.2
3	6.2	4	4	2.7	5.7
4	9.2	3.7	2.6	1.4	4.5
5	8.4	5.1	4.2	2.6	5.5
6	7.1	3.7	**4.3**	3.4	2.8
7	9.9	3.8	3.4	2.8	5.4
8	10.1	2.7	2.7	2.8	4.8
9	7.4	5.6	4	2.6	5.4
10	7.7	4.4	2.7	2.4	4.4
11	5.3	4.1	3.3	3.6	3.6
12	6.4	4.4	4.3	3.2	5.8
13	8	3.8	3.4	3.6	4
14	11.1	4.2	3.4	2.5	4.4
15	13.4	9.7	6.3	5.4	6.8
16	3.2	2.3	2.3	1.8	2.5
17	9.9	4.6	2.7	2.3	4.8
18	7.7	4.8	**4.4**	3	4.1
19	7.5	5.8	**5.6**	3.9	5.4
20	8.7	6.4	4.2	4.4	5.2

- **More than half of cases** showed residual pivot shift after ACLR alone
- **5 cases** in A5P5 and **3 cases** in A10P10 even after LM repair
- **Only 1 case** after centralization

Discussion

This study investigated contribution of **LM repair** and additional **centralization** to ALRI after **ACLR**

In many cases,
- ACLR alone was not enough to control pivot shift
- LM repair controlled pivot shift

▼

LM plays an important role in controlling ALRI even after ACLR

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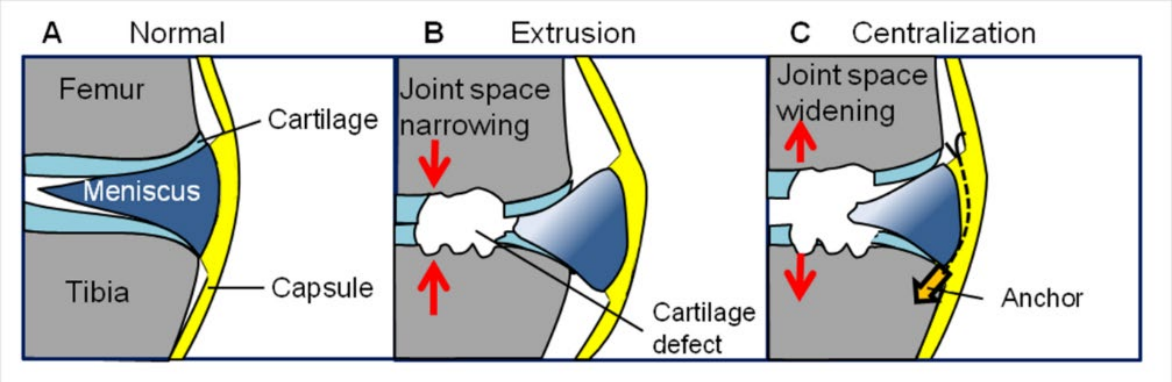
Some cases showed residual pivot shift even after **LM repair**

Arthroscopic **centralization**

Koga et al. Arthroscopy Techniques 2012, Arthroscopy 2016



- Improve load distributing function by reducing extrusion

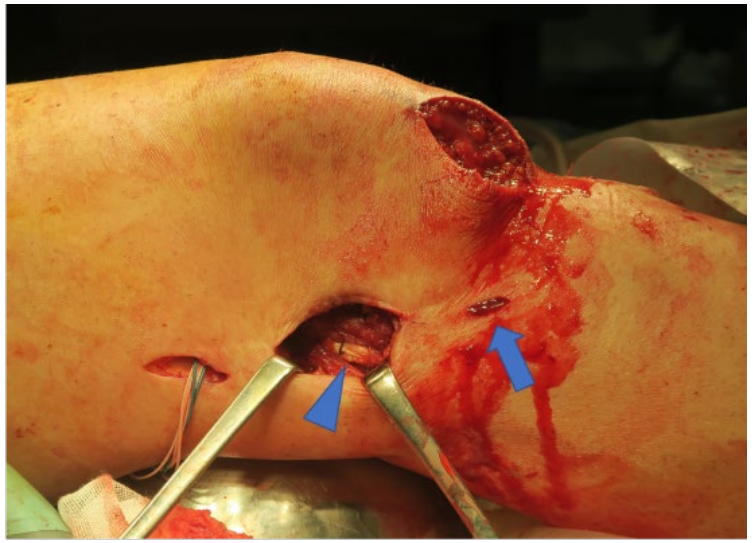
  Ozeki, Koga J Orthop Sci 2019, Amano Koga Arthroscopy 2024

- Improve **rotational stability** during ACLR by anchoring meniscotibial capsule

