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Research Article

Postoperative continuous transversus abdominis plane block vs continuous wound infusion of levobupivacaine in females undergoing open gynecologic procedures

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KEYWORDS

TAP block;
Continuous wound infusion;
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Abstract *Introduction:* Transversus abdominis plane (TAP) block is used as a part of multimodal analgesia in decreasing pain of lower abdominal wall incision. Local anesthetic instillation of wounds through subcutaneous or subfascial catheters is used to treat postoperative pain in different types of surgery. The aim of this randomized controlled trial was to study the opioid-sparing effect of these two techniques (if any) compared to placebo in women undergoing gynecologic procedures through transverse lower abdominal incisions.

Methods: Seventy-eight ASA I–II patients planned to undergo gynecologic procedures through a transverse lower abdominal incision were randomly divided into three equal groups: Control (C) group ($n = 26$), Continuous Wound Infusion (CWI) group ($n = 26$), and continuous transversus abdominis plane block (TAP) group ($n = 26$). After standardized general anesthetic and before extubation, the patients were given the allocated treatment. A morphine patient-controlled analgesia (PCA) was started postoperatively alongside with the local anesthetic (or placebo) infusion. Cumulative dose of morphine PCA in the first postoperative 48 h was the primary outcome. Secondary outcomes included visual analog pain score (VAS) at rest and on movement and complications of morphine PCA.

Results: The cumulative dose of morphine PCA in the first postoperative 48 h was higher in control group than in groups CWI and TAP ($P < 0.001$). However, no significant difference was found between groups CWI and TAP. No significant differences were found among the three groups regarding VAS during rest

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but TAP group showed less pain scores than groups C and CWI on movement. The three groups were similar regarding morphine side effects.

Conclusion: Continuous bilateral TAP block and CWI can decrease PCA morphine consumption in the first postoperative 48 h when compared to placebo in women undergoing gynecologic surgery through transverse lower abdominal incision. Continuous TAB block might give better analgesia with movement than CWI.

1. Introduction

The risks of postoperative epidural analgesia in gynecologic procedures done through lower abdominal transverse incision may outweigh its benefits [1]. Pain intensity in this type of incision is usually not as severe as in upper abdominal and thoracic incisions. Patient-controlled analgesia (PCA) is the most common modality used for postoperative pain control in women having gynecologic procedures [2].

Interest in transversus abdominis plane (TAP) block increased in the last decade after introduction of ultrasound in anesthetic practice. This block was used as a part of multimodal analgesia in decreasing pain of lower abdominal wall incisions [3–6].

Local anesthetic instillation of wounds through subcutaneous or subfascial catheters was used to treat postoperative pain in different types of surgery [7–9].

No study was found in the literature comparing the efficacy of continuous postoperative local anesthetic instillation in the wound (CWI) with continuous TAP block. It was hypothesized that both techniques could decrease the dose of morphine used postoperatively. The aim of this investigation was to study the opioid-sparing effect of these two techniques (if any) compared to placebo in women undergoing gynecologic procedures through transverse lower abdominal incisions.

2. Methods

After Local Ethics Committee approval and informed written consent were obtained, 78 ASA physical status I–III adult women scheduled for gynecologic procedures through a transverse lower abdominal incision were enrolled. The enrollment period lasted from November 2011 to September 2012 in King Fahd Military Hospital in Dhahran, KSA. Exclusion criteria included known allergy to amide local anesthetics or morphine, body mass index $>40\ \text{kg m}^{-2}$, and history of chronic use of opioids or other analgesics.

All patients were premedicated with oral lorazepam 1–2 mg the night before surgery. Standard monitors were applied before starting general anesthesia, which included electrocardiography, pulse oximerty, and noninvasive blood pressure. General anesthesia was induced by IV sufentanil 0.2–0.3 mcg kg^{-1} and propofol 2–2.5 mg kg^{-1}, and rocuronium 0.6 mg kg^{-1} to facilitate endotracheal intubation. Lungs were ventilated with 40% oxygen in medical air to keep end-tidal carbon dioxide concentration from 30 to 35 mmHg. Isoflurane was titrated to keep bispectral index (BIS) within 40–60. Sufentanil infusion (0.3–0.5 $\text{mcg kg}^{-1}\ \text{h}^{-1}$) was commenced after endotracheal intubation till starting closure of abdomen.

