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Clinical Studies

Opioid use prior to surgery is associated with worse preoperative and postoperative patient reported quality of life and decreased surgical cost effectiveness for symptomatic adult spine deformity; A matched cohort analysis



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ABSTRACT

Background: Preoperative opioid is associated with poor postoperative outcomes for several surgical specialties, including neurosurgical, orthopedic, and general surgery. Patients with symptomatic adult spinal deformity (SASD) are among the highest patient populations reporting opioid use prior to surgery. Surgery for SASD has been demonstrated to improve patient reported quality of life, however, little medical economic data exists evaluating impact of preoperative opioid use upon surgical cost-effectiveness for SASD. The purpose of this study was to evaluate the impact that preoperative opioid use has upon SASD surgery including duration of intensive care unit (ICU) and hospital stay, postoperative complications, patient reported outcome measures (PROMs), and surgical cost-effectiveness using a propensity score matched analysis model.

Methods: Surgically treated SASD patients enrolled into a prospective multi-center SASD study were assessed for preoperative opioid use, and divided into two cohorts; preoperative opioid users (OPIOID) and preoperative opioid non-users (NON). Propensity score matching (PSM) was used to control for patient age, medical comorbidities, spine deformity type and magnitude, and surgical procedures for OPIOID vs NON. Preoperative and minimum 2-year postoperative PROMs, duration of ICU and hospital stay, postoperative complications, and opioid use at one and two years postoperative were compared for OPIOID vs NON. Preoperative, one year, and minimum two-year postoperative SF6D values were calculated, and one- and two-year postoperative QALYs were calculated using SF6D change from baseline. Hospital costs at the time of index surgery were calculated and cost/QALY compared at one and two years postop for OPIOID vs NON.

Results: 261/357 patients (mean follow-up 3.3 years) eligible for study were evaluated. Following the PSM control, OPIOID (n=97) had similar preoperative demographics, smoking and depression history, spine deformity magnitude, and surgery performed as NON (n=164; p>0.05). Preoperatively, OPIOID reported greater NRS back

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pain (7.7 vs 6.7) and leg pain (5.2 vs 3.9), worse ODI (50.8 vs 36.9), worse SF-36 PCS (28.8 vs 35.6), and worse SRS-22r self-image (2.3 vs 2.5) than NON, respectively ($p < 0.05$). OPIOID had longer ICU (41.2 vs 21.4 hours) and hospital stay (10.6 vs 8.0 days) than NON, respectively ($p < 0.05$). At last postoperative follow up, OPIOID reported greater NRS back pain (4.1 vs 2.3) and leg pain (2.9 vs 1.7), worse ODI (32.4 vs 19.4), worse SF-36 PCS (37.4 vs 47.0), worse SRS-22r self-image (3.5 vs 4.0), and lower SRS-22r treatment satisfaction score (2.5 vs 4.5) than NON, respectively ($p < 0.05$). At last follow-up postoperative Cost/QALY was higher for OPIOID (\$44,558.31) vs NON (\$34,304.36; $p < 0.05$). At last follow up OPIOID reported greater postoperative opioid usage than NON [41.2% vs. 12.9%, respectively; odds ratio = 4.7 (95% CI=2.6-8.7; $p < 0.05$)].

Conclusions: Prospective, multi-center, matched analysis demonstrated SASD patients using opioids prior to SASD surgery reported worse preoperative and postoperative quality of life, had longer ICU and hospital stay, had less cost effectiveness of SASD surgery. Preoperative opioid users also reported lower treatment satisfaction, and reported greater postoperative opioid use than non-users. These data should be used to counsel patients on the negative impact preoperative opioid use can have on SASD surgery.

Level of evidence: Level III; prognostic

140 Character Tweet: Adult scoliosis patients using opioids preop have worse quality of life, longer ICU and hospital stay, and worse surgical cost effectiveness vs. non-users.

Background

Chronic opioid use is associated with poor patient reported quality of life, increased healthcare utilization, and increased risk for adverse events following major and minor surgeries [1–11]. Surgical health care expenditures in the United States exceed \$500 billion annually, accounting for approximately 40% of the national health care expenditure. [12] The adverse effects associated with opioid therapy in conjunction with the costs of surgical care in the United States has generated a national mandate to reduce opioid prescriptions. Despite the growing cognizance of the negative impacts of opioid therapy, patients with spine pathologies continue to be among the highest opioid utilizing patient populations [13].

Symptomatic adult spine deformity (SASD) is a debilitating condition that has a negative impact upon patient reported quality of life similar to cancer, diabetes, and heart disease [14]. Surgical treatment for SASD has been shown to be effective in improving patient reported quality of life [15,16]. Preoperative opioid use has been shown to negatively impact postoperative outcomes, thereby compromising the potential benefits of surgical treatment for spine pathologies [17–22]. The purpose of this study was to perform a propensity score matched analysis of preoperative opioid users vs. nonusers prospectively enrolled into a multi-center SASD database to evaluate the associations of preoperative opioid use with 1) preoperative and postoperative patient reported quality of life, 2) duration of postoperative ICU and hospital stay, 3) hospital costs, 4) cost per quality adjusted life years (cost/QALY) at one and two-years postoperative, 5) postoperative complications, and 6) opioid use at minimum 2-years postoperative.

