Egyptian Journal of Anaesthesia (2012) **28**, 55–60

Egyptian Society of Anesthesiologists

Egyptian Journal of Anaesthesia

www.elsevier.com/locate/egja
www.sciencedirect.com

Research Article

Post-thoracotomy pain relief: Thoracic paravertebral block compared with systemic opioids

Salah M. Asida [a,*], Ibrahim A. Youssef [b], Ahmad K. Mohamad [b], Amr N. Abdelrazik [b]

[a] *Qena University Hospital, Qena, Egypt*
[b] *Minia University Hospital, Minia, Egypt*

Received 27 August 2011; revised 23 October 2011; accepted 26 October 2011
Available online 16 December 2011

KEYWORDS

Thoracic paravertebral block;
Post-thoracotomy analgesia

Abstract *Background:* We evaluated the safety and efficacy of thoracic paravertebral block as a method of pain relief after thoracotomy in comparison with systemic opioids.
Study design: Randomized controlled trial.
Methods: We scheduled 40 patients divided into two groups to receive either 20 ml bupivacaine (0.5%) incremental injections for intra and postoperative analgesia via a catheter inserted in the thoracic paravertebral space. The other 20 patients received systemic morphine for postoperative analgesia. We recorded postoperative Visual Analog Scale pain score, total morphine consumption, time to first analgesic request, changes in pulmonary functions and side effects.
Results: Visual analogue scale (VAS) at rest was lower in the paravertebral group at all measurement points except at 16, 20 and 24 h postoperatively. Pain on coughing showed significant difference (P value < 0.05) at 8 and 16 h but not at 24 h. Post-operative consumption of morphine was 36 (22–42) mg in the control group versus 9 (2–22) mg in the paravertebral block group (PVB) (P value $= 0.003$). Total bupivacaine dose used in the PVB group in the first 24 h was 300–420 mg. For time to first analgesic request it was significantly longer in the morphine group than the paravertebral block group. VAS at first analgesic request was not statistically different between the two groups.
There was no significant difference between the two groups as regards to peak expiratory flow rate (PEFR) preoperatively, after 12 h or 24 h.

* Corresponding author. Tel.: +20 0105262075.
E-mail address: salasida@hotmail.com (S.M. Asida).

Peer review under responsibility of Egyptian Society of Anesthesiologists.
doi:10.1016/j.egja.2011.10.004

Production and hosting by Elsevier

There was a significant reduction in the incidence of side effects in the TPVB group compared to morphine group concerning vomiting and pruritus.no local anesthetic toxicity was reported.
Conclusion: We conclude that thoracic PVB provides effective post thoracotomy analgesia supported by lower VAS pain scores at rest and on coughing compared to intravenous morphine with significant less incidence of side effects.

1. Introduction

Thoracotomy produces many damaging surgical insults causing severe pain. This pain arises from chest wall trauma, including surgically fractured ribs, damaged peripheral nerves, and CNS hyperexitability. Part of this pain is due to continuous movement of the chest wall with respiration and if we consider clearing of secretions from the airway passages an additional problem is added. Patients may be elderly, malnourished, or have frequently cardiac and respiratory diseases.

We searched for many methods to control post-thoracotomy pain. Considering the origin of pain we found that regional modes of analgesia are more logic, this is because pain which occurs with intercostal nerve damage resulting from chest wall trauma in addition to CNS hyperexcitability are poorly sensitive to opioids for effective analgesia it seems better to start regional analgesic regimen in the pre-operative period and continue throughout the operation and for sufficient time after operation until wound healing is established [1].

Thoracic paravertebral block (TPVB) is a regional technique to block spinal nerves at the site where they emerge from the intervertebral foramina by injecting local anesthetic. It produces ipsilateral somatic and sympathetic nerve blockade in the thoracic dermatomes above and below the site of injection. Bilateral use of TPVB has been also described [2].

The aim of this study was to compare the safety and efficacy of thoracic paravertebral block as a method of pain relief following thoracotomy as compared to systemic morphia.

2. Patients and methods

The Ethical Committee of El-Minya Faculty of Medicine approved this prospective randomized study which was done in El-Minya university hospital in the period from April 2008 to April 2010. Written informed consents were obtained from 40 patients scheduled for lung surgery via a posterolateral midthoracic thoracotomy incision without costectomy.

