Association of the addition of a transversus abdominis plane block to an enhanced recovery program with opioid consumption, postoperative antiemetic use, and discharge time in patients undergoing laparoscopic bariatric surgery: a retrospective study

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ABSTRACT

Background Increasing numbers of laparoscopic bariatric surgeries are being performed and enhanced recovery from anesthesia and surgery (ERAS) protocols have been implemented to optimize care for these patients. We evaluated the effects of an anesthesiologist placed preoperative transversus abdominis plane block (TAP) as part of a bariatric surgery ERAS protocol. We hypothesized that an anesthesiologist placed preoperative TAP added to an ERAS protocol following laparoscopic bariatric surgery would reduce total opioid consumption.

Methods A retrospective cohort of consecutive patients between January 1, 2017 and December 31, 2018 at a single large tertiary care center studied. TAP blocks were added to the ERAS protocol beginning in the second quarter of 2017. The primary outcome was total opioid analgesia use in mg oral morphine equivalents. Secondary outcomes were antiemetics administered and length of hospitalization. Data were analyzed using a generalized linear mixed model adjusted for sociodemographic, surgical, and preoperative risk factors that have been associated with opioid and antiemetic use and length of hospitalization.

Results Five hundred and nine cases were analyzed; TAP blocks were performed in 94/144 (65%) laparoscopic Roux-en-Y gastric bypass (LRYGB) and in 172/365 (47%) laparoscopic sleeve gastrectomy (LSG) patients. Mean (95% CI) adjusted total opioid administered was lower by 11% (1% to 19%, p=0.02), antiemetic drug administration was lower by 15% (-2% to 25%, p=0.06) and discharge time lower by 39% (26% to 48%, p<0.01) following LRYGB in the TAP group. Mean (95% CI) adjusted total opioid administered was lower by 9% (2% to 16%, p<0.01), antiemetic drug administration was lower by 11% (3% to 18%, p<0.01) and discharge time lower by 11% (2% to 18%, p=0.02) following LSG in the TAP group.

Conclusions TAP blocks added to a laparoscopic bariatric surgery ERAS protocol were associated with decreased total opioid use, number of antiemetic treatments, and length of stay; however, these changes were not likely clinically important. Our findings do not support widespread clinical benefit of TAP use in ERAS protocols for laparoscopic bariatric surgery.

INTRODUCTION

Obesity is a significant cause of morbidity worldwide with a current estimated incidence of greater than 60%.[1] Bariatric surgery is the most effective and durable treatment for severe obesity and its comorbid conditions, contributing to a reduction in the risk of 5-year mortality and an improvement in quality of life.[2 3] With over 200 000 operations performed annually, bariatric procedures are among the most common surgical procedures in the USA.[4] Optimal management strategies including enhanced recovery from anesthesia and surgery (ERAS) protocols have been implemented to optimize care for patients undergoing bariatric surgery. ERAS protocols for bariatric surgery have been shown to reduce the length of hospital stay, with little negative impact on morbidity.[5] In addition to modifiable factors such as preoperative body mass index (BMI) and effective pain and antiemetic management in the postoperative period, non-modifiable factors influence the length of hospitalization following bariatric surgery including socioeconomic variables such as race, gender, and age.[6–8] Effective ERAS for bariatric surgery should encompass the extended preoperative, perioperative, and recovery phase to improve short-term and long-term outcomes.[9]

The transversus abdominus plane block (TAP) is a regional analgesia technique that targets the sensory nerves supplying the anterior-lateral abdominal wall. The nerve block targets the T7-T12 intercostal nerves.[10 11] TAP blocks have been successfully used for pain control following a number of laparoscopic and open abdominal procedures including hysterectomy, colorectal surgery, hernia repair, and gastric bypass surgery.[12] In laparoscopic bariatric surgery not using an ERAS protocol, TAP blocks have been shown to provide additional analgesia and improve outcomes such as nausea and time to discharge compared with IV postoperative analgesics only,[13–15] or when added to a multimodal analgesic regimen.[16] Unfortunately, when added to an ERAS protocol for bariatric surgery, no differences

in postoperative analgesic requirements, nausea/vomiting, or length of hospitalization were observed.[17]

The purpose of this study is to evaluate the effect of the addition of a TAP block to an established ERAS protocol for bariatric surgery. We hypothesized that the TAP block would reduce total opioid administration compared with patients that did not receive a TAP block. As secondary outcomes, we sought to evaluate the effect of the TAP block on nausea/vomiting treatments and length of hospitalization.

