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Knee Stability and Clinical Outcomes after Double-Bundle Posterior Cruciate Ligament Reconstruction Using Hamstring Tendon Autografts: Comparison With Single-Bundle Reconstruction

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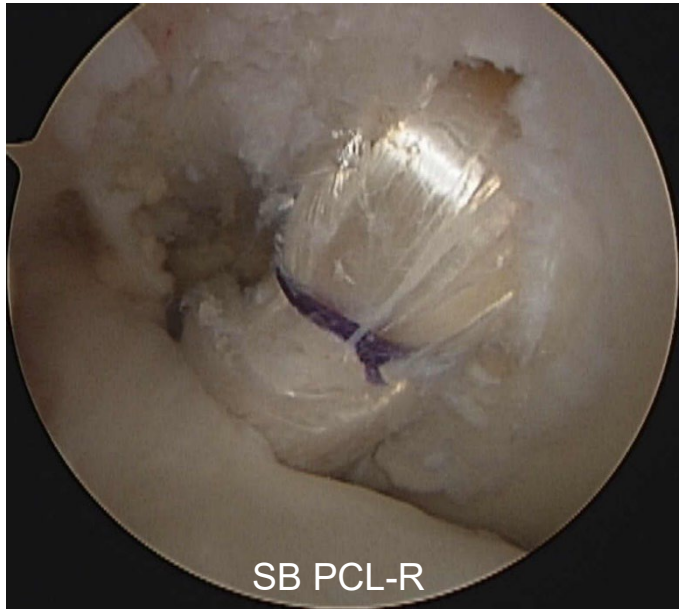
- PCL injury occurs in isolation, or, more commonly, in conjunction with multiple ligament knee injuries (MLKIs). [1-3]
- Several studies have reported favorable results of PCL-R using SB techniques.
- However, the clinical results of this surgery have shown that mild residual posterior laxity is common after surgery. [4]
- Biomechanical studies demonstrated that DB PCL-R provides better stability than SB-R. [5]
- Therefore, the authors have developed a DB PCL reconstruction procedure with hamstring tendon ‘hybrid’ autografts. [6]
- However, the superiority of SB or DB PCL reconstruction remains unproven.

Hypotheses

- The postoperative knee stability may improve after the SB and DB PCL-R procedures in an isolated and MLKIs.
- The DB procedure may be significantly better concerning the posterior laxity than the SB procedure, while there may be no significant differences in the objective and subjective clinical outcomes between the 2 procedures.



