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Comparison of resultant force through the repaired lateral meniscus with between inside-out and all-inside-suture repair techniques

Takehito Hirose[1)2)], Tatsuo Mae[3)4)], Satoshi Yamakawa[4)], Issei Ogasawara[5)], Shoji Konda[5)], Yasuhiro Take[1)], and Ken Nakata[5)]

1) Department of Orthopaedic Surgery, Daini Osaka Police Hospital, Osaka, Japan
2) Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Osaka, Japan
3) Osaka Yukioka Medical College, Osaka, Japan
4) Department of Sports Medical Biomechanics, Osaka University Graduate School of Medicine, Osaka, Japan
5) Department of Health and Sports Sciences, Osaka University Graduate School of Medicine, Osaka, Japan

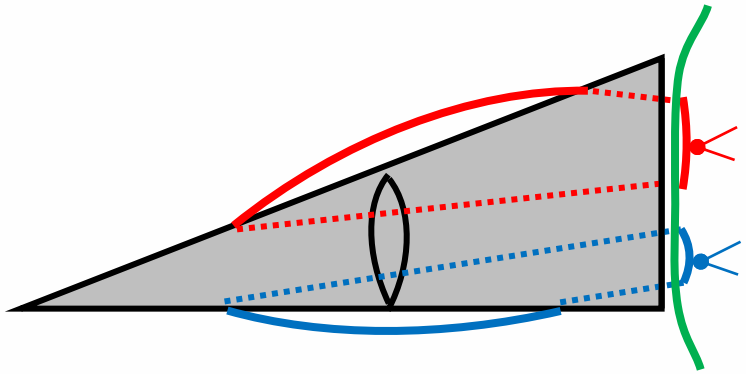
COI disclosure

Leading Presenter :Takehito Hirose

The authors declare no conflicts of interest associated with this presentation.

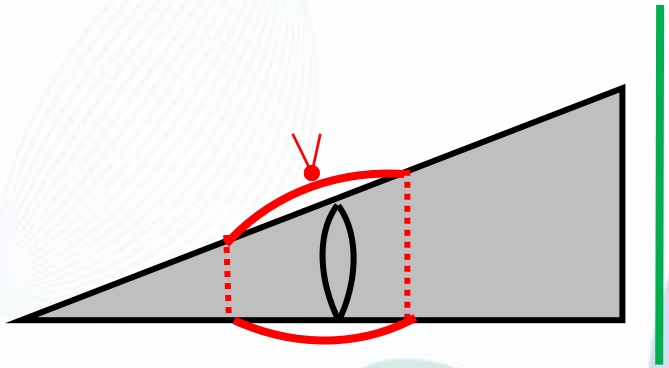
Techniques of meniscal repairing for longitudinal tear

Inside-out（IO）repair



Trans-capsular

All-inside-suture（AIS）repair



Completely anatomic

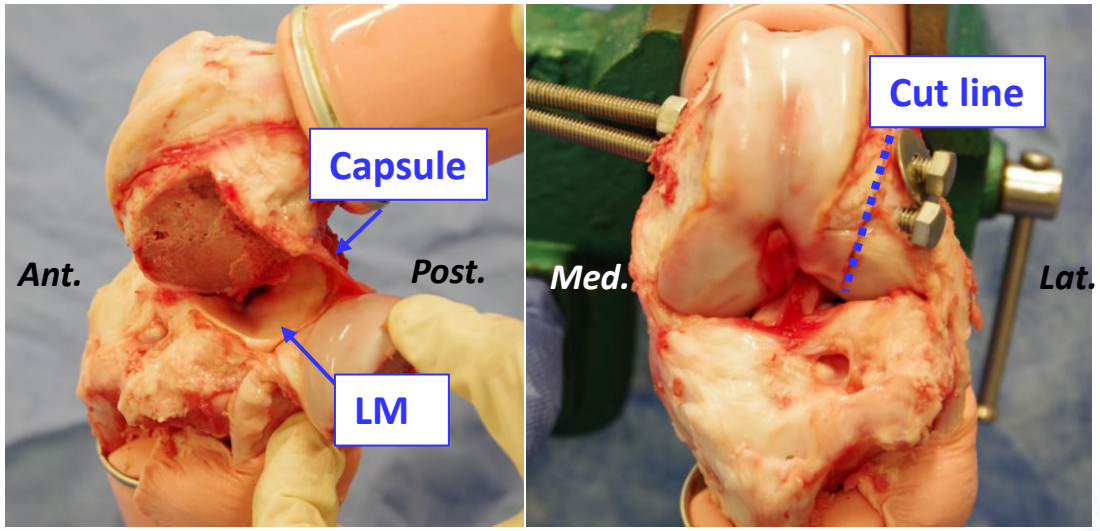
The effect on load transmission function of the repaired meniscus ??