METHODS

This study was approved by the Institutional Review Board of Rush University (18062101-IRB1). This manuscript was prepared using the Strengthening the Reporting of Observational Studies in Epidemiology guidelines. The study was granted waiver of informed consent because it evaluated existing records, was not greater than minimal risk, and was deemed to be Health Insurance Portability and Accountability Act compliant because safeguards were in place to protect the personal health information of the subjects. The study design was a retrospective cohort of adult patients that underwent laparoscopic bariatric surgery at Rush Medical Center between January 1, 2017 and December 31, 2018.

The ERAS protocol was implemented in the second quarter of 2016 and the specifics of the analgesic and antiemetic medications used in the protocol are described in the online supplementary appendix. Patients undergoing laparoscopic bariatric surgery were identified using the clinical resource management database. This database is linked to the electronic medical record and records procedural times and surgical information. The Department of Clinical Resource Management preforms ongoing monitoring of the bariatric ERAS outcomes and tracks compliance with the protocol. ERAS protocol adherence was tracked for analgesics, antiemetics, thromboembolic prophylaxis, fluid administration, recording of time when phase 1 and 2 liquid diet criteria were met and first day ambulation.

Patient sociodemographic characteristics were extracted from hospital medical records including age, gender, race, ethnicity, current smoking status, a history of diabetes, obstructive sleep apnea (OSA) defined as a diagnosis for OSA or a positive screen for OSA using the snoring, tiredness, observed apnea, high BP, BMI, age, neck circumference, and male gender (STOP-bang) questionnaire, a history of depression or an anxiety disorder or currently taking an antidepressant or anxiolytic medication per medication reconciliation. Medical records were also evaluated for a history of chronic pain or a diagnosis consistent with a chronic pain condition, as well as for current opioid analgesia use by history and medication reconciliation. Surgical characteristics included type of surgery, American Society of Anesthesiologist physical status classification, the BMI at the time of surgery, the use of a TAP block, intraoperative use, and the amount of remifentanil administered intraoperatively. Outcomes extracted from medical records included pain assessments preoperatively and postoperatively until discharge, postoperative analgesics and antiemetic medications, first oral intake of liquids and medications within 4 hours of surgery, and time to full liquid diet. Surgical duration, the length of postanesthesia care unit (PACU) stay and length of hospitalization were obtained from the clinical resource management database.

Anesthesiologists placed TAP blocks were initially started in the second quarter of 2017 in gastric bypass patients and in the third quarter of 2017 in sleeve gastrectomy patients. The TAP block was placed bilaterally using a subcostal approach in the preoperative area in the anterior-axillary line with ultrasound guidance (Sonosite S2 ultrasound system, Bothell, Washington, USA). A 22 G spinal needle was inserted using an in-plane approach along the axis of the low frequency linear array probe (5–10 mHz frequency) between the internal oblique and the transverses abdominis muscle. The technique of the TAP varied with the anesthesiologist, but the standard method was not to advance the needle in the facial plane created by the injection of the local anesthetic. After negative aspiration, ropivacaine 0.5%, 15–20 mL (75–100 mg) was injected on each side.

Pain assessments were made by nursing personnel using the Defense and Veterans Pain Rating Scale (DVPRS 2.0). Pain assessments were required by the ERAS protocol to be completed every 15 min from the entry in the PACU and every 4 hours following PACU discharge to discharge. Pain burden was calculated as the area under the by time curve using trapezoidal integration and the average area under the pain curve during hospitalization was calculated by dividing the pain burden by the length of hospital stay.[18 19] Length of stay was the time from hospital admission to actual discharge. Opioid analgesics administered intraoperatively, in the PACU and through hospital discharge were converted to oral milligram morphine equivalents using the conversion tool available from the American Pain Society.[20]

Primary and secondary outcomes

The primary outcome of this study was the amount of total opioid analgesics administered during the hospital stay. Secondary outcomes included the number of antiemetic medication doses received and the length of hospitalization. Laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic sleeve gastrectomy (LSG) patients are reported separately, because of the differences in length of surgery, total opioid consumption and the imbalance in TAP use between these surgical groups.

