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Association Between Intravenous to Oral Opioid Transition Time and Length of Hospital Stay After Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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ABSTRACT

Background: Transitioning from intravenous (IV) to oral opioids after posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) is necessary during the postoperative course. However, few studies have assessed the effects of longer transition times on hospital length of stay (LOS). This study investigated the impact of longer IV to oral opioid transition times on LOS after PSF for AIS.

Methods: The medical records of 129 adolescents (10–18 years old) with AIS undergoing multilevel PSF at a major academic institution from 2013 to 2020 were reviewed. Patients were categorized by IV to oral opioid transition time: normal (≤2 days) vs prolonged (≥3 days). Patient demographics, comorbidities, deformity characteristics, intraoperative variables, postoperative complications, and LOS were assessed. Multivariate analyses were used to determine odds ratios for risk-adjusted extended LOS.

Results: Of the 129 study patients, 29.5% ($n = 38$) had prolonged IV to oral transitions. Demographics and comorbidities were similar between the cohorts. The major curve degree ($P = 0.762$) and median (interquartile range) levels fused ($P = 0.447$) were similar between cohorts, but procedure time was significantly longer in the prolonged cohort (normal: 6.6 ± 1.2 hours vs prolonged: 7.2 ± 1.3 hours, $P = 0.009$). Postoperative complication rates were similar between the cohorts. Patients with prolonged transitions had significantly longer LOS (normal: 4.6 ± 1.3 days vs prolonged: 5.1 ± 0.8 days, $P < 0.001$) but similar discharge disposition ($P = 0.722$) and 30-day readmission rates ($P > 0.99$). On univariate analysis, transition time was significantly associated with extended LOS (OR: 2.0, 95% CI [0.9, 4.6], $P = 0.014$), but this assocation was not significant on multivariate analysis (adjusted OR: 2.1, 95% CI [1.3, 4.8], $P = 0.062$).

Conclusions: Longer postoperative IV to oral opioid transitions after PSF for AIS may have implications for hospital LOS.

Level of Evidence: 3.

Other and Special Categories

Keywords: adolescent idiopathic scoliosis, spine, surgery, opioids, posterior spinal fusion, length of stay, postoperative outcomes

INTRODUCTION

Rising health care expenditures in the United States have reaffirmed the need to search for strategies to mitigate costs while improving the quality of care.[1] Hospital length of stay (LOS) has been identified as a major contributor to health care spending and is a proxy for quality of care.[2,3] Surgical correction of adolescent idiopathic scoliosis (AIS) is an extensive operation associated with significant morbidity and health care utilization.[4] Previous studies have demonstrated various factors predisposing patients to prolonged LOS after posterior spinal fusion (PSF) for AIS, including gender, insurance access, comorbidities, and postoperative complications.[5] Therefore, identification of other hospital factors contributing to prolonged LOS is necessary to improve the quality of care and reduce costs for these patients.

The postoperative transition from intravenous (IV) to oral pain medications following PSF for AIS is necessary for home discharge.[6] In spite of this fact, many institutions have historically left the perioperative management of these patients at the discretion of the treating surgeon, leading to variability in the timing of this

transition.[6–8] This finding is notable, as previous studies have suggested that increased required amounts of IV opioids impact LOS.[9] As a result, further investigation on the impacts of prolonged IV to oral opioid transitions on LOS is merited. However, there remains a paucity of studies identifying the impact of longer IV to oral opioid transitions on patient LOS after PSF for AIS.

The aim of this study was to investigate the association between IV to oral opioid transition time and hospital LOS for adolescents undergoing PSF for AIS.

MATERIALS AND METHODS

The medical records of 194 adolescents (10–18 years old) with spinal deformities undergoing elective PSF at a major academic institution from 2013 to 2020 were retrospectively reviewed. Of the 194 patients screened, 129 were included in the study. Patients with a diagnosis of AIS were included, while syndromic and congenital scoliosis patients were excluded. The 129 included patients were categorized based on IV to oral opioid transition time into 2 groups: normal (≤2 days) vs prolonged (≥3 days). We identified 91 patients with normal transition times and 38 patients with prolonged transition times (normal: $n = 91$; prolonged: $n = 38$). The primary outcome investigated in this study was the association between IV to oral opioid transition time and length of hospital stay. Institutional review board approval was obtained prior to study initiation (protocol 2000028261).

