Randomized Trial

Analgesic and Respiratory Effects of Two Doses of Morphine as an Adjunct to Bupivacaine in Ultrasound-Guided Transversus Abdominis Plane Block in Upper Abdominal Surgery

Hala S. Abdel-Ghaffar, MD, Fatma G.E. Askar, MD, Huda H. Mohamed, MBBCH, Nagwa M. Ibrahim, MD, Amani H. Abdel-Wahab, MD, and Mostafa S. Abbas, MD

From: Department of Anesthesia and Intensive Care, Faculty of Medicine, Assiut University, Assiut, Egypt

Address Correspondence:
Hala S. Abdel-Ghaffar, MD
Department of Anesthesia and Intensive Care
Faculty of Medicine, Assiut University
Assiut, Egypt
E-mail:
hallasaad@yahoo.com

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Background: Opioid receptors are present at the terminals of afferent peripheral nerves; therefore, administration of opioids peripherally might provide a significant analgesic effect.

Objectives: We investigated the analgesic efficacy of 2 different doses of morphine in bilateral subcostal single-injection ultrasound-guided transversus abdominis plane (TAP) block in abdominal surgery.

Study Design: Randomized, controlled, double-blind trial.

Setting: University hospital.

Methods: We enrolled 90 patients (aged 18-60 years) who were scheduled for elective upper abdominal surgeries and received TAP block for postoperative analgesia. Patients received 20 mL bupivacaine 0.5% (group B) only or combined with 10 mg morphine (group BM10) or 15 mg morphine (group BM15). Study drugs were diluted with saline solution 0.9% to 40 mL volume and bupivacaine concentration of 0.25% and injected 20 mL on each side. Primary outcome was the verbal rating pain scale (VRS) over the first 24 hours postoperatively. Secondary outcomes were time to first request for analgesics, total analgesic consumption, lung spirometry, and adverse effects.

Results: Compared with group B, patients in BM10 and BM15 groups showed significantly lower postoperative VRS scores at rest and during cough. Patients in BM15 group had lower VRS scores at the 24th hour postoperatively at rest ($P = 0.034$) and during cough ($P = 0.040$), compared with group BM10, with no significant difference at other timepoints. The median time to first request for intravenous patient controlled analgesia (PCA) nalbuphine was 10 hours (range, 6-12 hours) in group B versus 15 hours (8-18 hours; $P = 0.000$) and 16 hours (10-23 hours; $P = 0.000$) in BM10 and BM15 groups, respectively. Total consumption of nalbuphine PCA in BM15 group was 12 mg (6-18 mg) compared with 26 mg (20-34 mg; $P = 0.000$) and 18 mg (12-24 mg; $P = 0.000$] in groups B and BM10, respectively, with a significant difference between BM10 and BM15 groups ($P = 0.000$) and without significant adverse effects.

Limitations: A limitation was a small sample size.

Conclusions: Addition of morphine to bupivacaine in single-injection subcostal TAP block controlled pain and reduced opioid requirements after abdominal surgery in a dose–dependent manner.

Key words: Abdominal surgery, analgesia, transversus abdominis plane block, morphine

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Postoperative pain is one of the main causes of respiratory function derangement after abdominal surgery (1). Epidural analgesia has been considered to be a gold standard modality for postoperative pain control, restoration of respiratory function, and prevention of other complications related to postoperative pain (2). However, the associated complications and contraindications of epidural analgesia may limit its use (3,4).

The transversus abdominis plane (TAP) block is a peripheral nerve block that involves the injection of a local anesthetic (LA) in the plane between the internal oblique and transversus abdominis muscle layers, with the aim of anesthetizing the intercostal nerves supplying the abdominal wall (from T6 to L1) (5). It provides adequate postoperative pain relief following various abdominal surgeries (6). Compared with epidural analgesia, TAP block has been shown to produce similar postoperative analgesia after abdominal surgery at rest and during movement or coughing (7-10).

The duration of the TAP block is limited to the effect of the administered LAs. Various adjuvant medications have been added to the LA to prolong the duration of TAP block and magnify its effects (11,12). Among opioids, morphine and tramadol have been proven to have significant peripheral analgesic effects (13). Opioid receptors are present at the terminals of afferent peripheral nerves; therefore, administration of opioids peripherally might provide a significant analgesic effect (13). Furthermore, morphine metabolites have an analgesic effect (14).