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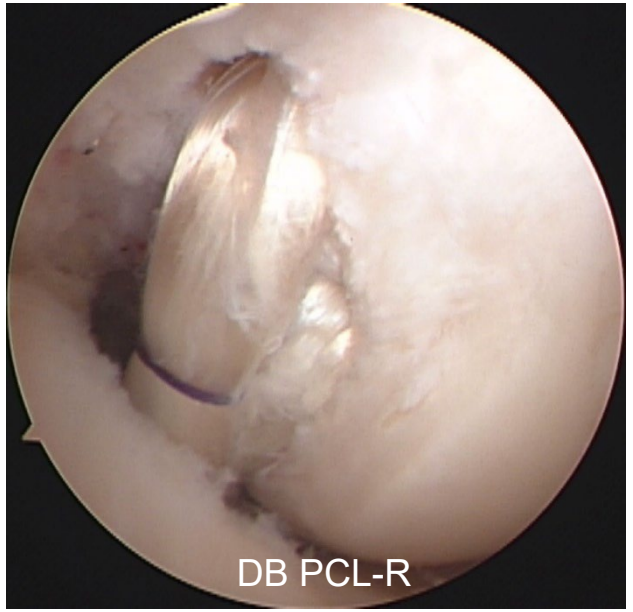
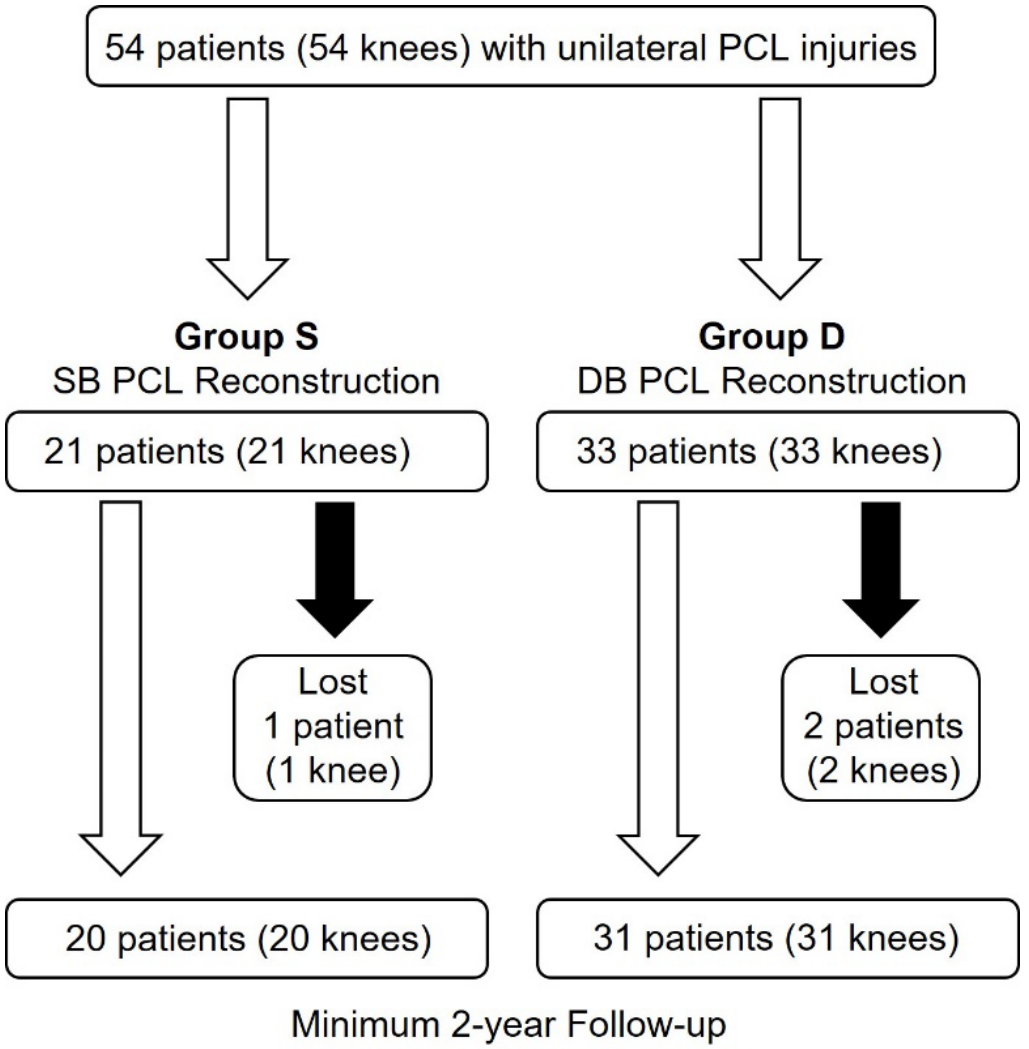


Study design

- A retrospective, comparative study (2010-2020)
  - ✓ Unilateral PCL injuries
- **Group S**
  - ✓ SB PCL-R w/ STG autograft (2010-2015)
- **Group D**
  - ✓ DB PCL-R w/ STG autograft (2016-2020)

  - Clinical evaluation @ 2 yrs
  - Statistical analysis
    - Paired Student t test
    - Mann–Whitney U test
    - Chi square test