Purpose

To compare the load transmission function of the repaired meniscus by AIS and IO technique using lateral meniscus (LM) longitudinal tear model in the experimental setting.

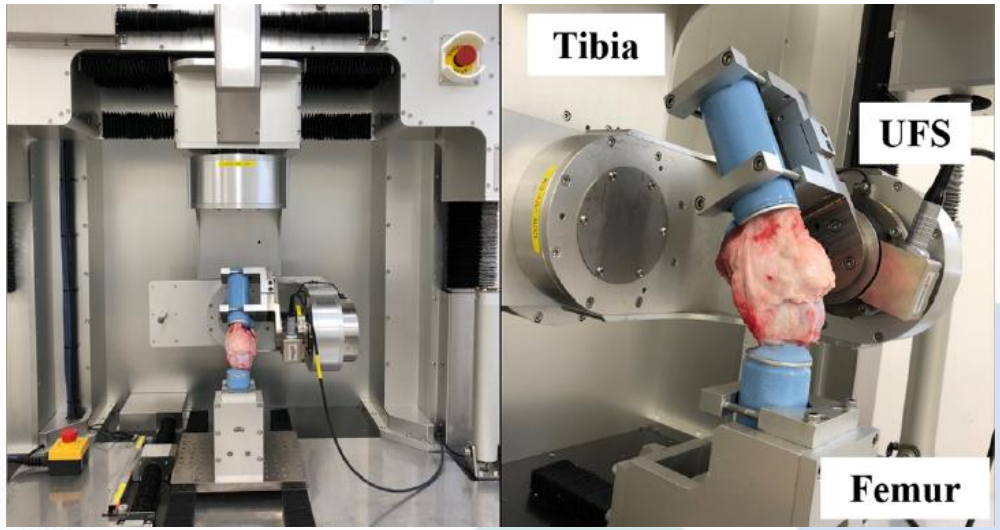
Method -set up-

- Nine fresh-frozen porcine knees



- LM after osteotomy (preserving post. capsule)
- Reduction & fixation

- 6- DOF robotic simulator

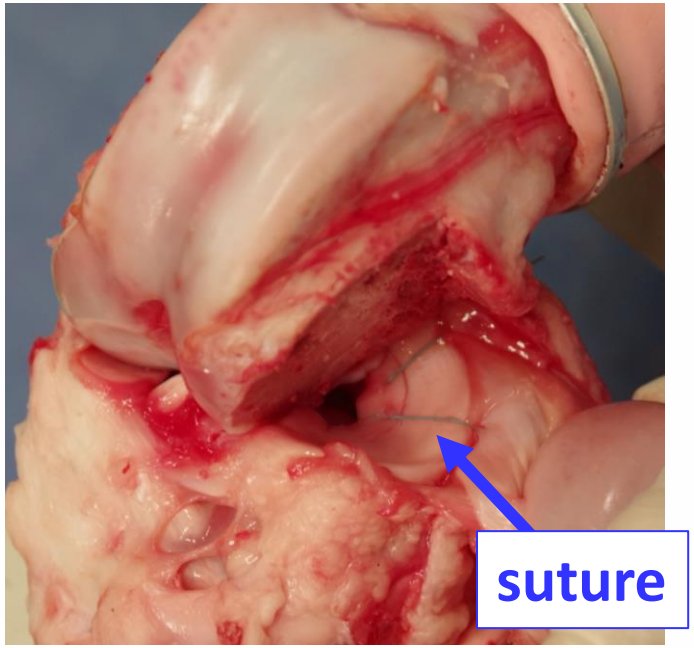


- Natural knee motion
- 3D combined force in knee coordinate system
- Reproduction of knee motion trajectory

