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HIP ARTHROPLASTY

Failure to Meet Same-Day Discharge is Not a Predictor of Adverse Outcomes

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Abstract

Introduction As more centers introduce same-day discharge (SDD) total joint arthroplasty (TJA) programs, it is vital to understand the factors associated with successful outpatient TJA and whether outcomes vary for those that failed SDD. The purpose of this study is to compare outcomes of patients that are successfully discharged home the day of surgery to those that fail-to-launch (FTL) and require a longer in-hospital stay.

Materials and methods We retrospectively reviewed all patients who enrolled in our institution's SDD TJA program from 2015 to 2020. Patients were stratified into two cohorts based on whether they were successfully SDD or FTL. Outcomes of interest included discharge disposition, 90-day readmissions, 90-day revisions, surgical time, and patient-reported outcome measures (PROMs) as assessed by the FJS-12 (3 months, 1 year, and 2 years), HOOS, JR, and KOOS, JR (preoperatively, 3 months, and 1 year). Demographic differences were assessed with chi-square and Mann–Whitney *U* tests. Outcomes were compared using multilinear regressions, controlling for demographic differences.

Results A total of 1491 patients were included. Of these, 1384 (93%) were successfully SDD while 107 (7%) FTL and required a longer length-of-stay. Patients who FTL were more likely to be non-married ($p = 0.007$) and ASA class III ($p = 0.017$) compared to those who were successfully SDD. Surgical time was significantly longer for those who FTL compared to those who were successfully SDD (100.86 vs. 83.42 min; $p < 0.001$). Discharge disposition ($p = 0.100$), 90-day readmissions ($p = 0.897$), 90-day revisions ($p = 0.997$), and all PROM scores both preoperatively and postoperatively did not significantly differ between the two cohorts.

Conclusion Our results support the notion that FTL is not a predictor of adverse outcomes as patients who FTL achieved similar outcomes as those who were successfully SDD. The findings of this study can aid orthopedic surgeons to educate their patients who wish to participate in a similar program, as well as patients that have concerns after they failed to go home on the day of surgery.

Level III Evidence Retrospective Cohort Study.

Keywords Same-day discharge · Outpatient · Failure to launch · Total hip arthroplasty · Total knee arthroplasty · Total joint arthroplasty

Introduction

Total joint arthroplasty (TJA) has proven to be one of the most successful elective procedures for patients suffering from debilitating osteoarthritis (OA). A plethora of literature exists pertaining to its beneficial effects with regards to pain reduction, functional improvement, and health-related quality of life [1–4]. The growing success of TJA, the continuously rising prevalence of OA, and the increased demand for improved mobility and quality of life have resulted in approximately 7 million individuals currently living with artificial hips and knees in the United States [5]. Traditionally, all total hip (THA) and knee (TKA) arthroplasty surgeries were performed as an inpatient procedure with varying in-hospital length of stay (LOS), with some patients even exceeding several weeks [6]. In today's healthcare landscape, as the emphasis on value-based care increases, these procedures are becoming more prevalent in the outpatient

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setting with many patients being successfully same-day discharged (SDD) following their surgery [7, 8].

With the improvement in surgical technique, blood loss management, anesthetic techniques, multimodal pain control regimens with decreased opioid utilization, and the development of various rapid recovery pathways that promote early postoperative mobilization, multiple studies have demonstrated the safety of SDD TJA in properly selected patients with outcomes similar to patients undergoing inpatient TJA [9–13]. The introduction of "fast-track" pathways for elective THA and TKA has not only proved to reduce LOS but also lower the number of complications and readmissions following these procedures [14–16]. However, despite these encouraging results, some previous studies have also raised concerns regarding the safety of SDD TJA, citing an increased risk of postoperative complications and readmissions [17–19]. Currently, outpatient TJA pathways have been developed and implemented throughout the world including our institution.