The aim of this study was to compare the safety and efficacy of the thoracic para-vertebral block as a method of pain relief following thoracotomy as compared to intravenous morphine.

Patients who were under 18 or over 70 years of age, weighed < 50 kg or > 100 kg, had an ASA physical status more than III, had an active pulmonary infectious process, a neurological disorder, were receiving opioid therapy for chronic pain, had abnormal coagulation tests, also patients with spine deformities or those who could not express pain intensity by visual analogue scale (VAS), these groups were excluded from the study.

Patients were assigned by pre-randomized, sealed envelopes to receive one of two different analgesic techniques: Group 1, general anesthesia (GA) followed by IV morphine ($n = 20$); and Group II, general anesthesia ($n = 20$) followed by thoracic paravertebral block.

2.1. Pre-anesthetic procedures

The pre-anesthesia procedure was the same in all patients: the patients were not pre-medicated before arrival in the operating room. After arrival, they were pre-hydrated (Ringer's lactate 8 mL/kg/h), monitored (electrocardiography, noninvasive blood pressure, and oxygen saturation in blood). Before the operation, postoperative pain relief technique during the first 48 h and how to use the visual analogue scale (VAS) for expression of pain was explained to all patients.

Pre and postoperative respiratory functions were tested. Peak expiratory flow rate (PEFR) was measured using an AsmaPLAN+ peak flow meter (Vitalograph, Milton Keynes, UK). In a sitting position after maximal inspiration, the patient was requested to exhale completely as fast as possible into the peak flow meter. The mean value of three measurements was recorded.

2.2. Anesthesia

Patients randomized to receive GA (group 1) received morphine (0.1 mg/kg) as a pre-emptive analgesia before induction of anesthesia while group II were given this dose of morphine after conducting the paravertebral block. Anesthesia in the two groups was induced with propofol 1.5–2 mg/kg IV and atracurium 0.5 mg/kg IV to facilitate the intubation of the trachea. Anesthesia was maintained with isoflurane in oxygen and incremental doses of atracurium (0.1 mg/kg). The isoflurane concentration was adjusted with the intention of keeping heart rate and blood pressure within $\pm 25\%$ of pre-induction values. Also, ephedrine 10 mg was given IV as needed for the same purpose. At the end of the operation, residual neuromuscular block was reversed with neostigmine (0.05 mg/kg) and atropine (0.01 mg/kg) before extubation. Electrocardiography, noninvasive blood pressure, SpO2, central venous pressure and end tidal CO_2 were monitored throughout the operative period.

Demographic variables, including age, gender, height, ASA physical status and weight, were recorded, in addition to preoperative PEFR. Intra-operatively hemodynamic data were recorded; these data included mean arterial blood pressure, heart rate, and oxygen saturation in blood.

Isoflurane administration was stopped at the beginning of parietal closure. At the end of the procedure, the patients were awakened and their tracheas extubated if they met standard extubation criteria (regular breathing, end-tidal carbon dioxide < 45 mm Hg and SpO2 more than 95%). The patients were transferred to the recovery room for close monitoring over the next 24 h (heart rate, blood pressure, oxyhemoglobin

saturation, respiratory rate and level of consciousness). All patients received oxygen via a face mask to maintain SpO2 more than 90% throughout the study period.

2.3. Post-anesthesia

When sufficiently awake for pain assessment, patients were asked to score pain on the VAS. A score more than 30 mm indicated pain requiring an analgesic administration in the form of IV morphine (0.05 mg/kg until the VAS pain score at rest was < 30 mm) for patients in the control group. While patients in the PVB group received firstly bupivacaine in the paravertebral catheter (20 ml bupivacaine 0.5% in 5 ml increments) then patients were asked to score pain at rest and on coughing on VAS scores, if VAS scores still > 30 mm morphine was given as patients in the control group. Patients received no sedatives or opioids other than IV morphine. IV morphine consumption was recorded in all patients. Also total bupivacaine dose (mg) was recorded in PVB group.

Pain at rest was scored on the VAS every 2 h from T2 (time 2 h postoperative) to T12 h and every 4 h for T12–T24 h. Pain on coughing was scored every 8 h on the VAS.

Side effects such as pruritus, nausea and vomiting were recorded over the 24 h study period.

