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ORIGINAL RESEARCH

Impact of Fascial Plane Block on Postoperative Length of Stay and Opioid Use Among Colectomy Patients Within an Established Enhanced Recovery After Surgery Program: A Retrospective Cohort Study

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Background: Use of fascial plane blocks is increasing yet their impact on hospital length of stay (LOS) and opioid use within the context of an enhanced recovery after surgery (ERAS) pathway has been inconclusive. We address this gap by examining the impact of fascial plane blocks on postoperative LOS and opioid use for colorectal surgical procedures in a hospital setting with a robust ERAS program.

Methods: This is a retrospective cohort study using electronic health record data from a large, integrated health care delivery system with an established ERAS program in Northern California. Patients include adults who underwent non-emergent laparoscopic (n=5496) or non-laparoscopic (n=708) colectomy surgery from January 1, 2015 to May 20, 2021. The main exposure was type of anesthesia: general with long-acting fascial plane block, general with short-acting fascial plane block, or general only. Outcomes included postoperative LOS and average daily morphine milligram equivalents (MME) up to three days post-surgery.

Results: Most patients were older than age 50 (86% laparoscopic; 83% non-laparoscopic), female (52% laparoscopic; 58% non-laparoscopic), and non-Hispanic White (64% laparoscopic; 62% non-laparoscopic). In LOS adjusted models for laparoscopic and non-laparoscopic surgery, there was no significant difference for LOS with general with long-acting fascial plane block or with general with short-acting fascial plane block, compared to general only. In MME adjusted models for laparoscopic surgery, general with short-acting fascial plane block was associated with higher MME compared with general only (RE: 1.14,[95% CI: 1.03–1.25], p-value=0.01). However, in non-laparoscopic surgery, general with long-acting fascial plane block was associated with lower MME (RE: 0.63, [95% CI: 0.42–0.93], p-value=0.02), compared with general only.

Conclusion: Fascial plane blocks did not impact postoperative LOS in either surgical group but long acting resulted in lower overall postoperative opioid use for non-laparoscopic surgery.

Keywords: regional anesthesia, length of stay, opioid analgesic, enhanced recovery after surgery, fascial plane block, ERAS

Background

Enhanced recovery after surgery (ERAS) pathways are evidence-based protocols that aim to decrease perioperative stress, maintain physiologic function, and accelerate recovery after surgery.[1] ERAS pathways have been associated with a reduction in hospital length of stay (LOS), decreased morbidity, faster recovery, and cost savings when compared to traditional care.[2] In addition to preoperative patient education and optimization, nutrition management, and early mobilization, core components of ERAS pathways include standardized analgesic and anesthesia protocols.[3]

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Current perioperative ERAS protocols bundle nonopioid pain medications such as nonsteroidal anti-inflammatory drugs and gabapentinoids with evidence-based practices, including early postoperative ambulation and regional anesthesia.[3] Regional anesthesia, including fascial plane blocks such as transversus abdominis plane and quadratus lumborum, have been incorporated within recovery pathways based on evidence of decreased LOS[4–6] and opioid consumption.[6,7]

Pain and subsequent opioid use can complicate recovery,[7] and these evolving regional anesthesia techniques aim to provide safe, easy, cost-effective, and long-acting opioid-sparing effects on surgical patients. Even as interest in fascial plane blocks may be increasing, the distinct effect of fascial plane blocks on LOS and opioid use in the context of an ERAS pathway utilizing multimodal analgesia has only recently been evaluated, with equivocal results.[8] To address this evidence gap, our objective was to examine the impact of long-acting and short-acting fascial plane blocks on post-operative LOS and postoperative opioid use for colectomy procedures in a large, integrated healthcare system within an established, multifaceted ERAS program.