As more centers introduce SDD, it is vital to understand the factors associated with successful outpatient TJA and the most common causes for failed SDD. The selection criteria for enrolling patients in an SDD program remains under debate [20–22], as some studies have also reported the utility of outpatient TJA in an unselected group of patients [23, 24]. However, only a few studies have evaluated reasons for unsuccessful SDD following enrollment in an outpatient TJA program [25–30]. In addition, there is a paucity of data in the literature analyzing the outcomes of patients who were enrolled in an SDD TJA program and were successfully SDD to those who failed-to-launch (FTL) and required a longer LOS.

The goals of this study are to (1) compare outcomes between patients enrolled in our institutions SDD TJA program who were successfully SDD to those who FTL; (2) identify baseline demographic differences between patients undergoing successful SDD and unsuccessful SDD; (3) determine the rate for successful SDD among pre-selected candidates and the LOS following unsuccessful SDD for those who FTL. We hypothesize that FTL SDD does not prevent the achievement of similar outcomes compared to patients who were successfully SDD following TJA.

Materials and methods

Study design

We retrospectively reviewed all consecutive patients who enrolled in our institution's SDD TJA program from January 2015 through October 2020. This study was conducted at a single, urban institution, which comprises a large academic center and a tertiary orthopedic specialty hospital. The records and existing data are de-identified and are part of our institutional quality improvement program; therefore, the present study was exempted from human-subjects review by our institutional review board (IRB). Patients undergoing bilateral or revision TJA, as well as TJA performed for non-elective or oncologic reasons, and patients who withdrew from the SDD program before the day of surgery were excluded. SDD is defined as patients who were discharged on the same calendar date as their surgery (LOS of 0 days). We defined FTL as any patient with a LOS of 1 night or more. Patients who met the inclusion criteria were stratified into two cohorts based on whether they were successfully SDD or FTL. Patients from 19 orthopedic surgeons participated in the SDD TJA program and were included in this analysis. All patients in the study were managed with the same institutional protocol from the time of the initial office visit when surgery was scheduled to discharge from the hospital. In addition, all surgeries were performed at the hospital and not in an ambulatory surgery setting.

Outcome measures

The primary outcome measures included discharge disposition (home vs. post-acute care facility), and postoperative adverse events such as 90-day all-cause readmission and revision rates. The secondary outcomes included surgical time (minutes), LOS (days), and patient-reported outcome measures (PROMs) as assessed by the Forgotten Joint Score-12 (FJS-12), Hip disability and Osteoarthritis Outcome Score, Joint Replacement (HOOS, JR), and Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS, JR). Surgical time was derived from calculating the time difference between initial skin incision and skin closure.

The FJS-12 questionnaire was developed with the understanding that joint awareness is a vital and extremely discriminative outcome parameter, especially in patients with good-to-excellent joint function [31]. Answers to each question are individually scored and summed to create a composite score, which is then converted to a 100-point scale. In theory, one is not particularly aware of a healthy joint during normal daily activities, thus it can be regarded as 'forgotten'. Therefore, higher scores indicate an increased level of a 'forgotten' joint and equate to better outcomes. The HOOS, JR and KOOS, JR surveys represent hip and knee health, respectively. They are scored on a 100 point scale, with 0 representing complete hip or knee disability and 100 representing perfect hip or knee health [32, 33].

Data collection

Collected variables included baseline demographics such as age, sex, marital status, smoking status, race, American Society of Anesthesiology (ASA) classification, Charlson Comorbidity Index (CCI), and body mass index (BMI; kg/

m^2) as well as clinical data such as surgical time, LOS, discharge disposition, 90-day all-cause readmissions, and 90-day all-cause revisions. All demographic and clinical data were extracted from our institution's electronic data warehouse (Epic Caboodle. version 15; Verona, WI) using Microsoft SQL Server Management Studio 2017 (Redmond, WA).

