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Title: Comparable Short-Term Clinical Outcomes In Rectangular-Tunnel Anterior Cruciate Ligament Reconstruction Using Quadriceps Tendon-Patellar Bone Autograft Over Round-Tunnel Reconstruction

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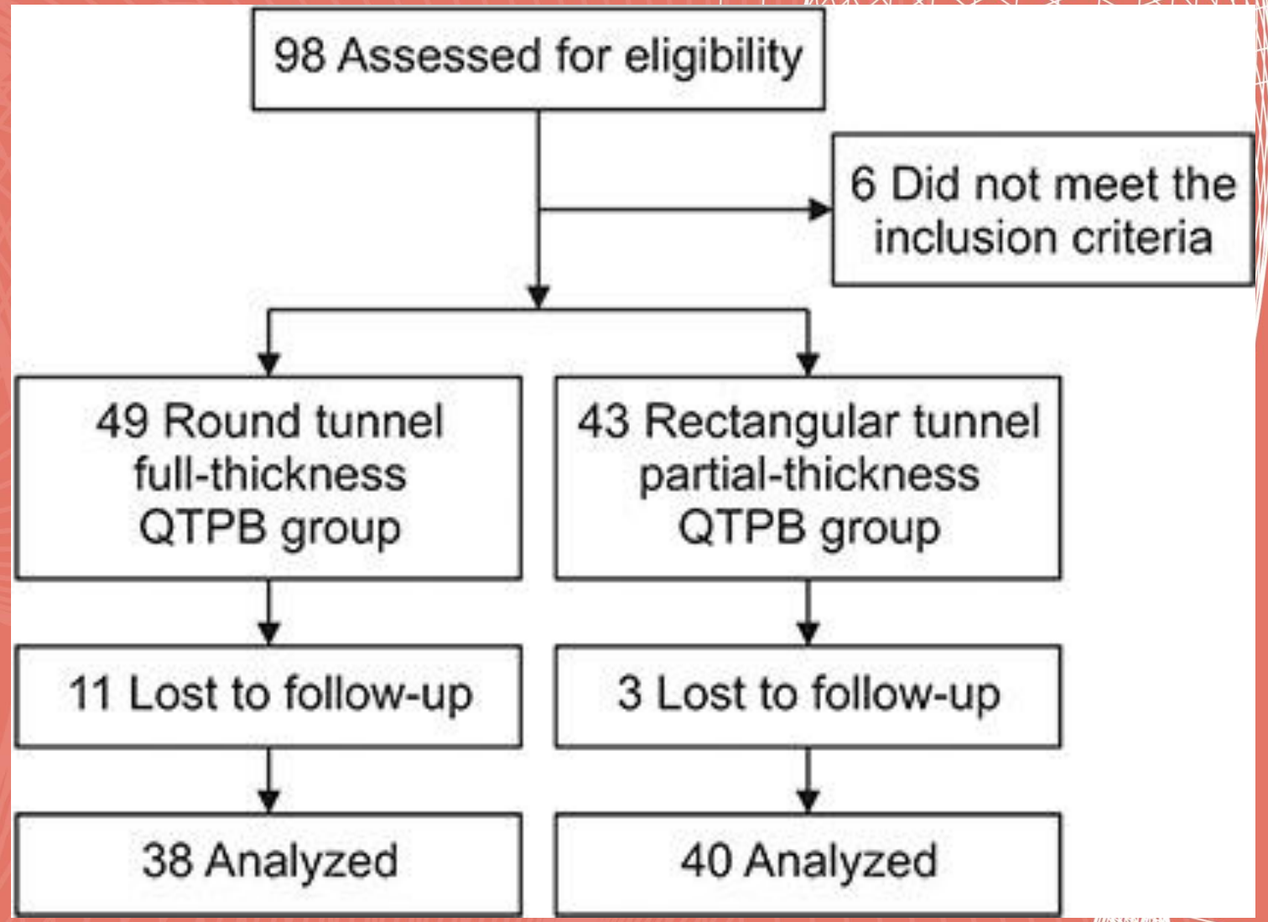
Background and Purpose

