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ORIGINAL ARTICLE

Comparison between the ultrasound-guided erector spinae block and the subcostal approach to the transversus abdominis plane block in obese patients undergoing sleeve gastrectomy: a randomized controlled trial

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ABSTRACT

BACKGROUND: Pain control in the morbidly obese has presented as an anesthetic challenge. The aim of this study is to assess the analgesic efficacy of ultrasound guided bilateral erector spinae block compared to bilateral subcostal transversus abdominis plane block.

METHODS: A prospective randomized, double-blinded controlled study was conducted at Kasr Alainy Hospital on 66 patients scheduled for laparoscopic sleeve gastrectomy. Patients were randomly allocated into three groups and received general anesthesia: bilateral erector spinae block at the level of T9 or bilateral subcostal transversus abdominis block or opioid analgesia (control group). The primary outcome was pain assessment by Visual Analogue Scale.

RESULTS: Visual Analogue Scale was lower in the erector spinae and transversus abdominis groups compared with the control group throughout the first 12 postoperative hours ($P \leq 0.001$). Visual Analogue Scale was lower in the erector spinae group in relation to control group at 18 postoperative hours ($P=0.034$). Visual Analogue Scale in the erector spinae group was significantly lower compared to transversus abdominis at the 12 postoperative hours. Twenty-four-hour postoperative pethidine consumption was higher in the control group (median 150, IQR 100-200) compared to both erector spinae (median 0, IQR 0-50) and transversus abdominis (median 50, IQR 0-100) groups ($P<0.001$). Erector spinae group showed less pethidine consumption than transversus abdominis group.

CONCLUSIONS: Ultrasound-guided single-shot T9 erector spinae plane block lowers postoperative pain scores, and reduces intraoperative and postoperative opioid consumption compared with both the subcostal approach transversus abdominis plane block and the control group in obese patients that had undergone sleeve gastrectomy.

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KEY WORDS: Erector spinae plane block; Transversus abdominis plane block; Subcostal approach of transversus abdominis block; Laparoscopic sleeve gastrectomy.

Pain control in the morbidly obese has consistently presented as an anesthetic challenge; obesity being a high-risk factor for opioid-induced respiratory depression. Laparoscopic bariatric procedures are mostly associated with moderate to severe visceral pain, resulting from surgical manipulation of the stomach and bowel. Despite the use of multimodal analgesic regi-

mens, the administration of high doses of opioids is often necessary.[1]

The use of combined regional and general anesthesia reduces surgical stress responses through the interruption of pain transmission signals, which facilitates pain control, decreases opioid consumption and improves the patient's postoperative satisfaction.[2] There are, however, several limitations to the use of regional anesthesia in cases of obese patients including difficulties in: 1) identifying key body landmarks; 2) patient positioning; 3) choosing a suitable needle length and 4) deciding on the appropriate dose of local anesthetic.[3]

Several studies have reported that the administration of the transversus abdominis plane block (TAP) in a range of surgical procedures had improved pain related outcomes.[2, 4, 5] It is worth noting that the subcostal approach targets the innervations of the upper abdominal trocar sites and more suitable for incisions in the supraumbilical region.[2, 6] Some studies have however demonstrated that the TAP block may not always reliably capture the T7 and T8 dermatomes. Sensory block at these dermatomes would be necessary to achieve analgesic satisfaction in cases of abdominal laparoscopic surgeries.[7, 8]

Ultrasound guided erector spinae (ESP) block is a novel regional anesthesia technique that allows a local anesthetic (LA) to spread craniocaudally over several levels. When LA is injected in the lower thoracic level, it penetrates anteriorly through the intertransverse connective tissue and enters the thoracic paravertebral space, blocking the ventral and dorsal rami of spinal nerves and the rami communicants of transmit sympathetic fibers, resulting in both visceral and somatic abdominal analgesia.[9] A limited number of case studies are investigating the efficiency of ESP in several types of abdominal surgeries, including ventral hernial repair,[10] abdominoplasty,[11] major abdominal surgeries,[12] cesarean section,[13] and laparoscopic surgeries.[14]

Chin *et al*.[9] reported the successful reduction of postoperative pain following three bariatric surgeries conducted under bilateral ESP block. We thus hypothesized that ESP would provide more satisfactory analgesia in cases of laparoscopic sleeve gastrectomy when compared with the more commonly conducted transversus abdominis plane (TAP) block regional anesthetic technique.

