Original Article

Ultrasound-guided rectus sheath and transversus abdominis plane blocks for perioperative analgesia in upper abdominal surgery: A randomized controlled study

ABSTRACT

Background: Regional anesthetic techniques can be used to alleviate postoperative pain in patients undergoing major upper abdominal surgery. Our aim was to evaluate the efficacy of bilateral ultrasound (US)-guided rectus sheath (RS) and transversus abdominis plane (TAP) blocks for better perioperative analgesia.

Patients and Methods: It is a prospective, observer-blinded, randomized clinical study. 40 eligible patients undergoing elective liver resection or Whipple procedure were included. All patients received a standardized anesthetic technique. Group 1 (n = 20) received preincisional US-guided bilateral RS and TAP blocks using 20 ml volume of bupivacaine 0.25% for each, and group 2 (n = 20) received local wound infiltration at end of surgery with 40 ml of bupivacaine 0.25%. A standardized postoperative analgesic regimen composed of intravenous paracetamol and a morphine patient-controlled analgesia (PCA). The use of intraoperative fentanyl and recovery room morphine boluses, PCA-administered morphine, pain scores as well as number of patients' experienced postoperative nausea and vomiting in the ward at 6 and 24 h were recorded.

Results: Group 1 patients received a significantly lower cumulative intraoperative fentanyl, significantly lesser boluses of morphine in postanesthesia care unit, as well, significantly lower cumulative 24 h postoperative morphine dosage than the group 2 patients. Pain visual analog scale scores were significantly lower at both 6 and 24 h postoperatively in TAP group when compared with the no-TAP group. There were no complications related to the TAP block procedures. No signs or symptoms of local anesthetic systemic toxicity were detected.

Conclusion: The combination of bilateral US-guided RS and TAP blocks provides excellent perioperative analgesia for major upper abdominal surgery.

Key words: Abdominal surgery; analgesia; rectus sheath; transversus abdominis plane block; ultrasound

Introduction

A significant pain experienced by patients after major upper abdominal surgery like liver resection and Whipple's procedure is derived from the abdominal wall incision.[1] Epidural analgesia remains the gold standard for pain control for abdominal surgical procedures.[2] Nevertheless, complications from epidural analgesia include hypotension, bradycardia, dural puncture, spinal infection, and rarely, but terribly, neurological damage.[3] Moreover, removal of the epidural

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catheters possibly will provide challenges and additional danger if patients develop coagulopathy on the basis of liver dysfunction.[4] Due to these risks, many anesthesiologists do not routinely insert epidurals for patients undergoing major liver resections. The idea of transversus abdominis plane (TAP) block is to anesthetize part of — or the entire — abdominal wall instead of using intrathecal or epidural techniques. Since the first description of the TAP block technique, this block has been increasingly used to provide somatic anesthesia of the antero-lateral abdominal wall.[5-8] Hebbard *et al*. described the US-guided continuous oblique subcostal TAP block.[9] Each can be done as a single shot or continuous catheter infusion technique, as well a combination of one or more can be done on a single side or both hemi-abdomens. The bilateral dual TAP (BD-TAP) block based on four single shot injections, aiming to anesthetize the entire abdominal wall.[7] The four injections of BD-TAP are; the epigastric area just below the xiphoid process medially to the costal curvature (subcostal) block, and the lateral classic TAP block in the lower abdomen on both hemi-abdomens. In our study, we replaced the subcostal TAP block by rectus sheath (RS) block. The central portion of the anterior abdominal wall is innervated by the ventral branches of the thoracolumbar nerves (Th6-L1). The ventral branches lie deep to the RA muscle but ventral to the posterior RS. The RS block has been utilized to provide analgesia for midline incisions and laparoscopic procedures.[6] RS block may also be effective in reducing postoperative pain in upper abdominal surgery as an alternative method of epidural analgesia in anticoagulated patients.[10] Therefore, in our study, we combined RS and TAP blocks for possible better perioperative analgesia in upper abdominal surgery.