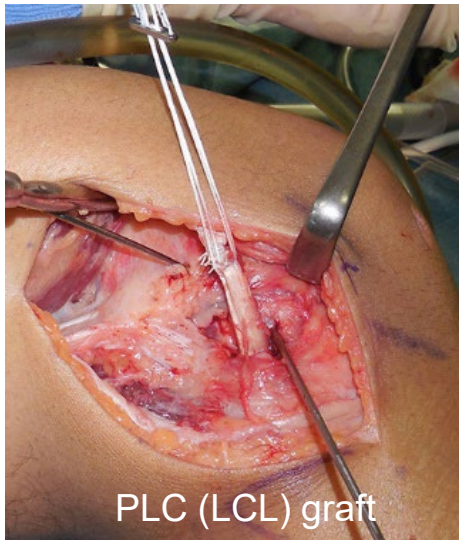


The surgical strategy for MLKIs

- Acute cases (< 3 wks after injury)
  - ✓ 1st stage: Repair of the grade III PMC or PLC injuries [3, 7]
  - ✓ 2nd stage: Simultaneous PCL and/or ACL-R
- Chronic cases (> 3wks after injury)
  - ✓ 1st stage: PCL and/or ACL-R and/or PMC or PLC-R [1]

Surgical procedure

- SB or DB PCL-R w/ STG [1, 6]
- SB or DB ACL-R w/ STG or BTB [8, 9]
- PMC-R w/ ST [10]
- PLC-R w/ Biceps [11]



Patient Demographics

	Group S (n=20)	Group D (n=31)	P Value
Age, y	36.6 (13.2)	33.4 (12.0)	*NS*
Damaged lig, No.			
PCL	7	10	*NS*
PCL, PMC	2	3	
PCL, PLC	2	2	
PCL, ACL	5	8	
PCL, ACL, PMC	4	4	
PCL, ACL, PLC	0	4	
Surgical procedure, No.			
SB/DB PCL-R	20/0	0/31	*NS*
SB/DB ACL-R	9/0	8/8	
PMC-R	4	7	
PLC-R	2	6	
Injury-to-operation interval, mo	21.1 (48.7)	23.4 (42.8)	*NS*

Mean (SD)

Knee stability in isolated and MLKIs

	Group S Pre (n=20)	Group S Post	Group D Pre (n=31)	Group D Post	*Pre vs. Post in Group S*	*Pre vs. Post in Group D*	*Intra-group comparison*
AP laxity, mm							
20°	5.6 (2.0)	1.9 (2.2)	5.3 (2.6)	2.2 (1.3)	*<0.0001*	*<0.0001*	*NS*
70°	7.3 (1.9)	2.7 (2.1)	6.9 (1.7)	2.0 (2.3)	*<0.0001*	*<0.0001*	*NS*
Anterior drawer, %	65.9 (5.1)	62.5 (2.3)	65.8 (5.0)	62.1 (6.1)	*0.0248*	*0.0335*	*NS*
Posterior drawer, %	34.9 (7.8)	43.8 (5.7)	38.2 (8.1)	54.0 (5.2)	*0.0030*	*<0.0001*	*<0.0001*
Medial opening, mm	9.0 (1.6)	7.4 (1.1)	9.6 (1.9)	7.6 (1.0)	*0.0025*	*<0.0001*	*NS*
IKDC, No. A	12	18	17	28	*NS*	*0.0048*	*NS*
B	5	2	9	3			
C	3	0	5	0			
D	0	0	0	0			
Lateral opening, mm	10.4 (2.2)	9.2 (1.3)	10.7 (2.3)	9.2 (1.5)	*0.0702*	*0.0042*	*NS*
IKDC, No. A	12	17	17	26	*NS*	*0.0355*	*NS*
B	6	3	8	5			
C	2	0	3	0			
D	0	0	3	0			

Mean (SD)