Materials and Methods

Setting

Kaiser Permanente Northern California (KPNC), a community-based, integrated healthcare delivery system, provides comprehensive care to more than 4.5 million members at 21 medical centers. KPNC has a socio-economically diverse membership similar to the local and state-wide insured population, except for lower proportions of those with very low or very high incomes[9] and has members insured through employer-based plans, Medicare, Medicaid and health insurance exchanges. In 2014, a comprehensive ERAS pathway was implemented throughout KPNC for colorectal surgery and has been described previously.[3,10] A major component of the pathway is multimodal analgesia and regional anesthesia. We used colectomy surgery as a model for studying regional anesthesia because it is a common and painful operation requiring multi-day hospitalization. This study was approved by the KPNC Institutional Review Board (IRB 1797487), which granted a waiver of informed consent, and data were maintained with confidentiality. This article was prepared according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[11]

Study Design and Population

This retrospective, cohort study included adult KPNC patients, aged ≥18 years, who underwent non-emergent colectomy using laparoscopic (including robotic) and non-laparoscopic (open) techniques from January 1st, 2015 to May 20th, 2021. Exclusion criteria were all emergent surgeries (within 24–48 hours), due to these patients' unique medical conditions and complications (eg sepsis), or surgery during an existing hospital stay, and less than one year of enrollment prior to the surgery date. Patients with a LOS of zero (eg same day surgery) or greater than two weeks were also excluded, the latter so as to not introduce cases who had developed complications (this constituted less than 5% of the data). We created two cohorts for analysis: laparoscopic and non-laparoscopic colon surgery. Cohort sample sizes were determined by patients meeting study criteria.

Data Source, Exposure, and Outcome Measures

The data source for all study measures was the KPNC electronic health record (Epic, Verona, WI, USA), which includes all inpatient and outpatient encounters, clinical diagnoses, procedures, medications, as well as all patient information such as demographics and health plan membership.

The main exposure was type of anesthesia: general anesthesia with a long-acting fascial plane block, general with a short-acting fascial plane block or general only. Fascial plane blocks included unilateral or bilateral transversus abdominis plane, quadratus lumborum, erector spinae, or rectus sheath; the majority were given by a single bolus injection. We used the procedure tables, surgical notes, and anesthesia notes with text string searches (Supplementary Table 1) to identify the type of regional anesthesia, verified by random sampling of 40 medical charts identifying the exposures of interest. Long-acting blocks were defined as blocks that utilized liposomal bupivacaine, with expected analgesic effects up to 72 hours; short-acting blocks were defined as blocks that did not use liposomal bupivacaine and

included plain bupivacaine and ropivacaine (lasting <24hrs).[12,13] The use of local anesthetic delivery systems such as elastomeric pumps was scarce and therefore not included in the study. Typical volumes for fascial plane blocks were 20–30 mL per site and per side.

Primary outcomes were two continuous measures: LOS and average post-surgical daily morphine milligram equivalents (MME). LOS was defined as the total time from when the patient exits the operating room to the time of discharge. MME represent oral morphine equivalents, calculated as an average rate of morphine equivalents overall for day zero to day three, post-surgery. The study focused on first three days post-surgery since this is the acute phase of recovery when pain levels are typically highest, and patients require more intensive pain management.

Potential confounders were included as covariates: age in five categories, sex, race/ethnicity (Asian, Black Hispanic, White, Other/Unknown), neighborhood deprivation index (NDI) as a geocoded measure of socio-economic status with higher values indicating greater deprivation, body mass index (BMI) measured within the year prior to and up to the day of surgery in four categories, and smoking status (never, current/ever) from self-reported information recorded up to two years before surgery. We also included a mean delta pain score, which is an internal measure calculated by subtracting postsurgical pain scores (ten-point scale) from the patient's acceptable pain score recorded before surgery. Several pain scores are recorded post-surgery from day zero to day three, thus scores are averaged. A positive score suggests inadequate pain control, while a negative score suggests adequate pain control.[10,14] Because comorbidity can impact surgical experience and analgesic approach, the Charlson comorbidity index using diagnoses from the year prior to surgery was included in four categories (0, 1–2, 3–4, ≥5). History of outpatient opioid use within prior year (eg, number of opioid fills, categorized as none [0], rare [1–3], occasional [4–10], frequent [≥11]) was also included. Operative characteristics included American Society of Anesthesiologists (ASA) score (1, 2, 3, 4–5 with higher scores indicating greater severity), and number of procedures on the same date (1–3, 4–6, ≥7), as proxy measures of patient and surgical complexity, respectively. Surgery year was also included.