Statistical analysis

The adjusted difference in total opioid analgesia was compared between the TAP and no-TAP groups using a generalized linear mixed model fit by maximum likelihood (Laplace approximation) using a log model link function. Fixed effects included in the model were age groups (20–39 years, 40–59 years, >60 years), anxiety, depression, gender, history of chronic pain, preoperative opioid use, OSA, race, remifentanil use, and TAP.[21] Duration of surgery was evaluated as a random effect. Counts of antiemetic doses were compared between the TAP and no-TAP groups using a generalized linear mixed using a Poisson distribution and a log model link function. Fixed effects in the model were age groups, anxiety, current smoker, and gender.[22] Random effects were duration of surgery and total opioid mg oral morphine equivalents (MME) consumed.[22] Duration of hospitalization was compared using and generalized linear mixed model using a log model link function. Fixed effects in the model were age groups, gender, and race and TAP.[6–8] The month of the study was entered as a random effect. The ratio of the TAP/no-TAP and the 95% CI of ratios are reported as a measure of the effect size. Estimated marginal means and 95% CIs of the estimates for the TAP and no-TAP groups were determined by back transformation. A sensitivity analysis of the primary outcome was performed by evaluating opioids administered per patient request postoperatively.

Clinical characteristics of the patients were compared between TAP and no-TAP groups using the Wilcoxon ranked sum test for continuous variables (age and BMI) and with a χ^2 statistic for categorical data. Unadjusted differences in the primary and

secondary outcomes and in pain burden, the average pain score during hospitalization, and the time to a full liquid diet were compared using the Wilcoxon Ranked Sum test. The number of patients that tolerated oral liquids and medications within 4 hours of surgery was compared using a χ^2 statistic. Differences in median and 95% CIs of the differences were calculated using a 10 000-sample bootstrap. Differences in the percentages for categorical data were calculated using the Clopper-Pearson method.

The distributions of the primary and secondary outcomes were tested using the Shapiro-Wilks test and examined graphically using q-q plots. A $p<0.05$ was required to reject the null hypothesis. The sample for this study was all patients undergoing bariatric surgery during the study period. A clinically significant reduction in the primary outcome was considered to be a relative decrease of 25% in total MME between the no-TAP group. Data were analyzed using RStudio V.1.2.5019 (Integrated Development for R. RStudio, Boston, Massachusetts, USA; URL: http://www.rstudio.com/) and R V.3.6.1, release date July 5, 2019 (The R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Five hundred and nine consecutive patients underwent laparoscopic bariatric surgery at Rush University Medical Center between January 1, 2017 and December 31, 2018 were included in the study. TAP blocks were performed in 94/144 (65%) of LRYGB procedures and in 172/365 (47%) of patients undergoing an LSG. The median (IQR) ERAS protocol adherence to administration of preoperative, intraoperative and postoperative scheduled analgesics, thromboembolic prophylaxis, and protocol-specified antiemetics was 91% (80%–93%). There were no missing sociodemographic, surgical, or outcome data. There were 14 633 pain assessments made by nursing personnel with the median (IQR) number of pain assessments per patient of 25 (19–32) and the minimum number of pain assessment in a patient of 10.

Clinical and surgical characteristics of laparoscopic bariatric surgery in the TAP and no-TAP groups are shown in table 1. In patients undergoing LRYGB, patients with TAP had a shorter median duration −12 min (95% CI −3 min to −20 min) of surgery and received less intraoperative remifentanil −1004 µg (95% CI −1382 µg to −458 µg) than the no-TAP group. Potentially clinical important, but not statistical differences between the TAP and no-TAP groups were an increased number of patients with OSA in the TAP group 16% (95% CI 0% to 32%) and a greater proportion of TAP patients that received intraoperative remifentanil 15% (95% CI −3% to 32%). In patients that had an LSG, the frequency of OSA was greater in the TAP group 17% (95% CI 8% to 27%). Patients with TAP had a shorter median duration −9 min (95% CI −2 min to −16 min) of surgery and received less intraoperative remifentanil −558 µg (95% CI −751 µg to −317 µg) than the no-TAP group.