The institutional standardized enhanced recovery after surgery (ERAS) care pathway was implemented after the study period; however, there were standardized practices in place during the study period. The perioperative care was overseen by the patient's surgical team primarily. Each patient received an acute pain service consult immediately after surgery—incorporating a patient-controlled analgesia (PCA) with either morphine or hydromorphone, along with acetaminophen and an IV muscle relaxant immediately postoperatively. The decision to transition from IV to oral opioids was contingent upon patient-reported pain and oral tolerance. Additionally, all patients received a physical therapy (PT) consult on postoperative day 1, with the goal of mobilization as soon as tolerated.

Baseline characteristics and demographic variables were assessed, including age, gender, race, ethnicity, and body mass index (as defined by patient height and weight at the time of surgery). Comorbidities assessed included affective disorders, attention-deficit disorder, attention-deficit hyperactivity disorder, autism spectrum disorder, congenital heart defects, asthma, anemia, obesity, hypothyroidism, seizure disorder, gastroesophageal reflux disease, eczema, and number of allergies. Preoperative lab values from labs collected within 1 month of surgery included hemoglobin (g/dL), hematocrit (%), albumin (g/dL), platelets (×1000 μL), and creatinine (g/dL). Anemia was defined using age-, gender-, and race-defined hemoglobin values.[10,11] Deformity characteristics included Risser stage and major and minor curve degrees of scoliosis, defined by preoperative standing scoliosis x-ray images.

Intraoperative variables included the number of vertebral levels fused, osteotomies performed, estimated blood loss, transfusion given (packed red blood cells, platelets/fresh frozen plasma, and cell saver), and administration of tranexamic acid and aminocaproic acid. Intraoperative procedure time (hours) and complications, including spinal cord injury, durotomy, and neuromonitoring changes, were collected. Additionally, the assistance of a plastic surgeon on closure, drain insertion, and intrathecal opioid administration was recorded.

Postoperative PT variables included the number of postoperative days until ambulation, number of steps taken on the first day of ambulation after surgery, and maximum number of steps taken prior to discharge. Pain was assessed by a physical therapist prior to the first PT session and categorized as none/mild, moderate/severe, or not specified if no pain information was recorded. Postoperative adverse events included persistent tachycardia, fever (>37°C), hypotension, hypertension, anemia, blood transfusions, atelectasis, ileus, and urinary retention. Postoperative hemoglobin (g/dL) and hematocrit (%) were collected within 24 hours after surgery. Other postoperative variables included pediatric intensive care unit LOS, discharge disposition (home vs home with home service), hospital LOS, and unplanned readmission within 30 days of discharge.

Statistical Analyses

Parametric data were expressed as means ± SDs and compared using the Student t test. Nonparametric data were expressed as medians (interquartile ranges) and compared via the Mann-Whitney U test. Nominal data were compared with χ^2 or Fisher's exact test if any cell had a count of <5. The Shapiro-Wilk normality test was used to determine the normality of the continuous variables. Extended LOS was defined as greater than the 75th percentile of LOS for the entire cohort (5 days). This definition of extended LOS has been utilized by several prior studies.[12–17] Univariate and multivariate logistic regressions were fitted with extended LOS as

Table 1. Patient demographics and comorbidities.

Variables	Normal (n = 91)	Prolonged (n = 38)	P Value
Age, y			0.755
Mean ± SD	14.1 ± 1.7	14.2 ± 2.2	
Median (IQR)	14.0 (13.0–15.0)	14.0 (12.2–16.0)	
Female, n (%)	72 (79.1)	28 (73.7)	0.497
Race/ethnicity			
Non-Hispanic white	62 (68.1)	30 (78.9)	0.286
Body mass index (kg/m^2)			0.916
Mean ± SD	22.0 ± 3.5	22.4 ± 5.4	
Median (IQR)	21.4 (19.4–23.5)	21.2 (19.5–24.4)	
Comorbidities, n (%)			
Affective disorder	8 (8.8)	3 (7.9)	>0.99
Attention-deficit/hyperactivity disorder	4 (4.4)	3 (7.9)	0.420
Autism spectrum disorder	4 (4.4)	0 (0.0)	0.319
Congenital heart defect	3 (3.3)	1 (2.6)	>0.99
Asthma	21 (23.1)	8 (21.1)	0.984
Anemia	24 (27.3)	9 (25.0)	0.971
Obesity	13 (14.3)	7 (18.4)	0.745
Hypothyroidism	2 (2.2)	0 (0.0)	>0.99
Seizure disorder	2 (2.2)	1 (2.6)	>0.99
Gastroesophageal reflux disease	2 (2.2)	1 (2.6)	>0.99
Eczema	6 (6.6)	1 (2.6)	0.673
Number of allergies, n (%)			0.885
0	52 (57.1)	23 (60.5)	
1	24 (26.4)	10 (26.3)	
>1	15 (16.5)	5 (13.2)	
Preoperative laboratory values, mean ± SD			
Hemoglobin, g/dL	13.0 ± 1.1	13.2 ± 1.3	0.572
Hematocrit, %	38.8 ± 3.2	39.1 ± 4.0	0.657
Albumin, g/dL	4.4 ± 0.2	4.5 ± 0.3	0.373
Platelets, ×1000 μL	290.0 ± 62.3	298.0 ± 70.2	0.449
Creatinine, mg/dL	0.6 ± 0.2	0.6 ± 0.2	0.901