2.4. Technique of thoracic paravertebral block

The patient in group 2 was placed in the lateral decubitus or sitting position. Complete aseptic condition was achieved by painting the skin of the back with povidone iodine. After local anesthetic infiltration of the skin and subcutaneous tissue, the upper edge of the spinous process of the fifth thoracic vertebral body (the commonest site used) was identified by counting down from the seventh cervical body. With an epidural needle (Tuohy 18 G; Braun, Melsungen, Germany) the injection point was identified 3 cm lateral to the midline. The transverse process of the sixth thoracic vertebra was contacted. The paravertebral space was punctured by advancing the Tuohy needle over the superior border of the transverse process. This was typically at a depth of 4–6 cm from the skin. A loss-of-resistance syringe was attached to the needle and, while continuously testing for loss of resistance to air, the needle was ''walked off'' the structure in an inferolateral (lateral and caudal) direction and advanced approximately 1 cm (but a maximum of 1.5 cm), ensuring that the bevel of the needle pointed laterally, away from the medial structures. As the costotransverse ligament was penetrated, a ''pop'' could usually be felt, and there was loss of resistance to air. The ''pop,'' however, was not consistently reliable. After that a catheter was advanced through the Touhy needle but with some difficulty than the epidural one. Easy advancement of the catheter may suggest that the catheter did not lie within the paravertebral space because advancement in the paravertebral space seemed to be associated with more resistance than anesthesiologists are used to in the epidural space. Although this observation has never been quantified or scientifically confirmed, easy advancement may imply that the catheter is intrapleural, epidural, or intrathecal. The catheter was typically advanced 2–3 cm beyond the tip of the needle against some resistance, which invariably causes the catheter to curl up in the paravertebral space.

After tunneling and securing the catheter, a test dose of 2 mL short-acting local anesthetic agent such as lidocaine (2%) with 1/200,000 epinephrine was injected through the catheter. Unintentional intrathecal injection should present with subarachnoid block, whereas intravascular injection should cause tachycardia.

Typically, 20 mL bupivacaine (0.5%) is administered in 5-mL incremental injections for intra- and postoperative analgesia.

The dermatomal spread of the blocks was tested both by sensation to cold stimuli (sensation to cold by dermatome was tested with an ice-water filled plastic glove), as well as response to a regular pinprick test, on dermatomes T1–T12 on both sides of the spine. The quality of the block within each dermatome was registered as complete block (++) = no sensation to cold and pinprick, partial block (+) = block to cold but still partial sensation of pinprick, or normal sensation (0). The patient was then turned supine and given morphine 0.1 mg/kg IV. General anesthesia was induced as in the other group. Ephedrine 10 mg was given IV as needed to keep MAP within $\pm 25\%$ of baseline. All patients were tracheally intubated and mechanically ventilated by using volume-controlled positive-pressure ventilation.

2.5. Statistical analysis

Statistical analysis was performed with SPSS for Windows, Release 11.0.1 (SPSS Inc., Chicago, IL). Normally distributed data were analyzed by using unpaired Student's *t*-tests or analysis of variance for repeated measurements, whereas for analysis of categorical and skewed data, Mann-Whitney *U*-tests, X^2 tests, were used as appropriate. The categorical data are presented as, median (interquartile range), or number of patients. $P < 0.05$ was considered statistically significant

3. Results

Forty patients scheduled for thoracic surgery were divided into two equal groups: group 1 who received general anesthesia followed by IV opioids and group II who received thoracic paravertebral block before general anesthesia.

Patient's characteristics were comparable in the two groups (Table 1) as no significant difference was found between the two groups. Also, the heart rate (Fig. 1), mean arterial blood pressure (Fig. 2).

There was statistically significant difference between the two groups as regards post operative pain at rest. Visual analogue scale (VAS) at rest was lower in the paravertebral

Table 1 Patients' characteristics in the two groups. Values are shown as mean ± SD and range.

Variables	Group I ($n = 20$)	Group II ($n = 20$)
Age (year)	55 ± 11	52 ± 8
Weight (kg)	79 ± 11	77 ± 11
Height (cm)	166 ± 5	164 ± 5
ASA I/II/III (n)	8/10/2	5/13/2
Gender (F/M)	7/13	8/12
Pre-operative respiratory functions (L/min)	370 (280–490)	330 (260–450)

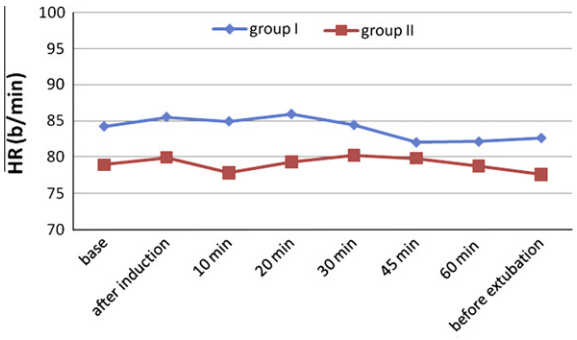

Figure 1 Changes in heart rate in the two groups.

