

“Lowered Patella and Higher Age” the Relevant Predictors of Patellofemoral Osteoarthritis after Anterior Cruciate Ligament Reconstruction of the Knee

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The authors declare no Conflict of Interest.

Introduction

Aim of this study

- Anterior cruciate ligament reconstruction (ACLR) has been considered more in older patients to prevent post-traumatic knee osteoarthritis.

Brown TD et al., J Orthop Trauma 2006

- Osteoarthritic change in the patellofemoral joint (PFOA)
 - 40 % of patients at 5 years after ACLR.
 - Main contributors or predictors to PFOA remain unclear

Hiranaka T et al., J Orthop Sci 2019

Patterson BE et al., Am J Sports Med 2018

- Therefore, the chief relevant predictors for PFOA after ACLR were retrospectively investigated.

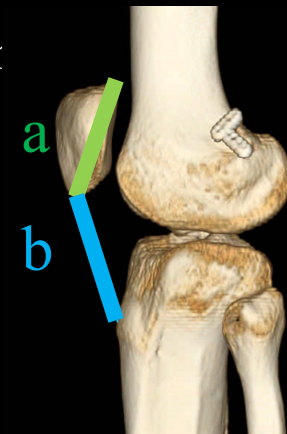
Patients & Therapeutic strategy

- **Subjects:** Fifty-four knees of 54 patients who underwent primary ACLR (2015.2 – 2018.12: t_0) and second-look arthroscopy (t_2) were subjected.
 - Patients who showed PFOA at primary ACLR were excluded.
- **Mean age of the patients:** 24.9 ± 11.8 years
- **Surgical procedure:** Double bundle ACLR with outside-in technique
- **Autograft:** Semitendinosus (ST) 50 knees, ST + Gracilis (G) 4 knees
- **Follow-up period** (from primary ACLR to Second-look): 27.5 ± 7.1 . months
- **Fixation**
 - Femur: Endobutton CL-BTB
 - Tibia: Interference screw and post-screw fixation
- **Evaluation for clinical outcome (one year after ACLR (t_1))**
 - Lysholm score
 - Knee extensor/flexor muscle strength
- **Rehabilitation protocol**
 - 4 weeks after ACLR Full Weight Bearing (without meniscal tear)
 - 8-10 months after ACLR Return to Sports

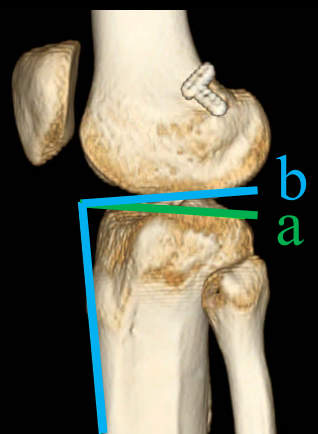
Investigation

Statistical analysis

- Patients who showed ICRS grade 2 or more at the second-look arthroscopy (t_2) were assigned to the PFOA (+) group.
- Investigation
 - Patient characteristics & clinical outcome
 - Age, sex, BMI, meniscus tear, knee extensor/flexor muscle strength
 - Clinical score: Lysholm score
 - Measurement via CT image
 - Insall-Salvati ratio (I-S ratio), Posterior tibial slope angle (PTS)
- Statistical analysis
 - Difference between the two groups
 - Student t -test, chi-square test, or Mann-Whitney U -test
 - Chief contributor to the PFOA
 - Univariable and Multivariable logistic regression analysis



I-S ratio (= b/a)



PTS angle ($a \sim b$)

Patient characteristics (t_0 : primary ACLR)

Variable (t_0)	non-PFOA (n = 47)	PFOA (+) (n = 7)	P Value
Age	22.1 ± 9.58	43.6 ± 7.52	<.0001
Female sex	34 (72.3%)	3 (42.9%)	0.188
BMI	23.1 ± 4.13	22.0 ± 2.20	0.226
MM tear	14 (29.8%)	3 (42.9%)	0.665
LM tear	11 (23.4%)	0 (0%)	0.567
Pre-operative Lysholm score	78.3 ± 12.9	71.6 ± 8.54	0.191
Insall-Salvati ratio	1.11 ± 0.15	1.01 ± 0.09	0.083
Posterior tibial slope	12.5 ± 3.38	12.6 ± 41.6	0.966

Patients in the PFOA (+) group were older than those in the non-PFOA group.