The aim of this study was to assess the postsurgical analgesic efficacy of the ultrasound guided bilateral erector spinae block compared with the bilateral subcostal transversus abdominis plane block following laparoscopic sleeve gastrectomy. Comparison was primarily conducted through the use of the postoperative visual analogue scale, and secondarily through the assessment of postoperative opioid consumption.

Materials and methods

This prospective randomized controlled trial was conducted at the Cairo University hospitals between December 2018 and July 2019 following the approval of the research ethical committee (N-125-2018). The study was registered at clinicaltrials.gov (NCT03747406). Sixty-six patients of both genders, 18 to 59 years of age with an American Society of Anesthesiology (ASA) physical status of II-III and a Body Mass Index (BMI) >40 kg/m^2 who were scheduled for elective sleeve gastrectomy, were enrolled in the study and consent form was explained to all participants. Exclusion criteria were; 1) the presence of coagulopathy or thrombocytopenia with a count less than 100,000/mL; 2) patients having hepatic or renal disease; 3) opioid addiction; 4) sepsis (due to the increased risk of meningitis); 5) infection at the puncture site; 6) pre-existing neurologic disease; or 7) a history of an allergy to local anesthetic.

Patients were randomly assigned to either one of three study groups on the day of surgery. Grouping was determined through a computer-generated list that was kept in a sealed envelope. Both patients and the anesthetists involved in postoperative data collection were blinded as to the treatment group to which each patient belonged. All groups initially received general anesthesia and one of three analgesic techniques was then conducted; The ESP group received a single shot of bilateral erector spinae plane block at the level of T9; the TAP group received a single shot of bilateral subcostal transversus abdominis plane block; and the controlled group received opioid analgesia.

All patients were assessed clinically and investigated for the presence of any of the exclusion criteria mentioned above. Intravenous access and IV crystalloids were applied. Patients were premedicated with 8 mg of intravenous dexamethasone and 4 mg of ondansetron. During the surgeries, electrocardiography (ECG), noninvasive blood pressure (NIBP) and pulse oximetry monitoring were conducted.

All patients in the study received general anesthesia in the form of 2 mg/kg of propofol and 0.5 mg/kg of atracurium (based on lean body weight), in addition to 100 μg of fentanyl for the induction of anesthesia. An endotracheal tube and mechanical ventilation were applied. Monitoring through ECG, NIBP, pulse oximetry and capnography ($ETCO_2$) continued throughout the surgeries. Ventilatory parameters were set at a tidal volume of 4-6 mL/kg at a respiratory rate of 12-15 breath/min to maintain $ETCO_2$ between 30 and 35 mmHg. As the surgeries progressed, 1.2% MAC of isoflurane and 10 mg of atracurium were administered every 20 minutes as maintenance anesthetic drugs.

Interventions

ESP block group

Each patient was rolled to their side. An 8-14 MHz curved array probe (Siemens ACUSON X300 Ultrasound System) was placed in a transverse orientation at T9 level to identify the tip of the T9 transverse process and the erector spinae. The tip of the transverse process was centered on the ultrasound screen and the probe was then rotated into a longitudinal orientation 2-3 cm lateral to vertebral column (the level of mid surgery). A skin wheal was made using 1% lidocaine at each level and then a 22-gauge, 8-cm Tuohy needle (Perifix Epidural Needle) was advanced in-plane from the cranial to caudal direction until it made contact with the T9 transverse process. The needle was then slightly withdrawn. Hydro-dissection with 2-3 mL of isotonic saline solution confirmed the correct needle tip position and, after negative aspiration, 30 mL of 0.25% bupivacaine (15 mL for each side) was injected slowly whilst carefully monitoring the spread of local anesthetic between transverse process and erector spinae muscle. The same procedure was repeated on the contralateral side.[15]