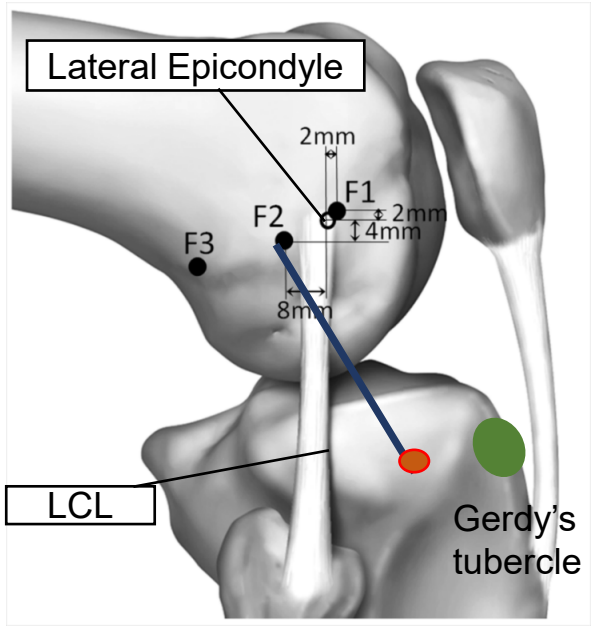
  Nakamura, Koga, Fu AJSM 2021

Additional **centralization** further reduces ALRI in cases with high risk of residual pivot shift

Anterolateral structure augmentation for high risk cases

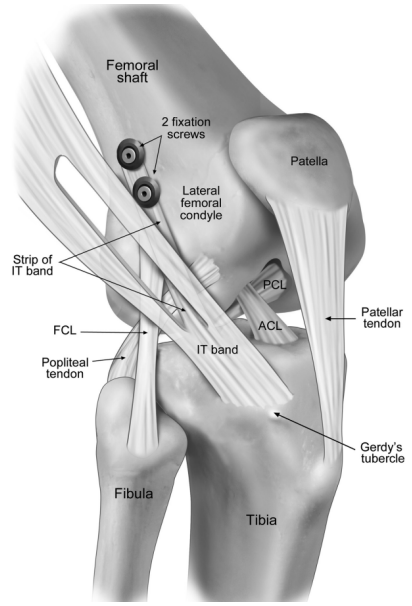


ALL reconstruction



Katakura, Koga et al. KSSTA 2017

Lateral extra-articular tenodesis



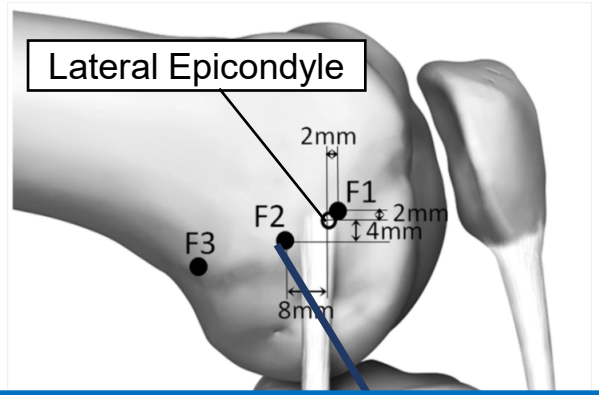
Slette et al. Arthroscopy 2016

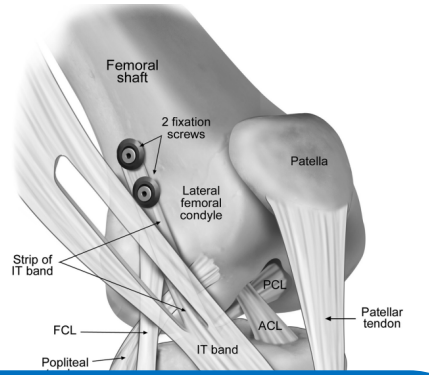
- Additional incision
- Bone tunnel
- Graft or tendon transfer

Anterolateral structure augmentation for high risk cases

ALL reconstruction

Lateral extra-articular tenodesis





In cases with LM injury,
Centralization can be one option to easily and less invasively control ALRI

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- Bone tunnel
- Graft or tendon transfer

Conclusions

- We investigated contribution of **LM repair** and additional **centralization** to ALRI after **ACLR**
- **ACLR** alone was not enough to control ALRI and **LM repair** reduced tibial acceleration during pivot shift, suggesting importance of **LM repair** to control ALRI
- Some cases showed residual pivot shift even after **LM repair**, and additional **centralization** further reduced ALRI
- In cases with LM injury, **centralization** can be one option to easily and less invasively control ALRI