Statistical Analysis

We examined the impact of general anesthesia with long-acting fascial plane blocks, general with short-acting fascial plane blocks, or general alone anesthesia (the referent) on postoperative LOS and on postoperative average daily MME separately in each cohort. Model distributions were selected based on the smallest AIC and achieving model convergence. For the continuous outcome of LOS, we performed generalized linear mixed models with a gamma distribution and log link, adjusting for patient-level, operative characteristics, and year covariates listed above, also clustering for surgeon and medical facility using a random nested effect. For the similar method of analysis of average MME from days zero to three, we used the lognormal distribution, which is interpreted similarly to the gamma distribution, in order to achieve model convergence. We computed the adjusted relative risk and 95% confidence interval (95% CI) for the effect on the overall mean LOS and MME. Models were adjusted for all covariates, and a p-value of <0.05 was considered statistically significant.

Sensitivity Analysis

To capture how MME can vary by day, we conducted a sensitivity analysis in the laparoscopic cohort where we modeled MME from day zero to day three as a continuous repeated measure using a repeated measures Generalized Estimating Equations approach to account for the correlations among MME measurements for the same patient on different days, with an interaction term for anesthesia type by day. Only patients with available data for all included covariates were included in multivariate models. For the sensitivity analyses, we used the Bonferroni method for 6 hypothesis tests, with a resulting p-value of $p<0.008$ considered statistically significant. All analyses were performed using SAS 9.4 (Cary, North Carolina).

Results

Table 1 shows the total number of adult patients who met study criteria from January 1st, 2015 to May 20th 2021 was 6204: laparoscopic = 5496 (2618 male; 2878 female), and non-laparoscopic = 708 (300 male; 408 female). The proportion of surgeries by yearly volume that used short-acting fascial plane blocks grew from 4% to 18% and long-

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Table 1 Characteristics of Laparoscopic and Non-Laparoscopic Patients

		Laparoscopic				Non-Laparoscopic			
		Full Cohort	**General + Long-Acting Block**	**General Only**	**General + Short-Acting Block**	**Full Cohort**	**General + Long-Acting Block**	**General Only**	**General + Short-Acting Block**
		N=5496	**N =781(14%)**	**N =3824(70%)**	**N =891(16%)**	**N =708**	**N =110(16%)**	**N =477(67%)**	**N =121(17%)**
Race/Ethnicity	Asian	564 (10.3%)	45 (5.8%)	417 (10.9%)	102 (11.4%)	83 (11.7%)	5 (4.5%)	69 (14.5%)	9 (7.4%)
	Black	423 (7.7%)	45 (5.8%)	342 (8.9%)	36 (4.0%)	60 (8.5%)	4 (3.6%)	50 (10.5%)	6 (5.0%)
	Hispanic	642 (11.7%)	65 (8.3%)	444 (11.6%)	133 (14.9%)	70 (9.9%)	10 (9.1%)	41 (8.6%)	19 (15.7%)
	Other/Unknown	364 (6.6%)	53 (6.8%)	264 (6.9%)	47 (5.3%)	55 (7.8%)	13 (11.8%)	34 (7.1%)	8 (6.6%)
	White	3503 (63.7%)	573 (73.4%)	2357 (61.6%)	573 (64.3%)	440 (62.1%)	78 (70.9%)	283 (59.3%)	79 (65.3%)
Gender	Female	2878 (52.4%)	413 (52.9%)	2014 (52.7%)	451 (50.6%)	408 (57.6%)	66 (60.0%)	265 (55.6%)	77 (63.6%)
	Male	2618 (47.6%)	368 (47.1%)	1810 (47.3%)	440 (49.4%)	300 (42.4%)	44 (40.0%)	212 (44.4%)	44 (36.4%)
Age, years	18–39	278 (5.1%)	32 (4.1%)	192 (5.0%)	54 (6.1%)	48 (6.8%)	5 (4.5%)	32 (6.7%)	11 (9.1%)
	40–49	511 (9.3%)	65 (8.3%)	346 (9.0%)	100 (11.2%)	81 (11.4%)	13 (11.8%)	54 (11.3%)	14 (11.6%)
	50–59	1328 (24.2%)	187 (23.9%)	918 (24.0%)	223 (25.0%)	152 (21.5%)	24 (21.8%)	98 (20.5%)	30 (24.8%)
	60–69	1526 (27.8%)	234 (30.0%)	1062 (27.8%)	230 (25.8%)	211 (29.8%)	30 (27.3%)	145 (30.4%)	36 (29.8%)
	70+	1853 (33.7%)	263 (33.7%)	1306 (34.2%)	284 (31.9%)	216 (30.5%)	38 (34.5%)	148 (31.0%)	30 (24.8%)
Smoking status	Never	2939 (53.5%)	407 (52.1%)	2039 (53.3%)	493 (55.3%)	381 (53.8%)	62 (56.4%)	256 (53.7%)	63 (52.1%)
	Current/Ever	2557 (46.5%)	374 (47.9%)	1785 (46.7%)	398 (44.7%)	327 (46.2%)	48 (43.6%)	221 (46.3%)	58 (47.9%)
Delta pain score	Mean (STD)	−0.5 (1.6)	−0.3 (1.7)	−0.5 (1.6)	−0.4 (1.6)	−0.1 (1.6)	−0.0 (1.6)	−0.1 (1.6)	−0.0 (1.6)
	Median (IQR)	−0.4 (−1.5, 0.7)	−0.3 (−1.5, 0.9)	−0.4 (−1.6, 0.6)	−0.3 (−1.4, 0.7)	−0.0 (−1.1, 1.0)	0.1 (−1.1, 1.0)	−0.0 (−1.2, 1.0)	0.0 (−0.9, 1.0)
Block type	TAP	1323	526 (67.3%)	NA	797 (89.5%)	191	87 (79.1%)	NA	104 (86.0%)
	Truncal	708	383 (49.0%)	NA	325 (36.5%)	135	72 (65.5%)	NA	63 (52.1%)
	Rectus Sheath	632	242 (31.0%)	NA	390 (43.8%)	97	45 (40.9%)	NA	52 (43.0%)
	Erector Spinae	10	8 (1.0%)	NA	2 (0.2%)	8	7 (6.4%)	NA	1 (0.8%)
	Quadratus Lumborum	38	20 (2.6%)	NA	18 (2.0%)	6	2 (1.8%)	NA	4 (3.3%)
	Lumbar plexus	6	0	NA	6 (0.7%)	0	0	NA	0

