Comparison Of Epidural Anesthesia And Paravertebral Nerve Block In Patients Undergoing Thoracotomy

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Citation

O Cucu, P Karaca, Y Enc, G Camur, N Yurtseven, T Okay, S Canik. *Comparison Of Epidural Anesthesia And Paravertebral Nerve Block In Patients Undergoing Thoracotomy*. The Internet Journal of Anesthesiology. 2005 Volume 11 Number 1.

Abstract

Purpose: This study aimed to compare thoracic paravertebral and epidural blocks in patients undergoing thoracotomy.

Methods: Fifty patients were randomized to be given either epidural (Group I) or paravertebral (Group II) block. All patients received a bolus dose of %0.25 bupivacaine 10 ml before wound closure and a infusion of %0.25bupivacaine 0.1ml/ hr was started immediately upon arrival to surgical intensive care unit. All subjects were allowed to take supplementary doses of morphine. Patients were asked to assess the pain at rest, using visual analogue scale (VAS) starting from 1 hr after arrival in the SICU and every 2 hr for the first 24 hr. Pulmonary function tests (PFTs) were performed before operation and 24 hr after operation.

Results: There were no significant differences between the groups with respect to morphine consumption, VAS scores. PFTs decreased significantly ($p<0.05$) after the operation compared to baseline values in both groups.

Conclusions: We conclude that paravertebral block is an effective method for the relief of post-thoracotomy pain and should be considered as an alternative to thoracal epidural anesthesia.

Poster presentation at the XII.th Congress of the Turkish Society of Anesthesiology and Reanimation, 2004.

INTRODUCTION

Post-thoracotomy pain is considered as the most severe type of postoperative pain [1,2]. Although various types of local anaesthetic techniques have been used for post-thoracotomy pain control, there are not enough randomized studies comparing these regimens [3]. Intercostal analgesia might control pain originating from somatic structures, however, high plasma levels of local anaesthetics have been reported after intercostal nerve blocks [4,5] .Continuous thoracic epidural analgesia is considered by many, as the gold standard, but is associated with its own complications such as hypotension [6,7] .

Compared with these methods, thoracic paravertebral block may have some advantages. A unilateral analgesia including sympathetic block may have less effect on patient's hemodynamics.

The aim of this study was to compare the analgesic, hemodynamic, and respiratory effects of continuous thoracic epidural and continuous thoracic paravertebral block after thoracotomy.

PATIENTS AND METHODS

After the approval of the local ethics committee, written informed consent was obtained from 50 American Society of Anesthesiologists (ASA) physical status I-III patients, aged 15 to 80 years undergoing elective anterolateral thoracotomy. All physicians and nursing staff who cared for the patients during and after surgery were blinded to the analgesic regimen in this prospective, randomized, double-blind study. Before surgery, patients were randomly assigned to receive either thoracal epidural or thoracal paravertebral block for postoperative pain treatment. Those with cardiac, hepatic, renal failure, infection at the operation site, coagulation disorders and/or allergy to local anaesthetics or morphine were excluded. All subjects unable to co-operate or with psychosocial disorders that could interfere with study protocol were also excluded. At the preoperative visit visual analog scale (VAS) and patient

controlled analgesia (PCA) device were explained to all patients. All patients were blinded to the type of analgesic procedure.

Premedication and anaesthesia were standardized. General anaesthesia was induced by sodium pentothal 5-7 mg.kg-1 and fentanyl 2µg kg-1 . Muscle relaxation was achieved by vecuronium bromide 0.1 mg kg-1. No additional IV opioids were given after induction. Anaesthesia was maintained with 50% nitrous oxide and 1-2% sevoflurane in oxygen. During one-lung ventilation patients received 100 % oxygen as a safety measure against hypoxia. Continuous electrocardiogram, invasive blood pressure, central venous pressure, end-tidal carbondioxide and oxyhemoglobin saturation were monitored throughout the surgery. Arterial blood-gas tensions were measured every hour during procedure and every two hour thereafter. During operation central venous pressures were kept between 5-8 mmHg by cyrstalloid infusion. Blood loss during operation and through the drainage after operation was measured and packed re blood cells transfused if hemoglobin decreased below 10 gr/dl. All operations were performed by the two surgeons using similar techniques. In each operation 1 or 2 chest tubes were placed at the end of the procedure.