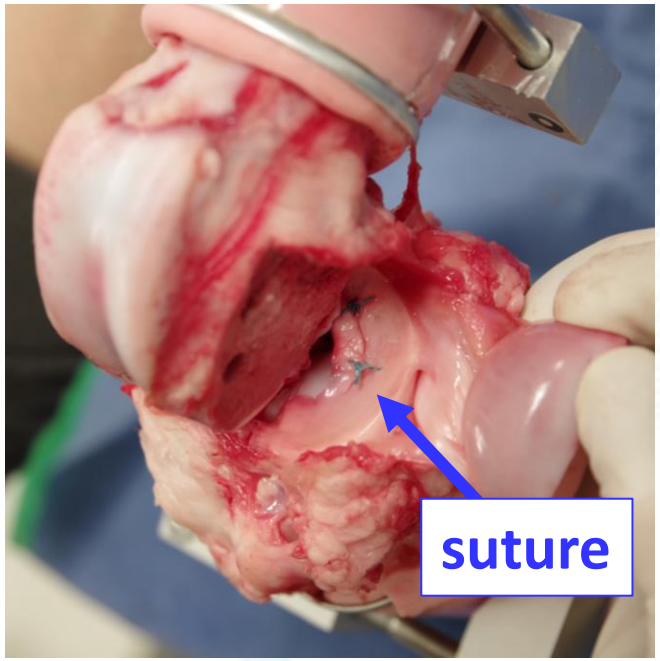
Fujie H, et al. J Biomech, 1996
Fujie H, et al. J Biomech Eng, 2004

Gross appearance

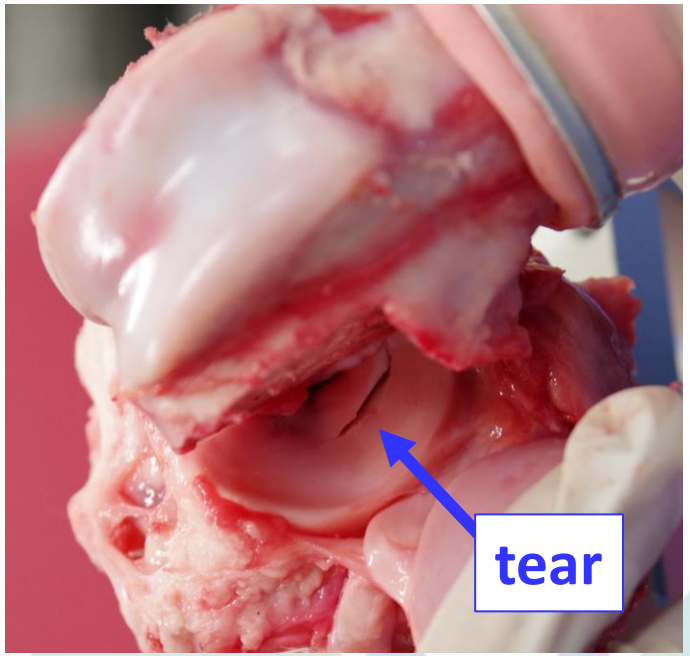
group IO*



group AIS**



group L

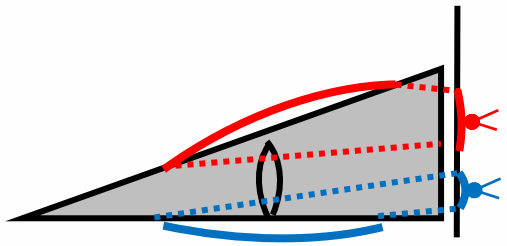


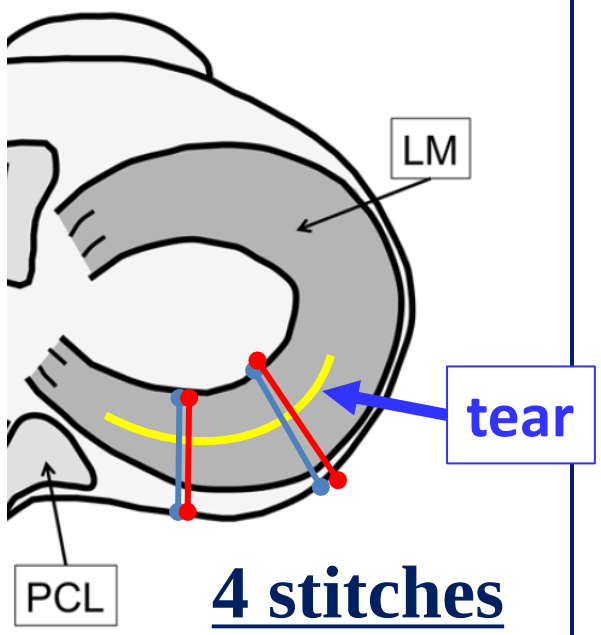
- Flex. @ 90°
- using 2-0 Ethibond
- knot tying* 5

*Henning Meniscal Repair Set (Stryker) ** FIRSTPASS MINI (Smith & Nephew)