In this study, we hypothesized that by adding morphine to bupivacaine in TAP block in abdominal surgery, we might expect a better analgesic profile and long-term analgesic effect because of its low lipid solubility and low absorption rate. This analgesic enhancement would probably improve the patients' postoperative respiratory functions.

We aimed to compare the analgesic efficacy of 2 different doses of morphine (10 mg and 15 mg) added to bupivacaine in bilateral subcostal single-injection sonar-guided TAP block in patients undergoing abdominal surgery.

Methods

Enrollment and Eligibility

This randomized, double-blind clinically controlled trial was conducted in the Assiut University main hospital after institutional review board approval from the Medical Ethics Committee, Faculty of Medicine, Assiut University, Assiut, Egypt. It was registered in the ClinicalTrials.gov trial registry (ID: NCT02976597), and strictly followed the regulations and amendments of the Helsinki declaration. Written informed consent was obtained from all patients before participation in the study. We enrolled 90 patients of either gender aged from 18 to 60 years, American Society of Anesthesiologists (ASA) I or II, with body mass index (BMI) < 30 kg/m2, scheduled for elective abdominal surgeries under general anesthesia who would receive bilateral subcostal single-injection TAP block for postoperative analgesia. Upper abdominal surgical incisions whose lower end was at or above the T10 thoracic dermatome were included (e.g., biliary bypass and transverse incisions for pancreatic surgery). Incisions that extended below T10 or extended laterally beyond the anterior axillary line were excluded.

Patients with a history of significant organ dysfunction, coagulation disorders, allergy to study medications, chronic use of pain medications, psychological disorders, respiratory tract infection within the last 2 weeks, previous abdominal surgery or trauma, and moderate and heavy smokers (>10 cigarettes per day) were excluded from the study.

Randomization and Blinding

Ninety patients were randomized to receive ultrasound-guided bilateral TAP block after the end of surgery and before discontinuation of anesthesia. The TAP block was performed using 20 mL bupivacaine 0.5% (group B, 30 patients), 20 mL bupivacaine 0.5% combined with 10 mg morphine (group BM10, 30 patients), or 20 mL bupivacaine 0.5% combined with 15 mg morphine (group BM15, 30 patients). The study drugs were diluted with normal saline solution 0.9% to a final volume of 40 mL and bupivacaine concentration of 0.25%. Each patient received 20 mL on each side. Randomization was based on a computer-generated randomization table and sealed opaque envelopes. An independent investigator not involved in the study opened the opaque envelopes before induction of anesthesia and prepared the study drug solutions in identical sterile syringes with matching random codes. The attending anesthesiologist, physician, data collection personnel, and the patient were blinded to the group assignment.

Study Protocol

Preoperatively, patients were instructed on how

to use the intravenous (IV) patient controlled analgesia (PCA) device, and on how to describe their pain using the verbal rating pain scale (VRS). Spirometric measurements were undertaken on the day of the operation approximately one hour before anesthesia induction. All tests were performed at bedside with the patients in the sitting position by the use of a hand-held spirometer (One-flow, Clement Clarke, Harlow, UK). Forced vital capacity (FVC), forced expiratory volume in first second (FEV1), and FEV1/FVC ratio were measured and expressed both in absolute value and in percentage of the predicted reference value. At least 3 acceptable measurements were taken to meet the European Respiratory Society criteria for reproducibility (15). At each assessment, the largest values of FEV1, FVC, and FEV1/FVC ratio were recorded.

Routine monitoring included electrocardiogram, pulse oximetry, noninvasive blood pressure, end-tidal carbon dioxide, and temperature. A standardized anesthetic protocol consisted of an IV induction with fentanyl 2 mcg/kg, propofol 2 mg/kg, and lidocaine 2 mg/kg. Cisatracurium 0.15 mg/kg was given to facilitate endotracheal intubation. The lungs were mechanically ventilated by volume-controlled mode adjusted to maintain normocapnia. Anesthesia and muscle relaxation were maintained with isoflurane in 50% oxygen/air mixture, and cisatracurium 0.03 mg/kg administered at fixed intervals. The depth of anesthesia was adjusted accordingly with a goal of 80% to 120% of baseline noninvasive mean arterial pressure. Fentanyl bolus dose of 1 mcg/kg IV was administered for any intraoperative increase in the heart rate or mean arterial pressure above 20% of baseline. A Foley catheter was inserted and remained in situ for 24 hours postoperatively. At end of surgery and after the performance of the TAP block, muscle relaxation was reversed by neostigmine 50 μg/kg and atropine 20 μg/kg. The patients were extubated awake and transported to the postanesthesia care unit (PACU), and an IV PCA was commenced with nalbuphine (1 mg bolus, lock out time interval of 10 minutes and 4 hour limit of 0.25 mg/kg without baseline infusion). The concentration of nalbuphine was 100 mg in 100 mL sodium chloride 0.9%. IV PCA was continued for 24 hours postoperatively.

