

Quantitative Evaluation of Knee Stability under Anesthesia in Simultaneous ACL/ALL Reconstruction and Isolated ACL Reconstruction: A Comparative Study

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INTRODUCTION: Anterior lateral ligament (ALL) reconstruction during anterior cruciate ligament (ACL) surgery leads to good clinical outcomes in patients with severe knee instability. However, only a few studies have investigated the effectiveness of simultaneous ACL/ALL and ALL reconstruction for managing knee instability, mainly through quantitative evaluation under anesthesia. We compared pre- and postoperative knee instability between simultaneous ACL/ALL reconstruction and isolated ACL reconstruction using quantitative evaluation under anesthesia and assessed the utility of ALL simultaneous reconstruction.

METHODS: This retrospective study included 181 patients who underwent primary ACL reconstruction between June 2016 and August 2022. Patients with contralateral knee or concurrent ligament injuries were excluded. A total of 150 patients were included in the quantitative evaluation under anesthesia during the preoperative, intraoperative, and one-year postoperatively stages. Patients were categorized into three groups: the ALLR group, which underwent ACL/ALL simultaneous reconstruction for pivot shift test grade 3 cases determined by the International Knee Documentation Committee (IKDC) criteria; the ACLR group, which underwent isolated ACL reconstruction for grade 3 cases; and the C group, which underwent isolated ACL reconstruction for grade 0–2 cases. The instability assessment involved the measurement of the side-to-side difference in anterior tibial translation (SSD-ATT). This was performed using a rolimeter during preoperative anesthesia for both the uninjured and injured sides, during ACL graft provisional fixation, additional provisional fixation of ALL grafts, and one-year postoperatively (Image 1). At each stage of the pivot-shift test, an inertial sensor was used to measure the composite acceleration (CA) and external rotation angular velocity (ER) to calculate the side-to-side ratio (SSR) (Image 2). Clinical evaluation included a comparison of the Knee Injury and Osteoarthritis Outcome Score (KOOS) and Lysholm scores preoperatively, six months postoperatively, and one-year postoperatively among the groups. Statistical analysis was performed using the Mann–Whitney U test with a significance level of 5%.

RESULTS: A total of 150 patients (57 males and 93 females; mean age, 27.7±11.5 years) were included in the analysis. The ALLR, ACLR, and C groups included 19, 17, and 114 patients, respectively. The preoperative SSD-ATT was significantly larger in the ALLR and ACLR groups than in the C group (7.2±1.3 mm, 6.9±1.3 mm, 4.7±1.7 mm, $p < 0.05$). However, improvements were observed according to the time of one-year postoperatively, with no significant differences between groups (Table 1). The SSR of CA and ER was significantly larger in the ALLR and ACLR groups than in the C group (CA: 7.8±3.7, 7.2±2.6, 3.9±2.6, ER: 4.8±2.8, 3.9±1.7, 3.4±1.9, $p < 0.05$, respectively), with improvements observed in all groups at the time of one-year postoperatively. However, the CA in the ACLR group remained significantly larger than that in the C and ALLR groups (1.4±0.6, 2.1±1.1, 1.5±0.9, $p < 0.05$ [in mm]) (Table 2). The KOOS and Lysholm scores improved in all groups preoperatively and six months postoperatively, and one-year postoperatively further led to improvement in all groups. Notably, no significant differences were observed between all the groups.

DISCUSSION: Quantitative evaluation under anesthesia showed severe anteroposterior and rotational instability in grade 3 pivot-shift knees. Despite observing good clinical outcomes in all three groups, our evaluation at one-year postoperatively suggested the possibility of residual knee instability resulting from isolated ACL reconstruction. Our study underscores the potential limitations of relying solely on clinical outcomes and focuses on the importance of a comprehensive quantitative evaluation, especially under anesthesia.

SIGNIFICANCE: These findings highlight the necessity of considering concurrent interventions such as simultaneous ACL/ALL reconstruction to enhance stability in patients with severe knee instability.



Image1



Image2

Table 1. The side-to-side difference in anterior tibial translation

	Group			P Value
	Control	ACLR	ALLR	
pre ope	4.7 ± 1.7	6.9 ± 1.3	7.2 ± 1.3	< 0.001
ACL graft fixation	-1.3 ± 1.2	-1.4 ± 1.2	-1.2 ± 0.9	0.864
ALL graft fixation	-	-	-1.6 ± 1.1	0.599
removal	1.2 ± 1.2	1.6 ± 1.3	1.1 ± 1.4	0.478

Table 2. The side-to-side ratio in composite acceleration and external rotation angular velocity

	Group			P Value
	Control	ACLR	ALLR	
CA SSR				
pre ope	3.9 ± 2.6	7.2 ± 2.6	7.8 ± 3.7	< 0.001
removal	1.5 ± 0.9	2.1 ± 1.1	1.4 ± 0.6	< 0.05
ER SSR				
pre ope	3.4 ± 1.9	3.9 ± 1.7	4.8 ± 2.8	< 0.05
removal	1.8 ± 1.3	2.6 ± 2.1	1.6 ± 0.8	0.051