TAP block group

Each patient was kept in the supine position. A 5-12 MHz linear array transducer (Siemens ACUSON X300 Ultrasound System) was positioned inferior and parallel to the costal margin. The external oblique, internal oblique and transversus abdominis muscles were identified immediately lateral to the linea semilunaris. A 22-gauge, 8-cm Tuohy needle (Perifix Epidural Needle) was advanced medially in-plane from the cranial to caudal direction until the tip lied between the fascia of the internal oblique muscle and the layers of the transversus abdominis muscle. After hydro-dissection with 2-3 mL of isotonic saline solution confirmed the correct needle tip position, 30 mL of 0.25% bupivacaine was injected slowly on each side, and the spread was observed between the two muscle layers.[6, 16]

Continuous monitoring of heart rate and arterial blood pressure was conducted. Incremental 50 microgram doses of fentanyl were administrated to counter any 20% increase in mean arterial blood pressure compared with baseline readings. Total intraoperative fentanyl requirements were carefully recorded.

After surgery and emergence from anesthesia, patients were first referred to the recovery unit, then to the surgery inpatient intermediate care unit.

Assessment of postoperative pain using the Visual Analogue Scale (VAS) was set as the primary outcome of this study. Patients were asked to record their level of pain at 30 minutes as well as at two, four, six, eight, 12, 18 and 24 hours postoperatively. A VAS pain score of three prompted the slow intravenous infusion of one gm of paracetamol (with maximum daily dose of 4 g/24 h). At a VAS of five or above, 50 mg of intravenous pethidine was administered. The total dose of analgesics administered during the first 24 hours was carefully recorded.

The following were set as secondary outcomes of this study: 1) total intraoperative fentanyl requirements; 2) intraoperative heart rate and mean arterial blood pressure; 3) duration of anesthesia (time from induction of GA till extubation); 4) in-

cidence of complications, including nerve injury, hematoma formation, LA toxicity, and intravascular injections; 5) the cumulative consumption of pethidine during the first 24 postoperatively; 6) the duration of time before the first request for rescue analgesia post-surgically.

The maximum allowed dose of pethidine was set at 5 mg/kg/24 h based on lean body weight. The blocks were considered as failed blocks if patients required more than two doses of rescue analgesia in the first postoperative hour. Failed blocks were excluded from the study and the cases were recorded.

Statistical analysis

Based on a pilot study, sample size was calculated according to the significant difference in the mean of VAS values over 24 hours (as a primary outcome) between control group (3.21±0.48), TAP group (2.23±0.41) and ESP group (1.51±0.35) using ANOVA test, with α=0.05, power of 80%, and an effect size of 0.4. Therefore, a sample size of 22 patients/group would be required (G-Power 301).

Data were tabulated using Microsoft Office Excel 2010 for Windows. Data was then transferred to the Statistical Package of Social Science Software Program v. 25 (IBM Corporation, Armonk, NY, USA) and data analysis was conducted. Categorical variables were presented as frequency (percentages) and were analyzed using the Chi-square test. The Shapiro-Wilk test was used to determine normality of data distribution. Normally distributed data were analyzed using a repeated measures general linear model analysis of variance (ANOVA) and presented as means and standard deviations.

Data that were found not to be normally distributed were presented as the medians and interquartile ranges (IQR) and were analyzed using the Kruskal-Wallis test as appropriate. VAS scores were analyzed using repeated measures analysis of variance. *Post-hoc* analysis was performed using the Bonferroni correction in order to detect pairwise differences.

Results

At the start of the study, 71 patients were screened for possible enrollment. Four patients were excluded, having not meet our inclusion criteria. One patient declined to participate. Sixty-six patients (22 for each group) were included in the randomization process (Figure 1). Demographic data, patient characteristics and durations of surgeries were comparable among the three groups (Table I).