Ultrasound-Guided TAP Block

At the end of surgery and before discontinuation of general anesthesia, TAP block was performed by an experienced investigator under dynamic ultrasound guidance (Sonosite Inc., Bothell, WA). A high frequency (5-10 MHz) ultrasound probe was placed obliquely on the upper abdominal wall, along the subcostal margin near the midline. After identifying the rectus abdominis muscle, the probe was gradually moved laterally along the subcostal margin until we identified the transversus abdominis muscle lying posterior to the rectus muscle. A needle of 21-G, 100 mm (SonoPlex Stim cannula, Pajunk GmbH, Geisingen, Germany) was then introduced medially in the plane of the ultrasound beam and directed toward the TAP (5). After careful aspiration, the investigator who was blinded administered the study drugs according to group assignment, and the detection of hypoechoic layer on the ultrasound screen was confirmed. Then the maneuver was repeated on the other side.

Assessment Parameters

Patient demographics and clinical data including age, weight, gender, ASA class, BMI, operation type, and surgery and anesthesia times were recorded.

Assessment of TAP Block Procedure Success

A pinprick test of the abdominal wall was performed postoperatively at one hour after the block, and after full patient recovery to determine the extent of dermatomal skin sensory loss accomplished with the TAP block. Using a sterile needle, the loss of sensation was tested through the anatomic distribution of intercostal nerves from T6 until L1 (depending on the standard chart of skin dermatomes; T6 at the level of xiphoid process, T8 at the lower curve of costal margin, T10 at the umbilicus, T12 above symphysis pubis, and L1 at the level of inguinal ligament). Patients with failed block were excluded from the study.

Postoperative Pain Assessment

VRS scores (ranging from 0 = no pain, 1 = mild pain, 2 = moderate pain, 3 = severe pain, and 4 = excruciating pain) were recorded at rest and during coughing (16). These were assessed on admission to PACU (baseline), and 2, 4, 6, 12, and 24 hours postoperatively. Patients received rescue analgesia if requested and if VRS scores were ≥ 2. The time to first request for rescue analgesia was recorded from the completion of TAP block to the first given analgesic dose. The total consumption of postoperative rescue analgesics were recorded.

Respiratory Function

FVC, FEV1, and FEV1/FVC ratio were recorded preoperatively and 6, 12, and 24 hours postoperatively.

Vital Signs

Noninvasive systolic and diastolic blood pressure, heart rate, and respiratory rate were recorded at baseline (before the block) and at 30 minutes, 2, 4, 6, 12, and 24 hours postoperatively.

Adverse Effects

Any perioperative adverse event was treated and recorded. These could include hypotension, bradycardia, nausea, vomiting, pruritus, respiratory depression, or complications related to the technique of TAP block (such as needle trauma, femoral nerve palsy, or inadvertent intravascular injury).

Statistical Analysis

Power Calculation

The primary outcome was the VRS scores during cough in the first 24 hours postoperatively. Secondary outcomes were the time to first request of rescue analgesics, total analgesic consumption, spirometric lung function testing, and postoperative adverse effects. Based on previous research (11,12), 26 patients in each group would be sufficient to detect a statistically significant difference between groups in the primary endpoint with a power of study 80% and a 2-sided type 1 error of 5%. To compensate for patient dropout, 90 patients were recruited and were equally distributed between the 3 groups.

Data Analysis

Data entry and analyses were performed using SPSS version 22 (IBM Corporation, Armonk, NY). Data normality was tested with the Kolmogorov–Smirnov test. Data were presented as mean (standard deviation), median (range), number, and percentage. The Student t test was used for normally distributed continuous data, and the Wilcoxon signed-rank test in case of nonparametric data. The chi-squared test or the Fisher exact test was used to analyze frequency variables, and ordinal variables were analyzed using the Mann–Whitney U test. A P value of < 0.05 was considered statistically significant.