Table 1 Clinical and surgical characteristics of laparoscopic bariatric surgery patients in the TAP block and no-TAP groups

	Roux-en-Y gastric bypass			Sleeve gastrectomy		
	TAP block	No-TAP	P value*†	TAP Block	No-TAP	P value*†
Sample size, n	94	50		172	193	
Sociodemographic characteristics						
Mean age (SD) in years	45.2 (11.3)	43.7 (11.5)	0.45	44.9 (11.2)	44.1 (10.7)	0.45
Female gender n(%)	79 (84)	37 (74)	0.18	135 (79)	160 (83)	0.29
Race n(%)						
White	60 (64)	30 (60)	0.66	69 (40)	70 (36)	0.41
African American	33 (35)	20 (40)		102 (59)	123 (64)	
Asian	1 (1)	0 (0)		1 (1)	0 (0)	
Ethnicity n (%)			0.43			
Hispanic	28 (30)	11 (22)		28 (16)	26 (14)	0.46
Comorbidities						
Current smoker n (%)	24 (25)	19 (38)	0.13		52 (27)	0.55
Obstructive sleep apnea n (%)	36 (38)	11 (22)	0.06		37 (19)	<0.01
Diabetes n (%)	28 (30)	21 (42)	0.15		46 (24)	0.90
Preoperative opioid use n (%)	8 (9)	5 (10)	0.77		16 (8)	0.88
History of chronic pain n (%)	20 (21)	17 (34)	0.11		37 (19)	0.79
Depression n (%)	4 (4)	4 (8)	0.45		13 (7)	0.66
Anxiety n (%)	12 (13)	9 (18)	0.45		20 (10)	0.62
Surgical characteristics						
Duration of surgery (SD) in minutes	113 (23)	125 (28)	<0.01	74 (29)	83 (36)	<0.01
ASA classification n(%)						
II	37 (39)	13 (26)	0.14	71 (41)	65 (34)	0.32
III	57 (61)	37 (74)		99 (58)	126 (65)	
IV				2 (1)	2 (1)	
Mean BMI (SD) in kg/m^2	39.9 (8.4)	38.5 (9.2)	0.39	39.8 (6.9)	38.3 (6.8)	0.04
Intraoperative remifentanil n(%)	72 (77)	31 (62)	0.08	109 (63)	102 (53)	0.05
Median (IQR) remifentanil dose in µg	1096 (729–1852)	2100 (1348–2592)	<0.01	665 (437–1079)	1223 (780–1674)	0.04

*P value compares TAP to no-TAP group.
†Group t-test used to compare means, Wilcoxon ranked sum test used to compare medians and χ^2 test used to compare proportions.
ASA, American Society of Anesthesiologists; BMI, body mass index; IQR, interquartile range (first to third quartile); TAP, transversus abdominis plane block.

Table 2 Unadjusted outcomes following laparoscopic Roux-en-Y gastric bypass surgery patients in the TAP block and no-TAP groups

	TAP	No-TAP	Difference (95% CI of the difference)*	P value†‡
Sample size, n	94	50		
Median PACU time (IQR) in minutes	84 (66–103)	81 (66–119)	3 (–22 to 15)	0.72
Median pain burden (IQR) in score*hours				
0–6 hours	34.2 (27.4–42.5)	39.4 (27.3–43.6)	–5.2 (–9.2 to 0.06)	0.24
6–12 hours	28.6 (17.8–42.3)	29.8 (18.4–40.0)	–1.2 (–8.1 to 6.6)	0.97
12–24 hours	70.4 (42.2–93.4)	72.2 (41.8–88.6)	–1.8 (–11.5 to 16.5)	0.8
24–48 hours	97.5 (64.4–125.8)	97.7 (56.6–137.2)	–0.2 (–21.3 to 37.9)	0.54
48–72 hours	121.4 (71.2–143.2)	90.7 (61.1–113.9)	30.6 (–31.9 to 69.5)	0.37
Median average pain score (IQR) on a 0–10 scale	3.7 (2.6–4.5)	3.4 (2.5–5.5)	0.3 (–0.4 to 1.2)	0.38
Median opioid analgesia (IQR) in MME				
Total opioid administered	171 (142–201)	211 (163 to 261)	–40 (–10 to –65)	<0.01
Postoperative opioids administered on request	51 (37–70)	70 (44–97)	–19 (–35 to –6)	<0.01
Median (IQR) nausea/vomiting treatment n (%)				
Total antiemetic doses	8 (6–12)	10 (7–13)	–2 (–4 to 0)	0.03
Tolerate oral liquids and medications (<4 hours) n (%)	74 (79)	33 (67)	12 (–4 to 29)	0.14
Median time to full liquid diet (IQR) in hours	19 (16–21)	21 (19–23)	–2 (–3 to –1)	<0.01
Median length of hospitalization (IQR) in hours	47 (32–59)	51 (34–59)	–4 (–18 to 12)	0.12