As part of our institutional standard of care, patients were preoperatively registered for an electronic patient engagement application (EPEA; Force Therapeutics, New York, NY) by clinical care coordinators at the time of surgical scheduling. The EPEA is a mobile and web-based technology that wirelessly delivers digital PROM surveys to patients at pre-defined time intervals. This application was used to collect FJS-12 scores at 3 months, 1 year, and 2 years postoperatively as well as HOOS, JR and KOOS, JR scores preoperatively, and at 3 months and 1 year postoperatively.

SDD protocol and perioperative management

Under the institution's SDD TJA integrated pathway, each SDD TJA was preoperatively risk-stratified and medically optimized before surgical intervention. Qualifying measures for the SDD TJA program patients included no history of active coronary artery disease or arrhythmias, not currently on chronic anticoagulation, no history of untreated moderate or severe sleep apnea, hemoglobin ≥ 12 g/dL, BMI ≤ 40 kg/m^2, and the ability to ambulate independently. Patients were required to undergo extensive preoperative education, which included a one-on-one encounter with a clinical care coordinator and a physical and occupational therapist for 2 h before the surgical date to educate the patient on the expected recovery course, pain management, physical therapy exercises, and postoperative expectations. Patients were also required to have a social support person (relative or friend) who would attend all preoperative education sessions, escort the patient out of the hospital to be discharged home, and be present at their home for at least the first night after discharge. At any point preceding the day of surgery, patients who no longer desired to take part in the SDD TJA program, or who failed to meet program requirements could withdraw from the program.

A hydration protocol was initiated on the day of surgery, in which patients were encouraged to drink 32 oz of clear fluids up to 2 h before surgery. Our institution transitioned from aspirin 325 mg BID to 81 mg BID within the timeframe of the study, thus thromboprophylaxis was achieved with either dosage, as well as mechanical compression devices for the first 2 weeks postoperatively. High-risk VTE patients were prescribed enoxaparin 40 mg daily for 4 weeks instead as per our institutional protocol. All patients received preemptive analgesia, consisting of meloxicam and acetaminophen. A standardized anesthesia protocol was used for all SDD patients. All patients received short-acting spinal anesthesia with 0.5% ropivacaine or bupivacaine to facilitate immediate postoperative patient mobilization, intravenous (IV) fentanyl, propofol, midazolam, and IV dexamethasone. A uniform perioperative multimodal pain regimen was established to reduce the need for narcotics. This included the use of a 0.25% bupivacaine with epinephrine and 30 mg ketorolac periarticular cocktail in addition to a liposomal bupivacaine periarticular injection before wound closure. However, this injection was not administered to patients with renal insufficiency or drug allergies to its contained contents. Due to institutional protocol change, the administration of the liposomal bupivacaine periarticular injection was discontinued on July 1, 2019. Following this policy change, patients received a traditional cocktail consisting of 0.25% non-liposomal bupivacaine with epinephrine and 15 mg of ketorolac prior to placing the final implant components.

Postoperative pain management was accomplished using mostly non-narcotic medications, such as oral acetaminophen and tramadol. In addition, patients undergoing TKA were prescribed oxycodone for pain control when necessary. Patient-controlled analgesia, as well as oral and intravenous opioid administration, was strongly discouraged, except in rare situations of breakthrough pain when alternatives had been exhausted. When the patient was deemed ready to be discharged from the post-anesthesia care unit, they were transferred to their assigned inpatient bed, where they were seen by physical therapists to assist with early ambulation and ensure the patient was safe to be discharged home. The criteria for safe discharge used by the physical therapist included an ambulation distance of 100 feet with minimal assistance and the ability to negotiate stairs. All patients received perioperative antibiotics for 24 h prophylactically.

Once deemed medically and functionally safe for discharge, all patients are discharged home under self-care. Home-healthcare services are provided at the discretion of the operating surgeon although the majority of our patients did not require such services. After discharge, all other aspects regarding medical management were identical for all patients irrespective of successful SDD or FTL SDD. On postoperative day 1, a clinical care coordinator nurse followed up with each patient to ensure the recovery process is progressing as anticipated.