Results

Among the 95 patients who were screened for eligibility, 90 patients were analyzed (Fig. 1). The demo-

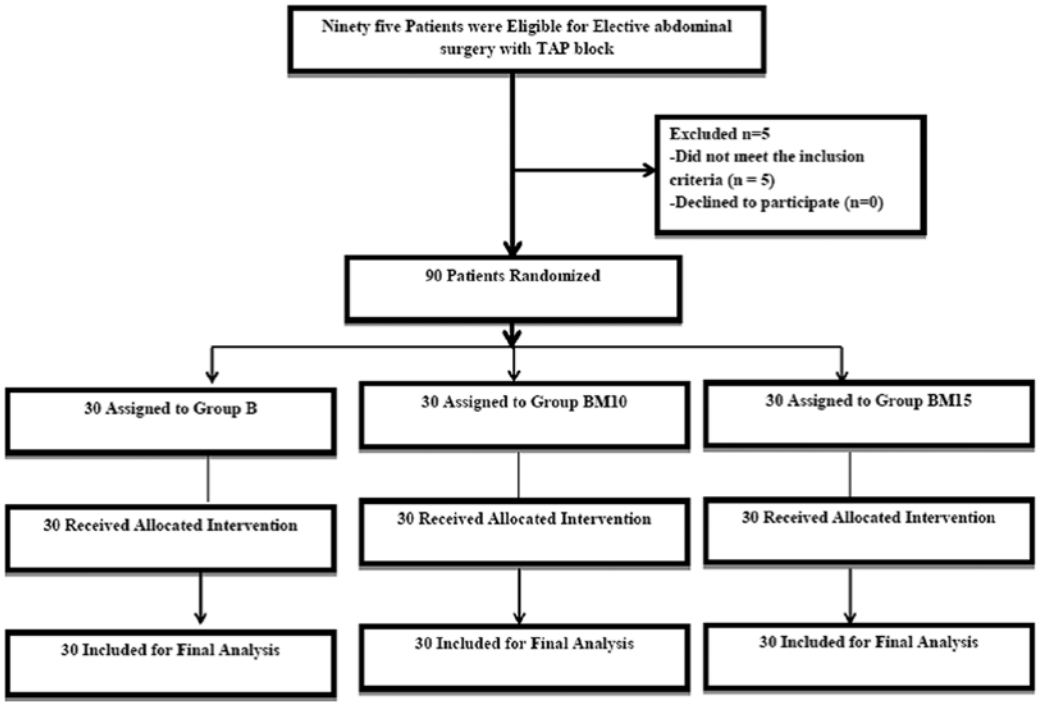

Fig. 1. *Participant flow diagram.*

graphic and clinical characteristics of enrolled patients are shown in Table 1. The dermatomal distribution of skin sensory loss in TAP block was matched between groups ($P > 0.05$; Table 2). No significant differences were recorded between groups in the postoperative hemodynamic vitals (data not presented).

From the second hour until the 24th hour postoperatively, the median resting VRS scores were significantly lower in the BM10 and BM15 groups compared with group B (Table 3). The median postoperative VRS scores after cough showed a highly significant decrease in the BM10 and BM15 groups ($P = 0.000$), compared with group B during all recorded timepoints. Patients in group BM15 had significantly lower VRS scores at the 24th hour postoperatively at rest ($P = 0.034$) and during cough ($P = 0.040$) compared with group BM10, with no significant difference in other timepoints.

The median time to first request for IV PCA nalbuphine was 10 hours (range, 6-12 hours) in group B versus 15 hours (8-18 hours; $P = 0.000$) and 16 hours (10-23 hours; $P = 0.000$) in BM10 and BM15 groups, respectively. The cumulative total consumption of nalbuphine PCA in BM15 group was 12 mg (6-18 mg) compared with 26 mg (20-34 mg; $P = 0.000$) and 18 mg (12-24 mg; $P = 0.000$] in groups B and BM10, respectively, with a significant difference between BM10 and BM15 groups ($P = 0.000$; Table 4).

Compared with preoperative baseline values, the mean FVC and FEV1 significantly decreased at 6, 12, and 24 hours postoperatively. The highest decrease was recorded in group B compared with BM10 and BM15 groups (Table 5). The recorded frequencies of postoperative adverse effects are listed in Table 1. No patient in this study experienced respiratory depression or sedation.