Clinical outcome (t_1 : 1 year after ACLR)

Variable (t_1)	non-PFOA (n = 47)	PFOA (+) (n = 7)	P Value
Isokinetic muscle strength of knee extensor (vs contralateral side, %)	85.1 ± 15.0	58.8 ± 31.0	0.001
Isokinetic muscle strength of knee flexor (vs contralateral side, %)	86.5 ± 12.3	82.2 ± 17.1	0.480
Anterior Translation of the Tibia (mm)	2.01 ± 2.60	1.50 ± 2.14	0.623
Lysholm score	98.1 ± 2.96	93.8 ± 5.45	0.006

The PFOA (+) group showed weaker knee extensor strength and lower Lysholm score.

Comparison in I-S ratio

Variable	non-PFOA (n = 47)	PFOA (+) (n = 7)	P Value
I-S ratio (t_0 primary)	1.11 \pm 0.15	1.01 \pm 0.09	0.083
I-S ratio (t_2 second-look)	1.09 \pm 0.12	0.92 \pm 0.08	0.001
Difference (%) ($(t_0 - t_2)/t_0$)	-1.37 \pm 5.6	-8.04 \pm 3.7	0.011

The **PFOA(+)** group showed significantly lower and decreased I-S ratio at second-look surgery than the non-PFOA group. (p = 0.011)

Univariable Regression Analysis	Odds ratio (95 % CI)	P value
Age(t_0)	1.179 (1.060-1.311)	0.002
Isokinetic muscle strength of knee extensor (t_2) vs contralateral side, (%)	0.930 (0.880-0.984)	0.011
Lysholm score (t_1)	0.757 (0.592-.968)	0.027
I-S ratio difference (%) (t_0 to t_2)	0.754 (0.606 – 0.937)	0.027

Multivariable Logistic Regression Analysis (Stepwise)	Odds ratio (95 % CI)	Standard error	P value	AUC	Cut off
Age (t_0)	1.47 (0.472-4.58)	0.58	<0.001	0.92249	34 Y
Isokinetic muscle strength of knee extensor (t_2) vs contralateral side, (%)	1.18 (0.463-3.01)	0.48	0.461		
Lysholm score (t_1)	0.584 (0.034-10.01)	1.45	0.434		
I-S ratio difference (%) (t_0 to t_2)	0.346 (0.002 – 59.5)	2.63	0.017	0.84954	-3.5%

Discussion

- Summary of the present study
 - patients in PFOA (+) group were older than those in non-PFOA group.
 - I-S ratio was significantly decreased in the PFOA (+) group.
 - Chief contributors to PFOA assessed by Univariable and multivariable logistic regression analysis.
 - Patients' age ($p < 0.001$, cut off = 34 years old at primary ACLR)
 - Decrease of I-S ratio ($p = 0.027$, cut off = -3.47 % relative to primary ACLR)
- Significant contributors to patellofemoral osteoarthritis (PFOA)
 - Bone-tendon-bone graft
 - Single bundle ACLR
 - Delay of the ACLR after injury
- Predictors for PFOA after single bundle ACLR
 - Patients' age
 - Weaker knee extensor strength
 - Meniscectomy at primary ACLR

Wenhan Huang et al. J Orthop Translat 2020

Lee DW et al., Clin Orthop Surg 2018

Discussion

- Association of the patellar malalignment with PFOA investigated via MRI images.
 - Lateralized patella
 - Higher sulcus angle

EM Macri et al., KSSTA 2017

- Smooth gliding motion of the patella is hampered after ACLR
 - Fibrosis of the infrapatellar fat pad.

Kitagawa T et al., J Phys Ther Sci 2019

- **Diffuse fibrosis in the infrapatellar fat-pad** was associated with shortening of the patellar tendon, as well as PFOA.

Yoon KH et al., Knee 2017

Limitation & Conclusion

• Limitation

- The greater number of the patients is needed in this study.
- Due to the lack of the data of MRI at the time of second-look surgery, fibrosis of the infrapatellar fat-pad was not evaluated in this study.
- Changes in the Insall-Salvati ratio over time were not studied.
- Causal relationship between PFOA and decreased patellar height remains unclear.

• Conclusion

- The present study investigated the main contributors to PFOA.
- Chief contributors to the development of PFOA
 - **Patients' age** ($p < 0.001$, cut off = 34 years old at primary ACLR)
 - **Decrease of I-S ratio** ($p = 0.027$, cut off = -3.47 % relative to primary ACLR)

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