Scheme of tear & repair

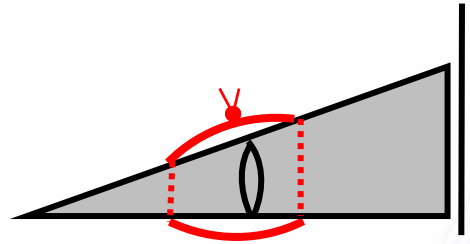
group IO

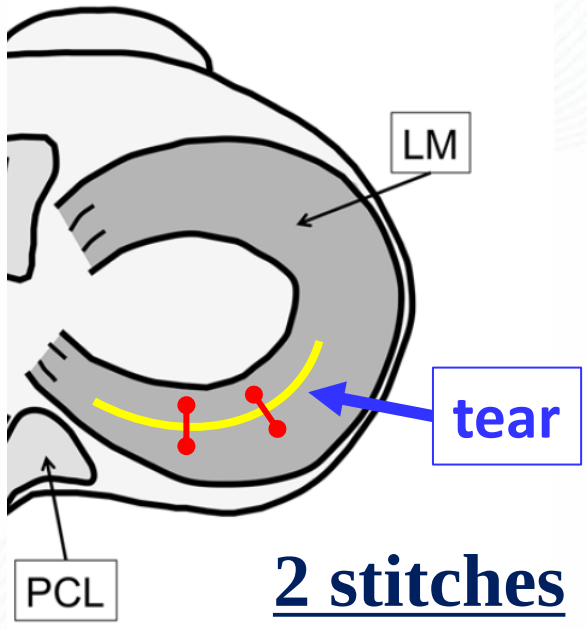




4 stitches

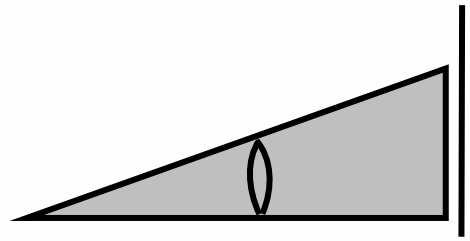
group AIS

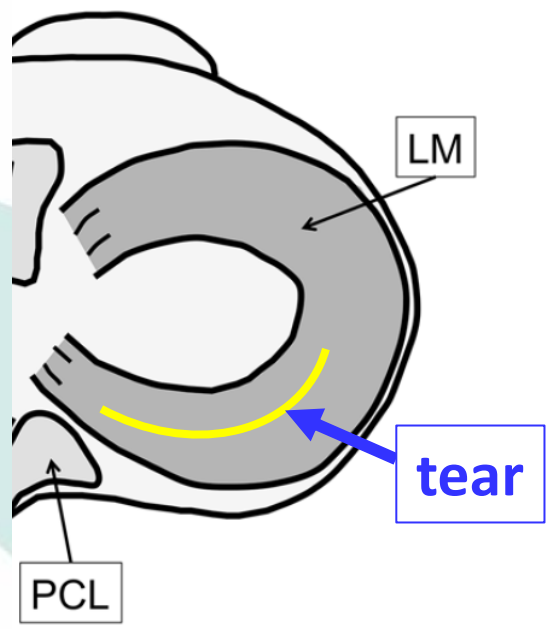




2 stitches

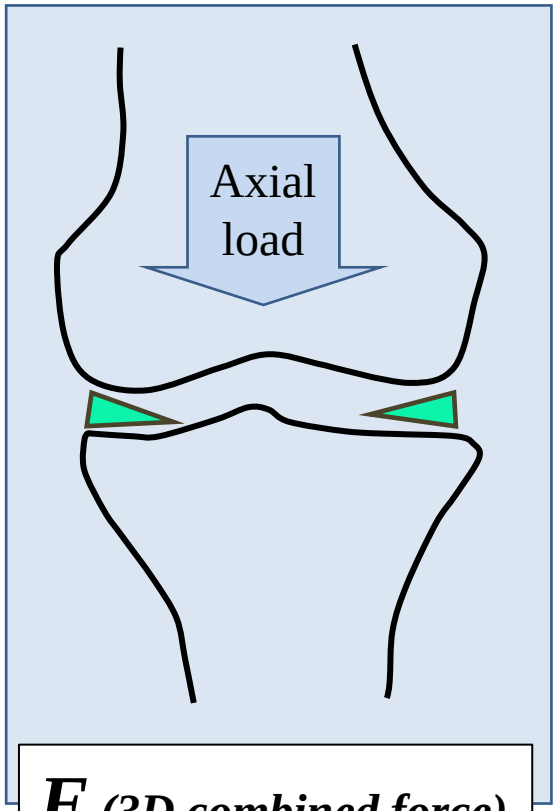
group L





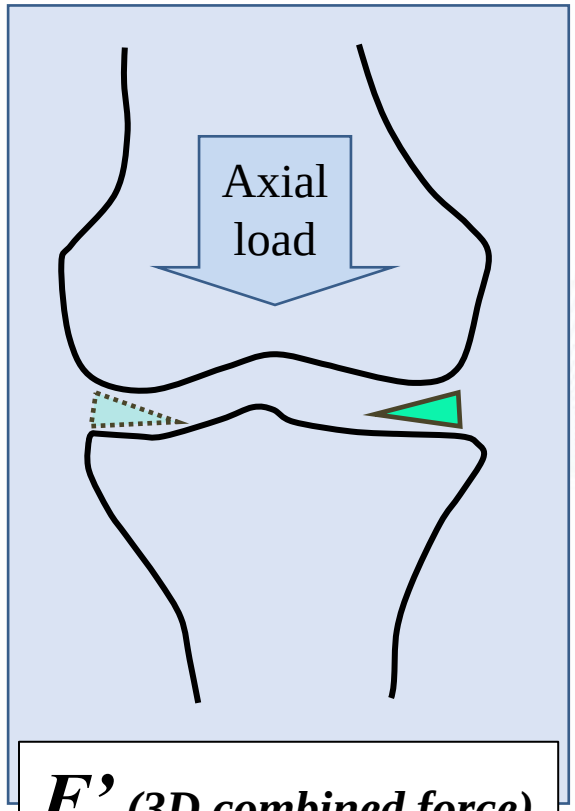
Method -principle of superposition-

Before total LMX

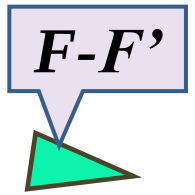


F ***(3D combined force)***

After total LMX



F' ***(3D combined force)***



F-F' **= Resultant force through the meniscus**

(combined force applied to the meniscus)