Table 1. *Patient demographics and clinical data.*

	Group B (n = 30)	Group BM10 (n = 30)	Group BM15 (n = 30)	*P* value
	Mean ± SD	Mean ± SD	Mean ± SD	
Age	41.5 ± 14.8	39.7 ± 12.9	40.2 ± 11.2	0.852
Gender				0.061
Male/ Female	20/10	11/19	14/16	
Weight	72.7 ± 11.3	71.9 ± 6.5	73.4 ± 8.9	0.808
Height	164.8 ± 8.2	165.4 ± 6.3	166.1 ± 7.6	0.783
BMI	26.7 ± 3.0	26.4 ± 2.8	26.6 ± 2.9	0.898
ASA Class				0.165
ASA I/ASA II	24/6	26/4	20/10	
Anesthesia time	180.6 ± 40.5	189.9 ± 49.8	188.6 ± 49.9	0.863
Operation time	140.8 ± 40.8	147.3 ± 48.9	144.67 ± 49.7	0.712
Postoperative adverse effects				
Vomiting	0 (0%)	2 (6.7%)	4 (13.3%)	0.117
Nausea	0 (0%)	5 (16.7%)	6 (20%)	0.040*
Pruritis	0 (0%)	2 (6.7%)	2 (6.7%)	0.351

Data expressed as mean ± SD and number.
Abbreviations: SD, standard deviation.
P < 0.05 significance between groups.

Table 2. *Dermatomal distribution of skin sensory loss in TAP block in the 3 studied groups*

Item	T6	T7	T8	T9	T10	T11	T12	L1
Group B	4	15	24	30	28	25	21	3
Group BM10	4	13	29	30	30	28	20	4
Group BM15	2	12	26	30	30	30	24	6
P value	0.638	0.730	0.140	-	0.129	0.053	0.487	0.533

Data expressed as number. P < 0.05 significance between groups.

Table 3. *Postoperative VRS score at rest and after cough in the 3 studied groups.*

Item	Group B (n = 30)	Group BM10 (n = 30)	Group BM15 (n = 30)	P value1	P value2	P value3
	Median (range)	Median (range)	Median (range)			
Resting VRS score						
Early postoperative	1 (0-2)	1 (0-2)	1 (0-2)	0.680	0.862	0.801
2 h	1 (0-2)	1 (0-2)	1 (0-1)	0.724	0.594	0.935
4 h	1 (0-1)	1 (0-1)	1 (0-1)	0.047*	0.025*	0.795
6 h	1 (0-2)	1 (0-1)	1 (0-1)	0.018*	0.004*	0.232
12 h	2 (1-3)	1 (0-2)	1 (0-2)	0.000*	0.000*	0.939
24 h	3 (2-3)	2 (1-2)	1 (0-2)	0.000*	0.000*	0.034*
VRS score on cough						
Early postoperative	3 (2-3)	2 (2-2)	2 (2-2)	0.000*	0.000*	1.000
2 h	3 (2-3)	2 (2-2)	2 (2-2)	0.000*	0.000*	1.000
4 h	3 (2-3)	2 (2-2)	2 (2-2)	0.000*	0.000*	1.000
6 h	3 (2-3)	2 (2-2)	2 (2-2)	0.000*	0.000*	1.000
12 h	3 (2-4)	2 (2-2)	2 (2-2)	0.000*	0.000*	1.000
24 h	4 (3-4)	3 (2-3)	2 (2-3)	0.000*	0.000*	0.040*

Data expressed as median (range). P value1: Significance between group B and group BM10; P value2: Significance between group B and group BM15; and P value3: Significance between group BM10 and group BM15. * = P < 0.05.

Table 4. *Postoperative analgesic consumption in the 3 studied groups.*

	Group B (n = 30)	Group BM10 (n = 30)	Group BM15 (n = 30)	P value1	P value2	P value3
	Median (range)	Median (range)	Median (range)			
Time to first request for analgesia (hour)	10 (6-12)	15 (8-18)	16 (10 -23)	0.000*	0.000*	0.067
Total dose of PCA nalbuphine (mg)	26 (20-34)	18 (12-24)	12 (6-18)	0.000*	0.000*	0.000*
Number of analgesia doses	5 (2-6)	3 (2-4)	2.5 (1-6)	0.000*	0.000*	0.039*

Data expressed as median (range). P value1: Significance between group B and group BM10; P value2: Significance between group B and group BM15; and P value3: Significance between group BM10 and group BM15. * = P < 0.05.