Patients and Methods

After Local Medical Ethics Review Board approval, 40 patients scheduled for major upper abdominal surgery were enrolled in this study. This is a prospective; observer-blinded, randomized clinical study, conducted at King Fahd Specialist Hospital. Eligible patients were recruited after getting written, informed consents. Patients were excluded if they had any contraindication for RS or TAP blocks, any known allergy for bupivacaine, physical or mental conditions which may vague measuring postoperative pain following surgery. Patients with morbid obesity (body mass index ≥40) were also excluded. Patients were randomized allocated into one of the two groups; block group (group 1) or local infiltration group (group 2). All patients received a standardized anesthetic technique for induction with 100-200 mcg fentanyl, 2-3 mg/kg propofol, and 0.15 mg/kg cisatracurium. Maintenance was achieved with oxygen/air sevoflurane, and intraoperative titration of intravenous (IV) fentanyl. Group 1 received preincisional ultrasound (US)-guided Bilateral RS and TAP blocks using 20-ml volume of bupivacaine 0.25% for each, and group 2 received local wound infiltration of 40 ml of bupivacaine 0.25% at end of surgery. Preincisional US-guided RS and TAP blocks were done by one of the authors with significant previous experience in US-guided techniques and after that not involved in the collection of the studied data. The surgeon and operating room staff (anesthesiologists and nurses) were not blinded to the treatment group. However, the patient and family, recovery room nurses, and study coordinator who collected the data were blinded. After aseptic preparation of the injection sites, a US transducer (linear 6-13 MHz, SonoSite M-Turbo®, Brothell, WA) (covered with sterile sheath) was used. A 22-gauge 10 mm insulated needle (Stimuplex® A, B-Braun Medical, Melsungen, Germany) is inserted in-plane to the transducer in a medial to lateral direction with the endpoint in the fascial plane between the rectus muscle and posterior RS or between the internal oblique and transversus abdominis muscles (TAP block). After negative aspiration, 20 ml of bupivacaine 0.25% was injected. The spread of the injectate should be observed to be distributed within these planes. The type of skin incisions included extended right subcostal incision which is appropriate for different operations on the liver, gallbladder and biliary tract and transverse incision for pancreatic surgery as Whipple's procedure, total pancreatectomy, and distal pancreatectomy. Antiemetic regimen consisted of 8 mg dexamethasone (IV) administered at induction and 4 mg ondansetron (IV) administered at the completion of surgery. All patients were managed in the postanesthesia care unit (PACU) where, 2 mg boluses of IV morphine were given if needed every 5 min if pain score was equal or more than 5, with maximum dose of 10 mg. In ward, postoperative analgesic regimen composed of six hourly IV paracetamol (1 g) and patient-controlled analgesia morphine delivering a bolus of 1 mg, 6-min lockout, and maximum 4 h dose limit of 25 mg. The use of intraoperative fentanyl, PACU morphine boluses, and number of patients' experienced postoperative nausea and vomiting (PONV), as well as pain scores at 6 and 24 h following completion of surgery were recorded. Patient-reported pain scores were assessed with a visual analog scale (VAS) ranging from 0 to 10 with 0 denoting no pain and 10 denoting the maximal pain imaginable.

Statistics

Categorical data were expressed as numbers (%) and compared using a Chi-square or Fisher's exact test as appropriate. Continuous data with a parametric distribution were presented with means and standard deviations (SDs) and compared using an independent *t*-test, whereas nonparametric data were expressed as median and inter-

quartile range and compared with a Mann–Whitney U-test. A result was deemed significant when $P < 0.05$.

Sample size calculation

Based on our unpublished data of mean differences and SD of intraoperative fentanyl and postoperative morphine usage, we hypothesized a 50% reduction in fentanyl and morphine usage because of bilateral RS and TAP block administration. We calculated that <20 patients were required in each group to give 80% power at a 5% significance level.

Results

Forty patients were recruited into this study. There were no significant differences in demographic or operative data [Table 1]. Group 1 patients received a lower cumulative intraoperative fentanyl dose 360 (SD 88.3) μg than group 2 patients 580 (SD 91.8) microgram with a statistically significant $P = 0.0001$. In the PACU, group 1 patients needed smaller amounts of morphine (1 [SD 6.5] mg] than the group 2 patients, who needed 5.6 (SD 1.54) mg with statistically significant $P < 0.0001$. As well, group 1 patients needed a lower cumulative 24 h postoperative morphine dosage 11 (SD 4.59) mg than the group 2 patients, who used 38.6 (SD 9.17) mg with a statistically significant $P < 0.0001$ [Table 2]. Total number of patients reported PONV at 24 h following surgery was 8 (40%) in the TAP block group compared to 12 (60%) in the control group, but it was statistically nonsignificant [Table 2]. Pain VAS scores were significantly lower in group 1 than group 2 at both 6 h postoperatively (2.19 [1-4] vs. 4.8 [3-7]) and 24 h postoperatively (2.5 [2-6] vs. 4 [3-7]) [Table 3]. There were no complications related to the RS or TAP block procedures. No signs or symptoms of local anesthetic systemic toxicity were detected.