Methods

Data for this study was obtained from a multi-center prospective, observational study of operatively and nonoperatively treated SASD patients (study registered at ClinicalTrials.gov Identifier: NCT00738439). Inclusion criteria is patients ≥ 18 years of age, and minimum of one of the following spine deformity parameters; maximal scoliosis $\geq 20^\circ$, sagittal vertical axis (SVA) ≥ 5 cm, pelvic tilt (PT) $\geq 25^\circ$, and/or thoracic kyphosis (TK) $\geq 60^\circ$ [23,24]. All patients were enrolled at one of eleven enrolling sites in the United States. All sites received IRB approval prior to enrolling patients into the prospective study. Additional inclusion criteria for the present study were 1) patients receiving surgery for SASD after study enrollment, 2) minimum five levels fused at the time of surgery, 3) no prior history of spine fusion surgery, and 4) minimum 2-years postoperative follow-up. Exclusion criteria for this study were spinal deformities associated with autoimmune, acute traumatic, neoplastic,

neuromuscular, syndromic and/or infectious disorders, and history of prior spine fusion surgery prior to study enrollment.

Classification of opioid use

SASD patients meeting inclusion criteria for the present study were assessed for frequency of preoperative opioid usage by evaluating the response to question 11 on the Scoliosis Research Society-22r questionnaire (SRS-22r), that asks “Which of the following best describes your pain medication use for back pain? 1) None, 2) Non-narcotics weekly or less, 3) Non-narcotics daily, 4) Narcotics weekly or less, 5) Narcotics daily” [25]. Patients were organized into two cohorts based upon their response to preoperative opioid consumption: preoperative opioid users=OPIOID (answer 4 or 5) and preoperative opioid non-users=NON (answers 1, 2, or 3).

Propensity score matching

Patients in the OPIOID and NON cohorts were propensity score matched (PSM) for 1) demographic and medical history variables associated with prolonged postoperative opioid use as reported by Brummett et al, including: age, gender, BMI, history of depression, and history of drug/alcohol abuse, 2) preoperative spine deformity magnitude including scoliosis location and magnitude, SVA, pelvic incidence-lumbar lordosis (PI-LL), and pelvic tilt (PT), and 3) type of surgery performed (including total fusion levels, upper (UIV) and lower (LIV) instrumented vertebra, and performance of 3-column osteotomies) [3]. Preoperative and postoperative opioid prescriptions for all patients evaluated in this study were given at the discretion of the treating physicians. There was no control or randomization for the type or dosage of preoperative or postoperative opioid usage. There was no randomization or control for the type of surgery performed for any study patient. The surgery performed on all patients was at the discretion of the surgeons according to the consent process between the treating surgeons and the patients.

Data analyzed

Preoperative and minimum 2- year postoperative data was compared for OPIOID vs. NON, including demographic, radiographic, and patient reported quality of life measures (PROMs). PROMs utilized for this study included preoperative and minimum 2- year postoperative numeric rating scales for back pain (NRS back) and leg pain (NRS leg), Oswestry Disability Index (ODI), Physical Component Summary (PCS) and Mental Component Summary (MCS) scores obtained from the Short Form-36v2 Health Survey (SF-36), and SRS-22r total and domain scores.[38,39]. Surgical data, length of ICU and hospital stay, and direct hospital costs for the episode of care at the time of surgery were evaluated. Hospital costs for the surgical episode of care was calculated using Diagnosis-Related Group (DRG) data. Cost data was generated from the Centers for Medicare and Medicaid Services (CMS) pricer tool, which calculates the CMS reimbursement amounts for each patient. Cost data were based

Table 1
Propensity score matched analysis of demographics, past medical history, radiographic parameters OPIOID vs. NON.

	OPIOID	NON	P-Value
N=261	N=97	N=164	
Last f/u (years)	3.4 (1.9-6.9)	3.3 (1.8-6.3)	0.7722
Demographics			
Age (years)	62.7 (29.3-86.2)	62.4 (18.5-80.1)	0.8414
BMI (mean)	27.3 (16.8-41.2)	26.8 (17.1-65.9)	0.5239
ASA (median)	2 (1-3)	2 (1-4)	0.0007
Preoperative Smoker	7.5%	3.1%	0.1078
Preoperative Alcohol/Drug Abuse	2.1%	1.4%	0.6895
History of Depression	24.7%	23.6%	0.8386
Radiographic			
Preop Max Scoliosis (°)	45.1 (7.7-102.5)	45.1 (10.4-98.4)	0.9150
Postop Max Scoliosis (°)	17.5 (0.8-70)	20.5 (0.2-94.4)	0.0551
Preop SVA (mm)	66.9 (-74.4 to 250.0)	54.4 (-83.7 to 225.6)	0.1237
Postop SVA (mm)	38.4 (-74.3 to 188.9)	16.9 (-97.7 to 200.2)	0.0012
Preop Lordosis (°)	37.1 (-15.1 to 101.9)	40.1 (-14.1 to 88.9)	0.2536
Postop Lordosis (°)	52.6 (15.6-87.9)	54.4 (11.4-90.7)	0.2166
Preop Kyphosis (°)	39.0 (0.4 to 107.4)	35.9 (-6.4 to 125.5)	0.1993
Postop Kyphosis (°)	60.2 (9.9 to 95)	56.0 (13.1 to 92.5)	0.0417
Preop PI-LL (°)	15.2 (-43.1 to 68.4)	15.6 (-35.1 to 56.6)	0.8898
Postop PI-LL (°)	0.5 (-28.9 to 46.9)	1.1 (-39.2 to 46.7)	0.7228