Abbreviation: IQR, interquartile range.

the outcome variable to calculate odds ratios (ORs) or adjusted ORs (aORs), respectively. Variables were included in the regression analysis if P values were <0.15 between the cohorts in previous statistical analyses and $N > 9$. Patient age and sex were forced into the multivariate regression to address plausible confounding. A P value <0.05 was considered statistically significant. For multivariate regression, a reverse feature elimination stepwise regression was used for model optimization. Statistical analysis was performed using R Studio, version 1.4.1717 (PBC, Boston, MA, USA).

RESULTS

Patient Demographics and Comorbidities

A total of 129 patients were included in this study, of whom 70.5% were categorized as having normal IV to oral transition times (n = 91) and 29.5% (n = 38) as having prolonged transition times (Table 1). Age (normal: 14.1 ± 1.7 years vs prolonged: 14.2 ± 2.2 years, P = 0.755), gender (normal: 79.1% women vs prolonged: 73.7% women, P = 0.497), and race (P = 0.286) were similar between the cohorts (Table 1). Body mass index (P = 0.916) and other comorbidities were also similar between the 2 cohorts (Table 1).

Deformity Characteristics

There were no significant differences in major curve degree (P = 0.762), minor curve degree (P = 0.302), and Risser stage (P = 0.246) between the 2 cohorts (Table 2).

Table 2. Deformity characteristics.

Variables	Normal (n = 91)	Prolonged (n = 38)	P Value
Major curve degree			0.762
Mean ± SD	60.9 ± 11.6	60.0 ± 9.8	
Median (IQR)	58.0 (52.5–64.0)	57.5 (53.0–63.0)	
Minor curve degree			0.302
Mean ± SD	43.6 ± 13.9	46.1 ± 11.9	
Median (IQR)	44.0 (36.0–51.0)	45.5 (38.0–51.8)	
Risser stage, n (%)			0.246
1–2	32 (35.2)	14 (36.8)	
3–5	51 (56.0)	17 (44.7)	
Not specified	8 (8.8)	7 (18.4)	

Abbreviation: IQR, interquartile range.

Table 3. Intraoperative variables.

Variables	Normal (n = 91)	Prolonged (n = 38)	P Value
Median fusion levels (IQR)	12.0 (11.0–13.0)	12.0 (12.0–13.0)	0.447
Osteotomies performed, *n* (%)	15 (16.5)	5 (13.2)	0.792
Estimated blood loss, mL			
Mean ± SD	1042.0 ± 502.0	1087.0 ± 494.0	0.745
RBC transfusion, *n* (%)			
Autologous	33 (36.3)	12 (31.6)	0.252
Nonautologous	16 (17.6)	5 (13.2)	0.319
Units of RBC transfused, *n* (%)			0.509
0	42 (46.2)	14 (36.8)	
1	20 (22.0)	8 (21.1)	
>1	29 (31.9)	16 (42.1)	
Platelets/fresh frozen plasma transfusion, *n* (%)	4 (4.4)	3 (7.9)	0.420
Cell saver, *n* (%)	91 (100.0)	37 (97.4)	0.295
Albumin transfusion, *n* (%)	54 (59.3)	27 (71.1)	0.292
Tranexamic acid used, *n* (%)	80 (87.9)	27 (71.1)	**0.039**
Aminocaproic acid used, *n* (%)	10 (11.0)	9 (23.7)	0.114
Procedure time, h			**0.009**
Mean ± SD	6.6 ± 1.2	7.2 ± 1.3	
Median (IQR)	6.5 (5.9–7.4)	7.0 (6.4–8.1)	
Spinal cord injury, *n* (%)	1 (1.1)	0 (0.0)	>0.99
Durotomy, *n* (%)	0 (0.0)	1 (2.6)	0.295
Neuromonitoring changes, *n* (%)	4 (4.4)	2 (5.3)	>0.99
Plastic surgery closure, *n* (%)	13 (14.3)	5 (13.2)	>0.99
Drain use, *n* (%)	85 (93.4)	38 (100.0)	0.178
Intrathecal opioid administration, *n* (%)	79 (86.8)	31 (86.1)	>0.99