Knee stability in isolated PCL injury

	Group S Pre (n=7)	Group S Post	Group D Pre (n=10)	Group D Post	*Pre vs. Post in Group S*	*Pre vs. Post in Group D*	*Intra-group comparison*
AP laxity, mm							
20°	5.5 (1.2)	1.8 (2.2)	4.5 (1.8)	1.4 (1.5)	*<0.0001*	*<0.0001*	*NS*
70°	8.6 (1.3)	2.1 (2.1)	7.3 (1.7)	1.9 (1.4)	*<0.0001*	*<0.0001*	*NS*
Posterior drawer, %	37.9 (4.8)	48.2 (2.8)	35.1 (5.8)	52.5 (3.9)	*0.0030*	*<0.0001*	*<0.0001*

Mean (SD)

Clinical results

	Group S Pre (n=20)	Group S Post	Group D Pre (n=31)	Group D Post	*Pre vs. Post in Group S*	*Pre vs. Post in Group D*	*Intra-group comparison*
Loss of ext. >5° , No.	2	1	4	0			*NS*
Loss of flex. >15° , No.	4	1	4	1			*NS*
Lysholm score, points	55.7 (22.0)	83.3 (15.0)	57.6 (24.7)	90.2 (10.7)	*<0.0001*	*<0.0001*	*NS*
IKDC, No.							
A	0	4	0	11	*<0.0001*	*<0.0001*	*NS*
B	0	10	0	12			
C	5	4	12	7			
D	15	2	19	1			
KOOS, points							
Pain	52.4 (17.0)	76.1 (20.0)	58.6 (21.8)	77.5 (16.8)	*0.0342*	*NS*	*NS*
Symptom	53.1 (18.8)	79.7 (16.6)	58.1 (21.5)	77.4 (16.5)	*0.0012*	*0.0453*	*NS*
ADL	57.0 (21.0)	80.5 (17.7)	62.8 (23.0)	84.3 (13.6)	*0.0311*	*NS*	*NS*
Sport/rec	26.6 (24.2)	66.4 (22.7)	32.4 (32.8)	65.7 (26.2)	*0.0064*	*0.0104*	*NS*
QOL	17.2 (10.8)	66.8 (23.8)	30.4 (27.1)	62.9 (19.3)	*0.0024*	*0.0024*	*NS*
Tegner scale, points	1.3 (0.6)	3.9 (1.1)	1.2 (0.5)	3.9 (0.7)	*<0.0001*	*<0.0001*	*NS*
Isokinetic peak torque, %[a]							
Quad	57.2 (15.6)	89.0 (6.4)	54.0 (20.0)	84.4 (11.6)	*<0.0001*	*<0.0001*	*NS*
Ham	52.9 (13.8)	82.2 (8.8)	58.5 (15.8)	83.3 (10.9)	*<0.0001*	*<0.0001*	*NS*

[a]Ratio of the treated knee to the uninjured knee

Mean (SD)

- The postoperative AP translation @ 20° and 70° and the relative femur-tibia position in the posterior stress radiographs @ 90° significantly improved postoperatively in both SB and DB PCL-R groups.
- The postoperative posterior stability @ 90° was significantly better in the DB PCL-R group than in the SB-R group not only in the isolated PCL injuries but also in the MLKIs.
- Although Lysholm score, objective IKDC evaluation, each subscale of the KOOS, Tegner activity scale, and isokinetic peak torque of quadriceps and hamstrings significantly improved after surgery in both group, there were no significant differences between the 2 procedures.

Study limitations

- A retrospective study
- The small number of cases
- The heterogeneity of the cases, which included isolated PCL injury and MLKIs
- The relative femur-tibia position in the AP stress radiograph were measured as the percentage.
- The present study did not measure external rotations of the knee after surgery.
  - ✓ Further long-term studies are needed to assess the subjective and objective patient outcomes of DB procedure in patients with the PCL-deficient knee.

Conclusions

- The postoperative AP translation and the relative femur-tibia position in the posterior stress radiographs significantly improved postoperatively in both SB and DB PCL-Rs.
- The postoperative side-to-side differences in AP translation @ 20° and 70° showed no significant difference between the groups.
- There were no significant differences in the Lysholm score, the objective IKDC evaluation, and the KOOS, the Tegner activity scale between both groups although there was significantly better posterior stability in 90° flexion with DB-R.

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