BMI=Body Mass Index; ASA=American Society of Anesthesiologists; SVA=Sagittal Vertical Axis; PI-LL=Pelvic Incidence minus Lumbar Lordosis

on the index surgical procedure. Quality adjusted life years (QALYs) were calculated using SF-36v2 scores converted to SF-6d Standard Gamble health state preference scores. Postoperative complications, and minimum 2-year postoperative opioid use were compared between the matched OPIOID and NON patients.

Radiographic measures

All radiographic analyses were performed at a single measurement center utilizing 36-inch cassette antero-posterior (AP) and lateral radiographs that visualized from the skull base to the pelvis. Coronal and sagittal spinal/spinopelvic alignment parameters were assessed using Spineview® (Laboratory of Biomechanics, Paris, France), as previously described [26,27].

Statistical methods

Skewness of data was evaluated using the Shapiro-Wilk test. Student's t test, Wilcoxon/Kruskal-Wallis tests, Chi², and Odds Ratios with a 95% confidence interval (CI) were used when appropriate. Statistics were performed using JMP version 15.0.0 (SAS Institute Inc., Cary, NC). R (version 3.6.2) and R Studio (version 1.2.5033) were used to perform PSM using the genetic matching package rgenoud, in package MatchIt (version 3.0.2) [28,29].

Results

Enrollment, demographic, radiographic and surgical data

SASD patients enrolled into the prospective study and surgically treated between August 2008 and August 2016 were included in this analysis. Of 357 patients eligible for study, 261 met inclusion criteria (73% follow-up; mean follow-up 3.3 years (range 1.8-6.9)). Following PSM, OPIOID (n=97) and NON (n=164) had similar preoperative age, gender distribution, medical comorbidities, history of depression, history of mental illness, history of drug and alcohol dependence, spine deformity magnitude (including scoliosis location and magnitude, SVA, PI-LL, and PT), distribution of ASD types (as defined by the SRS-Schwab ASD classification), and duration of postoperative follow-up (p>0.05; Table 1) [30,31].

Table 2
Propensity score matched analysis of surgical data, hospital stay, and complication rates OPIOID vs. NON.

	OPIOID	NON	P-Value
N=261	N=97	N=164	
Surgery			
Number of Levels	11 (5-18)	12 (5-23)	0.1013
LIV (% fused to pelvis)	86.6%	87.7%	0.8037
SICU (% of patients)	76.3%	68.8%	0.1941
SICU (hrs)	41.2 (0-394.2)	21.4 (0-156)	0.0065
Length of Stay (days)	10.6 (4-50)	8.0 (1-47)	0.0048
Complications			
Cardiopulmonary (% of patients)	15.5%	11.1%	0.3094
Gastrointestinal (% of patients)	6.2%	12.8%	0.0917
Infection (% of patients)	8.3%	6.8%	0.6606
Neurological (% of patients)	18.6%	17.4%	0.8141
Wound (% of patients)	1.0%	0.0%	0.1919

LIV=Lower Instrumented Vertebra; SICU= Surgical Intensive Care Unit

Preoperative and postoperative patient reported outcomes

Preoperatively, OPIOID reported worse NRS back pain (7.7 vs 6.7), worse NRS leg pain (5.2 vs 3.9), worse ODI (50.8 vs 36.9), worse PCS (28.8 vs 35.6), worse SRS-22r sub-score (2.5 vs 3.0), and worse values for the SRS-22r activity and self-image domains than NON, respectively (p<0.05; Figs. 1-5). OPIOID and NON demonstrated improvements in outcome measures at 2-years postoperative however, OPIOID demonstrated greater residual NRS back pain (4.1 vs 2.3) and leg pain (2.9 vs 1.7), worse ODI (32.4 vs 19.4), worse PCS (37.4 vs 47.0) and MCS (50.9 vs 43.4), worse SRS-22r sub-score (3.5 vs 4.0), worse values for all SRS-22r domains including activity, self-image, pain and mental health, and worse satisfaction with treatment scores (4.0 vs 4.5) compared to NON, respectively (p<0.05; Figs. 1-5).