- According to a recent anatomical study, the anterior cruciate ligament (ACL) appears to be a **flat, ribbon-like structure**, and the previously well-known “double-bundle” structure comes from the natural twist of this single, ribbon-like structure.
- **Rectangular grafts and tunnels** have been designed for anatomic ACLR mimicking the flat, ribbon-like shape of the native ligament.
- This study was performed to **compare** the short-term clinical results of **rectangular tunnel ACLR and round tunnel ACLR with quadriceps tendon-patellar bone (QTPB) autograft**.

Materials and Methods

- From February 2015 to September 2019,**38 patients** who underwent round tunnel ACLR with full-thickness QTPB autograft and **40 patients** who underwent rectangular tunnel ACLR with partial-thickness QTPB autograft were compared.
- Patients who were followed up for **at least 1 year** after primary ACLR were selected



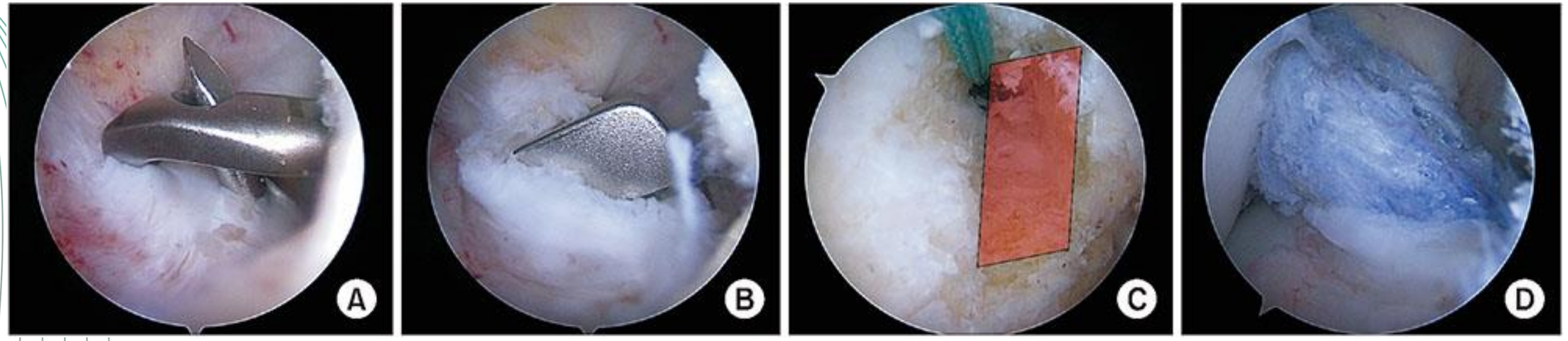
Demographics

Variable	Round tunnel QTPB group	Rectangular tunnel QTPB group	*p*-value
No. of knees	38	40	-
Age (yr)	32.1 ± 11.5	31.4 ± 10.0	0.796
Sex (male : female)	33 : 5	35 : 5	0.931
BMI (kg/m^2)	25.0 ± 4.3	25.2 ± 3.8	0.878
Side (right : left)	18 : 20	17 : 23	0.666

Surgical Technique

- Round Tunnel Group
  - A 10-mm-wide, 20–25-mm long, 7-mm-thick trapezoidal bone block was obtained from the patella with an oscillating saw. In continuity with this patellar bone block, ***a 10-mm-wide, 6-cm-long, full-thickness strip of the QT*** was excised.
- Rectangular Tunnel Group
  - The bone block was prepared with a 5-mm thickness, and the **QT was excised in partial thickness (5 mm thick) using a special harvesting device** (*Quad Cut; Karl Storz*).
  - With the bone block heading to the proximal, femoral tunnel direction, **the graft was passed to match the original twist of the graft**; the anterior portion of the graft at the tibia was aligned with the proximal part of the graft at the femur to mimic the AM bundle of the graft.