Statistical analysis

All data were organized and collected using Microsoft Excel software (Microsoft Corporation, Richmond, WA). A binary variable was created to identify patients who were successfully SDD and those who FTL SDD and required a longer hospital stay. Demographic and clinical baseline characteristics of study participants were described as means with standard deviations (SD) for continuous variables and

frequencies with percentages for categorical variables. Shapiro–Wilk test was performed to determine normality. Statistical differences in numeric, continuous variables were detected using Mann–Whitney *U* tests, whereas chi-squared ($\chi 2$) tests were utilized for categorical variables. Multivariate linear and logistic regressions were performed to control for potential confounding variables and reported as unstandardized beta coefficients for generalized linear models, or as exponentiated beta coefficients for logistic regressions. Confounding variables were selected based on demographic differences with a p-value less than 0.200 between the two cohorts, which included race, marital status, ASA class, and CCI. These regression models were used to compare surgical time, discharge disposition, 90-day all-cause readmissions, 90-day all-cause revisions, FJS-12, HOOS, JR, and KOOS, JR scores at each of the set timepoints between patients who were successfully SDD and those who FTL. A p-value of less than 0.05 was considered to be significant. All statistical analyses were performed using SPSS v25 (IBM Corporation, Armonk, New York).

Results

Demographics

A total of 1491 patients enrolled in our institution's SDD TJA program during the study period and were included in our analysis. Of these 1491 patients, 1334 (89%) underwent THA and 157 (11%) underwent TKA. Overall, 1384 (93%) TJA patients were successfully SDD while 107 (7%) TJA patients FTL and required a longer LOS. Of those who underwent THA, 1243 (93%) were successfully SDD, whereas 91 (7%) FTL. Among those who underwent TKA, 141 (90%) were successfully SDD, whereas 16 (10%) FTL.

Age ($p = 0.284$), sex ($p = 0.561$), race ($p = 0.190$), smoking status ($p = 0.919$), CCI ($p = 0.151$), and BMI ($p = 0.444$) differences between patients who underwent successful SDD TJA and those who FTL were not statistically significant. However, there were statistical differences in terms of marital status with patients who underwent successful SDD TJA consisting of 71% married and 29% non-married individuals, while those who FTL consisted of 59% married and 41% non-married individuals ($p = 0.007$). In addition, patients who FTL were statistically more likely to have an ASA classification of III compared to those who were successfully SDD (11% vs. 5%; $p = 0.017$). Baseline characteristics of the study cohorts are summarized in Table 1.

Table 1 Patient demographics ($n = 1491$)

	Successfully SDD ($n = 1384$)	Failed to launch ($n = 107$)	*P*-value
Age (years, ± SD)	57.99 ± 9.93	58.88 ± 10.45	0.284
Sex			0.561
Female	671 (48.5%)	55 (51.4%)	
Male	713 (51.5%)	52 (48.6%)	
Race			0.190
Caucasian	1131 (81.7%)	79 (73.8%)	
African-American	97 (7.0%)	12 (11.2%)	
Asian	21 (1.5%)	3 (2.8%)	
Other	135 (9.8%)	13 (12.1%)	
Smoking status			0.919
Never smoker	881 (63.7%)	66 (61.7%)	
Former smoker	416 (30.1%)	34 (31.8%)	
Current smoker	87 (6.3%)	7 (6.5%)	
Marital status			0.007
Married	987 (71.3%)	63 (58.9%)	
Non-married	397 (28.7%)	44 (41.1%)	
ASA class			0.017
I	238 (17.2%)	16 (15.0%)	
II	1,079 (78.0%)	79 (73.8%)	
III	67 (4.8%)	12 (11.2%)	
CCI	2.75 ± 1.67	2.93 ± 1.62	0.151
BMI (kg/m^2, ± SD)	27.63 ± 5.22	28.03 ± 5.12	0.629

BMI body mass index, *ASA* american society of anesthesiologist classification, *CCI* charlson comorbidity index, *SD* standard deviation