Surgery, hospital stay and postoperative complications

Following matching, OPIOID and NON had similar total spine levels fused at the time of surgery, similar LIV, similar LIV and similar percentage of patients fused to the pelvis, and similar percentage of patients admitted to the ICU postoperatively (p>0.05; Table 2). OPIOID spent more hours in the SICU (41.2 vs 21.4 hours) and had longer duration of hos-

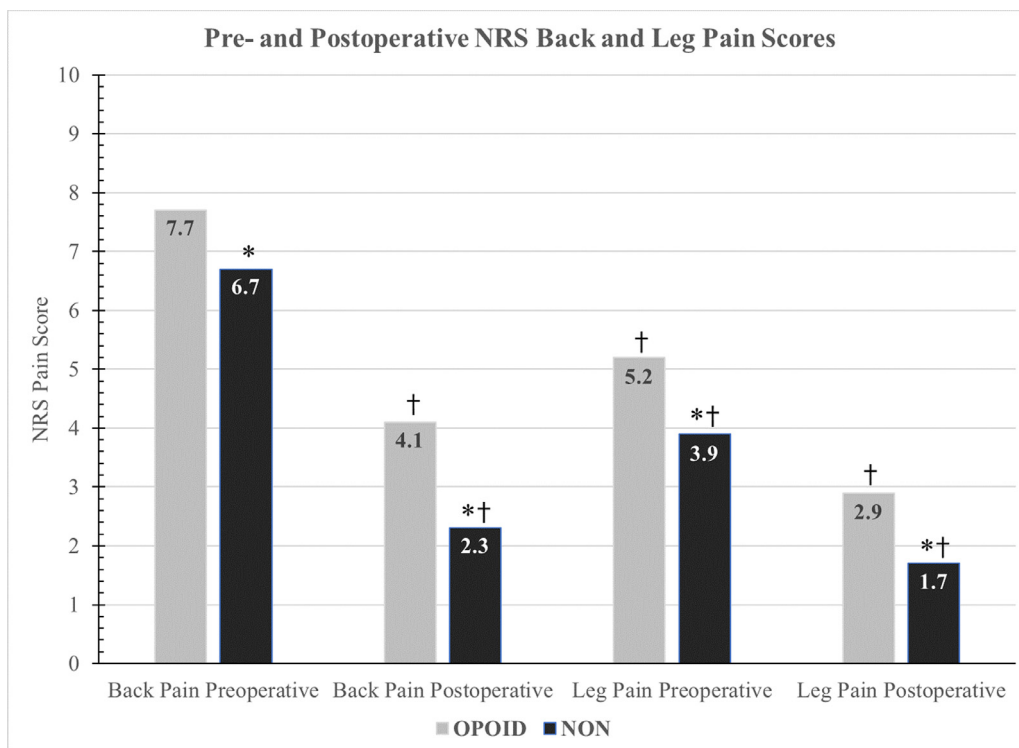


Fig. 1. Preoperative and Postoperative NRS Back and Leg Pain for OPIOID and NON. NRS=numeric rating scale; *=OPIOID significantly different than NON ($p<0.05$); †=postoperative values significantly improved from preoperative values ($p<0.05$).