Patients were randomized in to two groups: epidural group (Group 1; n = 25)- a thoracic 20-gauge catheter was introduced by the same anaesthesiologist before anaesthesia induction between the fifth and the seventh spinal processes through an 18-gauge Tuohy needle by the loss of pressure technique. After negative aspiration, a 3 to 4 ml test dose of lidocaine 2% with epinephrine 1 in 200,000 was injected; paravertebral group (Group 2; n= 25)- after outlining the midline at the level of T5 and T7 we inserted the needle 2.5 cm laterally to it. After the transverse process is contacted, we withdrawn the needle to skin level and redirected to 'walk off' the transverse process [8] and gently advanced until there was a loss of resistance to the injection of air. Thereafter a thoracic 20-gauge catheter was inserted and advanced 2 to 3 cm into the paravertebral space. In all patients methylene blue was injected before chest closure to confirm its successful position. All blocks were performed by the same anaesthesiologist before anaesthesia induction.

A 10- ml bolus of plain 0.25 % bupivacaine was given through the catheters before wound closure and a continuous infusion of 0.25% bupivacaine was started at 0.1ml.kg-1.hr-1 immediately after the patient had arrived in surgical intensive care unit (SICU) in both groups. The infusion was continued for 24 h. Correct catheter placement was confirmed by unilateral and bilateral somatic and sympathetic block in patients receiving paravertebral and epidural block respectively.

All patients allowed to take supplementary doses of morphine from a patient controlled analgesia (PCA) device (Abbot Pain Management Provider, Abbott Laboratories North Chicago,IL,USA).The device was programmed to give a bolus dose of 1 mg with 5 min.lock-out time. The total dose of morphine consumed was read from the history of the device 24 h after operation.

Assessment of pain in the postoperative period was done all the the times by the same resident who was blinded to analgesia technique, using a 100-Mm visual analogue scale (VAS) (0 mm= no pain ; 100mm = maximal pain) on emergence from general anesthesia (time 0) and every 2 h for the first 24 hours at rest . At the same occasions, the level of patient's sedation was assessed using a scale of : (0): completely awake, (1) awake, but tend to sleep, (2) asleep, but easy to awake, (3) asleep, difficult to awake, (4) asleep, not possible to awake [9]. The upper and lower levels of analgesia were assessed by the loss of pinprick sensation on arrival to SICU and 24 h after arrival.

Hemodynamic parameters were recorded before the anaesthesia induction and 20 min after the bolus dose of local anaesthetics and at 6 th, 12th and 24 th hours of operation. A mean arterial blood pressure lower than 75 mmHg was accepted as hypotension. The therapeutic regimen for the treatment of hypotension consisted of, fluid resuscitation (20 ml/kg) as a first line agent however if hypotension persists despite the volume loading or severe (mean blood pressure< 50 mmHg) vasopressor agent phenylephrine was the choice of drug.

Arterial blood-gas tensions were measured every hour during procedure and every two hour in SICU until 6 h after operation, and again at 12h and 24 h after operation. Oxygen saturation was monitored continuously by pulse oximetry until the first postoperative morning.

Spirometric measurements of FEV1, FVC and FEF25-75 were done before operation and 24 h after operation.

Patients were evaluated every two hours for adverse effects for the first 24 hours (i.e. drowsiness, nausea, vomiting, itching, difficulties with breathing or allergic reactions). They were required to grade them if they were having these symptoms as follows; 1 mild, 2 moderate, 3 severe. The highest score recorded during the study was the value

included in data analysis. Patients graded their symptoms as moderate to severe were given medication.

SPSS (Statistical Package for Social Sciences for Windows version 10.0 Chicago, IL, USA) was used for all statistical analysis. VAS scores were accepted as main outcome of this study and taken for power analysis. Statistical power analysis using ?= 0.05 and ?= 0.2 indicated that a total of 44 observations would be needed to detect a difference of 6 in VAS scores between groups with an assumed standard deviation of 10 with the power of 80 %. Data were expressed as mean±SD for continuous variables. VAS scores were compared by Mann-Whitney U test and sedation scores were compared by Chi-square tests. Chi-square and Fisher Exact tests were used for non-parametric data. Results were given in 95% confidence interval. A p value of 0.05 or less was considered to indicate statistically significant difference

RESULTS

Fifty, ASA physical status I-III , patients completed the study. Patient characteristics are presented in Table I. There were no statistically significant differences between the study groups.