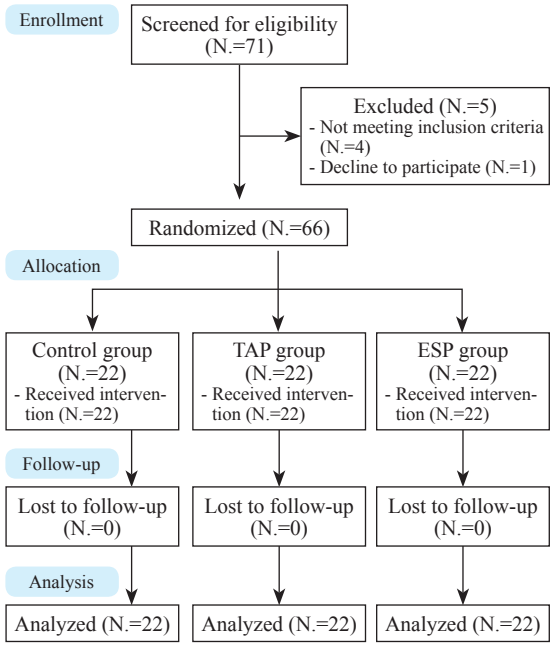

Figure 1.—Consort flow chart.

VAS were lower in the ESP and TAP groups compared with the control group throughout the first 12 postoperative hours (P≤0.001). VAS were lower in the ESP group compared with the control group at the 18th postoperative hour (P=0.034). There was no statistically significant difference between the ESP and TAP groups at the postoperative 30th minute. VAS in the ESP group were significantly lower compared with the TAP group at the 2nd, 4th, 6th, 8th, 12th postoperative hours. At the 24th postoperative hour, there was no statistically significant difference between the three groups (P=0.115). Comparable VAS were recorded in the ESP and TAP groups at the 18th and 24th postoperative hours (Table II).

The 24-hour postoperative consumption of pethidine was higher in the control group (median 150 and IQR 100-200) compared with both the ESP group (median 0 and IQR 0-50) and the

TABLE I.—*Demographic data and baseline characteristics.*

Characteristics	Control group (N.=22)	TAP group (N.=22)	ESP group (N.=22)	P value
Age, years	35.7±8.6	35.9±8.8	37.1±10.4	0.863
Sex, male	12 (54.5%)	13 (59.5%)	7 (31.8%)	0.153
BMI, kg/m^2	44.6±2.3	44.5±2.3	44.7±2.5	0.944
ASA class				0.456
II	16 (73%)	14 (64%)	12 (54%)	
III	6 (27%)	8 (36%)	10 (46%)	
Surgery duration, min	125.7±10.7	124.8±8.8	124.6±8.7	0.992

BMI: Body Mass Index; ASA: American Society of Anesthesiologists; TAP: transversus abdominis plane block; ESP: erector spinae plane block.

TABLE II.—*Postoperative analgesic requirements expressed as median and interquartile range.*

Variables	Control group (N.=22)	TAP group (N.=22)	ESP group (N.=22)	P value
Paracetamol consumption, g				
First 12 hours	1 (1-2)* †	1 (0-1)	1 (0-1)	<0.001
Second 12 hours	1 (1-1.25)*	1 (0.75-1)	0.5 (0-1)	0.011
Total consumption	2.5 (2-3)* †	1 (1-2)	1 (0-1)	<0.001
Pethidine consumption, mg				
First 12 hours	100 (50-100)* †	0 (0-50)	0 (0-0)	<0.001
Second 12 hours	50 (27-100)*	25 (0-50)	0 (0-50)	0.006
Total consumption	150 (100-200)* †	50 (0-100)	0 (0-50)	<0.001
N. of patients that needed pethidine	22 (100%)* †	12 (54.5%) ‡	7 (31.8%)	<0.001
First request of rescue analgesia, h	2 (0.5-2) * †	6 (4-8) ‡	24 (18-24)	<0.001

TAP: transversus abdominis plane block; ESP: erector spinae plane block.
*Statistically significant difference between ESP and control group, † between TAP and control group, and ‡ between TAP and ESP groups.

TAP group (median 50 and IQR 0-100) (P value <0.001).

Only 7 patients needed postoperative pethidine in the ESP group compared with 12 in the TAP group and 22 in the control group. Similarly, the total 24-hour paracetamol consumption in the ESP group (median 1, IQR 0-1) was comparatively less than in both the TAP (median 1, IQR 1-2) and the control group (median 2.5, IQR 2-3). There were statistically significant differences in the timing of the first request for rescue analgesia among the three groups (P<0.001). The timing was significantly delayed in the ESP group (median 24, IQR 18-24) compared with both the TAP group (median 6, IQR 4-8) and the control group (median 2, IQR 0.5-2). Data of postoperative analgesic requirements are presented in Table III.

