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Reduction of opioid use after implementation of enhanced recovery after bariatric surgery (ERABS)

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Abstract

Background Enhanced recovery after surgery (ERAS) protocols have been extensively proven in lower gastrointestinal surgery to decrease postoperative physiologic stress and length of stay (LOS). ERAS in bariatric surgery (ERABS) varies immensely from each program with inconsistent results with a predominant goal of reducing LOS. Our focus in implementing enhanced recovery after bariatric surgery (ERABS) protocols is aimed at reducing postoperative pain and opioid use.

Methods This is a retrospective review of patients who underwent laparoscopic Roux-en-Y gastric bypass (RYGB) or sleeve gastrectomy (VSG) at a single high-volume center from June 2016 to October 2017. Patients on previous standard protocol were categorized into "Pre-Liposomal Bupivacaine (LB) group." After routine use of Exparel™, patients were grouped into "LB group." After ERABS protocol was initiated, patients were categorized into "ERABS/LB group." Postoperative opioids were converted to morphine equivalents units (MEU); pain scores, LOS, and 30-day outcomes were analyzed using combination of *t* test and Mann–Whitney U.

Results A total of 1340 patients were included in the study: 304 patients in pre-LB group; 754 patients in LB group, and 282 patients in ERABS/LB group. Total hospital opioid use was 58.6 MEU in pre-LB, 40.8 MEU in LB, and 23.8 MEU in ERABS/LB ($p=0.01$). ERABS/LB group found a 59.5% decline in MEU requirements compared to pre-LB ($p<0.001$) and 44.9% of patients did not require any additional narcotics on the floor compared to 0% in pre-LB group ($p<0.001$). ERABS/LB LOS was an average of 1.48 days compared to 1.54 days in pre-LB group ($p=0.03$) with an overall decrease of 3.74% in readmission rates ($p=0.03$).

Conclusions Implementation of ERABS significantly reduced postoperative opioid use, LOS, and readmissions. With ERABS, a more profound effect was observed than simply adding Exparel™ to preexisting protocols. Almost half of these patients did not require narcotics while recovering on the surgical floor. More studies are required to assess the true effect of ERABS without use of Exparel™.

Keywords Enhanced recovery · Bariatric surgery · Opioid · Liposomal bupivacaine · Exparel · Postoperative pain

The opioid epidemic continues to be a challenging problem in the United States and worldwide [1]. Frequently, opioids are prescribed to manage pain after surgery. This seemingly benign exposure can lead to an increased risk of developing chronic opioid use, especially in opioid naïve patients [2, 3]. Bariatric patients are especially at risk for forming narcotic addictions as recent literature suggests a higher incidence of chronic pain and depression than in the general population [3]. Measures to minimize narcotic use and even initial exposure to narcotics after bariatric surgery can minimize potential for chronic opioid use. In one study, a 6.3% rate of chronic opioid use was found after bariatric surgery in patients who were opioid naïve. This was found to correlate with higher rates of depression and negative psychological outcomes [4]. Raebel et al. found that among those patients with chronic opioid use before bariatric surgery actually consumed a greater number of opioids several years after their

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surgery [5]. Protocols such as enhanced recovery after surgery (ERAS) allow improved pain control after surgery and have a potential for opioid-free perioperative management.

ERAS or enhanced recovery pathways after colorectal surgery have been well documented in the literature to improve patient outcomes by reducing length of stay (LOS), readmissions, and overall hospital cost [6, 7]. These pathways focus on optimizing pain control, goal directed fluid therapy, and facilitating early ambulation and gastrointestinal recovery.

Although the success and standardization of ERAS in colorectal surgery suggest easy implementation into other surgical disciplines, this has not had consistent results within bariatric surgery. ERAS protocols in bariatric surgery vary widely among bariatric programs and majority of the literature emphasize a reduction in LOS instead of opioid reduction [8–13]. As we historically have low length of stay rates, our focus in implementing ERAS in bariatric surgery (ERABS) was to determine if we could decrease opioid use after surgery.

