Comparing the Efficiency of Anterior Cruciate Ligament Reconstruction across Ambulatory Surgery Centers, a University Hospital, and a Hybrid Inpatient Hospital: A Prospective Study

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Introduction

The incidence of anterior cruciate ligament (ACL) injuries has been increasing among the pediatric and adolescent population in the last few decades, with an incidence of almost seven injuries per every 1000 hours of exposure in adolescent athletes.[1] Instead of traditional, large inpatient hospitals, orthopaedic surgeons are increasingly utilizing ambulatory surgery centers (ASCs).2 For example, the percent of knee arthroscopies performed at ASCs increased from 16% in 1996 to over 50% by 2006.[3] ASCs offer lower financial costs, increased patient convenience, and faster surgical times.[2,4] Kadhim et al. found in a retrospective review of 359 ACL reconstructions that surgeries performed at a traditional, university hospital had a greater median turnover time, longer workday, and reduced work efficiency than at an ASC.[5] Furthermore, Fabricant et al. found that performing surgery at ASCs instead of a traditional, university hospital can result in 17% to 43% cost savings for the hospital.[6]

The goal of this study was to prospectively determine if ACL reconstructions, performed by the same surgeon, differed in efficiency between a traditional, university hospital, ASCs, and a novel hybrid inpatient hybrid hospital. We hypothesized that both the ASCs and the hybrid inpatient hospital would be more surgically efficient than the university hospital.

Methods

Following Institutional Review Board (IRB) approval, patients aged 12 to 18 years at the time of ACL reconstruction were prospectively enrolled in this study. All ACL reconstructions were performed by a single, fellowship-trained pediatric sports surgeon. Patients requiring multiple ligament reconstruction other than anterolateral ligament (ALL) lateral extra-articular tenodesis (LET) or having had previous ipsilateral knee surgery were excluded. ACL reconstructions were performed at three types of sites: a traditional, tertiary-care university hospital, ASCs, and a new hybrid inpatient hospital. This hybrid hospital was initially an ASC and opened an inpatient wing in January 2022. Patients undergoing ACL reconstruction at this location before January 2022 were enrolled in the ASCs cohort, and those after January 2022 were enrolled in the new hybrid inpatient hospital cohort.

Preoperatively, we collected age, baseline pain score (NRS),[7] physical exam, physeal status, meniscal injuries, Pedi-FABS score,[8] and Pedi-IKDC score.[9] Surgical variables collected included: anesthesia time, concurrent procedures, regional anesthesia type, rate of opioids administered, type of ACL tear and type of graft used, surgery time, and in-room time. Postoperatively we collected postoperative pain scores (NRS) at post-op day one, three, and seven, and Pedi-FABS and Pedi-IKDC scores at three, six, nine, and twelve months post-op. Descriptive statistics, Pearson's Chi-squared test for independence, ANOVA, and Kruskall-Willis test were performed.

Results

Baseline Characteristics

98 patients (57.1% female, mean age 15.5 +/− 1.7 years) were enrolled. 29 patients (30.0%) received ACL reconstruction at the university hospital, 34 patients (35%) at ASCs, and 35 patients (36%) at the hybrid inpatient hospital. All patients underwent ACL reconstruction using quadriceps tendon autograft. There were no differences in age, sex, BMI, time from injury to surgery, and additional procedures between the three cohorts (Table 1).

Surgical Efficiency

The mean surgery duration for ACL reconstruction with ALL-LET (125.0 ± 28.0

Table 1. Demographic and Clinical Characteristics by Surgery Location

Characteristic	Total Cohort	University Hospital	ASCs	Hybrid Inpatient Hospital	p value
Male	42 (42.9%)	13 (44.8%)	17 (50%)	12 (34.3%)	0.406
Female	56 (57.1%)	16 (55.2%)	17 (50%)	23 (65.7%)	0.406
Age at Preoperative Visit (Years)	15.5 (±1.7)	15.8 (±1.9)	15.7 (±1.7)	15.0 (±1.6)	0.168
BMI	23.7 (±4.3)	25.6 (±4.8)	22.8 (±3.1)	23.6 (±4.7)	0.115
Time Between Injury and Surgery (Days)	69 (±73.7)	101 (±115.6)	53.7 (±37.6)	57.5 (±39.8)	0.198

*Data are presented as mean ± standard deviation or counts and percentage as appropriate.

min) did not exceed that of the overall study population. Mean ACL reconstruction surgery duration with a medial meniscus repair, lateral meniscus repair, and both menisci repair (155.5 ± 31.5, 146.7 ± 36.2, 162.1 ± 46.5 min) exceeded that of ACLR with no additional procedures (146.3 ± 30.9 min); however, these differences were not statistically significant ($p = 0.4034$). Length of surgery, time for anesthesia induction, duration of anesthesia, and overall time in the operative room were shorter in both the ASCs and the hybrid inpatient hospital in comparison to the university hospital (Table 2).

Pain Scores & Patient-Reported Outcomes

There were no differences in type of intra-operative opioid used, rate of intra-operative opioid, or postoperative pain scores between the three cohorts. Similarly, patient reported outcomes via the Pedi-FABS and Pedi-IKDC score did not differ at any time point post-operatively among the three cohorts (Table 3).

Discussion

Given the rising cost of healthcare, orthopaedic surgeons are increasingly utilizing ambulatory surgery centers (ASCs) for common, outpatient procedures.10 ASCs can increase cost savings and reduce hospital stay and postoperative complications.[10] In a previous retrospective analysis, Kadhim et al. found that performing ACL reconstructions at ASCs owned by the same institution as a traditional, university hospital could improve both surgical and workday efficiency.[5] The goal of this study was to prospectively compare the efficiency of ACL reconstructions at three types of sites: a university hospital, ASCs, and a novel hybrid inpatient hospital.