Figure 1

Table 1: Patient characteristics

	Epidural (n=25)		**Paravertebral (n=25)**		***p***
Age (yr)	50.36±16.46		49.40±19.16		***ns***
Height (cm)	171,32±5.45		171,72±4.94		***ns***
Weight (kg)	71,08±6.23		69,80±5.45		***ns***
Sex	n	%	n	%	
Male	19	76,0	19	76,0	***ns***
Female	6	24,0	6	24,0	
Preoperative disease	n	%	n	%	
Coronary artery disease	3	12.0	2	8.0	***ns***
Hypertension	5	20.0	6	24.0	***ns***
COPD	14	56.0	15	60.0	***ns***
Diabetes mellitus	4	16.0	3	12.0	***ns***
Preoperative medications	n	%	n	%	
β-adrenergic blocker	2	8.0	4	16.0	***ns***
Calcium channel blocker	2	8.0	2	8.0	***ns***
ACE inhibitor	3	12.0	3	12.0	***ns***
Inhaler β-adrenergic agonist	12	48.0	13	52.0	***ns***
Inhaler corticosteroid	2	8.0	1	4.0	***ns***
Type of surgery	n	%	n	%	
Wedge resection	14	56.0	12	48.0	***ns***
Lobectomy	7	28.0	8	32.0	***ns***
Pneumonectomy	4	16.0	5	20.0	***ns***
Duration of operation (min)	200,40±74.86		207,60±50.21		***ns***
Duration of anesthesia (min)	226,20±76.59		237,20±53.60		***ns***
Duration of OLV (min)	108,96±50.08		97,60±47.86		***ns***
Intraoperative fluids (ml)	1525.20±142.33		1540.00±123.32		***ns***

Data expressed as a mean±SD

Thoracal paravertebral catheter placement was successful in all patients. However the ease of insertion varies. In seven cases it was easy, in twelve patients some resistance was encountered and in five patients more than one attempt were required. In seven patients blood-stained fluid was aspirated but it was possible to clear the catheter from blood by saline. In epidural group in seven cases more than one attempt were required. No patients reported paresthesia during needle or catheter insertion in either group.

There were no significant differences between the groups with respect to VAS scores at any point of observation. The

mean pain scores were 52.40±21.50 and 44.40±19.40 in epidural and paravertebral groups respectively in the immediate postoperative period at rest and whereas at 4 th hour they were decreased to 30±14.10 and 27.20±13.40. In both groups pain scores were significantly lower compared to immediate postoperative period on all occasions of measurement (Table II).

Figure 2

Table 2: VAS scores

VAS scores	GROUP Epidural (n=25)	Paravertebral (n=25)	P
0.h	5.24±2.15	4,44±1.94	ns
2.h	3.56‡‡1.50	3,64†‡1.63	ns
4.h	3,00‡‡1.41	2,72‡‡1.34	ns
6.h	2,80‡‡1.12	2,96‡‡1.54	ns
12.h	2,64‡‡1.15	2,84‡‡1.43	ns
18.h	2,44‡‡1.04	2,80‡‡1.29	ns
24.h	2,40‡‡1.04	2,44‡‡0.96	ns

Data expressed as a mean±SD
† *Compared with basal values p<0,05*
‡ *Compared with basal values p<0.01*

There were no statistically significant differences between the groups in morphine consumption, 37.56±25.93 mg and 36.78±18.58 mg (p = 0.903) for epidural and paravertebral groups respectively.

FEV1, FVC, FEF25-75, and mean arterial pressure decreased significantly in both groups compared to basal values. No patients developed hypotension (MAP<75mmHg) at any times during study period. In comparisons between groups, heart rate and MAP were significantly lower in epidural group at postoperative 6 th,12th and 24 hours as compared to paraverteral group (p<0.01). Intragroup comparisons showed that, in epidural group MAP decreased significantly at all points of measurements compared to preinduction values (p<0.01). Also MAP at 6 h hours was found to be lower than the one measured after 20 minutes of bolus dose. Parallel to that, heart rate also was also found to be lower at all points of observations compared to preinduction and postbolus values in epidural group (Table III).