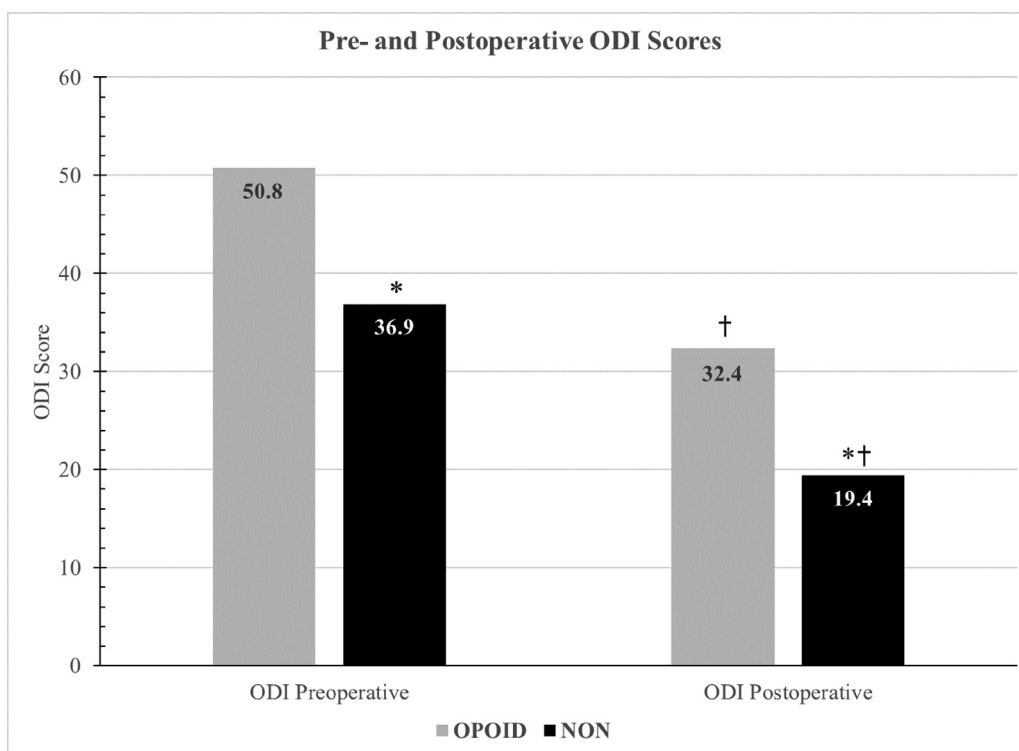


Fig. 2. Preoperative and Postoperative ODI for OPIOID and NON. ODI=Oswestry disability index[38, 39]; *=OPIOID significantly different than NON ($p<0.05$); †=postoperative values significantly improved from preoperative values ($p<0.05$).

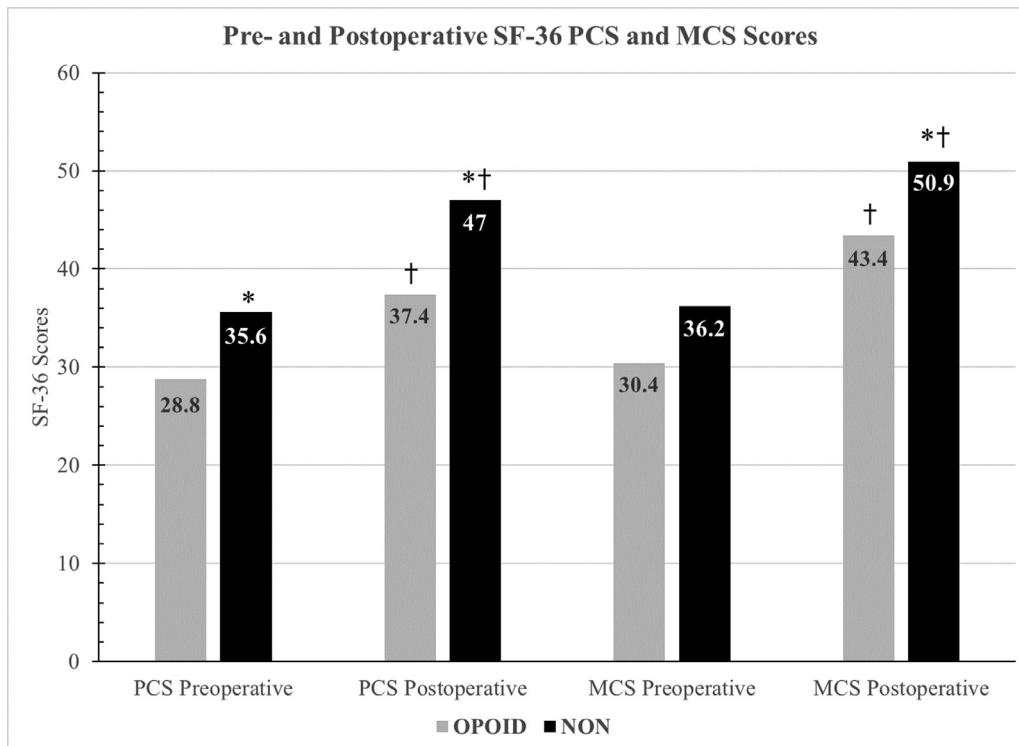


Fig. 3. Preoperative and Postoperative SF-36v2 PCS and MCS for OPIOID and NON. SF-36=Short form-36 version 2[40, 41]; PCS=physical component summary; MCS=mental component summary; *=OPIOID significantly different than NON (p<0.05); †=postoperative values significantly improved from preoperative values (p<0.05).