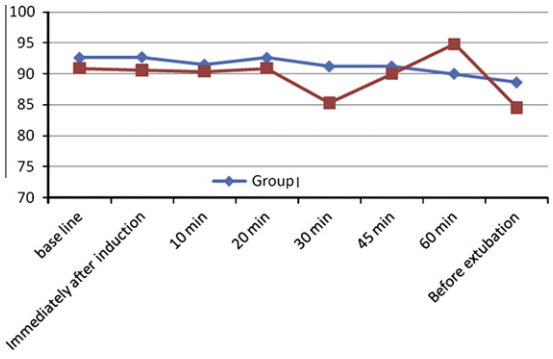

Figure 2 Changes in mean arterial blood pressure.

group at all measurement points except at 16, 20 and 24 h (Table 2).

Comparison between the two groups as regards pain on coughing shows significant difference (P value < 0.05) at 8 and 16 h but not at 24 h which shows insignificant difference (Table 3).

Post-operative median (25–75th percentiles) total use of morphine (along 24 h) was 41.5 mg [7–16] in the control group versus 11 (0.75–8.25) mg in the paravertebral block group (PVB) (P value = 0.003). Morphine consumption was increased significantly in the control group at each time point as reported in Table 4. Total bupivacaine dose used in the PVB group administered through the catheter inserted in the paravertebral space during the operative time as initial dose and top-up doses was 300–420 mg.

As regards time to first analgesic request this time was significantly longer in the group that used morphine as a sole analgesic postoperatively than the other group that used paravertebral block as a postoperative analgesic. VAS at first analgesic request was not statistically different between the two groups as shown in Fig. 3.

There was no significant difference between the two groups as regards to peak expiratory flow rate (PEFR) preoperatively, after 12 h or 24 h. As shown in Table 5.

There was a significant reduction in the incidence of side effects in patients who received thoracic paravertebral block as a postoperative analgesia (group II) in comparison to the patients who received intravenous morphine as a sole analgesic agent (group I). Eleven patients in group I reported side effects while only three patients in group II had side effects. Some patients reported both vomiting and pruritus while others developed only one side effect. As shown in Table 6. No patient in the PVB complained of symptoms of LA toxicity (convulsions and cardiac dysrhythmias). (Most signs of LA toxicity could be masked by general anesthesia.)

Table 2 Postoperative pain–visual analogue scale (VAS) at rest, data reported as median (interquartile range).

Time (h)	Group I (n = 20)	Group II (n = 20)	P value
2	48(28–62)	30(19–49)	0.019
4	35(13–42)	17(09–31)	0.025
6	17(7–37)	9(5–14)	0.016
8	14(5–34)	7(3–13)	0.019
12	15(8–33)	6(0–15)	0.016
16	13(5–19)	7(2–15)	0.096
20	8(1–24)	7(1–13)	0.730
24	7(1–23)	6(1–11)	0.830

P value < 0.05 = significant. VAS 0 mm = no pain, 100 mm = intolerable pain.

Table 3 Postoperative pain–pain on coughing during 24 h after surgery, data expressed as median (interquartile range).

Time (h)	Group I (n = 20)	Group II (n = 20)	P value
8	3.4(1.3/4.2)	1.6(0.9/3.1)	0.024
16	1.7(0.5/3.4)	0.6(0.3/1.3)	0.018
24	1.2(0.5/1.9)	0.6(0.2/1.5)	0.095

Table 4 Postoperative total morphine consumption at different time points (mg).