Patients were randomly assigned to three groups: continuous wound infiltration (CWI) with 0.25% levobupivacaine, continuous wound infiltration with normal saline (control group), or continuous bilateral transversus abdominis plane (TAP) block. Randomization was done using computerized randomization tables.

2.1. Continuous wound infiltration (Group CWI)

The surgeon inserted 2 multi-orifice G-20 epidural catheters superficial to the abdominal fascia in each half of the transverse wound. The two catheters were inserted transcutaneously by an introducer needle 1 in. from the two lateral edges of the wound. After closure of the skin, 10 ml of 0.25% levobupivacaine was injected in each catheter. The two catheters were taped to the skin and connected via a Y-connector to a prefilled electronic pump delivering 0.25% levobupivacaine at a rate of 4 ml hourly (2 ml per catheter) for 48 h (study period).

2.2. Control group (Group C)

The surgeon in this group inserted 2 multi-orifice G-20 epidural catheters the same way as in group W. Instead of injecting levobupivacaine, same volume of normal saline was injected via the catheters after closing the wound. Again, normal saline was used instead of levobupivacaine for postoperative infusion in the same rate.

2.3. Transversus abdominis plane block group (Group TAP)

After skin closure, patients were kept anesthetized, and bilateral ultrasound-guided transversus abdominis plane (US-guided TAP) block were performed under complete aseptic conditions. The block technique was similar to that described by Hebbard and colleagues [10]. A linear (5–12 MHz) US probe (Philips CX50, Bothell WA, USA) was positioned transversely in the mid-axillary line midway between the lower costal margin and iliac crest (Fig. 1). A 9-cm 18-G epidural needle was inserted in-plane under real-time US visualization from medial to lateral to be positioned in the plane between internal oblique and transversus abdominis muscles. One milliliter of normal saline was used to confirm the needle position, and then, 20 ml of 0.25% levobupivacaine were injected through the needle on each side. A multi-orifice 20-G epidural catheter was threaded where 7–8 cm of the catheter was left inside the TAP. The catheters were taped to the skin the same way in group W. The bilateral catheters were connected via Y-connector to a prefilled electronic pump delivering 0.25% levobupivacaine at a rate of 10 ml hourly (5 ml per catheter) for 48 h (study period).

All the study patients were given ondansetron 4 mg 30 min before extubation as antiemetic prophylaxis. Rocuronium effect was antagonized by neostigmine 40 mcg kg^{-1} and glyco-

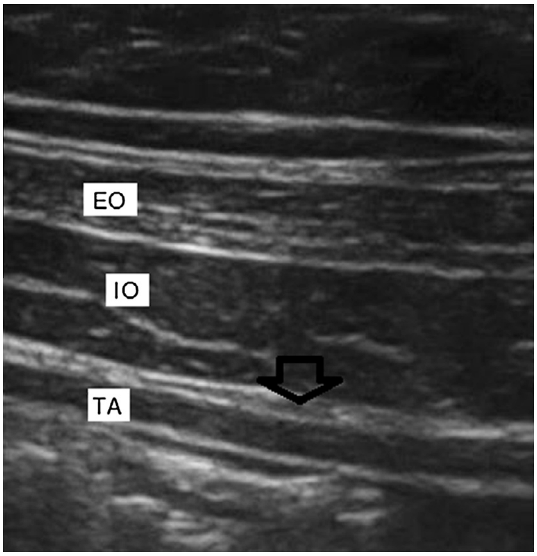

Figure 1 Ultrasound picture of lateral abdominal wall before the TAP block. Black arrow points to the plane of deposition of the local anesthetic. EO: external oblique muscle, IO: internal oblique muscle, TA: transversus abdominis muscle.

pyrrolate 8 mcg kg^{-1}, and then, the tracheas were extubated while the patients awake.