**P* values are derived from Mann–Whitney *U* tests for numerical values or $\chi 2$ tests for categorical values

Outcomes

After controlling for all significant demographic differences, discharge disposition did not statistically differ between the two cohorts as 100% of the patients who were successfully SDD were discharged to their homes in comparison to 99% of the patients who FTL ($p = 0.100$). One patient who FTL was discharged to an acute rehabilitation facility. Similarly, 90-day all-cause readmissions ($p = 0.897$) and 90-day all-cause revisions ($p = 0.997$) also did not statistically differ between the two cohorts. However, patients who FTL had a significantly longer surgical time compared to those who were successfully SDD (100.86 ± 33.36 vs. 83.42 ± 22.73 min; $p < 0.001$). These findings are summarized in Table 2.

Of the 22 patients who were successfully discharged SDD and had a readmission within 90 days, 10 were due to infection, four due to periprosthetic fractures, two due to mechanical loosening, one due to dislocation, and the remaining five due to other non-orthopedic reasons. Furthermore, between the two patients who FTL and had a readmission within 90 days, one was due to infection and the other for periprosthetic fracture. Thirteen patients who were successfully SDD required revision surgery within 90 days. Of these, four were due to infection, three due to mechanical loosening, five due

Table 2 Outcome comparison

	Successfully SDD	Failed to launch	Effect of failure to launch (95% CI)	*P*-value
Surgical time (min, ± SD)	83.42 ± 22.73	100.86 ± 33.36	16.83 min increase (12.15–21.50)	< 0.001
Discharge disposition			Odds Ratio: 3.01 (0.81–11.15)	0.100
Home	1384 (100%)	106 (99.1%)		
Other facility	0 (0.0%)	1 (0.9%)		
90-day Readmission	22 (1.6%)	2 (1.9%)	Odds Ratio: 0.91 (0.21–3.95)	0.897
90-day revision	13 (0.9%)	0 (0.0%)	Odds Ratio: 0.00 (N/A)	0.997

**P* values are derived from a multivariable linear regression for numerical values and multinomial logistic regressions for categorical value. These regressions account for significant demographic differences between groups. *CI* confidence interval, *OR* odds ratio, *SD* standard deviation

to periprosthetic fracture, and one due to instability. There were no patients who required revision with 90 days.

Patients who FTL had a mean LOS of 1.40 ± 0.54 days. The primary reasons for patients not being discharged on the day of surgery included poorly controlled pain, numbness, hypotension, nausea or light-headedness when ambulating with physical therapy, failure to void, and greater than average blood loss intraoperatively that required monitoring overnight. Specifically, four patients experienced urinary retention postoperatively and were observed overnight, but they were all able to void freely the next day thus did not require catheterization.

PROMs

Once again, significant demographic variables were controlled for in a multivariable analysis of PROM scores. There were non-statistically significant differences in mean FJS-12 scores at 3 months ($p = 0.098$), 1 year ($p = 0.744$), and 2 years ($p = 0.868$) postoperatively between patients who underwent THA and were successfully SDD and those who FTL. Similarly, FJS-12 scores did not statistically differ at 3 months ($p = 0.915$), 1 year ($p = 0.829$), and 2 years ($p = 0.265$) between patients who underwent TKA and were successfully SDD and those who FTL. Mean HOOS, JR scores among those who underwent THA did not statistically differ between the two cohorts preoperatively ($p = 0.663$) as well as 3 months ($p = 0.356$) and 1 year ($p = 0.272$) postoperatively. Those who underwent TKA followed a similar trend as mean KOOS, JR scores preoperatively ($p = 0.147$), 3 months postoperatively ($p = 0.280$), and 1 year postoperatively ($p = 0.979$) did not statistically differ between the two cohorts. Full PROM comparisons are summarized in Table 3.