Abbreviations: IQR, interquartile range; RBC, red blood cell.
Note: Bold indicates a statistically significant *P* value.

Intraoperative Variables

The procedure time was significantly longer in the prolonged cohort (normal: 6.6 ± 1.2 hours vs prolonged: 7.2 ± 1.3 hours, P = 0.009) (Table 3). The median (IQR) number of spinal levels fused during surgery (P = 0.447) and rate of osteotomies performed (P = 0.792) did not significantly differ between the 2 cohorts (Table 3). There were no significant differences in estimated blood loss (P = 0.745), or transfusions of packed red blood cells (P = 0.509), platelet/fresh frozen plasma (P = 0.420), cell saver (P = 0.295), or albumin (P = 0.292) (Table 3). Tranexamic acid was more frequently given to the normal cohort (normal: 87.9% vs prolonged: 71.1%, P = 0.039), while there was no difference in the use of aminocaproic acid (P = 0.114) (Table 3). The number of any surgical complications and the administration of intrathecal opioids (P > 0.99) were similar between the cohorts.

Postoperative Pain and Physical Therapy

There was no significant difference between the cohorts in the pain reported before the first postoperative PT session (P = 0.759) (Table 4). The normal cohort ambulated sooner following surgery (normal: 2.4 ± 0.9 days vs prolonged: 2.7 ± 0.8 days, P = 0.055), though the difference was not statistically significant (Table 4). The number of steps on the first day of ambulation was higher in the normal cohort (normal: 104 ± 106 steps vs prolonged: 69 ± 72 steps, P = 0.094), as was the maximum number of steps taken prior to discharge (normal: 202 ± 84 steps vs prolonged: 188 ± 85

Table 4. Postoperative pain and PT.

Variables	Normal (n = 91)	Prolonged (n = 38)	P Value
Pain before first PT session, *n* (%)			0.759
None/mild (0–5)	50 (54.9)	18 (47.4)	
Moderate/severe (6–10)	23 (25.3)	11 (28.9)	
Not specified	18 (19.8)	9 (23.7)	
Days to ambulation			0.055
Mean ± SD	2.4 ± 0.9	2.7 ± 0.8	
Median (interquartile range)	2 (2, 3)	3 (2, 3)	
Ambulation steps on first day of ambulation, mean ± SD	104.0 ± 106.0	69.2 ± 72.0	0.094
Maximum ambulation steps before discharge, mean ± SD	202.0 ± 83.7	188.0 ± 84.6	0.297

Abbreviation: PT, physical therapy.

Table 5. Postoperative variables.

Variables	Normal (n = 91)	Prolonged (n = 38)	P Value
Persistent tachycardia, *n* (%)	36 (39.6)	23 (60.5)	**0.047**
Fever, *n* (%)	28 (30.8)	19 (50.0)	0.062
Hypotension, *n* (%)	19 (20.9)	8 (21.1)	>0.99
Hypertension, *n* (%)	7 (7.7)	3 (7.9)	>0.99
Anemia, *n* (%)	85 (93.4)	35 (92.1)	0.722
Required blood transfusion, *n* (%)	16 (17.6)	6 (15.8)	>0.99
Atelectasis, *n* (%)	2 (2.2)	4 (10.5)	0.062
Ileus, *n* (%)	3 (3.3)	0 (0.0)	0.555
Urinary retention, *n* (%)	1 (1.1)	0 (0.0)	>0.99
Postoperative laboratory values, mean ± SD			
Hemoglobin, g/dL	9.8 ± 1.5	10.1 ± 1.3	0.204
Hematocrit, %	29.2 ± 4.2	30.0 ± 3.8	0.304
Total pediatric intensive care unit length of stay, d			0.076
Mean ± SD	1.4 ± 1.0	1.5 ± 0.6	
Total hospital length of stay, d			**<0.001**
Mean ± SD	4.6 ± 1.3	5.1 ± 0.8	
Median (interquartile range)	4 (4, 5)	5 (5, 6)	
Discharge disposition, *n* (%)			0.722
Home	85 (93.4)	35 (92.1)	
Home with home services	6 (6.6)	3 (7.9)	
30-d Unplanned readmission, *n* (%)	2 (2.2)	1 (2.6)	>0.99