Surgical Technique (Rectangular Tunnel Group)



- (A) Tibial tunnel positioning using a guide pin. (B) Tibial tunnel preparation using a rectangular shaped dilator. (C) Femoral tunnel viewed from the previously made tibial tunnel. The red-shaded area denotes the rectangular shape of the femoral tunnel. (D) Anterior cruciate ligament graft viewed from the anterolateral portal after graft passage.

Materials and Methods

- **Clinical evaluation**
  - Outcomes of interest included knee stability, quadriceps strength, clinical scores, postoperative knee range of motion (ROM), and any associated complications.
- **Radiological evaluation**
  - The cross-sectional areas of the two groups were compared. The graft thickness of full-thickness QTPB was calculated by measuring the thickness of the QT in the mid-sagittal plane using a preoperative MRI scan. Due to the harvesting method, the graft thickness of partial-thickness QTPB was consistently 5 mm.

Results (Knee stability)

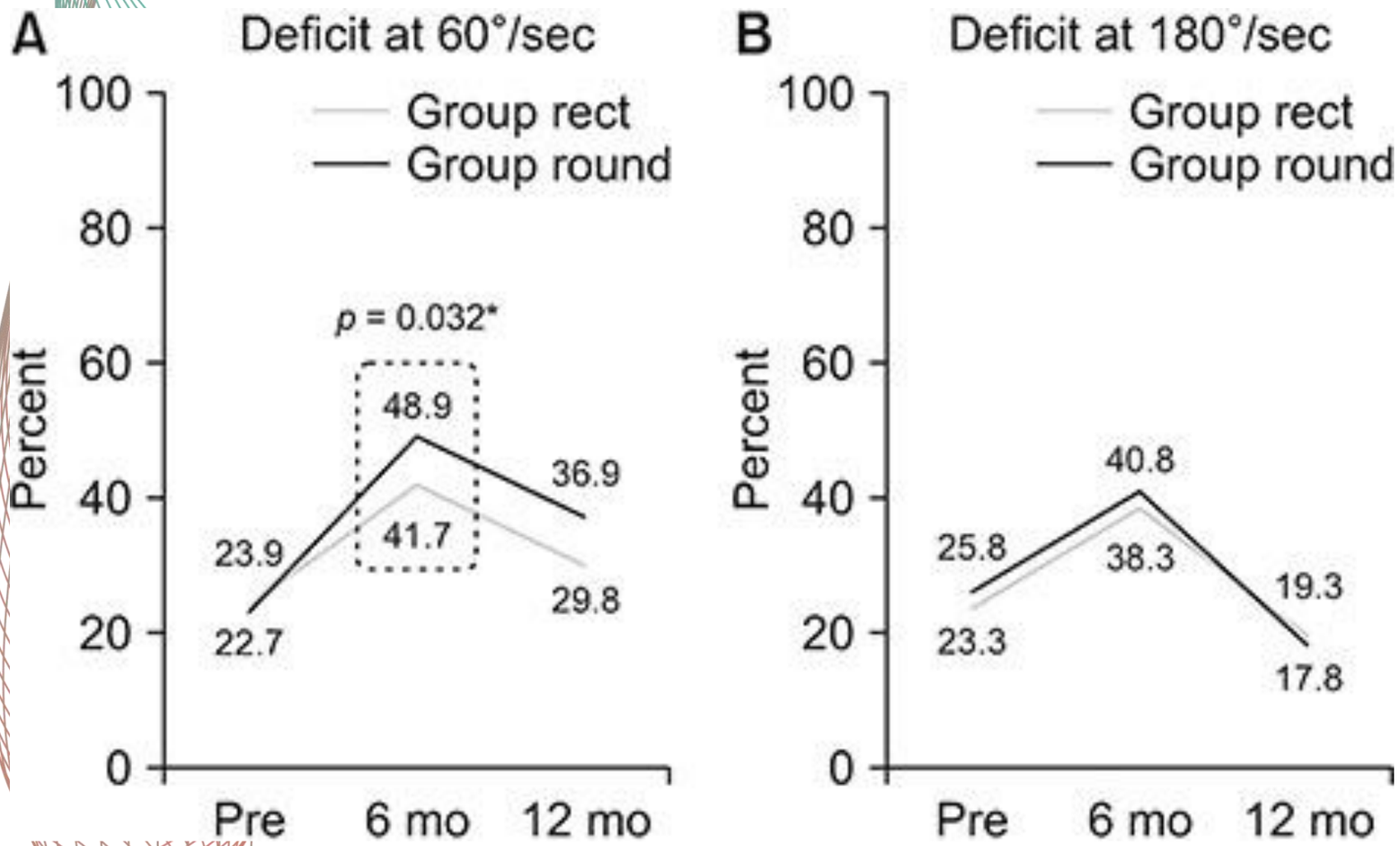
Variable	Preoperative			Postoperative 1 year		
	Round tunnel QTPB	Rectangular tunnel QTPB	*p*-value	Round tunnel QTPB	Rectangular tunnel QTPB	*p*-value
Lachman test			0.976			> 0.999
Grade 0	2 (5.3)	2 (5.0)		21 (55.3)	22 (55.0)	
Grade 1	18 (47.4)	17 (42.5)		16 (42.1)	16 (40.0)	
Grade 2	16 (42.1)	18 (45.0)		1 (2.6)	2 (5.0)	
Grade 3	2 (5.3)	3 (7.5)		0	0	
Pivot shift test			0.983			> 0.999
Grade 0	4 (10.5)	5 (13.8)		20 (52.6)	21 (52.5)	
Grade 1	12 (31.6)	14 (35.0)		16 (42.1)	17 (42.5)	
Grade 2	19 (50.0)	18 (45.0)		2 (5.3)	2 (5.0)	
Grade 3	3 (7.9)	3 (7.5)		0	0	
KT-2000 arthrometry	3.7 ± 2.0	3.7 ± 2.1	0.269	2.1 ± 1.1	1.8 ± 1.0	0.975