The was a notable variance in the levels of required intraoperatively administered fentanyl among the three groups. A median of 150 (IQR 137.5-200) was administered in the control group; medians of 100 (IQR 100-150) and 100 (IQR 100-100) were administered in the TAP and ESP groups respectively (P<0.001). Only one patient in the ESP group required fentanyl administration beyond the induction dose compared with seven patients in the TAP group and 17 patients in the control group (P<0.001) (Table IV).

Significant differences were found in the recorded heart rates and mean arterial blood

TABLE III.—*Intraoperative fentanyl requirements expressed as median and interquartile range.*

Variable	Control group (N.=22)	TAP group (N.=22)	ESP group (N.=22)	P value
Total fentanyl requirement, µg	150 (137.5-200)* †	100 (100-150) ‡	100 (100-100)	<0.001
N. patients needing fentanyl other than induction dose	17 (77.3%)* †	7 (31.8%) ‡	1 (4.5%)	<0.001

TAP: transversus abdominis plane block; ESP: erector spinae plane block.
*Statistically significant difference between ESP and control group, † between TAP and control group, and ‡ between TAP and ESP groups.

TABLE IV.—*Postoperative visual analogue scale (VAS) expressed as median and interquartile range.*

Timepoint	Control group (N.=22)	TAP group (N.=22)	ESP group (N.=22)	P value
30 min	2 (2-3.25)* †	1 (1-1.25)	1 (1-1.25)	<0.001
2 hours	3 (2-5)* †	1 (1-1.25) ‡	2 (1-2)	<0.001
4 hours	3 (2-5)* †	2 (2-2.25) ‡	2 (1-2)	<0.001
6 hours	3.5(3-5)* †	2 (1-4) ‡	1.5 (1-2)	<0.001
8 hours	3.5 (2.75-5)* †	2 (1-4.25) ‡	1.5 (1-2)	<0.001
12 hours	2.5 (2-5)* †	2 (2-3) ‡	1 (2-2)	0.001
18 hours	3 (2-5)*	2 (2-5)	2 (2-3)	0.034
24 hours	3 (2-5)	2 (2-3)	2 (2-3)	0.115

TAP: transversus abdominis plane block; ESP: erector spinae plane block.
*Statistically significant difference between ESP and control group, † between TAP and control group, and ‡ between TAP and ESP groups.

pressures between the ESP and control groups at 30, 60, 90, and 120 minutes intraoperatively, as well as at the first postoperative hour. Similar significant differences were noted between the TAP group and control group at 60, 90, 120 minutes intraoperatively and at the first postoperative hour. No statistically significant differences in these vital signs were found between the TAP and ESP groups except at the 30th intraoperative minute. Among the three groups, there were no statistically significant differences in the measured heart rates and mean arterial blood pressures in the first 24 hours postoperatively (Figure 2, 3).

More patients in the control group suffered from postoperative nausea and vomiting compared with either the ESP or the TAP groups. Specifically, 14 patients (63.6%) of control group

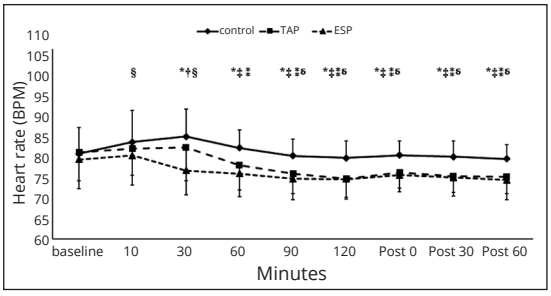

Figure 2.—Mean values of heart rate in the three studied groups measured at different time points (baseline preoperative reading, 10, 30, 60, 90, 120 minutes intraoperative and 0, 30, 60 minutes postoperative).
TAP: transversus abdominis plane block; ESP: erector spinae plane block.
*Statistically significant difference between control and ESP groups, † between ESP and TAP groups, ‡ between control and TAP groups, § in relation to baseline reading in control group, ⁎ in relation to baseline reading in TAP group, and δ in relation to baseline reading in ESP group.