Our primary aim of this retrospective study was to show reduction in opioid use after implementation of ERABS with secondary outcomes examining pain control scores, length of stay, readmissions, and complications.

Materials and methods

After Institutional Review Board approval, we performed a retrospective chart review of a prospectively maintained database. All bariatric patients undergoing laparoscopic vertical sleeve gastrectomy (VSG) or Roux-en-Y gastric bypass (RYGB), with the exclusion of revisional bariatric surgeries, were included in the study between June 2016 and October 2017 at our high-volume tertiary referral center. We started routine surgical site injection of Exparel™ in September 2016 instead of bupivacaine only injections. Exparel™ (Pacira Pharmaceuticals, Parsippany, NJ, USA) is a Food and Drug Administration approved surgical site injectable liposomal bupivacaine. We later implemented our ERABS protocol in July 2017 along with injection of Exparel™. Bariatric patients that underwent surgery during June 2016–September 2016 were labeled into a "Pre-Liposomal Bupivacaine (LB) group." Once Exparel™ was routinely used, bariatric patients were then analyzed from September 2016 to June 2017 and placed into "LB group." ERABS protocol was initiated from July 2017 to October 2017 and bariatric patients were included into "ERABS/LB group." Detailed information including patients' characteristics and histories, perioperative course and complications were collected. All opioids during administered during hospitalization were converted to morphine equivalents units (MEU) to standardize reporting.

Additional end points include pain scores using analog scales, complications, and postoperative 30-day readmissions and patient satisfaction scores. Analog pain rating scale ranged from 0 to 10 with 0 being no pain and 10 being the worst possible pain. Assessment of pain was performed every 4 h after operation until discharge. Postoperative follow-up was at 1-week, 3-week, and then at regular intervals.

ERABS protocol

ERABS protocol was created with guidelines from current ERAS practices from colorectal surgery [7, 14, 15]. In addition, the program was modified with input from nursing, operating room, ancillary staff, anesthesiologists, and surgeons for successful integration into practice.

Prior to initiation of ERABS, our standard practice did not include routine preoperative teaching on postoperative pain expectations (Fig. 1). With ERABS, an extensive preoperative discussion occurred with the patient about pain control and goals for discharge on postoperative day 1. Negative effects of opioid use were reviewed. Patients were instructed to take gabapentin 300 mg along with acetaminophen 1000 mg the evening before surgery and on the day of surgery. Clear liquids were encouraged until 2 h prior to surgery. Carbohydrate loading was not emphasized as we had difficulty with consistent patient adherence to high carbohydrate pre-surgery drinks during our trial phase of ERABS.

In the preoperative holding area, additional medications were administered to decrease nausea and anxiety before the operation such as decadron, scopolamine patch, and oral melatonin. Patients received mechanical and chemical venous thromboprophylaxis. Routine use of urinary catheters was discontinued. Prior to ERABS, patients routinely received 3 L of intravenous fluid and changed to goal directed fluid therapy for euvolemia. Exparel™ along with a mixture of bupivacaine and saline was injected into the laparoscopic port sites for pain control. Postoperatively, patients had scheduled intravenous ketorolac, oral acetaminophen, and gabapentin and patient-controlled analgesia pumps were discontinued.

Early postoperative ambulation was encouraged within 3 h of the operation and instructional videos on postoperative expectations and goals to discharge were viewed by the patients after their operation. Clear liquid diet was administered soon after the operation without postoperative imaging. Dieticians also visited each patient on postoperative day 1. Patients were discharged with nursing parameters for adequate oral intake, pain, and nausea control. At home, patients continued self-administration of scheduled acetaminophen until minimal discomfort. Patients were prescribed a limited amount of opioids and were seen for follow-up on postoperative day 7 and 21. Patients also saw dieticians