Note: Bold indicates a statistically significant *P* value.

steps, $P = 0.297$) (Table 4). These differences were also not statistically significant.

Postoperative Variables

There was a higher rate of persistent tachycardia in the prolonged cohort (normal: 39.6% vs prolonged: 60.5%, $P = 0.047$), while postoperative fever ($P = 0.062$), hypotension ($P > 0.99$), hypertension ($P > 0.99$), anemia ($P = 0.722$), blood transfusions ($P > 0.99$), atelectasis ($P = 0.062$), ileus ($P = 0.555$), urinary retention ($P > 0.99$), postoperative hemoglobin ($P = 0.204$), and hematocrit ($P = 0.304$) values were similar between the cohorts (Table 5). Patients with prolonged transitions from IV to oral narcotics had significantly longer LOS (normal: 4.6 ± 1.3 days vs prolonged: 5.1 ± 0.8 days, $P < 0.001$), whereas discharge disposition ($P = 0.722$) and rates of 30-day unplanned readmissions ($P > 0.99$) were similar between the cohorts (Table 5).

Univariate and Multivariate Regression for Extended Hospital LOS

On univariate analysis, IV to oral opioid transition time was significantly associated with extended LOS (OR: 2.0, 95% CI [0.9, 4.6], $P = 0.014$] but only trended toward significance on multivariate analysis (aOR: 2.1, 95% CI [1.0, 4.8], $P = 0.062$) (Table 6). Other variables associated with extended LOS on multivariate analysis included age (aOR: 1.4, 95% CI [1.1, 2.0], $P = 0.022$), female sex (aOR: 6.2, 95% CI [1.4, 16.3], $P = 0.034$), procedure time (aOR: 1.8, 95% CI [1.1, 2.9], $P = 0.015$),

Table 6. Univariate and multivariate logistic regression analysis for extended hospital LOS.

	Univariate Model		Multivariate Model	
Variable	OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Age	1.5 (1.1–2.1)	0.307	1.4 (1.1–2.0)	**0.022**
Female sex	3.4 (0.9–22.0)	0.116	6.2 (1.4–16.3)	**0.034**
Days to oral pain medication only	2.0 (0.9–4.6)	**0.014**	2.1 (1.0–4.8)	0.062
Days to ambulation	2.3 (1.3–4.2)	**0.006**	-	-
Tranexamic acid given	0.2 (0.1–0.6)	**0.002**	-	-
Aminocaproic acid given	5.0 (1.7–14.6)	**0.003**	-	-
Drain use	0.0 (0.0–0.0)	0.992		
Persistent tachycardia	1.9 (0.7–4.9)	0.172	-	-
Fever	2.0 (0.8–5.0)	0.151	-	-
Atelectasis	2.6 (0.3–14.2)	0.293	-	-
Procedure time, h	1.7 (1.2–2.6)	**0.005**	1.8 (1.1–2.9)	**0.015**
Ambulation steps on first day of ambulation	1.0 (1.0–1.0)	0.707	-	-
Pediatric intensive care unit LOS	2.0 (1.2–3.4)	**0.013**	2.0 (1.2–4.1)	**0.019**

Abbreviation: LOS, length of stay.
Note: Bold indicates a statistically significant *P* value.

and pediatric intensive care unit LOS (aOR: 2.0, 95% CI [1.2, 4.1], $P = 0.019$) (Table 6).

DISCUSSION

In this retrospective, single-institution study of 129 pediatric patients undergoing elective PSF for AIS, we demonstrate that longer postoperative IV to oral opioid transition time was associated with a longer LOS on univariate analysis and trended toward significance on multivariate analysis. These results suggest that longer IV to oral opioid transition time may have implications for LOS in these patients.