Our study found that patients undergoing ACL reconstruction at the ASCs or the novel hybrid inpatient hospital had lower length of surgery, anesthesia time, and overall operation time than patients who received the same surgery at a university hospital. Additionally, patients in the three cohorts did not demonstrate any significant differences in postoperative pain scores or patient-reported outcomes. Fabricant et al. similarly found that operating room time at ASCs was on average 64 minutes shorter than at the university hospital for common orthopaedic procedures.6 Kadhim et al. also found that the total operating room work time was shorter for hospital-owned ASCs in comparison to the inpatient hospital.[5]

There are several limitations to our study. First, the hybrid inpatient hospital was initially an ASC that was later converted to a hybrid inpatient hospital in 2022. In order to continue enrollment in our prospective study, we included patients receiving ACL reconstruction at this site after January 2022 in a separate cohort. Second, all ACL reconstructions were performed by a single surgeon, potentially limiting generalizability. However, by limiting our study to surgeries performed by one surgeon at sites all owned by the same institution, we were able to limit confounding in our findings. Lastly, the variables in our study do not capture all the surgical and patient-reported variables that characterize efficiency.

Table 2. Surgical Efficiency based on Surgery Location

Characteristic	Total Cohort	University Hospital	ASCs	Hybrid Inpatient Hospital	p value
Surgery Efficiency					
Time for Anesthesia Induction (Min)	13.7 (±8.8)	18.7 (±10.3)	9.9 (±6.4)	13.7 (±8.0)	0.0039*
Duration of Anesthesia (Min)	206 (±48.3)	262.4 (±39.5)	181.1 (±28.2)	185 (±28.6)	0.001*
Length of Surgery (Skin Open to Close) (Min)	149 (±36.0)	185.2 (±32.9)	132.8 (±23.2)	135.8 (±26.8)	0.001*
Time in Operative Room (Min)	200.3 (±46.4)	252.8 (±41.4)	178.1 (±28.3)	179.8 (±27.2)	0.001*
Continuous Peripheral Nerve Catheter	3 (3.1%)	3 (10.3%)	0 (0%)	0 (0%)	0.025*
Single-Injection Nerve Block	95 (96.9%)	26 (89.7%)	34 (100%)	35 (100%)	0.025*

*Data are presented as mean ± standard deviation or counts and percentage as appropriate.

Table 3. Pain Scores and Patient-Reported Outcomes by Surgery Location

Characteristic	Total Cohort	University Hospital	ASCs	Hybrid Inpatient Hospital	p value
Pedi-FABS	N				
Pre-Operative	99	19.4 ± 11.1	19.9 ± 9.2	17.0 ± 13.1	0.9439
3-Months Post-Op	91	2.7 ± 5.9	5.1 ± 11.3	2.1 ± 4.7	0.4550
6-Months Post-Op	86	5.3 ± 7.6	7.3 ± 8.1	10.1 ± 8.9	0.0554
9-Months Post-Op	72	10.7 ± 9.0	11.6 ± 11.13	13.1 ± 10.3	0.7549
1-Year Post-Op	45	10.3 ± 10.8	16.2 ± 12.3	11.2 ± 12.8	0.4416
Pedi-IKDC	N				
Pre-Operative	99	52.8 ± 39.4	62.61 ± 31.3	52.4 ± 39.4	0.8822
3-Months Post-Op	91	47.8 ± 31.1	61.3 ± 10.7	46.6 ± 31.1	0.5243
6-Months Post-Op	86	54.9 ± 34.1	43.4 ± 36.4	59.2 ± 33.3	0.11
9-Months Post-Op	72	49.6 ± 38.9	55.6 ± 39.5	52.2 ± 40.1	0.5007
1-Year Post-Op	45	56.3 ± 14.0	49.7 ± 21.6	53.8 ± 13.0	0.6309
Baseline Pain Scores at Preoperative Visit	2.2 ± 1.8				
Postoperative Pain Scores					
Maximum Pain Score: PACU	1.9 ± 2.8	2.1 ± 2.1	1.8 ± 1.4	2.6 ± 1.9	0.060
Median Pain Score: PACU	0 (0-2)	0 (0-3)	0 (0-2)	0 (0-0)	0.306
Maximum Pain Score: Day 1	5.8 ± 2.5	5.3 ± 2.9	5.8 ± 2.4	6.3 ± 2	0.636
Average Pain Score at Rest: Day 3	3.3 ± 2.1	4 ± 2.4	2.8 ± 2	3.2 ± 1.8	0.262
Average Pain Score at Rest: Day 7	1.8 ± 1.5	2.2 ± 1.4	0.9 ± 1.1	2.1 ± 1.6	0.023*
Rate of Intra-Operative Opioids Administered (Y/N)	34 (34.7%)	14 (48.3%)	11 (32.3%)	9 (25.7%)	0.158
Type of Intra-Operative Opioid Administered					
Morphine	7 (7.1%)	2 (6.9%)	2 (5.9%)	3 (8.6%)	0.909
Fentanyl	23 (23.5%)	9 (31%)	9 (26.5%)	5 (14.3%)	0.254

*Data are presented as mean ± standard deviation or counts and percentage as appropriate.

Conclusions

This prospective, multi-center study found that ACL reconstructions performed at either ASCs or a hybrid inpatient hospital can be more efficient than those performed at traditional, inpatient university hospitals. This information can help counsel both surgeons and families regarding both the financial and patient-centered benefits of undergoing outpatient surgeries at ambulatory centers.

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