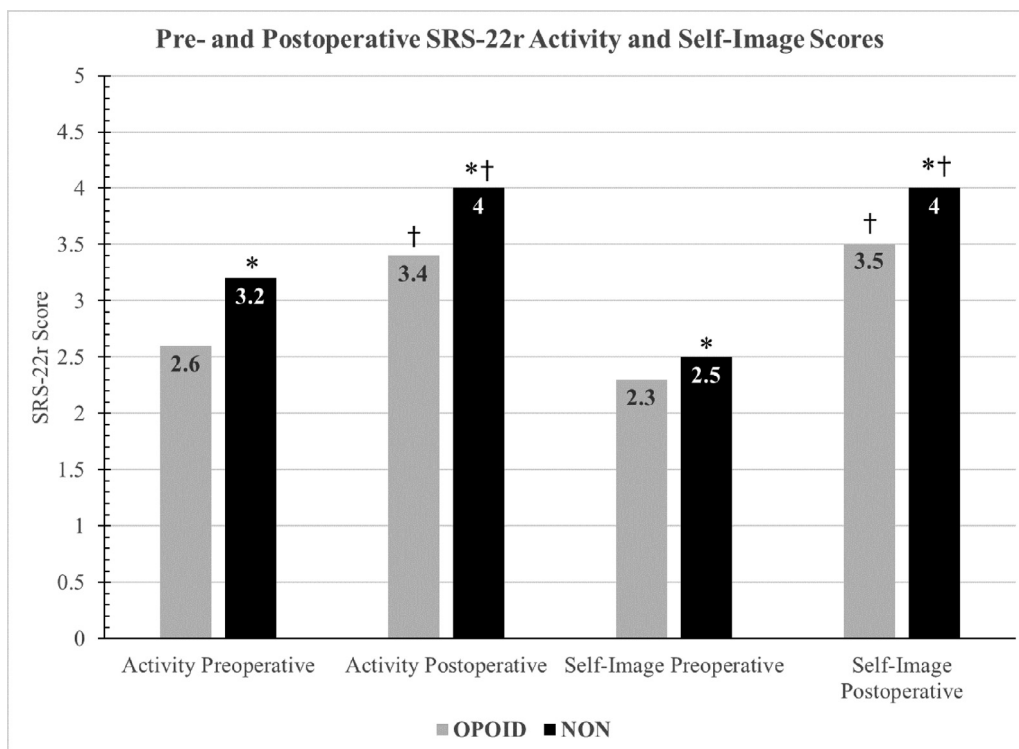


Fig. 4. Preoperative and Postoperative SRS-22r Activity and Self-Image for OPIOID and NON. SRS-22r=Scoliosis Research Society 22 item questionnaire, revised; *=OPIOID significantly different than NON (p<0.05); †=postoperative values significantly improved from preoperative values (p<0.05).

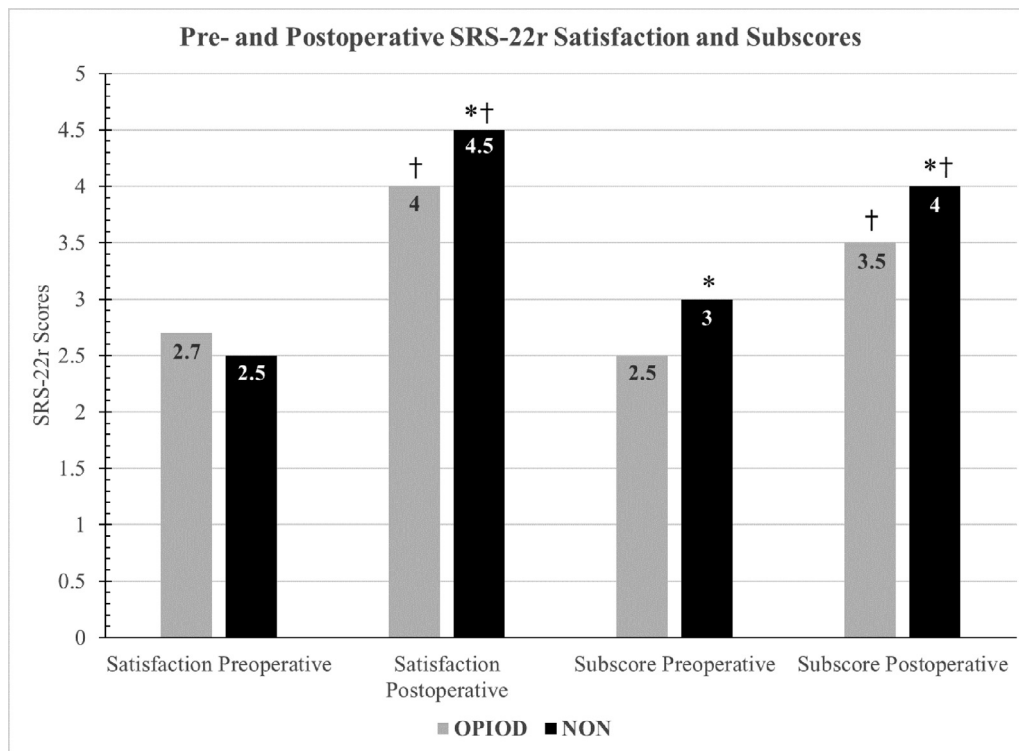


Fig. 5. Preoperative and Postoperative SRS-22r Satisfaction and Total Scores. SRS-22r=Scoliosis Research Society 22 item questionnaire, revised; *=OPIOID significantly different than NON (p<0.05); †=postoperative values significantly improved from preoperative values (p<0.05).

Table 3

Propensity score matched analysis of costs and cost effectiveness of index surgery OPIOID vs. NON.