Patients were transferred to the postanesthesia care unit (PACU) with the electronic infusion pumps. The name and the rate of the infusate were covered trying to make the patients and assessors blinded to the technique used. A standard postoperative regimen was started in the PACU consisting of IV paracetamol 1 g given on arrival to PACU and patient-controlled IV morphine (PCA) (bolus dose 1 mg, lockout interval 6 min, 4-h maximum dose 40 mg, with no background infusion).

The nurses of the PACU and ward who were assessing the severity of pain using a visual analog score (VAS) were blinded to group allocation. Pain severity was measured using VAS (10 cm marked line in which 0 cm referred to no pain and 10 cm to the worst pain imaginable). The time points of pain assessment were performed at 2, 4, 6, 12, 24, 36, and 48 postoperatively. Pain scores were measured at rest and on movement (patients asked to flex their knees). Ondansetron 4 mg was given as a rescue antiemetic 8-hourly.

The primary outcome of this study was PCA morphine consumption in the first postoperative 48 h (study period). Based on old hospital documents over the past 2 yr, women undergoing these types of surgery use PCA morphine on the average of 65 mg over the first 48 postoperative hours (with ±SD of 15 mg). It was assumed that 25% difference in morphine consumption among the groups would be clinically significant. A sample size was calculated to be 24 at an alpha error of 0.05 and a beta error of 0.1. Twenty-six patients were enrolled per group to accommodate for dropouts.

Secondary outcomes included time to first dose of morphine PCA, VAS scores, and the side effects of morphine use (nausea or vomiting, drowsiness, respiratory rate less than eight and pruritis).

Statistical analyses were performed using the SPSS for Windows, version 15 (SPSS Inc., Chicago, IL). Data were first tested for normality by Klomogorov–Smirnov test. Normally distributed continuous data were analyzed by using one-way analysis of variance (ANOVA). Pair-wise comparison of morphine consumption between every two groups was done using Student's *t*-test after Bonferroni adjustment. Non-normally distributed continuous and ordinal data were analyzed using Kruskall–Wallis test. Categorical data were analyzed by chi square or Fisher's exact test as appropriate. The results are presented as mean ± SD, median (range), or number of patients as appropriate. A P value < 0.05 was considered statistically significant.

3. Results

One hundred seven patients were found eligible for the study. Ten patients refused participation and 19 patients met exclusion criteria. Seventy-eight patients were randomized into three groups: Control (C) group (n = 26), continuous wound infiltration (CWI) group (n = 26), and transversus abdominis plane block (TAP) group (n = 26). No patient was excluded from the study.

The three study groups were found to be similar regarding age, body mass index, ASA classification, and duration of surgery and anesthesia (Table 1).

Table 2 shows that patients in control group asked for morphine earlier than patients in groups CWI and TAP. Moreover, patients in group CWI asked for morphine earlier than patients in group TAP. The cumulative dose of morphine PCA in the first postoperative 48 h was significantly higher in control group than in groups CWI and TAP. However, no significant difference was found between groups CWI and TAP.

No significant differences were found among the three groups regarding visual analog pain scores during rest at any measured time point (Table 3). However, the results regarding visual analog pain scores on movement were variable. Overall, group TAP showed less pain scores than groups C and CWI (details in Table 4).

No significant differences were found among the three study groups regarding incidence of postoperative side effects of morphine PCA (Table 5). Despite the higher incidence of postoperative nausea and vomiting in group C than in groups CWI and TAP, it did not reach a statistical significance.

4. Discussion

The main finding of this study is that postoperative continuous wound infiltration (CWI) and continuous TAP block with levobupivacaine 0.25% decrease the cumulative PCA morphine dose by more than 50% compared to placebo in women undergoing gynecologic procedures through transverse lower abdominal incision. Both treatment techniques were comparable in this opioid-sparing effect. In spite of achieving same VAS scores at rest, the TAP block has superior analgesic effect over CWI and placebo during movement.

Infiltration of the subcutaneous or subfascial planes of the wound by local anesthetics results in analgesia through different mechanisms. Simple local anesthesia is the main mechanism. Systemic absorption of the local anesthetic from the site of infiltration may have a role in analgesia [11]. Anti-inflammatory properties of local anesthetics may participate in analgesic effects especially after tissue injury [12].