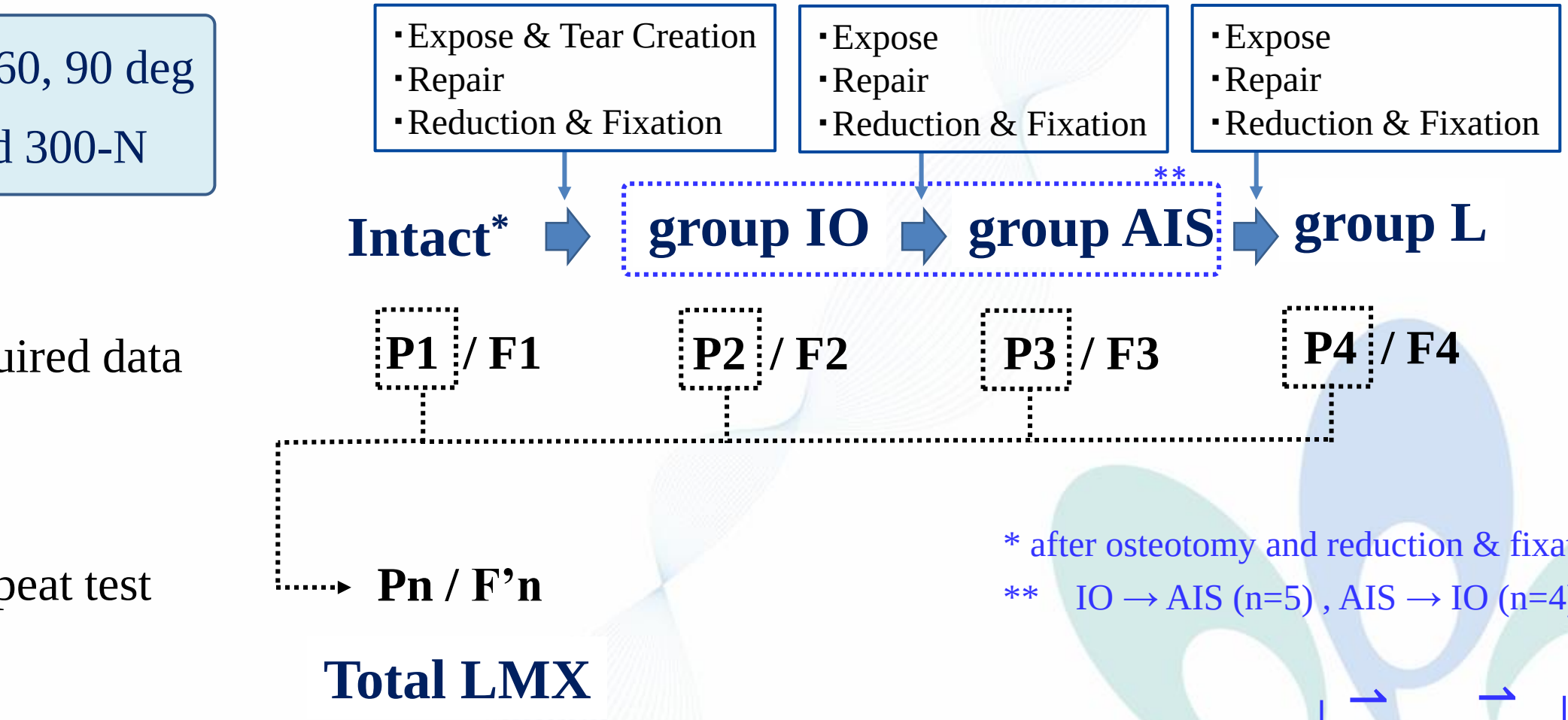
=

Load transmission function of the meniscus

Tachibana Y, et al. KSSTA. 2017
Ohori T, et al. KSSTA. 2020
Hirose T, et al. JEO. 2020