	OPIOID	NON	P Value
N=181	N=67	N=114	
Preop SF-6d	0.523 (0.316-0.887)	0.598 (0.319-0.965)	<0.0001
One Year Postop SF-6d	0.617 (0.38-0.852)	0.749 (0.461-1)	<0.0001
Last Postop Follow-Up SF-6d	0.638 (0.45-0.887)	0.747 (0.747-1)	<0.0001
One Year Postop QALY	0.570 (0.348-0.801)	0.674 (0.464-0.9615)	<0.0001
Last Postop Follow-Up QALY	1.518 (0.548-3.527)	1.711 (0.477-4.285)	0.1023
Cost	\$83,948.87 (\$41,657.90-\$170,548.63)	\$70,281.17 (\$36,798.31-\$165,984.71)	0.0005
One year Postop Cost/QALY	\$150,770.26 (\$73,237.53-\$299,450.63)	\$107,947.19 (\$49,506.51-\$327,386.01)	<0.0001
Last Postop Follow-Up Cost/QALY	\$44,558.31 (\$12,712.70-\$101,243.55)	\$34,304.36 (\$8,968.78-\$150,779.90)	0.0022

QALY=Quality Adjusted Life Year

pital stay (10.6 vs 8.0 days) than NON, respectively (p<0.05; Table 2). Postoperative complications including cardiopulmonary, gastrointestinal, systemic infections (including pneumonia and urinary tract infections), neurological complications and wound complications (including superficial and deep infections) were similar for OPIOID and NON (p<0.05; Table 2).

Hospital reimbursements and cost/QALY analysis

DRG data was available on 181 patients (OPIOID=67 and NON=114). Average CMS reimbursements for the costs of care for the index surgical procedure were greater for OPIOID vs NON (\$83,948.87 vs \$70,281.17, respectively; p<0.05; Table 3). Preoperative SF-6d scores were worse for OPIOID vs NON (0.523 vs. 0.598, respectively; p<0.05; Table 3). OPIOID and NON demonstrated improvement in SF-6d scores at one-year postoperative (0.617 vs 0.749) and at last follow-up (0.638 vs 0.747, respectively), however SF-6d values remained worse for OPIOID vs NON, at both follow-up time points (p<0.05; Table 3). Cost/QALY was greater for OPIOID at one-year postoperative (\$150,770.26 vs \$107,947.19) and at last postoperative follow-up (\$44,558.31 vs \$34,304.36) than NON, respectively (p<0.05, Table 3).

Postoperative opioid use

At mean follow-up 3.3 years, 41.2% of OPIOID patients reported postoperative opioid use compared to 12.9% of NON (p<0.05; Table 4). Odds ratio for continued opioid use for OPIOID vs. NON at one-year follow-up was 4.6 (95% CI=2.6-8.1) and at last follow-up was 4.7 (95% CI=2.6-8.7; p<0.05; Table 4).

Discussion

The results from this study support the growing evidence that preoperative opioid use is associated with worse surgical outcomes compared to nonusers [6,10,18,20,32-35]. Using a propensity score matched analysis of SASD patients enrolled into a prospective, multi-center study, we found that SASD patients using opioids preoperatively 1) reported worse preoperative quality of life including greater pain, worse physical function and mental health, and worse self-image, despite having similar medical comorbidities, and similar magnitudes of spine deformities as preoperative nonusers; 2) demonstrated longer ICU stay and longer hospital stay, despite having similar surgery performed as preoperative opioid nonusers; 3) had worse quality of life following surgery includ-

Table 4
Propensity score matched analysis of postoperative opioid use OPIOID vs NON.

	OPIOID	NON	P-Value
N=261	N=97	N=164	
Opioid Use at One Year Postoperative	50.5%	18.0%	<0.0001
Odds Ratio for Opioid Use at One Year Postoperative; OPIOID vs NON	Odds Ratio 4.6 (95% CI 2.6-8.1)		<0.0001
Opioid Use at Last Postop Follow-Up	41.2%	12.9%	<0.0001
Odds Ratio for Opioid Use at Last Postop Follow-Up; OPIOID vs NON	Odds Ratio 4.7 (95% CI 2.6-8.7)		<0.0001

ing greater residual pain, worse function, worse self-image, and were less satisfied with surgical treatment, despite having similar surgeries and similar complication rates as preoperative opioid nonusers; 4) had greater hospital costs and worse postoperative cost/QALY; and 5) had greater postoperative opioid use and had 4.7 times greater risk of continued opioid use at mean 3.3 years postoperative follow-up compared to nonusers.

Little data exists regarding the impact of preoperative opioid use on outcomes for SASD. Raad et al reported that ASD patients using daily opioids preoperatively had longer ICU and hospital stay, and had worse postoperative ODI scores than ASD patients that used opioids on a non-daily basis [20]. The results from Raad et al provides good initial insight to the impact of preoperative opioid use on ASD surgical outcomes, however, the study did not include a matched analysis, and the daily opioid users in the study by Raad et al were older, had more medical comorbidities, had worse preoperative sagittal malalignment, had greater incidence of 3 column osteotomy procedures, and longer surgical times than the non-daily users. The findings from the current study supplement the findings by Raad et al, demonstrating the negative associations between preoperative opioid use and SASD surgery, as we found that despite controlling for multiple confounding variables (including medical comorbidities, age, severity of spinal deformity malalignment, and surgical invasiveness), patients that used opioids preoperatively continued to report worse pre and postoperative health related quality of life, and had continued to have longer ICU and hospital stay [3,14]. Reasons for the preoperative opioid users reporting greater preoperative and postoperative pain, poor quality of life, and prolonged hospital stay are likely secondary to opioid induced hyperalgesia, as has been previously described for opioid users [2,5,36].