Phase of Care	Group	
	Standard Care	ERABS
Preoperative		
Diet	Full liquid diet day before surgery, NPO at MN	Full liquid diet day before surgery, Clear liquids day of surgery, 2 hours NPO
Pain control	None	Gabapentin and acetaminophen night of surgery and day of surgery
	Standard consent	Postoperative pain expectation handouts
Perioperative		
Nausea and pain control	None	Scopolamine patch, IV Dexamethasone, po Melatonin
Intraoperative		
Pain control	Port site bupivicaine injection	Port site Exparel™ and bupivicaine injection
	No anesthesia protocol	Anesthesia fentanyl limited at 150 mcg
Fluid management	3 liters IV fluid minimum	Goal directed fluid therapy, < 2L IVF
	Routine urinary catheter placement and removal on POD 1	No urinary catheters
Postoperative		
Diet	Clears POD 0	Clears POD 0
Ambulation	No protocol	Ambulate within 3 hours of surgery
Anxiety	None	PRN IV lorazepam
Pain management	Routine PCA use	Non-opioid management first line, no PCA
		Scheduled oral acetaminophen and IV kertorolac
Discharge		
Pain management	Hydrocodone/acetaminophen quantity 30 pills	Scheduled acetaminophen, limited oxycodone prescription

Fig. 1 Comparison of Pre-ERABS and ERABS protocols. Enhanced recovery after bariatric surgery (ERABS)

within 3 weeks of discharge to reinforce adherence to graduated diet.

Statistical analysis

Unadjusted means and standard deviations were calculated and presented for the descriptive statistics for each of the groups examined, as well as for the perioperative and postoperative metrics and 30-day outcomes. Consecutive sampling of patients was performed. Additional chart abstraction was completed on a subsample of each group to collect narcotic administration and recorded pain scores data and unadjusted means and standard deviations were calculated and presented. For continuous variables, normality of the distribution of data was assessed and either *t* tests or Wilcoxon–Mann–Whitney tests were performed as deemed appropriate. When comparing outcomes involving proportions between groups, 2-Prop *z* tests were utilized. Differences between group categorical variables were assessed using Fisher's Exact Test.

All statistical tests performed were 2-sided and p values < 0.05 was considered statistically significant. Statistical analysis was conducted in R Statistical Software version 3.5.1 (The R Foundation for Statistical Computing), NCSS 9/PASS 13 (NCSS, LLC), and Excel (Microsoft Inc).

Results

A total of 1340 patients were included in the study and analyzed according to Fig. 2. Baseline demographics are described in Table 1. There were no statistically significant differences in patient characteristics, surgeon performing the surgery, or between VSG or RYGB.

After routine use of intraoperative injections of LB, total MEU requirements declined significantly (Table 2). A greater effect was seen after introducing ERABS protocol with a 59.5% reduction in MEU compared to pre-LB ($p < 0.001$), and 41.8% reduction compared to LB ($p < 0.001$). More patients in LB and ERABS/LB group did not receive any opioids during their hospitalization after transitioning from post-anesthesia care unit (PACU). However, this was not significant for overall total hospital MEU when including opioid use while in PACU. The decrease in MEU requirements correlates with a 46.3% reduction in pain scores in the ERABS/LB group obtained on postoperative day 1 compared to pre-LB group ($p < 0.001$). When examining against the LB group, ERABS + LB group also had lower pain-level scores with a 46.5% difference ($p < 0.001$).

Perioperative hospital outcomes are described in Table 3. A significant reduction in length of stay and readmissions was also found. ERABS group had a 3.7% decline in LOS compared to pre-LB. Readmission rates also declined by 3.74% ($p = 0.03$), with the most common complications in each group from bleeding, (pre-LB 0.7% $n = 2$, LB 1.1% $n = 8$, ERABS/LB 1.4%, $n = 4$). Dehydration was the most common cause of readmission (pre-LB 1.3% $n = 4$, LB 1.2% $n = 9$, ERABS/LB 0.7% $n = 2$). Unexplained abdominal pain was the second most common cause of readmission (pre-LB 2.0% $n = 6$, LB 0.5%, $n = 4$, ERABS/LB 0%). There was no significant difference in reoperation rates, with most common exploration for bleeding pre-LB 0.3% ($n = 1$), LB 0.5% ($n = 4$), and ERABS/LB 0.7% ($n = 2$). No mortalities occurred during this study period.