Discussion

We investigated the analgesic efficacy of 2 different doses of morphine (10 mg and 15 mg) added to bupivacaine in bilateral subcostal single-injection TAP block on postoperative pain and respiratory functions after abdominal surgery. We recorded lower pain scores at rest and during coughing and better preservation of lung volumes during the early postoperative period in the morphine groups. The consumption of nalbuphine IV PCA in the first 24 hours postoperatively was reduced in the morphine groups in a dose–dependent manner.

These results are in accordance to previous studies that showed significant reduction in postoperative analgesic consumption in patients who received TAP block analgesia (6,10-12). Thanks to the simplicity of the technique and the absence of significant adverse effects, TAP block has been gaining popularity as a part of the multimodal analgesic regimen after abdominal surgeries (17).

The poor lipid solubility of morphine hinders the systemic absorption, thereby prolonging the duration of the locally administered morphine (18,19). Conse-

Table 5. *Changes in the lung spirometry with time in the 3 studied groups.*

	Group B (n = 30)	Group BM10 (n = 30)	Group BM15 (n = 30)	P value1	P value2	P value3
	Median (range)	Median (range)	Median (range)			
FVC:						
Preoperative	2.5 (1.8-3.9)	2.6 (2.0-4.3)	2.9 (0.9-3.3)	0.287	0.062	0.231
(% of predicted value)	73.5 (52.0-90.0)	74.0 (64.0-81.0)	83.5 (28.0-95.0)			
6 h postoperative	1.4 (0.9-2.6)	1.8 (1.2-2.6)	1.7 (0.9-2.5)	0.000*	0.023*	0.137
(% of predicted value)	43.0 (26-59)	48 (39-64)	48 (30-72)			
12 h postoperative	1.0 (0.8-1.6)	1.4 (0.8-2.2)	1.5 (1.0-2.2)	0.000*	0.000*	0.579
(% of predicted value)	29.5 (22-44)	39 (27-48)	43.5 (34-62)			
24 h postoperative	0.7 (0.4-1.4)	1.2 (0.7-1.8)	1.1 (0.8-1.7)	0.000*	0.000*	0.965
(% of predicted value)	19.5 (12-43)	30 (22-42)	34.5 (25-43)			
FEV1:						
Preoperative	2.1 (1.2-3.2)	2.4 (1.4-3.2)	2.2 (1.2-3.1)	0.322	0.871	0.304
(% of predicted value)	78.0 (57.0-93.0)	79.5 (58.0-91.0)	72.0 (57.0-95.0)			
6 h postoperative	1.2 (0.6-2.6)	1.6 (0.6-2.4)	1.2 (0.7-2.6)	0.000*	0.391	0.018*
(% of predicted value)	43 (20-67)	48.0 (25-71)	44.5 (24-74)			
12 h postoperative	0.8 (0.4-1.5)	1.2 (0.4-2.0)	1.1 (0.6-2.1)	0.000*	0.000*	0.098
(% of predicted value)	29 (16-46)	38.5 (17-50)	40.5 (22-64)			
24 h postoperative	0.6 (0.3-1.3)	1.0 (0.5-1.8)	0.9 (0.5-1.4)	0.000*	0.000*	0.657
(% of predicted value)	22 (11-34)	30.5 (19-48)	34 (23-47)			
FEV1/FVC:						
Preoperative	85.8 (56.8-98.4)	93.8 (61.1-109)	85.6 (62.4-100)	0.089	0.626	0.064
(% of predicted value)	105.0 (85-128)	110.5 (74-130)	101 (76.2-124)			
6 h postoperative	90.2 (40-100)	91.1 (33.1-102)	78.8 (35.4-100)	0.416	0.069	0.003*
(% of predicted value)	105 (54-131)	112.5 (81-126)	97 (43-124)			
12 h postoperative	90.1 (43.9-100)	88.2 (50.6-100)	76.3 (52.9-100)	0.458	0.054	0.002*
(% of predicted value)	109 (59-134)	110.8 (62-126)	95.5 (51-124)			
24 h postoperative	95.2 (59.6-100)	90.9 (54.6-100)	79.8 (54-100)	0.747	0.118	0.022*
(% of predicted value)	108.5 (76-132)	108 (66-127)	97 (70-124)			

Data expressed as median (range). P value1: Significance between group B and group BM10; P value2: Significance between group B and group BM15; and P value3: Significance between group BM10 and group BM15 for intergroup significance at each respective time. * = $P < 0.05$.

quently, local morphine analgesia appeared to be an effective adjuvant in this study.