Table 3 PROM comparison

	Successfully SDD	Failed to launch	Unstandardized beta coefficients (95% CI)	*P*-value
FJS-12 (THA)				
3 m	59.73 ± 27.92 (*n* = 337)	50.80 ± 29.43 (*n* = 29)	−8.94 (−19.54 to 1.66)	0.098
1y	71.90 ± 26.55 (*n* = 338)	69.34 ± 23.72 (*n* = 25)	−1.81 (−12.71 to 9.08)	0.744
2y	75.66 ± 26.77 (*n* = 269)	75.47 ± 31.59 (*n* = 18)	−1.11 (−14.20 to 11.99)	0.868
FJS-12 (TKA)				
3 m	28.45 ± 25.96 (*n* = 43)	29.19 ± 36.61 (*n* = 3)	−1.72 (−34.32 to 30.87)	0.915
1y	44.56 ± 30.28 (*n* = 42)	50.43 ± 39.28 (*n* = 5)	3.39 (−28.14 to 34.92)	0.829
2y	43.02 ± 33.19 (*n* = 14)	58.35 ± 38.37 (*n* = 4)	21.76 (−18.78 to 62.29)	0.265
HOOS, JR				
Preop	52.48 ± 13.48 (*n* = 617)	51.48 ± 13.80 (*n* = 47)	−0.89 (−4.89 to 3.11)	0.663
3 m	81.57 ± 14.84 (*n* = 551)	79.26 ± 15.50 (*n* = 44)	−2.16 (−6.77 to 2.44)	0.356
1y	87.47 ± 14.88 (*n* = 437)	90.47 ± 13.11 (*n* = 34)	2.91 (−2.20 to 8.11)	0.272
KOOS, JR				
Preop	48.25 ± 16.20 (*n* = 69)	54.58 ± 12.42 (*n* = 10)	8.11 (−2.91 to 19.13)	0.147
3 m	63.55 ± 11.58 (*n* = 53)	68.78 ± 13.65 (*n* = 7)	5.25 (−4.40 to 14.91)	0.280
1y	71.52 ± 17.07 (*n* = 43)	73.49 ± 15.93 (*n* = 6)	0.21 (−15.20 to 15.61)	0.979

**P*-values are derived from a multivariable linear regression. These regressions account for demographic differences between groups

Patients who FTL showed a higher statistical mean improvement in FJS-12 scores from 3 months to 2-year follow-up between both those who underwent THA (24.67 ± 19.40 vs. 15.93 ± 17.33; $p < 0.001$) and TKA (29.16 ± 23.77 vs. 14.57 ± 19.92; $p = 0.030$) compared to patients who were successfully SDD. In addition, the HOOS, JR score improvement from baseline to 1 year postoperatively was also statistically higher for patients who FTL compared to those who were successfully SDD (38.99 ± 8.53 vs. 34.99 ± 9.07; $p < 0.001$). However, delta improvement in KOOS, JR scores from baseline to 1 year postoperatively did not statistically differ between the two groups ($p = 0.103$). The mean delta improvements in PROMs are summarized in Table 4.

Discussion

Outpatient SDD TJA has been shown to be associated with substantial cost reduction and improved patient satisfaction and recovery [34]. Substantial improvements in perioperative and rehabilitation protocols have been pivotal for its current success [16]. However, to our knowledge, no study to date has directly compared outcomes between patients who enrolled in an SDD TJA program and were successfully discharged the day of their surgery to those who enrolled but FTL and were unsuccessfully SDD [28, 29, 35]. In this study, the success rate of SDD following THA and TKA was 93% and 90%, respectively. We identified marital status and ASA classification of III to be independent risk factors for FTL SDD in a preselected patient population. Although surgical time was found to be significantly longer in patients who FTL, discharge disposition, 90-day readmissions, 90-day revisions, and PROMs at each timepoint were statistically similar between patients who were successfully SDD and those who FTL.