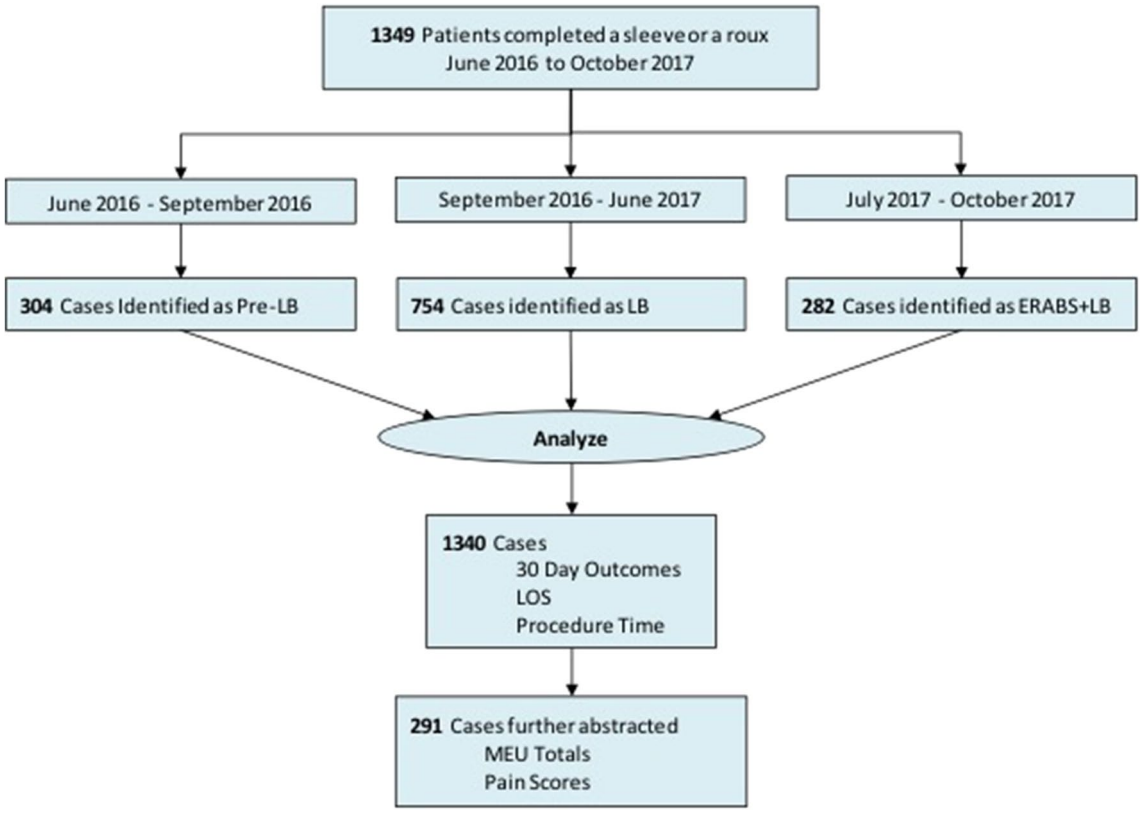

Fig. 2 Patient groups and analysis groups

Table 1 Baseline demographic characteristics

Characteristics	Pre-LB ($n=30$)	LB ($n=143$)	ERABS + LB ($n=118$)
Age, mean (SD), year	47.0 (13.0)	44.6 (11.4)	43.9 (13.5)
Weight, mean (SD), kg	123.2 (23.0)	129.4 (30.2)	127.4 (25.9)
Body mass index, mean (SD)[a]	45.1 (6.3)	46.7 (9.0)	46.4 (8.1)
Female	24 (80.0)	105 (73.4)	96 (81.4)
Diabetes	3 (10.0)	16 (11.2)	20 (16.9)
Insulin	2 (6.7)	7 (4.9)	5 (4.2)
Non-insulin	1 (3.3)	9 (6.3)	12 (10.2)
Gastroesophageal reflux	12 (40.0)	35 (24.5)	40 (33.9)
Hypertension	15 (50.0)	61 (42.7)	60 (50.8)
Obstructive sleep apnea	12 (40.0)	63 (44.1)	53 (44.9)
Hyperlipidemia	9 (30.0)	34 (23.8)	34 (28.8)
Smoked within 1 year	5 (16.7)	18 (12.6)	19 (16.1)