*Differences in continuous data presented as median difference, differences in categorical or binomial presented as percent difference.
†P value compares TAP to no-TAP group.
‡Wilcoxon ranked-sum test used to compare medians and χ^2 test used to compare proportions.
IQR, interquartile range (first to third quartile); MME, mg morphine equivalents (oral); PACU, postanesthesia care unit; TAP, transversus abdominis plane block.

A potentially clinical important, but not statistical differences between the TAP and no-TAP groups was the greater proportion of patients with TAP that received intraoperative remifentanil 10% (95% CI 0% to 21%).

Unadjusted outcomes following LRYGB surgery as shown in table 2. Median total opioids administered and postoperative opioids administered on request were lower by 40 MME (95% CI 10 MME to 65 MME) and 19 MME (95% CI 6 MME to 35 MME) in the TAP group, respectively. The number of antiemetic doses received was lower by 2 (95% CI 0 to 4) and the time to reach a full liquid diet was less by 2 hours (95% CI 1 hours to 3 hours) in the TAP group.

Unadjusted outcomes following LSG surgery as shown in table 3. Pain burden was less between 6 to 12 hours and 12 to 24 hours and the median average pain score was less by 0.4 (95% CI 0.1 to 0.8). Median total opioids administered and postoperative opioids administered on request were lower by 20 MME (95% CI 3 MME to 34 MME) and 15 MME (95% CI 2 MME to 20 MME) in the TAP group, respectively. The number of antiemetic doses received postoperatively was less by 1 (95% CI 0 to 2), the

Table 3 Unadjusted outcomes following laparoscopic sleeve gastrectomy surgery patients in the TAP block and non-TAP groups

	TAP	Non-TAP	Difference (95% CI of the difference)*	P value†‡
Sample size, n	172	193		
Median PACU time (IQR) in minutes	82 (67–97)	85 (67–111)	–3 (–10 to 5)	0.31
Median pain burden (IQR) in score*hours				
0–6 hours	33.9 (26–40.7)	35.6 (24.7–44.1)	–1.6 (–4.5 to 0.8)	0.28
6–12 hours	26.7 (16.7–38.9)	33.4 (19.1–43.6)	–6.7 (–11.0 to –2.3)	<0.01
12–24 hours	60.5 (40.0–84.1)	66.9 (47.5–88.7)	–6.4 (–14.7 to 3.2)	0.04
24–48 hours	97.6 (61.7–137.4)	104.9 (62.9–132.2)	–7.3 (–20.6 to 18.0)	0.95
48–72 hours	95.2 (21.7–150.0)	114.6 (89.8 –145.6)	–19.4 (–92.9 to 37.6)	0.41
Median average pain score (IQR) on a 0–10 scale	3.2 (2.2–4.4)	3.6 (2.6–4.7)	–0.4 (–0.8 to –0.1)	0.03
Median opioid analgesia (IQR) in MME				
Total opioid administered	158 (122–200)	178 (135–227)	–20 (–34 to –3)	0.02
Postoperative opioids administered on request	45 (30–67)	60 (39–84)	–15 (–20 to –2)	<0.01
Median (IQR) nausea/vomiting treatment n (%)				
Total antiemetic doses	9 (6–11)	10 (7–13)	–1 (–2 to 0)	<0.01
Tolerate oral liquids and medications (<4 hours) n (%)	143 (83)	133 (69)	14 (6 to 24)	<0.01
Median time to full liquid diet (IQR) in hours	18 (16–21)	20 (18–24)	–2 (–3 to 0)	<0.01
Median length of hospitalization (IQR) in hours	35 (32–52)	49 (33–56)	–14 (–17 to –10)	<0.01

*Differences in continuous data presented as median difference, differences in categorical or binomial presented as percent difference.
†P value compares TAP to no-TAP group.
‡Wilcoxon ranked-sum test used to compare medians and χ^2 test used to compare proportions.
IQR, interquartile range (first to third quartile); MME, mg morphine equivalents (oral); PACU, post anesthesia care unit; TAP, transversus abdominis plane block.