acting fascial plane blocks from 0% to 28% for all colon surgeries over the study period (Supplementary Figure 1). Among laparoscopic and non-laparoscopic surgeries, respectively, the type of anesthesia was 14% and 16% for general with long-acting, 16% and 17% for general with short-acting, and 70% and 67% for general only.

Patient Characteristics

Most patients were older than age 50, female, and non-Hispanic White (Table 1). For the laparoscopic and non-laparoscopic cohorts, respectively, approximately 28% and 33% had a normal BMI (≤24.9), 37% and 36% had Charlson comorbidity index of 1 to 2, 47% and 46% had ever smoked, 64% and 56% had no opioid usage in the prior year, 51% and 46% had an ASA physical status classification of 2, and 93% and 70% had 1–3 procedures per surgery.

Length of Stay

The unadjusted average and median LOS were 87 (STD=43) and 73 (IQR: 50, 99) hours, respectively for laparoscopic surgery; the unadjusted average and median were 116 (STD=64) and 97 (IQR: 71, 145) hours, respectively, for non-laparoscopic surgery. Table 2 shows adjusted models with no significant difference in LOS between type of anesthesia for either cohort.

Table 2 Adjusted Relative Effects for Mean LOS Among Patients Undergoing Colon Surgery

		Model 1: Laparoscopic (n=5496)		Model 2: Non-Laparoscopic (n=708)	
		Relative Effect (95% CI)	**P value**	**Relative Effect (95% CI)**	**P value**
Anesthesia	General only	Reference		Reference	
	General + short-acting fascial plane block	1.02,(0.98,1.08)	0.32	1.03,(0.92,1.16)	0.59
	General + long-acting fascial plane block	1.05,(0.98,1.11)	0.15	1.09,(0.96,1.25)	0.18
Race/Ethnicity	White	Reference			
	Asian	1.02,(0.97,1.07)	0.38	0.86,(0.76,0.98)	0.02
	Black	1.04,(0.99,1.1)	0.12	0.91,(0.79,1.05)	0.21
	Hispanic	1.02,(0.97,1.06)	0.47	0.94,(0.82,1.08)	0.38
	Other/Unknown	1.01,(0.96,1.07)	0.6	0.99,(0.85,1.14)	0.85
Gender	Female	Reference			
	Male	1.05,(1.02,1.08)	0.001	1.04,(0.96,1.13)	0.34
Age, years	18–39	Reference			
	40–49	0.91,(0.85,0.98)	0.01	1.13,(0.94,1.36)	0.18
	50–59	0.89,(0.84,0.96)	<0.01	0.97,(0.82,1.15)	0.73
	60–69	0.95,(0.89,1.02)	0.14	1.03,(0.87,1.22)	0.73
	70+	1.1,(1.02,1.18)	0.01	1.16,(0.97,1.39)	0.10
Body mass index, kg/m^2	<= 24.9	Reference			
	25–29.9	0.95,(0.91,0.98)	<0.01	1.03,(0.94,1.13)	0.57
	30 −34.9	0.97,(0.93,1.01)	0.12	0.96,(0.86,1.07)	0.47
	35 −44.9	0.97,(0.93,1.02)	0.25	1.09,(0.96,1.23)	0.21