Results of investigations studying CWI in postoperative analgesia are not uniform. Some studies showed favorable re-

Table 1 Patients and surgical characteristics. Data are mean (SD) or number. C: Control group, CWI: continuous wound infiltration group, TAP: transversus abdominis plane block group, NS: nonsignificant.

	Group C (n = 26)	Group CWI (n = 26)	Group TAP (n = 26)	P value
Age (yr)	41 (8)	43 (10)	39 (12)	NS
Body mass index (kg m^{-2})	27 (2.9)	29.2 (3.1)	27.8 (2.6)	NS
ASA (I/II/III)	5/14/7	6/15/5	7/13/6	NS
Type of surgery				
Total abdominal hysterectomy	18	15	16	NS
Ovarian cystectomy	8	11	10	
Duration of surgery (min)	111 (28)	114 (24)	115 (19)	NS
Duration of anesthesia (min)	128 (27)	131 (30)	142 (28)	NS

Table 2 Patient-controlled analgesia morphine use. Data are mean (SD) or median (range).

	Group C (n = 26)	Group CWI (n = 26)	Group TAP (n = 26)	P value
First morphine dose (h)	1 (1–3)	7 (1–8)	9 (1–12)	< 0.001†
48 h PCA morphine (mg)	59 (15)	21 (10)	16 (9)	< 0.001*

C: Control group, CWI: continuous wound infiltration group, TAP: transversus abdominis plane block group.
† P: group C vs group CWI < 0.001, group C vs group TAP < 0.001, and group CWI vs group TAP = 0.001.
* P: group C vs group CWI < 0.001, group C vs group TAP < 0.001, and group CWI vs group TAP = 0.3.

Table 3 Visual analog score at rest. Data are median (range). C: Control group, CWI: continuous wound infiltration group, TAP: transversus abdominis plane block group, NS: nonsignificant.

	Group C (n = 26)	Group CWI (n = 26)	Group TAP (n = 26)	P value
2 h	2(1–5)	1(1–4)	1(1–4)	NS
4 h	2(1–6)	1(1–5)	1(1–5)	NS
6 h	1(1–5)	1.5(1–4)	1(1–4)	NS
12 h	2(1–5)	2(1–4)	1.5(1–5)	NS
24 h	2(1–5)	1(1–5)	2(1–4)	NS
36 h	1.5(1–4)	2(1–5)	1(1–4)	NS
48 h	1(1–4)	1.5(1–4)	1(1–3)	NS

Table 4 Visual analog score on movement. Data are median (range).

	Group C (n = 26)	Group CWI (n = 26)	Group TAP (n = 26)	P value
2 h	4 (1–6)	3(0–5)	2(0–5)	< 0.001†
4 h	4(1–6)	4(1–5)	2(0–5)	< 0.001*
6 h	3(1–7)	4(1–5)	3(1–5)	< 0.001 +
12 h	4(1–6)	3 (1–6)	3(1–5)	0.025§
24 h	4(1–6)	3(1–5)	3(1–5)	0.41 ±
36 h	3.5(1–5)	3(1–5)	3(1–5)	0.48‡
48 h	3(1–4)	3(1–3)	2(1–3)	NS

C: Control group, CWI: continuous wound infiltration group, TAP: transversus abdominis plane block group, NS: nonsignificant.
† P: group C vs group CWI < 0.001, group C vs group TAP < 0.001, and group CWI vs group TAP = 0.001.* P: group C vs group CWI = 0.16, group C vs group TAP < 0.001, and group CWI vs group TAP < 0.001.
+ P: group C vs group CWI = 0.45, group C vs group TAP < 0.001, and group CWI vs group TAP = 0.36.
§ P: group C vs group CWI = 0.26, group C vs group TAP = 0.008, and group CWI vs group TAP = 0.09.
± P: group C vs group CWI = 0.27, group C vs group TAP = 0.008, and group CWI vs group TAP = 0.1.
‡ P: group C vs group CWI = 0.27, group C vs group TAP = 0.008, and group CWI vs group TAP = 0.1.

sults [7–9], while others did not show any benefit [13,14]. These paradoxical results can be explained by the different types of surgery, different types of catheter and local anesthetic, the plane of catheter residence, and even the types of pump. Most of favorable results were associated with cesarean deliveries

Table 5 Incidence of postoperative side effects of morphine patient-controlled analgesia. Data are number (percentage). C: Control group, CWI: continuous wound infiltration group, TAP: transversus abdominis plane block group.