Table 4 Multivariable adjusted primary and secondary outcomes

	TAP	No-TAP	Ratio (95% CI of the ratio)*	P value†‡
Roux-en-Y gastric bypass surgery				
Mean (95% CI) estimated opioid analgesia in MME§				
Total opioid administered	188 (161 to 218)	209 (181 to 242)	0.89 (0.81 to 0.99)	0.02
Postoperative opioids administered on request	46 (33 to 62)	57 (42 to 76)	0.80 (0.68 to 0.99)	0.02
Median (95% CI) nausea/vomiting treatments n¶				
Antiemetic doses	8 (7 to 10)	9 (8 to 11)	0.85 (0.75 to 1.02)	0.06
Mean (95% CI) length of hospitalization in hours**	38 (31 to 45)	61 (53 to 72)	0.61 (0.52 to 0.74)	<0.01
Gastric sleeve surgery				
Mean (95% CI) estimated opioid analgesia in MME§				
Total opioid administered	186 (164 to 210)	205 (182 to 231)	0.91 (0.84 to 0.98)	<0.01
Postoperative opioids administered on request	61 (44 to 78)	71 (54 to 88)	0.85 (0.75 to 0.99)	0.02
Median (95% CI) nausea/vomiting treatments n¶				
Antiemetic doses	9 (8 to 10)	10 (9 to 11)	0.89 (0.82 to 0.97)	<0.01
Mean length of hospitalization (IQR) in hours**	45 (41 to 49)	50 (47 to 54)	0.89 (0.82 to 0.98)	0.02

*Ratio of TAP/no-TAP and 95% CI of the ratio.
†P value compares TAP to no-TAP group.
‡Adjusted values estimated using generalized mixed effect model with opioid administered and length of stay using a log-normal distribution and number of antiemetic doses a Poisson distribution.
§Opioid consumption adjusted for age, anxiety, depression, duration of surgery, gender, history of chronic pain, preoperative opioid use, obstructive sleep apnea, race, and remifentanil use.
¶Antiemetic doses adjusted for age, anxiety, current smoker, duration of surgery, gender, and total opioid administered.
** Length of stay adjusted for age, gender, month of study, and race.
IQR, interquartile range (first to third quartile); MME, mg morphine equivalents (oral); TAP, transversus abdominis plane block.

number of patients tolerating liquids and medications at 4 hours greater by 14% (95% CI 6% to 24%) and the time to reach a full liquid diet lower 2 hours (95% CI 0 to 3) in the TAP group. The length of hospitalization was less by 14 hours (95% CI 10 hours to 17 hours) in the TAP group.

Adjusted primary and secondary outcomes are shown in table 4. Following LRYGB adjusted total opioid administered was lower by 11% (95% CI 1% to 19%) and the administration of patient request opioids lower by 20% (95% CI 1% to 32%) in the TAP group. Adjusted antiemetic drug administration was lower by 15% (−2% to 25%) and discharge time lower by 39% (26% to 48%). Following LSG adjusted total opioid administered was lower by 9% (95% CI 2% to 16%) and the administration of patient request opioids lower by 15% (95% CI 1% to 25%) in the TAP group. Adjusted antiemetic drug administration was lower by 11% (3% to 18%) and discharge time lower by 11% (2% to 18%).

DISCUSSION

The important findings of this study were that while the addition of a TAP block to an ERAS protocol for bariatric surgery was associated with a small statistically significant reduction in the total opioid administration; however, the 9%–11% decrease seen in this study are well below the 25% threshold that we considered clinical important. While the TAP was associated with a larger effect on postoperative opioids on demand, scheduled opioid administration per the ERAS protocol likely offset the magnitude of this effect on total opioid consumption. TAP blocks were also associated with a small decrease in antiemetic treatment administrations as well as reduction in mean length of hospitalization, although the magnitude of these differences is not likely of substantial importance clinically. Taken together, our findings suggest only a small clinical value for the addition of a TAP block to ERAS protocols for laparoscopic bariatric surgery.

Prior studies have failed to show improvement in analgesia or other outcomes in patients receiving a TAP block in bariatric surgery. Surgeon performed TAP blocks using bupivacaine 0.25% did not reduce MME use in patients undergoing either LRYGB or LSG procedures.[23] Albrecht *et al* studied the effect of bilateral TAP block using 30 mL of bupivacaine 0.25% plus epinephrine 1:200 000 in sleeve gastrectomy patients and found no difference in cumulative opioid in the first 24 hours postoperatively.[14] There was no difference in pain scores, time to phase I recovery or length of stay. The average length of stay in the aforementioned study was approximately 10 hours longer than in the current study.