Patients who FTL and were admitted overnight had a relatively short LOS with most spanning 1 to 2 in-hospital days. This is similar to what has been previously reported in other SDD TJA programs [28, 36]. This suggests that most early symptoms and side effects that render patients to additional in-hospital stay than originally planned are usually mild and resolve rather quickly. In addition, as outpatient TJA are increasingly being transitioned to ambulatory surgery centers, which have limited overnight stay options, optimizing successful SDD rates, and having an in-hospital backup plan is necessary for patients who FTL. Similar to our study, rates of successful SDD following THA and TKA have been reported from 76 to 100% and 93–100%, respectively [8, 23, 37, 38]. Furthermore, the FTL rate in this study was 7%, which represents an improvement from the early years of our SDD TJA program [7, 39].

In terms of patient demographics, our study population was statistically similar with respect to age, sex, race, smoking status, CCI, and BMI. This is similar to some previous reports [28, 29, 40]; however, it is not consistent with many other existing studies that report increasing age and obesity as risk factors for prolonged LOS following TJA [26, 41–43]. However, these studies did not include pre-selected patients, as morbidly obese patients were excluded from participating in our SDD TJA program. Furthermore, although non-married patients were more likely to FTL compared to married individuals, prior studies analyzing the effects of marital status on TJA outcomes have been largely inconclusive. However, a few recent studies have suggested that married individuals demonstrate superior psychological adjustment as well as mental health and that these factors along with perceived social support play an important role in optimizing outcomes and influencing LOS following surgery [42, 44–49]. While all patients that participated in the SDD TJA program were required to have a social support person that stayed with them overnight at their home the day of their surgery, it is possible that non-married patients that FTL lacked adequate social support at home spanning past this point thus preferred a longer in-hospital stay. Although marital status was used as a surrogate for social support in the present study, we believe that being married does not capture social support in its entirety as some patients may likely have support at home in the form of family and friends without being married.

The results of the present study suggest that patients with a higher ASA class had a greater likelihood of unsuccessful SDD. In general, ASA class III is associated with longer LOS, higher risk of readmissions, and early postoperative complications [42, 50, 51]. This finding may be explained by the fact that most patients with an ASA ≥ III tend to be excluded from participating in SDD TJA programs [20]. While ASA class III patients were not excluded from participation in our SDD program, the study population as a whole remained relatively young and healthy. We controlled for ASA classification in our regression models making our results further generalizable to most patients who are eligible to participate in SDD programs, as these individuals are

Table 4 PROM delta improvement

	Successfully SDD	Failed to launch	*P*-value
FJS-12 (THA) 3 m to 2y	15.93 ± 17.33	24.67 ± 19.40	< 0.001
FJS-12 (TKA) 3 m to 2y	14.57 ± 19.92	29.16 ± 23.77	0.030
HOOS, JR Preop to 1y	34.99 ± 9.07	38.99 ± 8.53	< 0.001
KOOS, JR Preop to 1y	23.27 ± 10.55	18.91 ± 9.56	0.103

*P-values are derived from two-sample *t*-test

generally younger and healthier. Contrary to our findings, a recent study by Keulen et al. [29] which aimed to identify predictors of successful and unsuccessful SDD in selected patients following outpatient THA and TKA found that patients with ASA II (mild systemic disease) had a statistically significant higher risk of failing SDD. However, they did mention that patients with ASA III also showed a higher tendency of unsuccessful SDD following outpatient TJA, but their study lacked adequate numbers to show a meaningful difference. Therefore, future studies evaluating the specific comorbidities within the ASA II and III categories that influence the success of SDD TJA would be highly valuable as it may further aid orthopedic surgeons with the preoperative stratification of patients.

Keulen et al. [29] also evaluated preoperative PROMs which consisted of the Visual Analog Scale (VAS) for pain, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Oxford Hip and Knee Scores (OHS/OKS). They showed that patients who were successfully SDD had statistically higher preoperative WOMAC scores and less pain (lower VAS pain score) compared to patients who were unsuccessfully SDD. Preoperative OHS/OKS scores were statistically similar in their study. However, unlike the present study, they did not any analyze PROMs postoperatively between the two groups. With regards to our PROM findings, there were no significant differences between patients who were successfully SDD and those who FTL at any timepoint irrespective of the assessment questionnaire administered. Interestingly, patients who FTL showed a statistically larger improvement from baseline in both FJS-12 and HOOS, JR scores. However, these findings may not be clinically significant as the number of patients who FTL and had a recorded PROM score was far less than those who were successfully SDD. Nevertheless, this supports the hypothesis that FTL does not prevent the achievement of similar outcomes in comparison to patients who are successfully SDD.