	Group I (n = 20)	Group II (n = 20)	P value
4 h	5 (3–8)	1 (0–2.5)	0.0007
8 h	7.5 (5–16)	2 (1–5)	0.0005
16 h	11 (9–20)	3 (1–8)	0.004
24 h	18.5 (11.5–21.5)	5 (1–10)	0.002
Total consumption	41.5 (7–16)	11 (0.75–8.25)	0.003

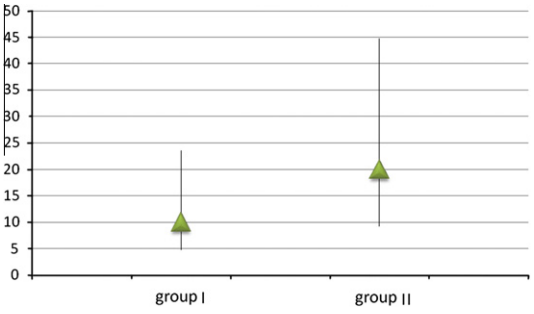

Figure 3 Time to first analgesic request (minutes).

Table 5 Pulmonary functions–comparison between the two groups.

PEFR (L/min)	Group I (n = 20)	Group II (n = 20)
Pre-operative	370 (250–440)	340 (240–430)
After 12 h	230 (180–320)	220 (130–310)
After 24 h	240 (170–330)	200 (180–300)

Data are presented as median (interquartile range) as appropriate.

Table 6 Comparison between the two groups as regards side effects.

Side effects	Group I (n = 20)	Group II (n = 20)	P value
No side effects	9 (45%)	17 (85%)	0.01
Nausea, vomiting	11	3	
Pruritis	7	0	

P value < 0.05 = significant.

4. Discussion

This prospective, randomized trial demonstrates that thoracic paravertebral block with a catheter using bupivacaine as a local anesthetic provides better postoperative analgesia than intravenous morphine as a sole analgesic agent in patients undergoing lung surgery via a posterolateral midthoracic thoracotomy incision.

The paravertebral space is a wedge – shaped space that lies to the side of the vertebral column and contains the spinal (intercostal) nerve, the dorsal ramus, the rami communicantes and the sympathetic chain. Placement of local anesthetic within the paravertebral space produces unilateral somatic and sympathetic block, which is advantageous for unilateral surgical procedures of the chest and abdomen [3].

The use of this technique for control of post-thoracotomy pain was done to try a simple and effective technique for analgesia and to avoid the side effects of systemic opioids and even epidural blocks. As the thoracotomy incision is one sided no need for extended block. This technique has minimal hemodynamic effects, preserves respiratory functions and devoid of side effects of systemic morphine.

In our study thoracic PVB produced no significant differences in hemodynamics (heart rate, mean arterial blood pressure, oxygen saturation) as compared to control group either intraoperatively or postoperatively. These results were in agree with the results of Dabbagh and Elyasi who used PVB in breast surgery in the form of a single preoperative injection of lidocaine 2% in the paravertebral space and compared it with general anesthesia and noted that PVB did not affect hemodynamics as no patient out of 30 patients suffered from hypotension or bradycardia [4].

The dose of bupivacaine (20 mL 0.5%) which was used in our study as a pre-emptive dose was similar to several studies such as André and colleagues who used the same dose in a catheter for breast surgery [5]. Also Richardson and colleagues used the same dose in a large study [6].

As regards the effect of paravertebral block on postoperative pain either at rest or on coughing, this was the main goal of this study, we observed that paravertebral block produced significant decrease in VAS postoperatively in the first 16 h as compared to intravenous morphine. Patients in PVB group reported less pain at rest and on coughing than patients in the morphine group.

These results were similar to the results of Bilgin et al. (2003) who compared the effects of continuous paravertebral block (with a catheter) using bupivacaine to intravenous metamizol as a systemic analgesic. They found that paravertebral block decreased pain severity significantly than the systemic analgesic up to 72 h postoperatively [7].

Also Kairaluoma et al. (2006) found nearly the same results as those in our study when they compared pre-incisional paravertebral block (single injection) with bupivacaine to IV oxycodone for relieving postoperative pain after breast surgery. PVB in this study reduced chronic pain symptoms up to 12 months postoperatively [8].

Hill et al. showed also significant difference between PVB group and IV morphine group after thoracoscopic procedures as regards cumulative morphine consumed but only in the first 6 h postoperatively. Median cumulative morphine use in the PVB group at 6 h after paravertebral injection was 0.11 mg/kg compared with 0.17 mg/kg in the placebo group (P = 0.029). Also this could be explained by the absence of a catheter for supplemental doses of bupivacaine [9].