Figure 3

Table 3: Respiratory and hemodynamic variables

		GROUP Epidural	Paravertebral	p
FEV_1	preop	75,81±16.23	67,44±18.15	ns
	postop	27,51±10.83*	31,13±11.59*	ns
FVC	preop	68,81±14.90	61,10±17.56	ns
	postop	23,98±9.27*	27,18±9.81*	ns
FEF_{25-75}	preop	82,06±25.62	75,18±27.09	ns
	postop	43,06±16.91*	45,91±18.95*	ns
HR	pre induction	81,32±13.06	79,80±13.86	ns
	post bolus	77,08±12.13β	77,48±13.56	ns
	6 th hr	69.12±4.52*γ	73.00±3.21β	0.001
	12 th hr	68.88±4.38*†	73.04±3.50 β	0.001
	24 th hr	68.84±3.46*†	72.28±3.40 β	0.001
MAP	pre induction	89,72±13.20	90,24±9.48	ns
	post bolus	81,20±13.40β	86,68±9.77β	ns
	6th hr	79.16±9.48*γ	87.88±7.08	0.001
	12th hr	79.00±9.11*	87.08±7.65	0.001
	24th hr	80.08±9.00*	87.92±8.10	0.002
CVP	pre induction	4.56±1.87	4.04±1.56	ns
	postbolus	6.24±1.30*	5.92±1.22*	ns
	6th hr	6.20±0.81*	6.08±0.70*	ns
	12th hr	6.36±0.81*	6.08±1.03*	ns
	24th hr	6.12±0.92*	6.28±0.67*	ns

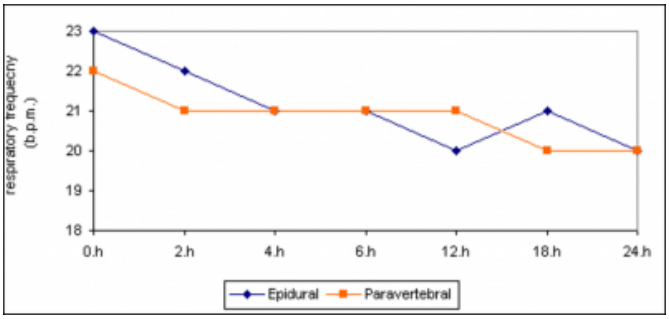
FEV_1, FVC, and FEF_{25-75} are presented as percentage of the predicted value
Heart rate (HR; units beat per min), mean arterial pressure (MAP; units mmHg)
Data expressed as a mean±SD
* intragroup comparison,compared to baseline p<0.01
γ intragroup comparison, compared to postbolus p<0.05
† inragrop comparison, compared to postbolus p<0.01
β intragroup comparison, compared to baseline p<0.05

In paravertebral group, although not as much as epidural group, heart rate was also found to be lower at all occasions as compared to prenduction values (p<0.05) . However ,in paraverebral group MAP did not decrease at any points. In both groups CVP was found to be higher at all points as compared to preinduction values (p <0.01) (Table 3).

Respiratory frequency was similar in both groups (Figure I).

Figure 4

Figure 1: Respiratory frequencies in study groups



Arterial partial pressure of oxygen (PaO2) was similar in both groups. No patient had hypercapnia (PaCO2 higher than 6.5 kPa) during first 24 h following surgery and consequently no patient had respiratory acidosis.

In epidural and paravertebral groups 3 and 2 patients

experienced at least one nausea and vomiting episode respectively, graded as severe and they were given ondansetron (p=1.000). Two patients in each groups reported nausea episode graded as mild and they were not given any medication. Urinary retention could not be assessed, since patients routinely had Foley catheters inserted at the time of surgery.

Somatic blockade, assessed by segmental spread of pinprick analgesia was similar in two groups; both at the beginning and at 24 th h of study.(T3-T7;T3-T7)

There were no significant differences with respect to sedation scores between the groups except for the 2 nd hour following surgery. At the 2 nd hour following operation, 14 patients in paravertebral group and 6 patients in epidural group were awake but tended to sleep (sedation score = 1) (p =0.008). There were no patients having a sedation score of 4 at any point of measurement.

At the end of the first postoperative day patients were evaluated for satisfaction with the analgesia technique. Three patients in paravertebral group and two patients in epidural group reported that they would choose different analgesia technique for the next time. These were the ones in whom difficult catheter placement was encountered.

No signs of local anaesthetic toxicity were detected in any of our patients who were under close observation in SICU during the first 24 h. All the patients were transported to wards after 24 hours of operations and their catheters were removed by an anestehesia resident. Their analgesic treatment were switched to oral and parenteral analgesics.

DISCUSSION

Many anaesthesiologists agree that post-thoracotomy pain is one of the most severe type of pain and requires excellent analgesia. But, still, there is no consensus concerning the choice of analgesic technique. When the origin of the pain is considered, regional anaesthesia seems to be the most logical approach. However, in literature there are few direct, controlled, randomized comparisons of different regional anaesthesia techniques for post-thoracotomy pain relief.