Testing protocol

- Flex. 30, 60, 90 deg
- Axial load 300-N

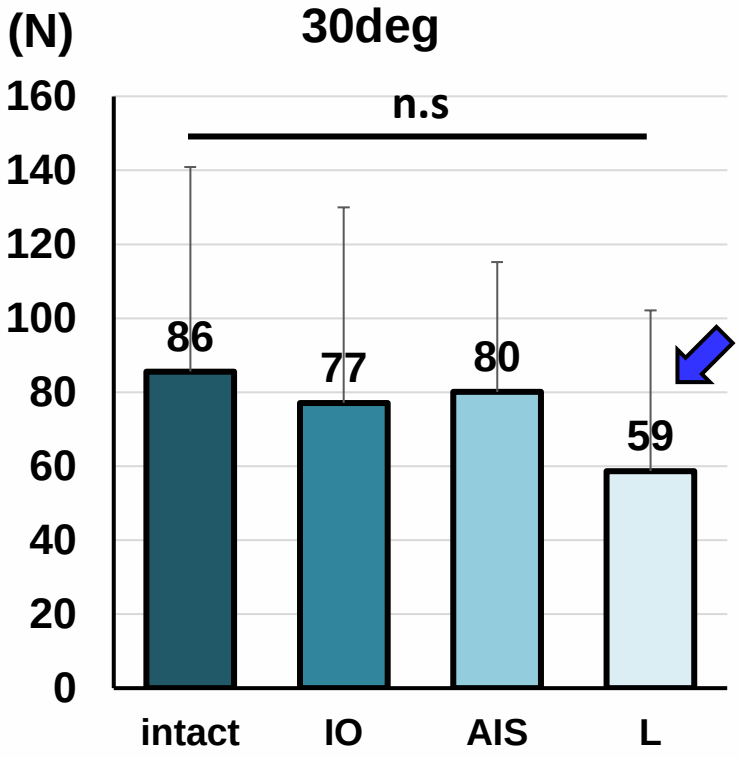


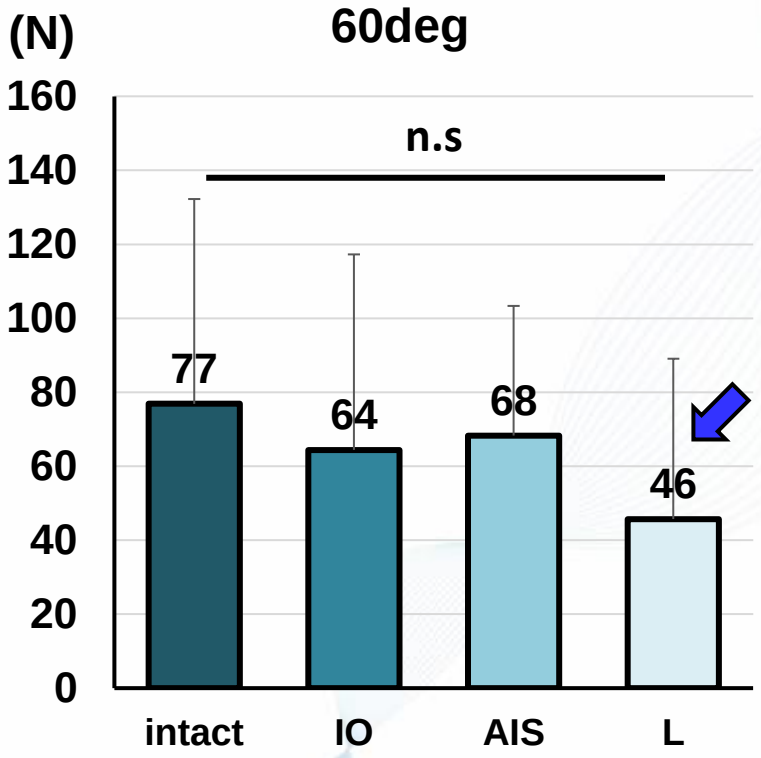
* after osteotomy and reduction & fixation