Table 1: Patients characteristics and duration of surgery

	TAP block group ($n = 30$)	No TAP block group ($n = 30$)	*P*
Age	32.2 (6.27)	34.8 (6.34)	0.20
Sex male/female	12/8	14/6	0.75
Height (cm)	169 (6.9)	170 (3.5)	0.57
Weight (kg)	74.2 (10.5)	76.95 (5.24)	0.18
Duration of surgery	486 (45.23)	482 (23.97)	0.78
Type of surgery			
Liver donor hepatectomy	15	17	0.69
Whipple	5	3	

Data are presented as mean ± SD for age, height, weight and duration of surgery and as number of patients for sex and type of surgery. TAP: Transversus abdominis plane; SD: Standard deviation

Table 2: IO and PO opioid usage and incidence of PONV

	TAP block group ($n = 30$)	No TAP block group ($n = 30$)	*P*
IO fentanyl consumption (microgram)	360 (88.3)	580 (91.8)	0.0001
Morphine usage in PACU (mg)	1 (6.5)	5.6 (1.54)	0.0001
Cumulative morphine usage at 24 h PO (mg)	11 (4.59)	38.6 (9.17)	0.0001
Patients reported PONV after 24 h PO	8/20	12/20	0.34

Data are presented as mean (SD) or number. PACU: Post anesthesia care unit; IO: Intraoperative; PO: Postoperative; PONV: PO nausea and vomiting, TAP: Transversus abdominis plane

Table 3: VAS scores at different time points in patients receiving TAP catheters or epidural analgesia

	TAP block group ($n = 30$)	No TAP block group ($n = 30$)	*P*
At 6 h	2.19 (1-4)	4.8 (3-7)	0.0001
At 24 h	2.5 (2-6)	4 (3-7)	0.001

Values are median (range). VAS: Visual analog scale, TAP: Transversus abdominis plane

Discussion

Optimal analgesia is an essential aspect of adequate recovery after major abdominal surgery. Regional analgesia of the abdominal wall can provide good analgesia for a variety of surgical operations especially when used as part of a multimodal technique. Between the internal oblique and transversus abdominis muscles lies a plane that contains the anterior rami of the lower six thoracic nerves (T7 to T12) and first lumbar nerve (L1), supplying the skin, muscles, and parietal peritoneum, this study was based on our experience with TAP block that proposed the technique was effective analgesic intervention for kidney transplant recipients. The clinical importance of our findings is the significant opioid-sparing effects of bilateral RS and TAP blocks both in the intraoperative as well as the postoperative period. Opioids, though very effective in perioperative pain management, may be associated with nausea-vomiting, pruritus, and respiratory depression. Moreover, some patients who are morbidly obese or having obstructive sleep apnea will be maximally benefitted from bilateral RS and TAP blocks through the opioid-sparing effects. Besides this, bilateral RS and TAP blocks also prevent the hemodynamic responses of surgical incision, so patients having ischemic heart disease or stenotic valvular lesion like mitral or aortic stenosis, where tachycardia is undesirable, will also be benefitted from preincisional bilateral RS and TAP blocks. These blocks may be a relatively safer alternative to neuraxial block for perioperative analgesia in patients having coagulopathy as it would occur in our cases of liver resections.

Our study has a few limitations. First, it is tricky to recognize insufficient analgesia intraoperatively. Though we controlled the depth of anesthesia by BIS monitoring,

ensured adequate muscle relaxation, prevented hypovolemia, indirect assessment of intraoperative pain by hemodynamic parameters may be imperfect. Second, we evaluated the postoperative pain at only 2 time periods (6 and 24 h) and only at rest, which is NOT the optimal, we would recommend for further comparative studies to increase the frequency and measure the VAS both at rest and on coughing.

Conclusion

The combination of bilateral US-guided RS and TAP blocks provide excellent perioperative analgesia for major upper abdominal surgery.

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Conflict of interest
There are no conflicts of interest.

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