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Second-Look Arthroscopic Evaluation and Clinical Outcomes after Anatomic Double Bundle Anterior Cruciate Ligament Reconstruction: Comparison of Different Knee Flexion Angles during Tibial Graft Fixation

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Presenters' Financial Disclosures

There are no company affiliations and/or conflict of interest notifications as noted in our Financial Disclosure Statement.

Introduction

- **The following factors should be considered for successful anterior cruciate ligament (ACL) reconstruction: graft choice, tunnel placement, fixation strategies, rehabilitation protocol, as well as graft tensioning and graft fixation angles at which the tension is applied intraoperatively.**
- **Graft fixation angle is an important factor associated with graft tension.[1] Several studies have reported that wrong graft fixation angles may lead to loss of knee extension (LOE), over constraining of the knee, and graft failure. [2-4]**
- **However, there is no consensus on the most appropriate knee flexion angle at the time of graft fixation in the anatomic double-bundle ACL reconstruction (ACLR).**

The aim of this study was to investigate whether graft fixation angles affect ligamentization of the grafts and clinical outcomes after anatomic double-bundle ACLR.

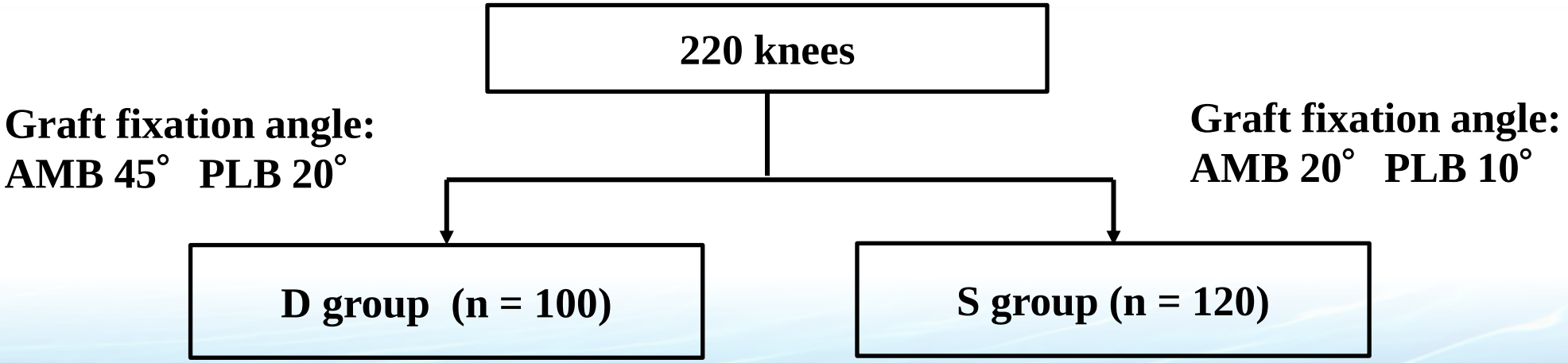
Subjects

- **Two hundred twenty patients (220 knees) underwent anatomic double-bundle ACLR with semitendinosus tendon autografts.**
- **All operations were performed by one experienced surgeon.**
- **These patients consented to remove the grafts fixator and to a second-look arthroscopic examination.**

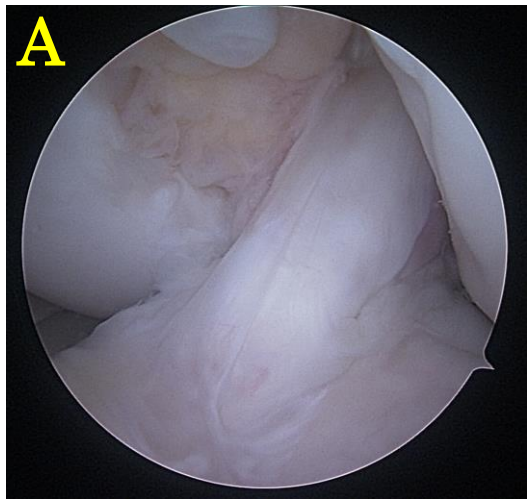
Gender, Male : Female n	**Male 78 : Female 142**
Mean age, y	**20.8 ± 9.5 (13-50)**
Mean time to surgery period, months	**6.9 ± 22.9 (1-240)**
Mean follow-up period, months	**15.8 ± 4.9 (12-48)**
Participation in sports, n	**201/ 220** **Basketball 98, Volleyball 28, Soccer 24, Badminton 10,** **Martial Arts 9, Handball 8, Baseball 8, Rugby 5, Others 11**