	≥ 45	0.94,(0.84,1.04)	0.22	1.17,(0.89,1.54)	0.26
Smoking status	Never	Reference			
	Ever	1.01,(0.98,1.04)	0.47	1.04,(0.96,1.12)	0.38
Charlson score	0				
	1–2	1.03,(0.99,1.07)	0.12	1.01,(0.91,1.13)	0.82
	3–4	1.05,(1.01,1.1)	0.03	1.1,(0.96,1.26)	0.15

(*Continued*)

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Table 2 (Continued).

		Model 1: Laparoscopic (n=5496)		Model 2: Non-Laparoscopic (n=708)	
		Relative Effect (95% CI)	**P value**	**Relative Effect (95% CI)**	**P value**
	5+	1.11,(1.05,1.16)	<0.0001	1.09,(0.96,1.25)	0.17
Neighborhood deprivation index	< - 0.85	Reference			
	≥ −0.85 - < 0.40	1.01,(0.97,1.05)	0.59	1.04,(0.93,1.16)	0.53
	≥ 0.40 - < 0.21	1.05,(1.01,1.09)	0.02	1.01,(0.9,1.12)	0.9
	≥ 0.21	1.05,(1.01,1.1)	0.03	1.07,(0.96,1.2)	0.24
Opioid history	None	Reference			
	Rare	1.03,(1.0,1.07)	0.04	1.05,(0.97,1.15)	0.22
	Occasional	1.02,(0.96,1.08)	0.57	1.16,(1.0,1.35)	0.05
	Frequent	1.03,(0.95,1.12)	0.43	1.14,(0.94,1.39)	0.18
Delta pain score		1.06,(1.05,1.07)	<0.0001		
Number of procedures	1–3	Reference			
	4–6	1.26,(1.19,1.33)	<0.0001	1.17,(1.06,1.29)	0.001
	7+	1.52,(1.22,1.89)	<0.001	1.53,(1.32,1.78)	<0.0001
ASA rating	1	Reference			
	2	1.07,(0.98,1.18)	0.14	0.85,(0.64,1.14)	0.28
	3	1.14,(1.04,1.26)	<0.01	0.95,(0.71,1.29)	0.76
	4–5	1.39,(1.22,1.58)	<0.0001	1.06,(0.71,1.57)	0.78
Surgery Year	2015	Reference			
	2016	1.01,(0.96,1.06)	0.72	1.05,(0.91,1.21)	0.5
	2017	0.97,(0.92,1.02)	0.21	1.01,(0.87,1.16)	0.94
	2018	0.92,(0.88,0.97)	<0.01	0.93,(0.81,1.07)	0.32
	2019	0.89,(0.84,0.94)	<0.0001	0.82,(0.71,0.96)	0.01
	2020	0.83,(0.78,0.87)	<0.0001	0.82,(0.7,0.95)	0.01
	2021	0.88,(0.82,0.94)	<0.001	0.74,(0.62,0.87)	0.001

Morphine Milligram Equivalents

The unadjusted average and median daily MME post-surgery was 17mg (STD=55mg) and 5.5 (IQR: 1.5, 13.8), respectively, for laparoscopic surgery; the unadjusted average and median daily MME post-surgery was 43mg (STD=92mg) and 10.2 (IQR: 3.4, 27.3), respectively, for non-laparoscopic surgery. In the laparoscopic MME model, general only with short acting fascial plane block was associated with higher MME vs general only (RE: 1.14, [95% CI: 1.03–1.25], p-value<0.01). For non-laparoscopic MME models, general with long-acting fascial block was associated with lower MME (RE: 0.63, [95% CI:0.42–0.93], p-value=0.02), compared with general only (Table 3).