	Group C (n = 26)	Group CWI (n = 26)	Group TAP (n = 26)	P value
PONV	19(73)	12(46)	13(50)	0.1
Drowsiness	2(7)	0(0)	0(0)	0.5
Respiratory depression (rate < 8/min)	1(3)	0(0)	0(0)	0.4
Pruritis	5(19)	2(7)	1(3)	0.1

and gynecologic procedures [7,9,15] in which the site of incision is similar to that used in the current study.

A 20-G multi-orifice epidural catheter was used in the current study. This relatively large bore was selected to avoid occlusion that may occur in smaller catheters. Andersen et al. did not find difference of spread of local anesthetic between the commercial multi-orifice catheter and triple-orifice epidural catheter after total hip replacement [16].

Insertion of the CWI above the abdominal fascia might have helped in increasing its efficacy. Hafizoglu et al. found that postoperative analgesia in women undergoing hysterectomy was better with CWI catheters left above the abdominal fascia than with catheters left deep to the fascia [15]. The type of pump used may play a role in the success rate of the CWI technique [17]. Elastomeric pumps are liable to failure and the infusion rate may decrease by time. The electronic pump used in the current study is much more accurate.

All the above mentioned factors played a role in the favorable results of the CWI group over the control group.

The TAP block is used to anesthetize the abdominal wall nerves that supply the skin, muscles, and parietal peritoneum through the anterior rami of the lower six thoracic nerves and the first lumbar nerve [18].

In spite of being a relatively new technique, many investigations have been done about TAP block [3–5]. Introduction of ultrasound in anesthetic field added in increased accuracy of instillation of the local anesthetic in the correct plane between the internal oblique and transversus abdominis oblique muscles where the intercostal nerves run to supply the abdominal wall. The site of local anesthetic injection used in this study (between the lower costal margin and iliac crest at the anterior axillary line) usually results in involvement of four nerves (T10–L1) which is enough to cover the transverse lower abdominal incision [6]. Higher levels (T6–T9) need a modified higher subcostal approach [19]. However, higher blocks may occur with continuous TAP blocks as described in a case report by Forero et al. [20]. They used continuous bilateral TAP block for postoperative analgesia in a patient with severe cardiopulmonary disability having total abdominal hysterectomy. The investigators reported extension of the block higher to T6. The mechanism of this high level is not fully understood. The authors rendered this effect to possible extension of the large-volume local anesthetic infusate to higher levels. The sensory level block was not assessed in TAP block group to avoid unblinding. Spread to the paravertebral area is a theoretical possibility and this may result in visceral block which is not provided by the usual single-shot TAP block that causes only somatic block. This theory may explain the superior analgesia produced in TAP group over CWI group during movement. Future studies are needed to assess the exact sensory level block attained by bilateral lumbar TAP block catheters to aid explaining the different patterns of spread as all dye studies were done on single-shot technique [21–23].

The efficacy of TAP block in decreasing postoperative morphine consumption in the current study is agreeing with previous studies [5,24]. In the study performed by Carney et al. [24], TAP block could decrease postoperative PCA morphine dose in the first 48 h by 50%. In spite of using single-shot block in their study, the opioid-sparing effect was comparable to the current study (70% decrease). This may be due to the higher dose and concentration of ropivacaine they used (1.5 mg kg^{-1} of 0.75% solution) and the higher age group in their study (54 ± 11 yr) which might have made the patient more sensitive to the local anesthetic. The investigators used more lateral anatomic landmarks of Petit triangle not the ultrasound-guided block. This lateral approach could have resulted in paravertebral spread of the local anesthetic and augmentation of the block.

Shin et al. [25] did not find a difference in morphine consumption between patients receiving single-shot TAP block and control patients undergoing abdominal hysterectomy. They used only 20 ml of ropivacaine 0.375% as a single shot. This dose might have been insufficient to produce long-lasting analgesia which was produced in the current study by the continuous infusion of levobupivacaine.