Data are expressed as No. (%) of participants unless otherwise indicated

[a]Calculated as weight in kilograms divided by height in meters squared

Discussion

In this retrospective study, we found a significantly reduced amount of opioid use in the hospital after laparoscopic RYGB or VSG after ERABS was implemented. There was a 59.5% decline in opioid use and 46.3% average decrease in pain scores with ERABS/LB compared to our previous protocol. This decline may have been multifactorial, as patients had more extensive preoperative discussion of pain expectations and discontinuing routine use of patient-controlled analgesia pumps in the pre-LB group. In addition, ERABS encouraged nursing and anesthesia participation in opioid reduction by emphasizing opioid pain sparing measures. Although there were improvements in pain scores, decline of opioid requirements, reduction of LOS and readmissions after we introduced intraoperative injection of Exparel™, the greatest and most significant decline in opioid requirements occurred after implementing the ERABS protocol. Our program initiated ERABS after Exparel™ became a routine part of our protocol and we could not directly compare the effect of ERABS without Exparel™ in this study. To our knowledge, the

Table 2 Postoperative morphine equivalent unit (MEU) Hospital requirements

Metrics[a]	Pre-LB ($n=30$)	LB ($n=143$)	ERABS + LB ($n=118$)	p Value between[b] Pre-LB and LB	p Value between[b] LB and ERABS + LB	p Value between[b] Pre-LB and ERABS + LB
Pain level						
Avg pain level entering PACU	6.3 (2.9)	4.9 (3.6)	2.6 (3.3)	0.04	$p<0.001$	$p<0.001$
Avg pain level exiting PACU	4.3 (2.3)	4.4 (2.4)	3.0 (2.2)	0.76	$p<0.001$	0.01
Avg pain level POD 1	2.7 (2.3)	2.7 (2.1)	1.4 (2.2)	0.95	$p<0.001$	0.002
Narcotic administration						
Total MEU's Intraop	11.2 (10.0)	16.1 (7.7)	9.4 (3.5)	0.002	$p<0.001$	0.74
Total MEU's PACU	11.3 (13.0)	7.4 (6.4)	6.0 (4.6)	0.36	0.19	0.10
Total MEU's Floor	36.0 (35.1)	17.3 (19.4)	8.4 (12.5)	0.001	$p<0.001$	$p<0.001$
TOTAL MEU's	58.6 (40.7)	40.8 (24.5)	23.8 (13.7)	0.01	$p<0.001$	$p<0.001$
MEU per Day	40.3 (30.3)	26.3 (12.1)	16.7 (9.2)	0.03	$p<0.001$	$p<0.001$
% Pt's NO Narcotic in PACU [%(n)]	20.0 (6)	19.6 (28)	19.5 (23)	0.99[c]	0.99[c]	0.99[c]
% Pt's NO Narcotic on Floor [%(n)]	0.0 (0)	13.3 (19)	44.9 (53)	0.048[c]	$p<0.001$[c]	$p<0.001$[c]
% Pt's NO Narcotic in PACU/ Floor [%(n)]	0.0 (0)	4.9 (7)	10.2 (12)	0.61[c]	0.15[c]	0.07[c]

