# Increased Operative Time is an Independent Risk Factor for Developing Surgical Complications Following Isolated Anterior Cruciate Ligament Reconstruction in Skeletally Immature Patients

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## INTRODUCTION:

In the context of recent trends towards early sport specialization and intensive year-round training amongst youth athletes, there has been a drastic increase in the incidence of ACL reconstructions performed in skeletally immature patients. There is a growing interest in identifying and minimizing surgical complications for these patients. Although the literature in adult ACL reconstruction has demonstrated an association between prolonged operative time and risk of surgical complications, this has not been explored in skeletally immature patients. The purpose of this study was to determine whether operative time is an independent risk factor for developing complications following ACL reconstruction in skeletally immature children and adolescents.

## METHODS:

A prospective, multicenter surgeon-driven quality improvement registry of consecutive patients was reviewed to identify skeletally immature patients who underwent a primary isolated ACL reconstruction, with minimum 8-month follow-up. Demographics, surgical characteristics, operative time, and complications were recorded. During analysis, operative time was divided into 15-minute increments to determine whether a 15-minute extension of operative duration predicted increased complication risk. Cases were excluded if operative time was > 2 standard deviations above the mean, to eliminate outlier effects. Continuous variables were compared via independent t-test or ANOVA, and categorical variables were compared via Chi-squared or Fisher's exact tests. Comparisons were deemed to be statistically significant using a threshold of p < 0.05. Multiple logistic regression analysis was performed to control for demographic and surgical characteristics.

## **RESULTS:**

#### Preoperative Characteristics

A total of 711 patients, from a registry of 9,351 patients at the time of analysis, were included with mean follow-up of 17.6  $\pm$  8.6 months (range 8-30 months). 479 (67.4%) were male. Mean age was 13.2  $\pm$  1.9 years and mean BMI percentile by age was 69.8  $\pm$  25.5. Mean operative time was 112.3  $\pm$  38.8 minutes (**Table 1**). Obese patients, patients who underwent surgery in a surgery center, patients who received only regional anesthesia, patients without a tourniquet placed during surgery, and patients who had combined transphyseal ACL reconstruction with IT band lateral extraarticular tenodesis (LET) all experienced longer operative times (**Table 2**).

#### Complications

The overall complication rate for the cohort was 15.19%. The most common complications included graft failure (4.78%), arthrofibrosis (2.95%) and surgical site infection (2.39%) (**Table 3**). Patients who developed a complication had on average an approximately 12-minute longer operative time versus patients who did not develop a complication (122.3  $\pm$  38.8 vs. 110.5  $\pm$  35.5 minutes, p = 0.002) (**Figure 1**). After adjusting for demographic and surgical characteristics, increased operative time remained an independent risk factor for developing a surgical complication in general (OR = 1.17, p = 0.02) (**Table 3**; **Figure 2**). Specifically, increased operative time was an independent risk factor for developing a surgical site infection (OR = 1.25, p=0.045) or arthrofibrosis (OR = 1.40, p=0.001) (**Table 3**).

### DISCUSSION AND CONCLUSION:

A review of a prospective, multicenter surgeon-driven quality improvement registry revealed that increased operative time was associated with an increased risk of developing surgical complications following ACL reconstruction for skeletally immature patients, when controlling for demographic and perioperative patient characteristics. Specifically, increased operative time was associated with an increased risk of surgical site infection and arthrofibrosis. Future efforts to increase operative efficiency are warranted in order to reduce operative time and thereby improve patient outcomes.

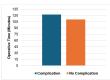


Figure 1: Operative Time versus Complications

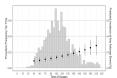


Figure 2: Predicted Linear Correlation betwee Operative Time and Complications

Characteristic		n (%)	
Gender	Male	479 (67,5%	
	Female	231 (32.5%	
Age at Support (Years)		13.2 ± 1.9	
BMI Percentile by Age		69.8 ± 25.5	
Tourniquet	Yes	555 (78.7%	
	No	150 (21.3%	
Surgery Location	Surgery Center	555 (78.7%	
	Hospital	150 (21.3%	
Operative Time (Minutes)		$112.3 \pm 38.1$	
ACL Graft Technique	Transphysoal	327 (46.0%	
	All-Epiphyscal*	117 (16.5%	
	ITB Extraosseous Extraphyseal	152 (21.4%	
	Combined Transphyseal and ITB LET	100 (14.1%	
Follow-Up Time (Months)		17.6±8.6	

			Malayaning	
	0	Opestave Time (minutes)	\$30 (55% CD)	p-vida
Gesder				
54	479	111.2 ± 35.4	Reference	
P .	231	134.7 + 37.8	1.95 (9.96 - 1.14)	0.318
EBEI Category®				
Underweight	34	95.6 = 36.3	0.8519.52-1.300	
Healthy Weight	429	109.0 ± 34.6	Reference	
Overweight	137	115.0 ± 36.4	1.85 (9.96 - 1.20)	
Obese	115	125.0 = 40.6	1.50 (1.16 - 1.45)	<0.00
Lucation of Surgery				
Surpery Center	331	117.7 ± 34.4	Enlarger	
Hospital	376	107.6 ± 37.2	0.79 (3.72 - 0.86)	<0.00
Annthnia Type				
Regional Only	97	1346+357	Reference	
General	654	130.2 ± 35.6	0.61 (0.53 - 0.71)	<0.00
Tommiguel Use				
Ves	555	107.7 ± 35.5	Reference	
No	150	128.8 ± 33.7	1.59 (1.25 - 1.54)	=0.00
ACL God Technique				
Transplayment	327	112.0 ± 40.7	Reference	
All-Epiphysosi	117	111.1 ± 34.2	1.16 (1.94 - 1.28)	
IT'R Extraessous Extraplysed	152	133.9 ± 28.7	0.97 (0.86 - 1.00)	
Hybrid Combined Tramphysesi, and ITB LET Selected for all characteristics in this table	300	114.0 ± 33.3	1.48 (1.11 - 2.81)	0.64

	Ranco)	Millowiste		
		OR (89% CD)	pvsta	
Complication	15.19	1.17 (1.06 - 1.26)	0.002	
Surgical Site Infection	2.35	1.25 (1.00 - 1.55)	0.845	
Hospital Readmission	0.28	1.80 (1.13 - 1.50)	0.996	
Recognition)*	0.42	1.49 (0.92 - 2.69)	0.119	
DVT et PE	0.14	0.35 (0.81 - 2.80)	0.407	
Security or Motor Less	0.42	0.92 (0.47 - 1.54)	0.774	
Arthreliberth	2.99	1.48 (1.14 - 1.75)	0,003	
Recognitive riskest innovational pain	2.11	1.01 (0.79 - 1.26)	0.549	
Hemotheosis or effector	0.56	0.55 (0.20 - 1.85)	0.156	
Meaniness or persons	0.25	1.35 (0.71 - 3.99)	0.332	
Demastologic complaint (msh, skin tdost	0.56	0.72(0.28 - 1.63)	0.491	
blases				
Confl Evidore	4.78	1.11 (0.85 - 1.30)	0.384	
Continued Mechanical Symptoms or Eurobility	0.42	1.05 (0.45 - 1.96)	0.991	
Acquired Leg Length Deformity	0.28	1.06 (0.38 - 1.76)	0.818	
Acquired Augular Deferrainy	0.42	0.57 (0.06 - 1.92)	0.996	