The dose and volume of local anesthetic infusion needed to produce efficient analgesia in TAP block is not yet agreed. Being not highly vascular, the volume of local anesthetic used in this study was probably safe to infuse in the transversus abdominis plane. Putting in mind the possibility of paravertebral spread, doses used in this study were safely described in continuous paravertebral block [26,27].

The decreased opioid use in the treatment groups probably resulted in decreased incidence of PONV. However, it did not reach a statistical significance. This may be explained by three reasons. Firstly, the study was not powered enough to detect a statistical difference. Secondly, these types of surgery are associated with high incidence of PONV, especially with the relatively low mean age of patients [28]. Lastly, because no score for PONV was used, any episode of PONV was recorded as nausea/vomiting. The patients in the treatment groups might have lower intensity of PONV than control group, but all the complaints were recorded as having the complication.

One shortcoming of the study regarding its blindness should be raised. Despite the efforts taken to make the patients and assessors blind to the study, they were probably not so. The numbness of abdominal wall in TAP group might have made those patients aware of their group allocation. This probable patient's awareness might not greatly affect the PCA morphine use because the doses were similar in TAP and CWI groups. The different rates of postoperative levobupivacaine (or saline) infusion among the groups might have been observed by the ward nurses. Covering the rate panel of the infusion pump was probably not enough to make them completely blind to group allocation. Observation of the remaining fluid volume in the infusion pump after a fixed time interval could enable them to differentiate between the groups. However, setting the PCA morphine dose (not the VAS scores) as the primary outcome of the study may "partially" compensate for the inappropriate blinding of the study.

Another shortcoming of the study is the different levobupivacaine rates of infusion and consequently its doses. This discrepancy could have caused the "subtle" better analgesia observed during movement in TAP group. As stated before, part of the analgesic effects of local anesthetics might be related to its systemic anti-inflammatory action [11,12]. If this is true in the current study, the anti-inflammatory action might not be fixed and could have contributed to the observed better analgesia in TAP group.

In conclusion, continuous bilateral TAP block and CWI can decrease PCA morphine consumption in the first postoperative 48 h when compared to placebo in women undergoing gynecologic surgery through lower transverse abdominal incision. Continuous TAB block might give better analgesia with movement than CWI.

References

[1] Chen LM, Weinberg VK, Chen C, Powell CB, Chen LL, Chan JK, et al. Perioperative outcomes comparing patient controlled epidural versus intravenous analgesia in gynecologic oncology surgery. Gynecol Oncol 2009;115:357–61.

[2] Dolin SJ, Cashman NJ, Bland JM. Effectiveness of acute postoperative pain management: I. Evidence from published data. Br J Anaesth 2002;89:409–23.

[3] Niraj G, Searle A, Mathews M, Misra V, Baban M, Kiani S, et al. Analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing open appendicectomy. Br J Anaesth 2009;103:601–5.

[4] Belavy D, Cowlishaw PJ, Howes M, Phillips F. Ultrasound-guided transversus abdominis plane block for analgesia after Caesarean delivery. Br J Anaesth 2009;103:726–30.

[5] Abdallah FW, Halpern SH, Margarido CB. Transverse abdominis plane block for postoperative analgesia after cesarean delivery performed under spinal anaesthesia: a systematic review and metaanalysis. Br J Anaesth 2012;109:679–87.

[6] Finnerty O, McDonnell JG. Transversus abdominis plane block. Curr Opin Anaesthesiol 2012;25:610–4.

[7] Fredman B, Shapiro A, Zohar E, Feldman E, Shorer S, Rawal N, et al. The analgesic efficacy of patient-controlled ropivacaine instillation after cesarean delivery. Anesth Analg 2000;91:1436–40.

[8] Forastiere E, Sofra M, Giannarelli D, Fabrizi L, Simone G. Effectiveness of continuous wound infusion of 0.5% ropivacaine by on-Q pain relief system for postoperative pain management after open nephrectomy. Br J Anaesth 2008;101:841–7.