[a]Data are expressed as Mean (SD) unless otherwise indicated

[b]Mann–Whitney test

[c]Fisher Exact test

Table 3 Length of stay and perioperative outcomes

Metrics[a]	Pre-LB ($n=304$)	LB ($n=754$)	ERABS + LB ($n=282$)	p Value between[b] Pre-LB and LB	p Value between[b] LB and ERABS + LB	p Value between[b] Pre-LB and ERABS + LB
Procedure time (min)	89.7 (30.4)	92.5 (33.2)	93.7 (29.4)	0.41[c]	0.13[c]	0.04[c]
Length of stay (day)	1.54 (0.79)	1.59 (0.73)	1.48 (0.75)	0.06[c]	$p<0.001$[c]	0.03[c]
Procedure [n (%)]						
Roux-en-Y gastric bypass	178 (58.6)	310 (41.1)	114 (40.4)			
Vertical sleeve gastrectomy	126 (41.4)	444 (58.9)	168 (59.6)			
30 Day outcomes [n (%)]						
Readmissions	20 (6.6)	37 (4.9)	8 (2.8)	0.28	0.15	0.03
Reoperations	7 (2.3)	13 (1.7)	2 (0.7)	0.53	0.22	0.12
Complications	15 (4.9)	37 (4.9)	11 (3.9)	0.99	0.49	0.54
Interventions	6 (2.0)	14 (1.9)	2 (0.7)	0.90	0.18	0.19

[a]Data are expressed as mean (SD) unless otherwise indicated

[b]2-Prop Z test

[c]Mann–Whitney test

majority of the studies on ERAS in bariatric surgery was not routinely using liposomal bupivacaine injections yet saw an improvement in pain scores and decreased opioid consumption after ERAS was initiated [16].

Protocols vary widely among bariatric institutions in terms of perioperative and postoperative care. Therefore, it can be difficult to directly compare one program's ERAS protocol to another. For instance, some centers routinely leave drains during bariatric surgeries and obtain postoperative screening imaging for anastomotic leaks. Others define ERAS as organizing nursing floors for bariatric directed nursing care. The majority of literature on ERAS have shown safe adaptation of the program and focus on reduction of LOS and readmissions [8–11]. Prior to ERABS, our average LOS was already lower than reported rates found in other studies [17]. Overall, our reduction in LOS was consistent with those findings in other bariatric protocols and overall length of stay may be lower than some studies [8, 10, 12, 13, 18, 19]. In addition, our decreased readmission

rates as well as our cost decrease were also consistent with findings in Malczak et al. [17].

Our protocol slightly differs than those recently published on ERAS in bariatric surgery [8, 12, 20, 21]. For instance, we initiate a clear diet immediately postoperatively and we do not routinely place intraabdominal drains or obtain postoperative imaging. In addition, we did not have patients adhere to a strict preoperative carbohydrate load and encourage patients to have clear liquids up until 2 h prior to surgery. During our trial phase of ERABS, we found difficulty with patients consistently adhering to the recommended carbohydrate load. Our pain and anxiety regimen also consisted of adding gabapentin the evening and day of surgery and melatonin in preoperative holding area. Gabapentin has shown to have an opioid sparing effect on pain [22]. Melatonin has also been shown to reduce perioperative anxiety and may also have a role in improving pain levels and quality of sleep after surgery [23–25]. Though the use of Exparel™ may be cost prohibitive at other facilities, we found that along with implementation of ERABS, the hospital realized a total variable cost savings of $456.79 per bariatric surgery. For our institution, this cost savings would have projected an annual savings of $548,148 (based on an average annual volume of 1200 cases).

Limitations of the study include the retrospective nature of the review and inherent bias with consecutive sampling. Data abstraction of MEU in pre-LB group was tedious as it was difficult to abstract PCA dosing on a large scale. After hospital discharge, the effect of ERABS in reducing home opioid use is not known and may be more important in addressing total opioid use. In addition, we are unable to distinguish patients with a history of chronic opioid use or chronic pain syndrome and how this affected the study outcomes. As we had already implemented routine surgical site injection of Exparel™, the true effect of ERABS without Exparel™ is unknown.

Conclusions

Implementation of ERABS significantly reduced hospital postoperative opioid use, LOS, and readmissions. With ERABS, a more profound effect was observed than simply adding Exparel™ to preexisting protocols. Almost half of these patients did not require any narcotics on nursing floor. More studies are required to assess the true effect of ERABS without use of Exparel™.

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Compliance with ethical standards

Disclosures Dr. Ma, Dr. Boone, Dr. Higa, Ms. A. Jackson, Ms. M. McGrath, Mr. R. Moore, and Mr. A. Lloyd have no conflicts of interest or financial ties to disclose, or association with any pharmaceutical companies.

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