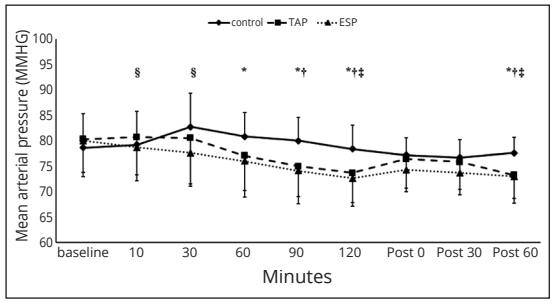

Figure 3.—Mean arterial blood pressure (baseline preoperative reading, 10, 30, 60, 90, 120 minutes intraoperative and 0, 30, 60 minutes postoperative).
TAP: transversus abdominis plane block; ESP: erector spinae plane block.
*Statistically significant difference between control and ESP groups, † between control and TAP groups, ‡ in relation to baseline reading in control group, and § in relation to baseline reading in TAP group.

suffered from postoperative nausea (P=0.003) among whom seven (31.8%) suffered from additional postoperative vomiting (P=0.029). There were no significant differences between the ESP and TAP groups with regards to postoperative nausea (40.9% in TAP *vs*. 36.4% in ESP) and vomiting (18.2% in both groups) (Table V).

None of the patients in the three groups complained of postoperative shoulder pain. No notable intraoperative or postoperative complications were recorded for any of the three study groups. There were no cases of failed TAP or ESP blocks.

Discussion

As our results indicate, VAS was lower in the ESP and TAP groups compared with the control group throughout the first 12 postoperative hours (P≤0.001). VAS was lower in Erector spinae

TABLE V.—*Number of patients experiencing postoperative nausea and vomiting.*

Complication	Control group (N.=22)	TAP group (N.=22)	ESP group (N.=22)	P value
Nausea	14 (63.6%)* †	9 (40.9%)	8 (36.4%)	0.003
Vomiting	7 (31.8%)* †	4 (18.2%)	4 (18.2%)	0.029

TAP: transversus abdominus plane block; ESP: erector spinae plane block.
*Statistically significant difference between ESP and control group, † between TAP and control group, and ‡ between TAP and ESP groups.

group in relation to control group at 18th postoperative hour (P=0.034). VAS in the Erector spinae group were significantly lower compared to TAP at the 12 postoperative hours. Moreover, the ESP group required less intraoperative fentanyl compared to both control or TAP group. 24 hours postoperative pethidine consumption was higher in the control group compared to both erector spinae and transversus abdominis groups (P<0.001). Erector spinae group showed less pethidine consumption than TAP group.

The postoperative period following a laparoscopic sleeve gastrectomy is often characterized by a combination of parietal abdominal wall pain and visceral pain caused by the surgical manipulation of the stomach. Moreover, laparoscopic sleeve gastrectomy often leads to shoulder pain due to diaphragmatic irritation caused by pneumoperitoneum.

It is worth noting that a number of proposed anesthetic protocols have been investigated in several previous studies with the aim of reducing or completely avoiding the use of opioids postoperatively (in part due to the cardiopulmonary effects of opioids). Paracetamol, NSAID, COX-2 inhibitors, gabapentin, ketamine and dexmedetomidine, have all been tested as sole analgesic agent or in different combinations, with resultant reductions in postoperative opioid consumption and improved pain relief. However, the problems of over sedation, hypotension, hallucinations, dysphoria and even insufficient analgesia invariably limit their use/efficacy.[17, 18]

The use of regional techniques combined with general anesthesia result in better pain management with less use of opioids in comparison with traditional techniques whilst avoiding thrombotic and infectious sequalae. They do not interfere with respiratory functions whether intraoperatively or postoperatively. This invariably reduces levels of stress and hospital stay.[19]

Previous studies have investigated different analgesic techniques for laparoscopic surgeries. Incision instillation of local anesthetics has been reported on. Reports indicate, however, that its analgesic effect is weak and limited to a few postoperative hours.[20] Intraperitoneal instillation of local anesthetics showed only a limited analgesic effect.[21, 22] Whilst epidural analgesia has been long regarded as a successful postoperative analgesic technique, there is lack of evidence concerning its cost-benefit ratio.[22, 23] Naja *et al.*[24] reported that bilateral paravertebral block using a nerve stimulator was effective in blocking both visceral and parietal pain after laparoscopic cholecystectomies. However, the use of the blind technique risked serious complications such as subdural spread of local anesthetics and pneumothorax.