[9] Maric S, Banovic M, Sakic ZK, Bartolek D, Stefancic L, Krleza DS. Continuous wound infusion of levobupivacaine after total abdominal hysterectomy with bilateral salpingo-oophorectomy. Period Biol 2009;111:299–302.

[10] Hebbard P, Fujiwara Y, Shibata Y, Royce C. Ultrasound-guided transversus abdominis plane block. Anaesth Intens Care 2007;35:616–7.

[11] Yardeni IZ, Beilin B, Mayburd E, Levinson Y, Bessler H. The effect of perioperative intravenous lidocaine on postoperative pain and immune function. Anesth Analg 2009;109:1464–9.

[12] Hollmann MW, Durieux ME. Local anesthetics and the inflammatory response: a new therapeutic indication. Anesthesiology 2000;99:1173–9.

[13] Hamid SK, Scott NB, Sutcliffe NP, Tighe SQM, Anderson JR, Cruikshank AM, et al. Continuous coeliac plexus blockade plus intermittent wound infiltration with bupivacaine following upper abdominal surgery: a double-blind randomised study. Acta Anaesth Scand 1992;36:534–9.

[14] Polglase AL, McMurrick PJ, Simpson PJ, Wale RJ, Carne PW, Johnson W, et al. Continuous wound infusion of local anesthetic for the control of pain after elective abdominal colorectal surgery. Dis Colon Rectum 2007;50:2158–67.

[15] Hafizoglu MC, Katircioglu K, Ozkalkanli Y, Savaci S. Bupivacaine infusion above or below the fascia for postoperative pain treatment after abdominal hysterectomy. Anesth Analg 2008;107:2068–72.

[16] Andersen LØ, Kristensen BB, Madsen JL, Otte KS, Husted H, Kehlet H. Wound spread of radiolabeled saline with multi- versus few-hole catheters. Reg Anesth Pain Med 2010;35:200–2.

[17] Gupta A. Wound infiltration with local anaesthetics in ambulatory surgery. Curr Opin Anaesthesiol 2010;23:708–13.

[18] Jankovic Z. Transversus abdominis plane block: the holy grail of anaesthesia for lower abdominal surgery. Period Biol 2009;111:203–8.

[19] Hebbard P. Subcostal transversus abdominis plane block under ultrasound guidance. Anesth Analg 2008;106:674–5.

[20] Forero M, Neira VM, Heikkila AJ, Paul JE. Continuous lumbar transversus abdominis plane block may spread to supraumbilical dermatomes. Can J Anesth 2011;58:948–51.

[21] Tran TMN, Ivanusic JJ, Hebbard P, Barrington M. Determination of spread of injectate after ultrasound-guided transversus abdominis plane block: a cadaveric study. Br J Anaesth 2009;102:123–7.

[22] Barrington M, Ivanusic JJ, Rozen WM, Hebbard P. Spread of injectate after ultrasound-guided transversus abdominis plane block: a cadaveric study. Anaesthesia 2009;64:745–50.

[23] Carney J, Finnerty O, Rauf J, Bergin D, Laffey JG, McDonnell JG. Studies on the spread of local anesthetic solution in transversus abdominis plane blocks. Anaesthesia 2011;66:1023–30.

[24] Carney J, McDonnell JG, Ochana A, Bhinder R, Laffey JG. The transversus abdominis plane block provides effective postoperative analgesia in patients undergoing total abdominal hysterectomy. Anesth Analg 2008;107:2056–60.

[25] Shin HJ, Kim ST, Yim KH, Lee HS, Sim JH, Shin YD. Preemptive analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing gynecologic surgery via a transverse lower abdominal skin incision. Korean J Anesthesiol 2011;61:413–8.

[26] Kotze A, Scale A, Howell S. Efficacy and safety of different techniques of paravertebral block for analgesia after thoracotomy: a systematic review and metaregression. Br J Anaesth 2009;103:626–36.

[27] Joshi GP, Bonnet F, Shah R, Wilkinson RC, Camu F, Fischer B, et al. A systematic review of randomized trials evaluating regional techniques for postthoracotomy analgesia. Anesth Analg 2008;107:1026–40.

[28] Gan TJ. Risk factors for postoperative nausea and vomiting. Anesth Analg 2006;102:1884–98.