Conversely, several studies have shown a benefit of TAP analgesia in bariatric surgery. In a feasibility study of TAP use in patients undergoing LSG, Wassef *et al* found a decrease in mean pain scores from 8 to 4 at 30 min following block placement with 30 mL of ropivacaine injected bilaterally at the level of the rib cage.[13] Postoperative pain was lower at 6 hours and 12 hours but not at 24 hours postsurgery. There was no difference in patient-controlled analgesia in the postoperative period. Singh *et al* found lower pain scores at rest and with movement and rescue analgesia in LSG patients that received bilateral TAP blocks of 20 mL of ropivacaine 0.375% compared with saline.[9] Time to first ambulation and patient satisfaction were also improved in the TAP group. Mittal *et al* found decrease in pain scores and in rescue analgesia use in LSG patients that received bilateral TAP of 40 mL of 0.375% ropivacaine compared with saline. Time to ambulation and satisfaction were also improved in the TAP group.[15]

In a randomized controlled trial of TAP block after LSG using an ERAS protocol, Saber *et al*, found a decrease in pain scores at 3 hours but not at other intervals in the TAP group.[14] Twenty milliliters of bupivacaine 0.25% with or without epinephrine 1:200 000 units was placed bilaterally by the surgeon intraoperatively at the end of surgery. There were no differences in opioid consumption, nausea/vomiting or length of stay. Reported length of stays were approximately 6 hours shorter than the current study, but not adjusted for non-modifiable factors. Similar to the aforementioned study,

we found only a small difference in pain burden (area under the DVPRS by time curve) in LSG patients between 6 and 12 hours postoperatively. Nonetheless, we found a reduction in supplemental analgesia administration in both LSG and LRYGB patients. A possible reason for the differences found in our study compared with the Saber *et al* study could be the higher dose of local anesthetic used even after considering the relative potencies of ropivacaine to bupivacaine or the time of administration preoperatively versus the end of the case in the current study.[24] In our study, the earlier times to resuming diet and reduced need for antiemetic treatment may have contributed to the earlier discharge even after adjusting for non-modifiable factors in the TAP group.

The results of our study should only be interpreted in the context of its limitations. Our study was a retrospective analysis of clinical use based on provider preference prior to and during the phase in of TAP blocks as part of an ERAS protocol for bariatric surgery at a single large tertiary care university medical center. We did not compare minor and major complications between TAP and non-TAP groups, although prior studies have shown these to be unaffected by the implementation of ERAS protocols. We used an anterior subcostal approach for placement of the TAP blocks, and despite recent studies suggesting that this approach may provide better analgesia for upper abdominal surgical procedures, this method may not be as effective as a block placed at the posterior axillary line and fail to block both the anterior and posterior branches of the intercostal nerves.[25 26] Although we have attempted to adjust our analysis for potential biases, unknown confounders may not have been captured in our study design. In addition, improvements in the application of the ERAS protocol over the 2-year study period may have affected some of our outcomes, despite the addition of time as random effect in some of our analytical models. Nonetheless, given the large sample size and large numbers of anesthesia providers placing the TAP blocks, we believe that our data accurately represent a pragmatic longitudinal study of clinical outcomes following the addition use of a TAP block to an ERAS protocol for bariatric surgery. While we believe that our ERAS protocol is representative of best evidence and encompasses all aspects of clinical care, differences in ERAS protocols may lead to different conclusions regarding the efficacy of TAP analgesia. Further random controlled trials of the addition of a TAP block to an ERAS protocol for bariatric surgery are warranted.

In conclusion, an ultrasound-guided TAP block placed by anesthesiologists in the preoperative time period prior to bariatric surgery was associated with statistically significant but clinically small reductions in total opioid analgesia administration, antiemetic treatments and discharge time when used in conjunction with a multimodal anesthesia/analgesia protocol as a component of a comprehensive ERAS protocol. Our findings cannot support the widespread adoption of the addition of a TAP blocks to a comprehensive ERAS protocol for bariatric surgery.