Ultrasound-guided TAP block is an analgesic technique that blocks nerve branches at T6 to L1. The sensory block can differ with different approaches to the TAP block.[8] Several studies have reported that administration of a TAP block, regardless of it being conducted using the blind technique[25, 26] or with aid of ultrasonography,[27, 28] had reduced postoperative pain scores and postoperative opioid consumption, especially in surgeries of the lower abdomen.

In this study, we performed a subcostal approach of TAP block. We regarded it as being more suitable for the purpose of abolishing pain at the site of the epigastric and subcostal ports. We reasoned that, whilst the conventional TAP block provides sensory block at T10 to L1, the subcostal approach would cover T7 to T12. Tolchard *et al.*[27] introduced the subcostal approach of ultrasound guided TAP block in the postoperative analgesia after laparoscopic cholecystectomy and demonstrated that it had better analgesic quality compared with port site infiltration. Shin *et al.*[28] compared ultrasound guided

subcostal TAP with conventional TAP, and they confirmed the superiority of the subcostal approach in reducing pain scores and the need for the administration of opioids postoperatively.

Taking into consideration that the pattern of sensory distribution after a TAP block depends on the volume of local anesthetic used, we used 30 ml of 0.25% bupivacaine in order to increase the analgesic potency and the number of blocked dermatomes.

Previous studies have reported the superiority of paravertebral blocks over subcostal TAP.[29, 30] Whereas the effects of TAP blocks are limited to somatic pain, paravertebral blocks control both somatic and visceral pain, the latter of which constitutes most of the pain felt following laparoscopic surgeries.

ESP is a new regional anesthesia technique that was first introduced to control thoracic neuropathic pain and acute pain after thoracic surgery or trauma.[31] It showed an equipotent analgesic effect to paravertebral nerve block for post thoracotomy pain with advantages of safety and simplicity of technique.[32] Gürkan *et al.*[33] demonstrated the efficiency of the administration of ESP at the 4th thoracic vertebrae for postoperative analgesia after breast surgery.

In this study we performed bilateral ESP at the level of T9 using 15 mL of 0.25% bupivacaine on each side. In previous studies, the volume of local anesthetic used in bilateral ESP block varied between 15 and 20 mL.[10-14] For safety reasons, we chose to administer 15 ml at each side. We do however recommend that further studies be conducted to compare the efficacy of different volumes and concentrations of local anesthetics in ESP.

The columnar arrangement of the erector spinae muscle and its associated retinaculum can also provide abdominal analgesia if ESP is performed at a lower thoracic level.[34] There are many case series that have pointed to the safety and efficiency of bilateral ESP after bariatric[9] and laparoscopic[35] surgeries. However, the small number of patients in these studies limits the ability to generalize upon their findings.

Many cadaveric studies have been conducted in order to investigate the exact mechanism of action of the ESP using both magnetic resonance imaging and anatomical dissection.[35-37] These studies pointed to three patterns of distribution of the local anesthetic. Firstly, there was vertical spread beneath the transvers-spinalis muscles. This would allow for the blockage of the dorsal rami of the spinal nerve. Secondly, there was lateral spread. This would allow for the blockage of the intercostal nerve and/or the lateral cutaneous branches of the intercostal nerve. Finally, they noted a limited spread in the paravertebral space. However, the difference in tissues between cadavers and living person should be taken into consideration when assessing these findings.