Prior literature has attempted to identify patient- and surgical-level factors associated with longer IV to oral opioid transitions following PSF for AIS. In an institutional retrospective review of 56 patients with AIS undergoing PSF, Sugarman et al demonstrated that patients in the hybrid instrumentation group had significantly more days on PCA pumps before transition to oral medications compared with the all-pedicle screw instrumentation group.[18] Similarly, in another retrospective institutional study of 374 patients undergoing PSF for AIS, Chan et al found that obese patients had greater total PCA morphine use prior to transitioning to oral narcotics than did healthy weight patients.[19] In a dual-center prospective cohort study of 60 patients with AIS undergoing PSF, Chan et al also demonstrated that the use of a single surgeon resulted in significantly greater PCA morphine use prior to oral opioid transition compared with dual-surgeon approaches.[20] Likewise, in a retrospective single-institution study of prospectively collected data from 71 patients with idiopathic scoliosis who underwent PSF, Mihara et al showed that patients undergoing surgery during the daytime had significantly greater PCA morphine usage before switching to oral narcotics than patients undergoing surgery after hours.[21]

Analogous to these results, our study did not show differences in demographics, comorbidities, or deformity characteristics between patients having longer and shorter IV to oral opioid transitions. However, patients with longer transitions did have longer operative times. The reasons for this finding are unclear, as prior studies have shown that prolonged operative times in AIS surgeries are associated with increased curve magnitude, number of levels fused, and increased body weight.[22,23] Each of these variables was similar between our cohorts; however, it is possible that our findings are due to our small sample size. Further studies incorporating a larger number of patients have the potential to more effectively characterize the impact of various patient- and surgical-level risk factors predisposing to longer IV opioid use to better optimize preoperative expectations and patient care.

There have been conflicting data regarding the impact of longer IV to oral opioid transition times on LOS. In a study of 44 patients undergoing PSF for AIS, Mari et al demonstrated that increased IV morphine usage prior to sole use of oral narcotics was significantly associated with prolonged hospital LOS.[9] Likewise, in a retrospective review of prospectively collected data on 169 patients undergoing PSF for AIS, Martin et al showed that continued high levels of IV morphine consumption on postoperative days 1 and 2 were significantly associated with longer LOS.[24] Conversely, in a retrospective, monocentric observational study of 163 patients undergoing surgical correction of AIS, Julien-Marsollier et al found that continued high levels of IV morphine consumption on day 2 or on day 3 postoperatively were not independently predictive of hospital LOS.[25] In our study, we demonstrated that although longer IV opioid usage was associated with longer LOS on univariate analysis, it only trended toward significance on multivariate analysis. Therefore, it is important to fully elucidate the impact of the duration of IV narcotic use on postoperative outcomes to improve the quality of care while decreasing health care expenditures.

Given the potential negative impacts of extended IV to oral narcotic transitions on postoperative outcomes, there have been protocols recently developed at several institutions involving improved perioperative care, including emphasizing early transitions to oral opioids in patients undergoing surgery for AIS with promising results. In an institutional retrospective cohort study of 279 patients undergoing PSF for AIS from 2006 to 2008, Fletcher et al demonstrated that the introduction of earlier transitions from PCA pumps to oral pain medications resulted in significantly shorter LOS and reduced costs when compared with a standard postoperative care protocol.[6] In this study, the authors describe a standard postoperative care protocol with specific decisions at the discretion of the treating surgeon consisting of PCA use for 2 days postsurgery on average.[6] Additionally, mobilization with PT occurred once daily beginning on postoperative day 1.[6] Similarly, in an institutional quality improvement project of 322 patients undergoing spinal fusion for idiopathic scoliosis from 2011 to 2015, Muhly et al showed that the introduction of a rapid recovery pathway incorporating shorter transitions from IV to oral narcotics led to a decrease in mean hospital LOS compared with a traditional care pathway.[8] The authors noted that

traditional perioperative care entailed 1 dose of methadone intraoperatively at 0.1–0.2 mg/kg, postoperative PCA use with morphine or hydromorphone for 3 to 4 days, along with an oral muscle relaxant, followed by oral oxycodone and acetaminophen.[8] Pain management was overseen by the treating surgeon and managed by the acute pain service.[8] Furthermore, PT was initiated on postoperative day 2.[8] Likewise, in a retrospective multi-institution cohort study of 105 patients undergoing PSF for AIS from 2011 to 2012, Fletcher et al found that implementing a novel pathway emphasizing early transitions to oral pain medications resulted in a significantly reduced hospital LOS and a lower total complication rate despite no difference in readmission rate.[7] Here, the standard care pathway was at the discretion of the treating surgeon, with PCA use occurring for 2 days, followed by oral pain medications and mobilization with PT occurring once daily beginning on postoperative day 1.[7]