As regards peri-operative respiratory functions, we used peak expiratory flow rate (PEFR) as a measurement of respiratory functions like Richardson and his colleagues (1999) in the largest controlled trial over 100 adult patients underwent thoracotomy incisions that used PEFR as a measurement of peri-operative respiratory functions. They concluded that pulmonary function as assessed by PEFR was significantly better preserved in the PVB group as compared to the thoracic epidural one [6].

Barron et al. used two regimens of bupivacaine dose, low dose regimen ranged from 310–450 mg and high dose regimen ranged from 890–990 mg in the first 24 h. They used continuous paravertebral blockade for post-thoracotomy analgesia and concluded that higher dose paravertebral bupivacaine was strongly predictive of lower VAS scores at rest, when compared with lower dose regimes at 8 h after operation, 24 h and 48 h Although there was a trend to improved analgesia on coughing at all time points, the difference did not reach statistical significance [11].

Total morphine consumed by patients in the PVB group included in our study was significantly less than that consumed by patients in the control group (24 h postoperatively, group I = 18.5 (11.5–21.5) mg vs. Group II = 5 mg [1–10]). This observation was the same as Kairaluoma et al. who observed that patients who received pre-emptive single injection PVB needed significantly less IV oxycodone than patients who did not receive PVB but only in the period of post-anesthesia care unit (PACU), however there was no significant difference between the two groups as regards oxycodone consumption after 8 h up to 24 h. This could be explained by the single injection of bupivacaine not continuous injection via a catheter [12].

Hill et al. showed also significant difference between PVB group and IV morphine group after thoracoscopic procedures as regards cumulative morphine consumed but only in the first 6 h postoperatively. Median cumulative morphine use in the PVB group at 6 h after paravertebral injection was 0.11 mg/kg compared with 0.17 mg/kg in the placebo group (P = 0.029). Also this could be explained by the absence of a catheter for supplemental doses of bupivacaine [9].

As regards peri-operative respiratory functions, we used peak expiratory flow rate (PEFR) as a measurement of respiratory functions like Richardson and his colleagues (1999) in the largest controlled trial over 100 adult patients underwent thoracotomy incisions that used PEFR as a measurement of peri-operative respiratory functions. They concluded that pulmonary function as assessed by PEFR was significantly better preserved in the PVB group as compared to the thoracic epidural one [6].

In our study there was no significant difference between PVB patients and control group patients as regards peri-operative

respiratory functions assessed by PEFR either preoperatively, after 12 h or 24 h.

Our results were similar to the results of Vogt et al. who used a single-injection thoracic paravertebral block for postoperative pain treatment after thoracoscopic surgery compared with a control group in whom a back puncture was done without injecting morphine to the patient. They used PEFR as a measurement of peri-operative pulmonary functions and observed that after 24 and 48 h. of surgery the groups did not differ with regard to peak expiratory flow rate [13].

Hill et al. showed that there was no significant difference between single-dose multi-level paravertebral block and systemic analgesia using PCA morphine as regards peri-operative pulmonary functions. They used forced vital capacity (FVC) and forced expiratory volume in 1st second (FEV1) as measurements of pulmonary functions [9].

The results of Bilgin et al. were against our results as they observed that there was a significant reduction in FEV1 and FVC in the systemic analgesia group (group II) (using metamizol) when compared with ***PVB group (group I***) 24 h and 48 h postoperatively. A decrease in FVC and FEV1 values was found in both groups when compared to the preoperative values. On the first day when the mean FVC and FEV1 values were compared with the preoperative values, in group I FVC was 54% and FEV1 was 55% and in group II, FVC was 42% and FEV1 was 38% of the preoperative values [7].

We observed that in our study there was a significant reduction in the incidence of side effects in patients who received thoracic paravertebral block as a postoperative analgesia (group II) in comparison to the patients who received intravenous morphine as a sole analgesic agent (group I). Leaven patients in group I reported side effects while only three patients in group II had side effects. These side effects were nausea, vomiting and pruritis.

Our results were similar to the results of Naja et al. as regards postoperative nausea and vomiting (PONV). They studied nerve-stimulator guided paravertebral blockade versus general anesthesia for breast surgery in a prospective randomized trial. They observed that the incidence of PONV was significantly lower in the PVB group [14].

El-Nasr et al. who studied the effects of paravertebral blockade versus general analgesia for breast surgery, concluded that PVB is associated with significantly less incidence of PONV [15].