Table 3 Adjusted Relative Effects for Post-Operative Average Daily Morphine Milligram Equivalents for Colon Surgery

		Laparoscopic (n=5496)		Non Laparoscopic (n=708)	
		Relative Effect (95% CI)	**P value**	**Relative Effect (95% CI)**	**P value**
Anesthesia	General only	Reference		Reference	
	General + short acting fascial plane block	1.14,(1.03,1.25)	0.01	1.04,(0.77,1.39)	0.81
	General + long acting fascial	1.06,(0.94,1.2)	0.37	0.63,(0.42,0.93)	0.02
Race/Ethnicity	White	Reference		Reference	

(*Continued*)

Table 3 (Continued).

		Laparoscopic (n=5496)		Non Laparoscopic (n=708)	
		Relative Effect (95% CI)	**P value**	**Relative Effect (95% CI)**	**P value**
	Asian	0.72,(0.66,0.79)	<0.0001	0.51,(0.38,0.7)	<0.0001
	Black	0.92,(0.83,1.02)	0.11	0.85,(0.59,1.21)	0.36
	Hispanic	0.96,(0.88,1.05)	0.38	0.89,(0.64,1.24)	0.5
	Other/Unknown	0.92,(0.83,1.03)	0.14	1.13,(0.79,1.62)	0.49
Gender	Female	Reference		Reference	
	Male	1.1,(1.05,1.17)	<0.001	1.24,(1.02,1.52)	0.03
Age, years	18–39	Reference		Reference	
	40–49	0.77,(0.66,0.89)	<0.001	0.88,(0.56,1.38)	0.58
	50–59	0.67,(0.59,0.76)	<0.0001	0.78,(0.51,1.18)	0.23
	60–69	0.57,(0.5,0.66)	<0.0001	0.54,(0.36,0.83)	<0.01
	70+	0.43,(0.37,0.49)	<0.0001	0.36,(0.23,0.57)	<0.0001
Body mass index, kg/m^2	<= 24.9	Reference		Reference	
	25–29.9	1.07,(1,1.15)	0.05	1.13,(0.9,1.42)	0.3
	30 −34.9	1.1,(1.01,1.19)	0.02	1.42,(1.09,1.86)	0.01
	35 −44.9	1.08,(0.98,1.18)	0.13	1.98,(1.45,2.71)	<0.0001
	≥ 45	0.93,(0.75,1.14)	0.48	1.97,(1.01,3.84)	0.05
Smoking status	Never	Reference		Reference	
	Ever	1.14,(1.08,1.21)	<0.0001	1.09,(0.9,1.32)	0.39
Charlson score	0	Reference			
	1–2	1.05,(0.98,1.13)	0.2	1.23,(0.94,1.62)	0.13
	3–4	0.99,(0.9,1.08)	0.76	1.19,(0.86,1.66)	0.29
	5+	1.04,(0.95,1.15)	0.39	1.09,(0.79,1.51)	0.6
Neighborhood deprivation index	< - 0.85	Reference		Reference	
	≥ −0.85 - < 0.40	1.09,(1.01,1.18)	0.03	1.14,(0.87,1.51)	0.34
	≥ 0.40 - < 0.21	1.03,(0.95,1.11)	0.51	1.22,(0.92,1.6)	0.17
	≥ 0.21	1.02,(0.93,1.11)	0.7	0.97,(0.73,1.28)	0.81
Opioid Use History	None	Reference		Reference	
	Rare	1.22,(1.14,1.29)	<0.0001	1.24,(1,1.53)	0.05
	Occasional	1.53,(1.37,1.72)	<0.0001	1.67,(1.15,2.43)	0.01
	Frequent	2.59,(2.21,3.02)	<0.0001	2.24,(1.38,3.64)	<0.01
Delta pain score		1.48,(1.45,1.51)	<0.0001	1.35,(1.26,1.44)	<0.0001
Number of procedures	1–3	Reference		Reference	
	4–6	1.26,(1.13,1.4)	<0.0001	1.38, (1.06,1.8)	0.02
	7+	1.11,(0.72,1.7)	0.64	2.15, (1.39,3.34)	<0.001
ASA rating	1	Reference			
	2	1.05,(0.87,1.26)	0.63	0.96,(0.46,2.01)	0.91
	3	1.04,(0.86,1.26)	0.68	1.17,(0.55,2.5)	0.68
	4–5	0.96,(0.75,1.24)	0.77	1.62,(0.59,4.44)	0.35
Surgery Year	2015	Reference		Reference	
	2016	0.96,(0.88,1.06)	0.45	0.49,(0.34,0.7)	0.0001
	2017	0.81,(0.74,0.89)	<0.0001	0.4,(0.28,0.57)	<0.0001
	2018	0.52,(0.47,0.58)	<0.0001	0.31,(0.22,0.46)	<0.0001
	2019	0.47,(0.43,0.52)	<0.0001	0.21,(0.14,0.31)	<0.0001
	2020	0.39,(0.35,0.43)	<0.0001	0.21,(0.14,0.32)	<0.0001
	2021	0.35,(0.31,0.41)	<0.0001	0.14,(0.09,0.22)	<0.0001