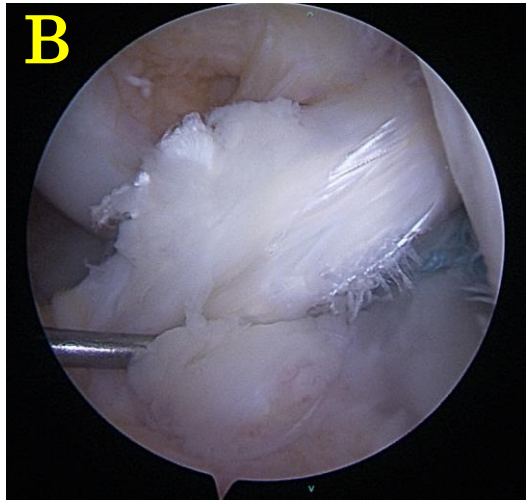
Methods

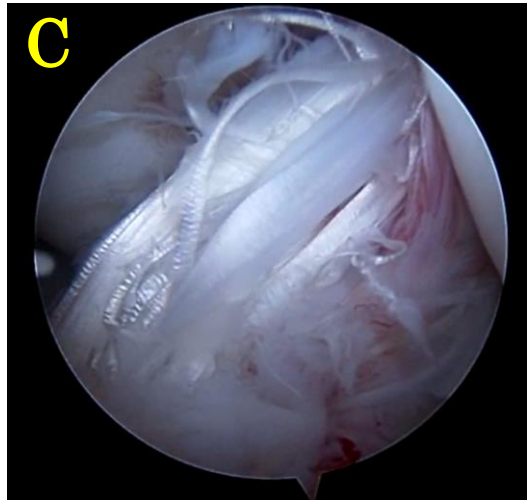
- Patients were divided retrospectively into two groups by graft fixation angle.
- During graft fixation, manual maximum force was applied to the anteromedial bundle (AMB) graft at 45° and to the posterolateral bundle (PLB) at 20° of knee flexion to those placed in the deep group (D group).
- Force was applied to the AMB graft at 20° and to the PLB at 10° of knee flexion to those in the shallow group (S group).



Second-look Arthroscopic Examination







	Thickness and apparent tension	Synovium coverage
A	no laceration or elongation of a sufficiently thick graft	completely covered
B	partial laceration of a sufficiently thick graft or no laceration or elongation of a relatively thin graft	partially covered
C	complete tear or obvious elongation of a graft	almost not covered

The AMB and PLB grafts were evaluated as excellent, fair, or poor according to the Hokkaido University classification.[5]

Clinical Evaluations

- **Instrument-measured anterior laxity (KS),** **KS Measure KSM-100® (SIGMAX, JAPAN)**
- **Heel height distance (HHD)**
- **Peak isokinetic (60˚ /s) and isometric (80˚ of flexion) torque of the quadriceps and hamstrings,**

  CYBEX NORM® (CSMI, USA)
- **One-leg hop test**
- **Lysholm score**
- **International Knee Documentation Committee (IKDC) subjective score**
- **Tegner activity scale**
- **Incidence of huge cyclops lesion with loss of extension (LOE)(HHD ≥ 30mm)**

Statistical Analysis

The statistical comparison among the two groups were evaluated by using Student t-test, Welch t-test and Chi-squared test. For all analyses, statistical significance was set for $P < 0.05$.

Patient Characteristics

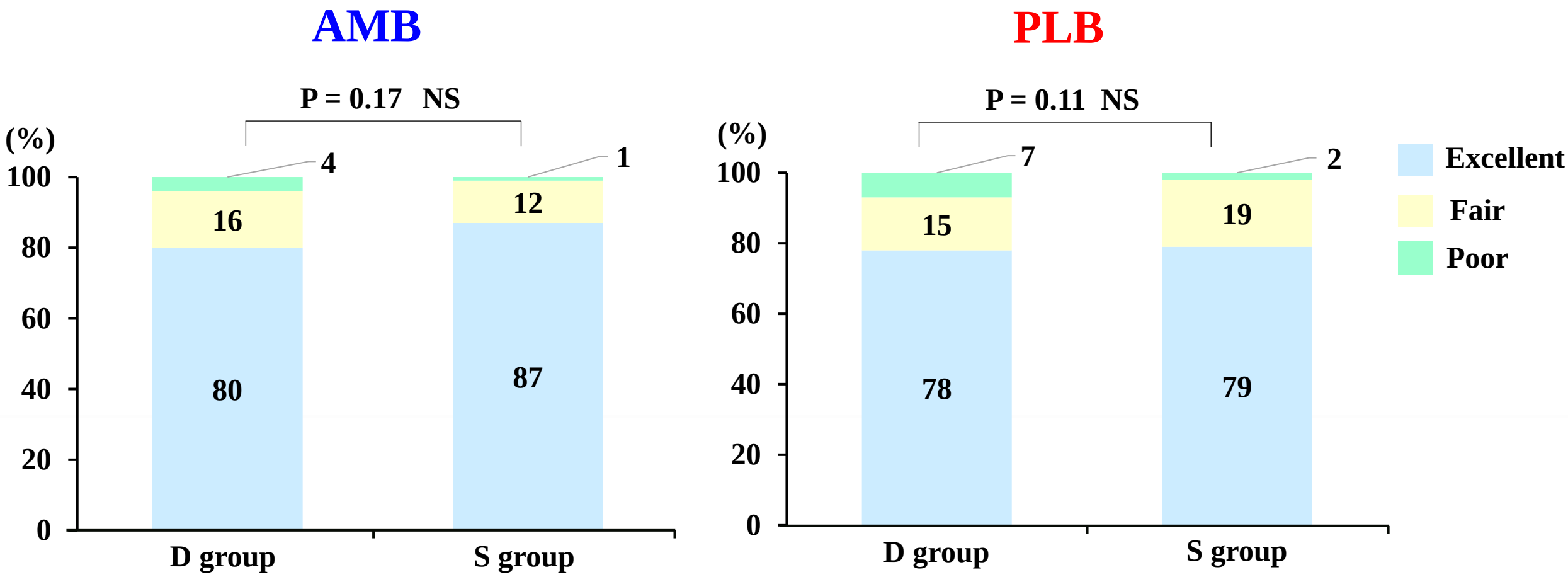
(Mean ± SD)