In our study, no patients suffered from complications due to LA toxicity manifested by convulsions or cardiac dysrhythmias. Lower doses of bupivacaine which were given in incremental doses after test doses (with epinephrine) may contribute to the absence of toxicity complications.

In a systemic review and metaregression by Kotzé et al. in 2009 the investigators studied the efficacy and safety of different techniques of paravertebral block for analgesia after thoracotomy. They studied 25 controlled trials and concluded that the occurrence of complications of the PVB or of surgery was not as well reported as pain scores and pulmonary function. Possible LA toxicity was the only complication reported in the majority of studies. Only 15 of the 19 studies using bupivacaine reported specifically whether this complication occurred or not. Neurological effects which may have been due to LA toxicity occurred in four of 225 patients in the higher dose bupivacaine trials, compared with two of 110 patients in the lower dose trials ($P = 1.0$). Cardiac arrhythmias occurred in two of 173 patients who received higher dose bupivacaine, and none of the 69 patients who received lower dose bupivacaine ($P = 1.0$). No lasting patient harm was reported due to possible LA toxicity [16].

We conclude that continuous thoracic PVB with bupivacaine provides effective analgesia after thoracic surgery supported by lower values of VAS pain scores at rest and when coughing as compared to systemic analgesia with significant less incidence of complications and side effects such as pulmonary complications, PONV and pruritus.

References

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

[2] Karmakar MK. Thoracic paravertebral block. Anesthesiology 2001;95:771–80.

[3] Messina M, Boroli F, Landoni G, et al. A comparison of epidural vs paravertebral blockade in thoracic surgery. Minerva Anesthiol 2009;75:616–21.

[4] Dabbagh A, Elyasi H. The role of paravertebral block in decreasing postoperative pain in elective breast surgeries. Med Sci Monit 2007;13:464–7.

[5] André P, Med M, Robert M. Continuous thoracic paravertebral block for major breast surgery. Region Anesth Pain Med 2006;31(5):470–6.

[6] Richardson J, Sabanathan S, Jones J, et al. A prospective, randomized comparison of preoperative and continuous balanced epidural or paravertebral bupivacaine on post-thoracotomy pain, pulmonary function and stress responses. Br J Anaesth 1999;83:387–92.

[7] Bilgin M, Akcali Y, Oguzkaya F. Extrapleural regional versus systemic analgesia for relieving post-thoracotomy pain: a clinical study of bupivacaine compared with metamizol. J Thorac Cardiovasc Surg 2003;126:1580–3.

[8] Kairaluoma PM, Bachmann MS, Rosenberg PH, Pere PJ. Preincisional paravertebral block reduces the prevalence of chronic pain after breast surgery. Anesth Analg 2006;103:703–8.

[9] Hill SE, Keller RA, Stafford-Smith M, Grichnik K, White WD, D'Amico TA, Newman MF. Efficacy of single-dose, multilevel paravertebral nerve blockade for analgesia after thoracoscopic procedures. Anesthesiology 2006;104:1047–53.

[10] Luketich JD, Land SR, Sullivan EA, et al. Thoracic epidural versus intercostal nerve catheter plus patient-controlled analgesia: a randomized study. Ann Thorac Surg 2005;79:1845–50.

[11] 11- Barron DJ, Tolan MJ, Lea RA. A randomized controlled trial of continuous extrapleural analgesia post-thoracotomy: efficacy and choice of local anaesthetic. Eur J Anaesth 1999;16:236–45.

[12] Kairaluoma PM, Bachmann MS, Korpinen AK, Rosenberg PH, Pere PJ. Single-injection paravertebral block before general anesthesia enhances analgesia after breast cancer surgery with and without associated lymph node biopsy. Anesth Analg 2004;99:1837–43.

[13] Vogt A, Stieger S, Theurillat C, et al. Single-injection thoracic paravertebral block for postoperative pain treatment after thoracoscopic surgery. Br J Anaesth 2005;95:816–21.

[14] Naja MZ, Ziade MF, Lönnqvist PA. Nerve-stimulator guided paravertebral blockade vs general anaesthesia for breast surgery: a prospective randomized trial. Eur J Anaesth 2003;20:897–903.

[15] El Nasr G, EL Moutaz H, Youssef M. Paravertebral block versus general anesthesia in breast surgery. JESMP 2002;20:125–30.

[16] Kotzé A, Scally 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.