One particularly interesting finding of our study was that prolonged surgical time was a significant factor in patients that FTL compared to those who were successfully SDD. Some previous studies have associated longer surgical times with increased LOS [52, 53]. It is possible that the longer operative time for patients who FTL may be due to these patients requiring more complex surgery. Longer operative time could have also led to higher intraoperative blood loss. This may have possibly contributed to the postoperative dizziness and hypotension that some patients who FTL experienced, which ultimately led to their extended in-hospital stay. Postoperative dizziness or orthostatic intolerance has been previously suggested to pose issues with early mobilization following TJA [54]. Previous studies that assessed reasons for unsuccessful SDD in patients who participated in an SDD TJA program found that besides patient preference, pain, dizziness/orthostatic hypotension, and nausea were the preeminent causes for unsuccessful SDD [8, 25–27, 30]. All of which coincides with the findings of this study.

This study is not without limitations. The retrospective nature of the study spanning over several years subjects it to the bias of evolving institutional and office-based protocols. Our institution does an excellent job abiding by our SDD protocol, therefore, obtaining a larger FTL comparison group is not feasible making it an inherent limitation of this analysis. Although the current analysis included both THA and TKA, the vast majority of the cases performed in our SDD program during the study period have been THA. When the program initially launched, only THA cases were included; however, TKA was later supplemented to the program. The statistically significant findings pertaining to delta improvements in PROMs may be due to the small sample size of patients who FTL and answered a PROM questionnaire. External validity is limited due to the fact we analyzed preselected patients based on our SDD TJA program protocols. Our institution is a high-volume center; therefore, the protocols were implemented in corroboration with our anesthesiologists' extensive experience in TJA. While our anesthesia department was comfortable using short-acting sedation protocol for our SDD TJA patients, these results may not be generalizable to lower-volume centers. Furthermore, hospital logistics, payment models, perioperative protocols, and selection criteria may differ in hospitals worldwide. Finally, all data concerning readmissions and revisions were obtained solely from our institution's electronic medical records, thus some readmissions and revisions occurring at other healthcare institutions may not be included in our analysis. However, this data discrepancy was deemed to be minor as our follow-up rate was close to 100%. To ease data collection, the analysis of readmissions and revisions was limited to the 90-day episode of care for better data registry and capture. Despite these limitations, these results are valuable and encouraging, as patients who FTL achieved similar outcomes compared to their counterparts who were successfully SDD.

Conclusion

This study adds to a growing body of literature on the success of institutional SDD TJA care pathways across the world. SDD following TJA was highly achievable for the majority of patients participating in the SDD TJA program. Our results support the notion that FTL is not a predictor of adverse postoperative outcomes as patients who FTL achieved similar outcomes as those who were successfully SDD. However, multidisciplinary care team coordination, standardized perioperative protocols, discharge planning, and careful patient selection are still necessary. The findings

of this study can be used to aid orthopedic surgeons to educate their patients who are eligible and wish to participate in a similar program.

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Declarations

Conflict of interest V.S and A.M.N have nothing to disclose. W.M holds stock options in OrthoAlign. R.S is a paid consultant for Intellijoint and Smith & Nephew and holds stock options in Gauss Surgical. R.D is a paid consultant for Radlink, Schaerer Medical, Exactech, and Medtronics. The authors declare that they have no conflict of interest pertinent to this study.

Ethical approval The present study was exempt from human-subjects review by our institutional review board (IRB).

Informed consent Informed consent was obtained from all individual participants included in the study.

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