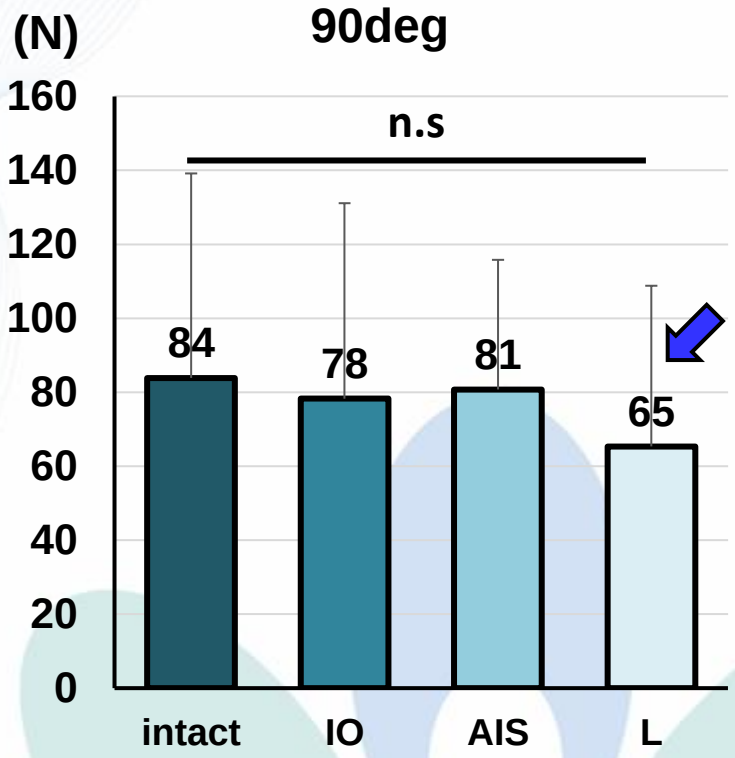
** IO → AIS (n=5) , AIS → IO (n=4)

$$\text{Resultant force (RF)} = \left|\vec{Fn} - \vec{Fn'}\right|$$

Result - Resultant force







Tested by repeated measures ANOVA

Although there were no statistical differences, **RF in group L was lower** than those in intact, IO, & AIS groups, while **RFs in group IO & AIS were almost equal to that of intact** w/o difference b/w each other.

Discussion - The effect of IO & AIS repair on LM tear

Longitudinal tear @ Outer or Inner third of **MM**
➡ Resultant force of **MM ↓ (= function↓)**