In this study, we selected the doses of 10 mg and 15 mg morphine with TAP block based on previous studies reporting that postoperative analgesia occurred when doses > 5 mg local morphine were administered (12,20-22). Dose dependency in the analgesic effect of the locally administered morphine has been previously reported (21). In accordance, we found that patients who had received 15 mg morphine in TAP block showed lower pain scores, longer time to first request for rescue analgesia, and reduced postoperative opioid consumption compared with those who received morphine 10 mg.

Regardless of the anesthetic technique, postoperative derangement of respiratory functions after upper abdominal surgery is almost inevitable (23). Postoperative pain and diaphragmatic dysfunction are listed as the main causes for such deterioration (24). Consequently, increasing the risk of postoperative pulmonary complications (24). Patients with upper abdominal surgery can suffer from postoperative restrictive respiratory derangements with > 50% reduction in vital capacity and > 30% reduction in functional residual capacity (23). The FEV1 is also reduced secondary to the reduction in lung volumes rather than due to airway obstruction (24). In this study, we reported similar de-

creases in postoperative FVC, FEV1, and FVC/FEV1 and the greatest decrease was recorded at 24 hours postoperatively. Patients who received TAP block with added morphine had less decrease in these parameters, implying the effect of morphine analgesia on postoperative respiratory function. Longer periods of postoperative follow-up (> 24 hours) would be needed to confirm the effect of TAP block with and without morphine on restoration of respiratory functions after abdominal surgery.

By blocking intercostal nerves T6 to L1, TAP block efficiently blocks somatic pain after abdominal wall surgery (10). Carrie and Biais (8) in their single patient case report found that bilateral subcostal TAP block restored FVC, FEV1, and diaphragmatic movements after splenectomy. Wu et al (25) reported that single-injection subcostal TAP block provided effective postoperative analgesia at rest and while moving after upper abdominal surgery compared to IV opioid analgesia. They also found, however, that it was less effective than continuous thoracic epidural analgesia. Baeriswyl et al (10) in their meta-analysis had concluded that there is moderate evidence that TAP block and epidural analgesia are equally effective in treating postoperative pain in both pediatric and adult patients. Moreover, patients who received TAP blocks showed less hypotension and reduced hospital length of stay (10). A limitation to this study was the lack of a control group without TAP block, which if present could have confirmed the benefits of TAP block on postoperative respiratory functions.

Chen et al (26) investigated the extent of cutaneous sensory blockade of the abdomen at 30 minutes after administering single-injection bilateral oblique subcostal TAP block in 12 healthy volunteers, and its regression over 26 hours after the block. Using the pinprick method, we tested the success of our performed blocks postoperatively after full patient recovery (at one hour after block performance). In accordance with Chen et al (26), we found that T6 and L1 intercostal nerves were the least to be blocked with subcostal TAP block. We believe that testing the extent of the area of cutaneous sensory block of the anterolateral abdomen after TAP block helps investigators to screen the validity of their blocks and to be confident in their analgesic profile. In addition, monitoring the regression of the skin sensory block helps to investigate the effect of the administered LA and the added adjuvants.

In this study, postoperative nausea, vomiting, and pruritus were reported in patients who received TAP block with morphine compared with the TAP block with bupivacaine only group (group B). The use of postoperative IV PCA with nalbuphine (an opioid with agonist/antagonist activity) might be responsible for the absence of such adverse effects in group B. In addition, we can suggest that these adverse effects might be attributed to the systemic absorption of the locally administered morphine.

In this study, we used nalbuphine for PCA because we administered a relatively large dose of morphine in TAP block. We always put in our minds the fear of systemic absorption of morphine. If we administered morphine also in PCA, we feared increased incidence of adverse effects, mainly respiratory depression. The use of nalbuphine PCA as an opioid with agonist antagonist actions will be safer in this setting.

A limitation to this study was that we did not assess serum levels of morphine to confirm or declare the role of systemic absorption of the local morphine. Another possible limitation may include the lack of a true control group/sham TAP group. CONCLUSIONS

The addition of morphine to bupivacaine in single-injection subcostal TAP block controlled pain and reduced opioid requirements after abdominal surgery in a dose–dependent manner. The impact of TAP block analgesia on postoperative functional outcomes such as restoration of respiratory functions, return of bowel movements, and early ambulation should be investigated.

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