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Sensitivity Analyses

The sensitivity models in the laparoscopic cohort (n=5496) examining MME by day showed that on Day 1 (RE: −5.33, [95% CI: −8.13,- 2.53], p-value<0.001), and on Day 2 (RE: -6.41, [95% CI: −10.97,-1.85], p-value=0.006) general with long-acting anesthesia was associated with lower MME compared to general only (Supplementary Table 2). General with short acting was associated with lower MME compared to general only on Day 1 (RE: −5.64, [95% CI: −8.29, −2.99], p-value<0.0001), and on Day 2 (RE: −8.08, [95% CI: −12.40, -3.76], p-value<0.001). There were no significant interactions between post-operative Day 3 and anesthesia type. Supplementary Figure 2 illustrates these relationships that are tested in Supplementary Table 2. The intersection between the lines on the graph indicates that MME dosage is changing per day at each exposure, at different magnitude of slopes between Day 1 and Day 2 but in an overall similar direction for each anesthesia exposure.

Discussion

This study found that fascial plane blocks did not impact LOS, however the long-acting blocks were associated with lower postoperative opioid use in non-laparoscopic surgeries while the short-acting blocks were associated with higher overall opioid use in laparoscopic procedures. The lack of associations for LOS is surprising but aligns with other equivocal evidence in the field, as do the lower opioid use findings in non-laparoscopic procedures.[15]

Several small randomized controlled trials (RCTs) on laparoscopic colorectal surgery patients showed no benefit for transversus abdominis plane (TAP) blocks in terms of pain, opioid use, or LOS, which is partially consistent with our study findings.[16–18] However, a 2019 systematic review and meta-analysis of 12 RCTs using liposomal bupivacaine TAP blocks in colorectal surgery patients[15] showed decreased LOS and morphine use, albeit with low confidence in study estimates. A different review in 2019[19] examined eight RCTs of TAP blocks in laparoscopic colorectal surgery patients and found opioid reduction in the first 24 hours, but no change in LOS across five studies. A review of 13 RCTs in colorectal surgery patients conducted in ERAS settings found limited evidence regarding the effects of regional anesthesia, including fascial plane blocks, on post-operative opioid use and LOS.[20] Our findings add to the literature supporting a benefit for long-acting fascial plane blocks with a large sample in a real-world setting.

It is important to interpret our study results within the context of a comprehensive ERAS program implemented in 2014 in this health system.[21] In ERAS, multidisciplinary personnel (eg physical therapists, nutritionists, and discharge planners) collaborate to expedite patient recovery, utilizing multiple evidence-based interventions, including opioid-sparing analgesia, early ambulation, and limiting unnecessary fasting. The independent contribution of regional anesthesia, such as fascial plane block, in this ERAS environment is uncertain for LOS. Mariano et al noted the potential difficulty of identifying the individual impact of ERAS components, such as regional anesthesia.[20] The synergy among the various ERAS components may be the crucial factor, even if individual components show inconsistent effects.