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Contributors RJM was involved in the conception or design of the study, data analysis and interpretation, drafting the article, critical revision of the article, and final approval of the version to be published. KGI was involved in the acquisition of the data, drafting the article, critical revision of the article, and final approval of the version to be published. EAR was involved in the acquisition of the data and data interpretation, drafting the article, critical revision of the article, and final approval of the version to be published. AMA was involved in the acquisition of the data and data interpretation, drafting the article, critical revision of the article, and final approval of the version to be published. AKR was involved in the acquisition of the data and data interpretation, drafting the article, critical revision of the article, and final approval of the version to be published. PAO was involved in data interpretation, drafting the article, critical revision of the article, and final approval of the version to be published. AB was involved in the conception or design of the study, drafting the article, critical revision of the article, and final approval of the version to be published.

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Appendix:

The implementation of the ERAS protocol for bariatric surgery was developed with input from all stakeholders, (surgery, anesthesiology, dietary, nursing, hospital administration, rehabilitation, and pharmacy) and includes preoperative, intraoperative and postoperative recovery patient management. In the preoperative phase patients receive extensive counseling and metabolic preparation. A proton pump inhibitor was initiated starting one week prior to surgery and continued into the postoperative period. Preoperatively, patients are instructed to consume only clear liquids the day prior to surgery and nothing after midnight. They are instructed to apply chlorohexidine wipes to their abdomen the night before and morning of surgery. Intraoperatively, nasogastric tubes and intraabdominal drains were avoided as were high intrabdominal pressures. Venous thromboembolic prophylaxis, antiemetic and analgesic agents are administered preoperatively and an optimized intraoperative anesthesia and postoperative multimodal pain management protocol is implemented (Table 1).

Table 1: Enhanced recovery after surgery bariatric surgery analgesic and antiemetic protocol.

Agent	Dose	Indication
Preoperatively		
Transdermal scopolamine	1.5mg patch applied in holding area	Antiemetic
Acetaminophen liquid	975 mg orally in holding area	Analgesic
Transverses abdominis plane block (TAP)	Ropivacaine 0.5% solution administered as 15 ml or 20 ml bilaterally using ultrasound guidance	Analgesic
Intraoperatively		
Ketamine	0.5 mg/kg IV bolus at skin incision	Analgesic
Dexamethasone	0.1 mg/kg IV bolus to maximum of 8mg	Antiemetic/analgesic
Propofol	Anesthesia induction	
Volatile anesthesia	Anesthesia maintenance	
Propofol infusion		
Remifentanil infusion		

Ropivacaine	Infiltration of 30 ml of 0.5% at port sites at closure	Analgesic
Acetaminophen	1000 mg IV at skin closure	Analgesic
Ondansetron	4 mg IV at skin closure	Antiemetic
Post anesthesia care unit		
Ondansetron	4 mg IV push if needed (maximum of 2 doses in first 6 hours postoperatively)	Antiemetic
Fentanyl	25 μg prn as needed for pain (NRS>4)	Analgesic
Postoperative Hospital Unit – Until patient tolerates clear liquids		
Acetaminophen	1000mg IV q 8 hours x 2 doses	Analgesic
Hydromorphone	0.3mg IV q4hr as need for pain (NRS>4)	Analgesic
Ondansetron	4mg IVP q 6hr x 2 then as needed	Antiemetic
Prochlorperazine	10mg IVP q6hr prn	Antiemetic
When patient tolerates clear liquids		
Acetaminophen	1000 mg orally every 8 hours	Analgesic
Tramadol	100mg orally four times a day	Analgesic
Oxycodone	5mg orally as need for pain (NRS > 4)	Analgesic

Postoperatively, patients receive intravenous analgesics and antiemetic agents per protocol, until the patient was able to take clear liquids at which point, they were converted to oral analgesics. Patients that failed to have their nausea and or vomiting controlled using the standard regimen received additional antiemetic agents per physician order.

Pain assessments were made using the eleven-point Defense and Veterans Pain Rating Scale (DVPRS 2.0) where 0 equals no pain and 10 equals worst pain imaginable. This method uses a numeric rating scale enhanced by functional word descriptors, color coding and pictorial facial expressions. The method has been demonstrated to have high interrater (Chronbach's

alpha = 0.87) and test-retest reliability.[1] Pain assessments are scheduled every 15 minutes from admission to discharge from the post anesthesia care unit (PACU) and then every four hours until hospital discharge per protocol.

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