Like the conventional care pathways described in these studies,[6–8] our institution has no standardized care pathway following PSF for AIS. Each patient's perioperative care is overseen by the treating surgeon. Patients receive an acute pain service consult as soon as possible following PSF. They receive a PCA on postoperative day 0, with either morphine or hydromorphone, along with acetaminophen and an oral muscle relaxant, if tolerated. The decision to transition from IV to oral opioids depends on several factors, including patient-reported pain, perioral tolerance, and patient/provider preference. Additionally, all patients received a PT consult on postoperative day 1, with the goal of mobilization as soon as possible following surgery. While these steps are similar to reports in the literature, exact comparisons of outcomes are challenging given the possibility of differences in treating provider preferences. It is reasonable to assume, however, given the results, that standardized perioperative care pathways emphasizing earlier IV to oral transitions have the potential to notably reduce LOS. As a result, further studies assessing more widespread implementation of these protocols are needed.

Along with protocols, there have been studies assessing other pain medications to reduce IV to oral transition time. In a retrospective multicenter cohort study of 7349 patients undergoing PSF for AIS, Rosenberg et al demonstrated that while the use of ketorolac and γ-aminobutyric acid analogs was a significant predictor of shorter IV opioid use, benzodiazepine use was significantly associated with longer IV opioid use.[26] Similarly, in an institutional retrospective cohort study of 138 patients undergoing PSF for AIS between 2014 and 2015, Gornitzky et al showed that the implementation of a rapid recovery pathway emphasizing a standardized multimodal analgesic and rehabilitation protocol led to a significantly shorter duration of PCA use.[27] Likewise, in a retrospective observational single-institution before and after study of 117 patients undergoing PSF for AIS, Rao et al found that the implementation of an ERAS protocol involving a multimodal pain regimen and optimized advancement of diet and activity helped patients to discontinue PCA pumps earlier.[28] In an institutional retrospective case comparison study from 1989 to 2009 of 146 patients undergoing PSF for AIS, Ravish et al demonstrated that patients receiving combined intrathecal morphine and epidural analgesia compared with conventional IV PCA had significantly less total IV opioid use and lower postoperative pain scores.[29] Similarly, in an institutional retrospective cohort study of 407 patients with idiopathic scoliosis undergoing PSF, Tripi et al showed that patients who received medium- or high-dose intrathecal morphine required significantly less IV morphine during the first 48 hours after surgery.[30] Likewise, in an institutional retrospective cohort study of 244 pediatric patients undergoing PSF for AIS between 2003 and 2008, Ross et al found on multivariate regression analysis that continuous infusion of bupivacaine predicted lower rates of postoperative IV morphine use, while diazepam and intraoperative morphine predicted increased postoperative IV morphine use.[31] Implementing opioid analogs into ERAS protocols may provide avenues for better pain control and the reduction of postoperative opioid use. Creating such protocols for AIS may result in better patient care, reduction of inpatient expenditures, and limiting the need for extended postoperative opioid use.

Limitations

This study has limitations with potential implications for study interpretation. First, all variables were reviewed retrospectively and, as such, are limited by the weaknesses inherent to retrospective analyses. Second, we were limited to what was available in our institution's medical records; therefore, the total amount of narcotics given was not assessed, which may have had implications on our results. Whereas narcotic use was our primary variable, the use of other analgesic medications was not included; this omission may have biased our results. Finally, a relatively small patient sample size from a single institution was used, making broad conclusions difficult and potentially biasing our results for particular patient populations or treatment paradigms.

Despite these limitations, this study sheds light onto the impact of longer postoperative IV to oral opioid transitions on adolescent patients undergoing PSF for AIS.

CONCLUSIONS

Our study suggests that longer postoperative IV to oral opioid transitions after PSF for AIS may have implications for LOS. Further studies are necessary to better identify approaches that may reduce IV to oral opioid transition times. Implementing opioid analogs into ERAS protocols may provide avenues for better postoperative pain control and a reduction in opioid usage.

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