Results (Clinical scores and graft cross-sectional area)

Variable	Round tunnel QTPB	Rectangular tunnel QTPB	*p*-value
Subjective IKDC			
Preoperative	48.1 ± 14.5	57.1 ± 12.8	0.02
Postoperative 1 yr	76.5 ± 11.8	80.8 ± 11.2	NS
Lysholm			
Preoperative	67.1 ± 16.2	72.7 ± 14.3	NS
Postoperative 1 yr	90.6 ± 7.1	91.5 ± 7.8	NS
Tegner			
Preoperative	3.3 ± 1.7	2.8 ± 1.3	NS
Postoperative 1 yr	4.9 ± 1.6	5.1 ± 1.0	NS
KOOS			
Preoperative	274 ± 103	316 ± 64.1	NS
Postoperative 1 yr	420 ± 45.7	425 ± 43.6	NS

- The thickness of the full-thickness QTPB graft was 8.0 ± 1.1 mm, which was thicker than the partial-thickness QTPB graft (5 mm).
- The cross-sectional area of the partial-thickness QTPB graft (rectangular tunnel ACLR group) was **62.5% of the average cross-sectional area of the full-thickness QTPB graft** (round tunnel ACLR group).

Results (Quadriceps strength)



- The **mean side-to-side ratio of peak torque values according to Cybex II isokinetic testing** performed at 60° (A) and 180° (B) per second at each time period. The asterisk denotes the statistically significant difference (< 0.05).

Conclusion

- Despite a smaller cross-sectional area (about 60%), rectangular tunnel ACLR showed comparable short-term clinical outcomes in comparison to conventional round tunnel ACLR and
- Postoperative reduction in knee extension strength was smaller with the partial-thickness QTPB (rectangular tunnel ACLR group) at 6 months, although this difference was not maintained until 1 year.
- In the short-term, **rectangular tunnel ACLR with partial-thickness QTPB** is a **comparable reconstruction technique and reduces donor site morbidity** (knee extension strength deficit).

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