It is worth noting that both LOS and opioid use decreased in this health system over the study years – opioid use much more dramatically. It is possible that identifying an additional change in LOS specifically related to fascial plane blocks was challenging within an environment where LOS was already down-trending, likely due to evolving ERAS program awareness and implementation. Additionally, LOS was selected as the primary outcome measure since it is an important metric for patients and health systems, but it may be too broad to demonstrate an association with nerve blocks specifically.

Findings for postoperative opioid use indicate that long-acting blocks may have added benefit for pain management even within an ERAS program where opioid use has been decreasing.[22] Non-laparoscopic surgery is generally considered a more painful operation than the minimally invasive counterparts. Further, sensitivity analyses suggested that long-acting fascial plane blocks may be most impactful in the acute phase of recovery, the first and second days post-surgery. The association of short-acting fascial plane blocks with higher overall post-surgical MMEs may reflect that short acting blocks wear off sooner, needing increased analgesia to help with pain control post-surgery, whereas the long-acting block would provide longer relief.[23] Future analyses could benefit from exploring a cumulative measure of post-operative opioid use, which was not available in our dataset.

The importance of fascial plane blocks should not be evaluated merely with LOS and opioid use, and future research should examine patient-centered metrics such as function, pain severity, and sleep quality, to fully assess the value of fascial plane blocks. These patient-reported outcomes may shed light on inconsistent findings to date, and help identify for whom, and in what settings, fascial plane blocks may be most effective.

Strengths and Limitations

Study strengths include a large surgical cohort, both laparoscopic and non-laparoscopic surgeries, and a mature EHR with broad data capture. The study has limitations, including that it is set in an integrated health care delivery system in Northern California serving insured patients, which may limit generalizability. However, the patient population is diverse, and the ERAS program is representative of those found elsewhere. The study is susceptible to biases common to retrospective, cohort studies, such as potential differences in patient severity by exposure group. To the extent possible, we have included covariates to adjust for these potential differences, including ASA score, a baseline comorbidity score, and accounting for multiple procedures during the surgery. We examined study measures across exposure groups and did not find significant differences. Our focus was on immediate recovery, so it excluded patients who stayed in the hospital beyond 2 weeks, which may limit generalizability to those patients. The distribution of surgeries that used acetaminophen IV/PO in combination with another analgesic was 99% for general with long-acting nerve blocks, 96% for general with short-acting nerve blocks, and 99% for general-only surgeries. Given the high and consistent use of multimodal analgesics across exposure condition, we did not control for this component but acknowledge there may have been confounding. Detailed data on adherence to ERAS modalities was not available, however the study goal was not to examine the ERAS program or its impact; thus it relied on implied adherence to ERAS protocols. The overall ERAS program has been studied previously,[3,10] and clinicians follow very standard protocols that involve opioid and nonopioid practices. KPNC clinicians use standardized perioperative order sets at their discretion and based on their clinical expertise and patient needs. The study did not model which fascial plane blocks were utilized during surgery, since our study questions were not focused on specific block type and we aggregated the blocks into exposure categories to have sufficient power. We also did not have the sample size to conduct sensitivity analyses on non-laparoscopic colon surgeries.

Conclusion

Fascial plane blocks did not impact postoperative LOS but long-acting blocks did exhibit promising evidence in favor of reduced postoperative opioid use for non-laparoscopic procedures within the context of an established, multi-departmental ERAS program.

Abbreviations

ASA, American Society of Anesthesiologists; BMI, Body mass index; CI, Confidence interval; ERAS, Enhanced recovery after surgery; KPNC, Kaiser Permanente Northern California; LOS, Length of stay; MME, Morphine milligram equivalents; NDI, Neighborhood deprivation index; RCT, Randomized controlled trials; TAP, Transversus abdominis plane.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request and with appropriate data sharing agreements and institutional review board approval.

Ethics Approval and Consent to Participate

This study was approved by the Kaiser Permanente Northern California Institutional Review Board (IRB 1797487), which granted a waiver of informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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