	D group (n = 100)	S group (n = 120)	P Value	
Gender, male : female, n	30 : 70	47 : 73	0.16[b)]	NS
Age, y	21.0 ± 10.0	20.8 ± 9.2	0.87[a)]	
Height, cm	162.9 ± 8.3	164.5 ± 8.7	0.93[a)]	
Weight, kg	60.1 ± 10.4	61.3 ± 13.1	0.77[c)]	
Time to surgery period, months	4.9 ± 10.2	8.6 ± 29.5	0.20[c)]	
Follow-up period, months	16.5 ± 6.1	15.6 ± 4.4	0.20[c)]	

a) Student t-test b) Chi-squared test c) Welch t-test

There was no significant difference between the groups with respect to patient characteristics.

Results: second-look arthroscopic examination



The ligamentization of the AMB and the PLB grafts in second-look arthroscopic examination revealed no significant differences between the groups.

Chi-squared test

Results: clinical evaluations

(Mean, ±SD)

	D group	S group	P Value	
KS SSD, mm	0.07 ± 1.7	0.02 ± 1.3	0.81[c)]	NS
HHD, mm	17.4 ± 20.4	22.3 ± 23.1	0.10[a)]	
Isokinetic strength*, %				
quadriceps muscle	83.8 ± 18.7	84.6 ± 18.8	0.76[a)]	
hamstrings muscle	87.6 ± 17.7	88.1 ± 16.6	0.82[a)]	
Isometric strength*, %				
quadriceps muscle	87.3 ± 17.2	88.5 ± 17.1	0.58[a)]	
hamstrings muscle	80.5 ± 19.8	81.1 ± 18.1	0.81[a)]	
One-leg hop test* , %	90.7 ± 14.8	88.7 ± 13.0	0.29[a)]	
Lysholm score	95.4 ± 6.6	94.3 ± 7.4	0.26[a)]	
IKCD subjective score	88.3 ± 12.1	89.4 ± 12.1	0.51[a)]	
Tegner activity scale	6.7 ± 1.2	6.7 ± 1.4	0.96[a)]	
Cyclops lesion, %	15.0	6.7	0.04[b)]	

SSD, side-to-side difference , * Percentage of contralateral Side

a) Student t-test b) Chi-squared test c) Welch t-test

Huge cyclops lesions with LOE occurred significantly less frequently in the S group than in the D group.

Discussion

- In single-bundle ACLRs, a recent systematic review suggested no difference in clinical outcomes across either graft fixation angles of < 30° and graft fixation angles of 30°, with similar rates of graft failure across both groups.[6]

- On the other hand, Koga et al.[7] and Kondo et al.[8] compared double-bundle ACLRs with different graft fixation angles (Koga et al.: AM/PL 20/20 vs 20/25 vs 20/45, Kondo et al.: AM/PL 30/30 vs 10/10) and showed that the PLB deep group had a significant higher rate of knee instability (KT-2000, mm: 0.4 vs 0.3 vs 1.3), the shallow group of graft fixation angles had significantly lower rate of LOE (LOE >5°: 9% vs 0%).

- Symptomatic cyclops lesion are a known complication after ACLR with a described incidence between 1.9% to 10.9%.[9] Delaloye et al.[10] reported on 3633 patients who underwent primary ACLR, the authors determined that the most important risk factor for reoperation for a symptomatic cyclops lesion was an extension deficit in the early postoperative period.

Conclusion

There was no significant difference observed in ligamentaization and clinical outcomes of different fixation angles.

Our study showed shallow graft fixation angle may have an effect on the decrease in cyclops lesion restricted knee full extension.

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