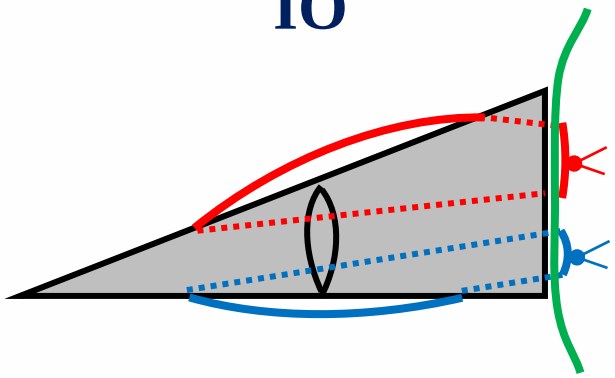
Tachibana Y, KSSTA, 2019

Our **LM** tear model

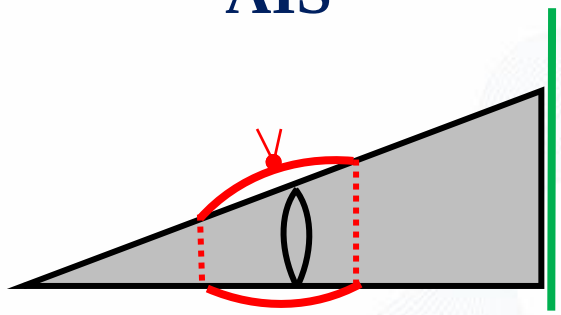
Longitudinal tear ➡ resultant force ↓

Our repaired **LM** model

IO



AIS



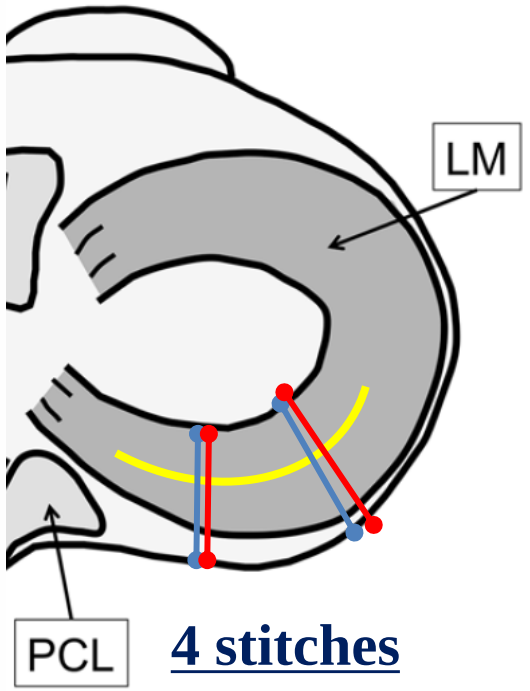
Restoration of resultant force @ time zero

➡ IO = AIS

Trans-capsular repair equivalently restored meniscal load transmission function compared to anatomic all-inside-suture repair.

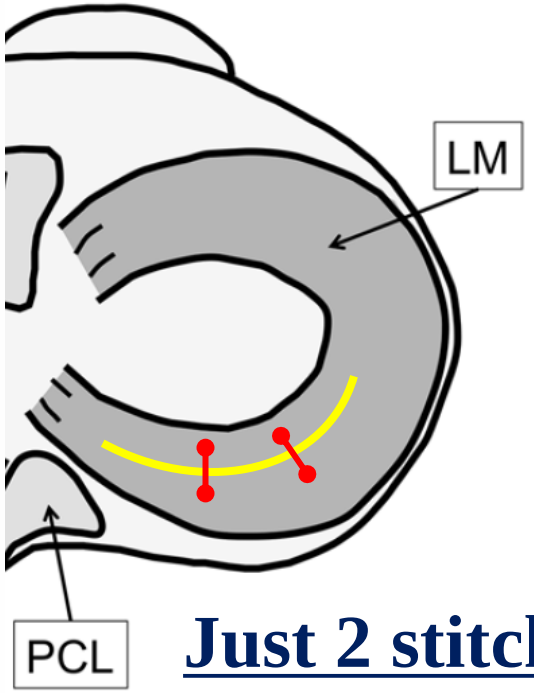
Discussion - Advantage & disadvantage of AIS repair

IO



4 stitches
（2 stitches each on the top & bottom sides）

AIS



Just 2 stitches

Advantage

- Lower number of stitches
- Time efficiency
- No additional incision

Disadvantage

- Less blood supply from capsule

Conclusions

- In the repair of the LM longitudinal tear, both the IO & AIS techniques equivalently restored the resultant force through the meniscus at time zero.

- Both techniques are excellent options for LM longitudinal tear repair, and surgeons can select either one according to the tear site.

References

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2) Fujie H, et al. A novel robotic system for joint biomechanical tests: application to the human knee joint. J Biomech Eng, 2004
3) Tachibana Y, et al. Effect of radial meniscal tear on in situ forces of meniscus and tibiofemoral relationship. KSSTA. 2017
4) Ohori T, et al. Different effects of the lateral meniscus complete radial tear on the load distribution and transmission functions depending on the tear site. KSSTA. 2020
5) Hirose T, et al. Reduction of in situ force through the meniscus with phased inner resection of medial meniscus: an experimental study in a porcine model. JEO. 2020
6) Tachibana Y, et al. A longitudinal tear in the medial meniscal body decreased the in-situ meniscus force under an axial load. KSSTA. 2019