Cost Drivers for Revision Anterior Cruciate Ligament Reconstruction: A Retrospective Analysis of 82 Patients

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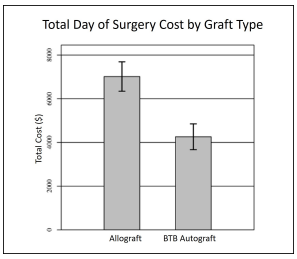
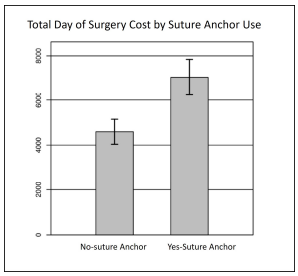
INTRODUCTION:
Anterior cruciate ligament reconstruction (ACLR) is one of the most common procedures performed in orthopaedics and has been shown to generally have high rates of patient satisfaction. Despite this, there have been reported revision rates of 7.2% at 9 years after surgery. Revision ACLR (R-ACLR) is typically performed in single-stage or two-stage fashion. Revision procedures are more technically challenging, require additional time to remove the previous graft, and staging to fill the previous tunnels with bone graft in some instances. Currently there is a paucity of literature surrounding the surgical costs of performing a R-ACLR. The purpose of this study was to determine the cost of performing single-stage R-ACLR using allograft or bone-patellar tendon-bone (BTB) autograft. We hypothesized that use of allograft would result in higher costs compared to BTB autograft use in R-ACLR. The primary outcome of interest was day of surgery (DOS) costs. Secondary outcomes included operative time and cost drivers related to DOS costs.
METHODS:
A retrospective case series was conducted within a single metropolitan healthcare system. The electronic medical record (EMR) was queried for R-ACLR cases conducted from 2010-2022. Patients were excluded if they were missing cost data, received a graft besides allograft or BTB autograft, underwent unicompartmental arthroplasty, or underwent two-stage R-ACLR. Time-driven activity based-costing was used to determine DOS costs. Implant costs were collected via chart review and cross referenced with the chargemaster database. All costs were adjusted to 2023 United States Dollars. Patient demographics and surgical characteristics were collected via chart review. Statistical analyses included descriptive statistics, independent samples t-tests, chi-square tests, fisher exact tests, and analysis of variance (ANOVA).
RESULTS:
A total of 82 patients met criteria for analysis. There were 43 female patients (52.4%), with an average age of 33.4 years old. The average body mass index (BMI) was 22.6. Most patients were assigned an American Society of Anesthesiologists score of 1 (n=50, 61.0%). More than half of the patients received an allograft for their R-ACLR (n=46, 56.1%). Most patients underwent additional procedures (68.3%) consisting of meniscus repair (28.1%), meniscectomy (32.9%), chondroplasty (7.3%), and lateral extra-articular tenodesis (LET) (14.6%). A higher proportion of patients whose original graft was hamstring autograft were revised to BTB autograft compared to allograft (71.0% vs. 29.0%), while patients whose original graft was BTB autograft were commonly revised to allograft (81.3% vs. 18.7%) ($p<0.001$). The average patient age of those who received allograft was significantly older compared to those who received BTB autograft (39.8 vs. 25.1, $p<0.001$, respectively).

The average operative time for a R-ACLR was 142.2 minutes. DOS costs on average were $5,628.41±2,282.41. Older patient age was correlated with higher costs ($r=0.40$, $p=0.001$). Total cost was found to be significantly higher for patients who received allograft compared to those who received BTB autograft for their revision ($6,674 vs. $4,320.52, $p<0.001$, respectively). Patients who also underwent an LET had significantly decreased costs compared to those who did not ($p=0.041$). More of these patients received BTB autograft compared to allograft (25.0% vs. 6.5%, $p=0.027$, respectively). The use of suture anchors and Tightrope were also correlated with higher costs ($7,037.22 and $6,936.12, $p<0.001$, respectively). Operative time was found to be significantly longer in patients who received BTB autograft compared to allograft (162.3 minutes vs. 126.46 minutes, $p=0.001$, respectively).
DISCUSSION AND CONCLUSION:
This study describes the DOS costs for patients who have undergone R-ACLR. The average cost was $5,628 and was found to differ by graft type. Although operative time is shorter for allograft, this decrease in time does not overcome the cost incurred by using an allograft. Additional fixation including suture anchors and Tightrope were also shown to increase the cost of R-ACLR. Orthopaedic surgeons should be aware of these costs when considering graft selection and additional fixation when performing R-ACLR. Future studies should evaluate the ratio of the cost of care to patient outcomes to maximize the value of R-ACLR.





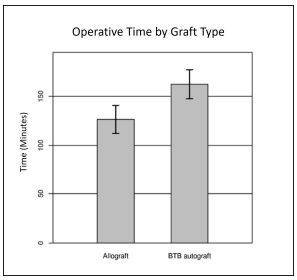


Table 1. Patient Demographic Data (N=82)

	Allograft (n=46)	BTB[a] Autograft (n=36)	p-value
Sex			0.200
Male	19 (41.3)	20 (55.6)	
Female	27 (58.7)	16 (44.4)	
Age	39.8 ± 13.8	25.1 ± 10.8	**< 0.001**
BMI[b]	25.7 ± 9.7	25.4 ± 7.3	0.889
ASA[c] Score			**0.003**
1	22 (47.8)	28 (77.8)	
2	23 (50.0)	6 (16.7)	
3	1 (2.2)	2 (5.6)	
Meniscal Operation	25 (54.4)	23 (63.9)	0.384
Repair	5 (10.9)	18 (50.0)	**< 0.001**
Meniscectomy	21 (45.7)	6 (16.7)	**0.006**
LET[d]	3 (6.5)	9 (25.0)	**0.019**
Chondroplasty	6 (13.1)	0 (0.0)	**0.024**
Operative Time (Min)	126.5 ± 49.3	162.3 ± 45.0	**< 0.001**
Total Day of Surgery Cost	$6,674.73 ± 2,129.89	$4,320.52 ± 1,742.10	**< 0.001**

Continuous data reported as mean ± S.D. Categorial data reported as N/n (%). P-value ≤ 0.05 indicates statistical significance.
[a]BTB = Bone-Tendon-Bone
[b]BMI = Body Mass Index
[c]ASA = American Society of Anesthesiologists
[d]LET= Lateral Extra-articular Tenodesis