Patients often desire surgical treatment to reduce pain and eliminate the need for opioid use. However, Pitter et al reported that one year postoperative opioid consumption levels remained similar to preoperative opioid consumption levels for surgically treated ASD patients that reported preoperative opioid use [22]. Our study found that, while there was a postoperative reduction in opioid use following SASD surgery, >50% of preoperative opioid users reported opioid use at one-year postoperative and >40% reported opioid use at mean 3.3 years postoperative, compared to 18% and 13% of nonusers during similar time frames, respectively. These findings emphasize the need to identify patients that are opting for surgical care to in order to eliminate the need for opioid therapy, and counsel these patients that preoperative opioid use is a strong risk factor for continued postoperative use [18,20,21,37].

The findings in this study of the negative economic impact associated with preoperative opioid use are critically important, as health care providers are increasingly required to justify the costs of the care provided. Waljee et al reported that preoperative opioid use correlated with increased healthcare utilization costs following abdominal surgery, including longer hospital stay, greater likelihood of discharge to a rehabilitation facility, and greater 90-, 180-, and 365-day expenditures following surgery compared to preoperative nonusers [11]. Sharma et al utilized the national MarketScan database to evaluate pre- and postoperative opioid use patterns in surgically treated patients with adult degenerative scoliosis [21]. The authors reported that patients using opioids prior to surgery were 1) likely to remain on opioids after surgery and 2) patients that remained dependent on opioids after surgery incurred significantly higher healthcare utilization costs at 3 months and

at 3 to 15 months after surgery than patients not using opioids. Jain et al performed retrospective review of the Humana commercial insurance database to evaluate postoperative complication rates and associated payer reimbursements for complications following cervical surgery [17]. The authors found that patients reporting preoperative opioid use were more likely to receive epidural or facet joint injections within 1 year postoperative and were more likely to undergo a repeat cervical fusion than patients who did not have preoperative opioid use. We found that SASD patients using opioids preoperatively had increased costs for the episode of surgical care and had greater cost/QALY than nonusers, despite having similar demographics and receiving similar surgical procedures as preoperative nonusers. The OPIOID group had longer ICU and hospital durations of stay, which likely accounted for much of the increased cost of care for the OPIOID group. Additionally, the OPIOID group also demonstrated greater residual postoperative health deficits than the NON group. Consequently, QALYs were worse at one-year and last postoperative follow-up for OPIOID, leading to worse postoperative cost/QALY values for OPIOID vs. NON.

There are several limitations to this study, including no randomization of patients receiving opioids, no control of the type, amount, or duration of preoperative opioids used in this study, and morphine milligram equivalents (MMEs) were not calculated for patients in this study. We used an established methodology to assess patient opioid consumption, however, greater granularity on daily MME use and duration of opioid use among SASD patients is needed and is currently underway via a prospective study by our study group. Additionally, because we did not calculate pre and postoperative MME usage, we dichotomized patients into opioid users and nonusers, and this methodology could under recognize the benefits of surgery if a preoperative opioid user has a significant reduction in MME after surgery. Approximately 59% of the OPIOID cohort reported they no longer used opioids at minimum two-years postoperative. It is possible that there was additional postoperative benefit among the OPIOID cohort patients via reduction in MME consumption, despite reporting continued postoperative opioid use. Further limitations for this study includes use of a prospective, observational design, therefore there are inherent confounding factors between the OPIOID and NON patients evaluated in this study. We attempted to control for confounding variables that may explain differences between the OPIOID and NON cohorts, by using a propensity score matching methodology to control for confounding variables including demographic, medical history, mental illness and depression, as well as radiographic and surgical variables. Additionally, to avoid the confounding impact of a history of prior spine surgery on patient outcomes and opioid use, we only evaluated SASD patients with no history of prior spine fusion surgery. However, despite these efforts there are likely confounding variables that were not controlled for in this study.

In conclusion, this propensity score matched analysis of SASD patients demonstrated that SASD patients using opioids prior to SASD surgery had worse preoperative and worse 2-year postoperative pain, physical function, mental health and self-image, had longer ICU and hospital stays, had greater episode of care costs at the time of surgery, had worse satisfaction with surgery, had greater postoperative opioid usage, and had worse postoperative cost/QALY following surgery compared to preoperative nonusers. Preoperative opioid usage in SASD should be identified and attempts made to reduce opioid consumption prior to

SASD surgery through enhanced recovery or other opioid reduction programs.

Summary

Following the use of propensity score matching to control for confounding factors between preoperative opioid users and nonusers we found that preoperative opioid users had worse postoperative outcomes, cost more per improvement in PROMs, and were more likely to use opioids at >2yrs postoperatively.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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