Our study is based on comparison of two different nerve block techniques as a sole analgesia after sleeve gastrectomy surgery aiming to decrease or avoid the use of systemic analgesia and their potential side effects.[1, 3] Thus, the use of systemic analgesia on regular basis may hinder to reach a solid conclusion about using both techniques a sole analgesic method.[33] On the other hand, when designing our study, we faced the problem of incident pain especially for control group patients. To overcome this, we discharged all patients postoperatively to intermediate care unit with complete attendance of full-time anesthesiologist who was blinded to the study group for monitoring and early management of any attack of pain.

Fortunately, none of the patients suffered from failed ESP block or TAP block with minimal amount of paracetamol and pethidine consumption compared to the control group as shown in result section. Previous studies have demonstrated that the differences in fascia, incorrect dermatomal choice, or volume and concentration of local anesthetic may affect the rate of block success.[38, 39] More studies with larger number of patients are required to record the success rate of both techniques in morbidly obese patients.

In this study, there were no cases of postoperative shoulder pain in any of the three groups. However, the incidence of shoulder pain after laparoscopic surgeries varies greatly, with some studies reporting incidences as high as 30-50%.[40] The cause of absence of shoulder pain in our patients can be attributed to the application of low insufflation pressure during surgical procedure.

In this study, the number of patients who experienced postoperative nausea and vomiting was higher in the control group (14 patients (63.6%) of control group suffered from nausea and seven (31.8%) suffered from postoperative vomiting) compared to ESP (36.4% for nausea 18.2% for vomiting) and TAP groups (36.4% for nausea, 18.2% for vomiting). The incidence of postoperative nausea and vomiting in laparoscopic surgeries is reported to be higher than that after other types of surgeries. A rate of 46% to 75% has been reported for patients who did not receive antiemetic premedication with the use of opioids as a postoperative analgesia.[41] Moreover, the high pain score and pethidine dose needed for control group could explain the increased incidence of nausea and vomiting. It must be noted that the use of inhalational anesthetics, the nature of the surgery conducted (which causes mechanical irritation of the stomach) and the routine use of ondansetron and dexamethasone as antiemetics constitute confounders that potentially limit the value of our results.

On the other hand, the authors did not encounter any technical difficulties or complications while performing either the ESP or TAP. We used a blunted tip Tuohy needle to facilitate the differentiation of different tissue plane sensations which helped us in situations where ultrasound visualization was difficult due to large amount of subcutaneous fat and the difficulties in identifying anatomical landmarks. Safety of these blocks have been investigated in previous studies, however there were some reports of local anesthesia toxicity following ESP block[38] and visceral injury following TAP block.[39]

Limitations of the study

There was a limitation to this study, we performed both ESP and TAB after the induction of general anesthesia. Therefore, the assessment of sensory onset and of blocked dermatomes was not performed. Further studies should be conducted in order to assess sensory onset in both techniques. Further studies should also be conducted in order to detail the optimal volume, concentration and type of local anesthetic for ESP for this type of surgery.

Conclusions

With the administration of the ultrasound-guided single-shot T9 erector spinae plane block, there were lower postoperative pain scores, and reduced intraoperative and postoperative opioid consumption compared with both the subcostal approach transversus abdominis plane block and the control group in obese patients that had undergone sleeve gastrectomy. However, more research with larger sample sizes are required to confirm our findings. We have concluded that ESP is a safe, easily performed and effective regional analgesic technique. Future studies are required to investigate the optimal volume, concentration and type of local anesthetic for ESP when conducted for sleeve gastrectomy.

What is known

- Pain control in the morbidly obese can increase sensitivity to opioid-induced respiratory depression.
- Previous studies have shown that the administration of transversus abdominis plane block improves pain related outcomes after a multitude of surgical procedures.

What is new

- The subcostal approach targets the innervations of the upper abdominal trocar sites and is more suitable for incisions in the supra-umbilical region.
- Ultrasound-guided erector spinae block is a novel regional anesthesia technique that blocks the ventral rami and rami communicants that include sympathetic nerve fibers, as the local anesthetic spreads through the paravertebral space which reduces both somatic and visceral pain.
- Single shot ultrasound guided erector spinae block can be a sole analgesic technique producing effective 24 hours postoperative analgesia without requirement of additional doses of systemic analgesia in morbidly obese patients undergoing laparoscopic sleeve gastrectomy surgeries.

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