In the present study we compared the efficacy of continuous thoracal epidural and paravertebral block in the treatment of pain following thoracotomy. VAS scores and total morphine consumption are the primary outcomes of the study. Since patients titrated the dose of morphine from a PCA device, it is logical to consider the consumption of morphine as a valid measure of the efficacy of the two techniques compared in this study. The amount of morphine did not differ significantly between the groups (37.56±25.93 mg and 36.78±18.58 mg for epidural and paravertebral groups respectively). This amount is surprisingly lower than the amount reported in other studies in which supplementary opioids have been given either i.m or i.v on request [10,11]. But because the VAS scores were in acceptable range, we can assume that analgesia was sufficient so that patients did not require higher doses from PCA device. The two local anaesthetic methods were equally effective in the relief of post-thoracotomy pain. This is consistent with the results of the study done by Matthews and Govenden [12] and Richardson and co-workers [13].

Sabanathan and colleagues [14] reported better pain relief and pulmonary function in paravertebral nerve block compared with placebo group in a double-blind, controlled study. Their study differs from the present study due to their use of placebo. On the other hand, Matthews and Govenden did not reported any improvement in pulmonary functions in patients receiving paravertebral block in their study comparing paravertebral and epidural infusion of bupivacaine. [12]. In addition to his work, Bigler and colleagues compared epidural morphine, bupivacaine combination with paravertebral bupivacaine in patients undergoing cholecystectomy [15] . They found better pain scores in epidural group but no difference in pulmonary function. In another study Pertunnen and colleagues compared extradural, paravertebral and intercostal blocks for post-thoracotomy pain[11]. Similar levels of pain, opioid requirements and pulmonary function were found in all groups. Parallel to their findings we did not find any advantage of paravertebral block on respiratory functions either. This is consistent with comparable VAS scores and morphine consumption in both groups.

No patient had respiratory depression in the present study. The number of patients having sedation score of 1 was higher in paravertebral group compared to epidural group 2 h after operation. Three patients in epidural group were asleep and difficult to awake 2 h following surgery. In paravertebral group there were no such patients. Depending on this data we might assume that patients in the epidural group might have needed more morphine from the PCA device as compared to patients in the paravertebral group in the early postoperative period. However, since we did not measure morphine consumption hourly, this speculation is need to be confirmed by objective criteria.

The amount and concentration of local anaesthetics used in both techniques varies depending on the physician and institute. We used the lowest concentration and amount reported in literature [16,17].Since we do not have opportunity to monitor plasma levels of local anaesthetic we preferred this regimen. Neither group demonstrated pain-related complications and we assume that both methods of analgesia were able to provide adequate pain control.

Hypotension is a common finding after thoracal epidural analgesia due to bilateral sympathetic block [18]. Although less hypotension were reported with the paravertebral blockade it can still cause hypotension in dehydrated patients [19]. In the present study no episode of hypotension were noted in both groups (MAP? 75 mmHg) hovewer blood pressure decreased significantly in epidural group compared to both baseline values in the same group and also paravertebral group, despite hydratation of patients adequately before the bolus dosages and the lower concentration and amount of local anaesthetics given. Heart rate also was found to be lower in epidural anesthesia group as compared to paravertebral group. However there were no difference found when the postbolus measurements were compared to baseline values. This might be resulting from that 20 minutes was not enough for the block to manifest its hemodynamic effects.

There was no evidence of contralateral blockade from paravertebral injection. This is rarely reported following paravertebral block but may develop due to injection through medially directed needle or excessivelly high volume of the injectant [20,21].

One of the limitations of our study is that the authors were able to continue analgesic treatment for 24 hours after surgery. The reason for that is patients were transported to the wards on the first postoperative day. Epidural and paravertebral infusions were discontinued after patients are discharged from intensive care because serious complications might be underestimated on the surgery ward. Secondly, the VAS scores in the immediate postoperative period were high compared to other studies. The interval from injection of bupivacaine to the beginning of the study was about 45 minutes. Under normal circumstances it should have been sufficient for analgesia. We could have bolused the catheters prior to skin incision but we wanted to confirm the correct catheter placement before starting drug infusion. And also we could have used opioids peroperatively but that could have changed the results. One could argue the use of bupivacaine but not bupivacaine and opioid combination in the present study. First of all epidural bupivacaine has been shown to provide excellent analgesia [22,23]. In addition to this, opioids are primarily c-fiber inhibitors and pain is probably generated by intercostal A-delta fibers because of intercostal nerve and ligamentous damage after thoracotomy .Therefore we believe that opioids cannot be expected to provide better pain relief than bupivacaine [24].

As a conclusion although there has been a remarkable improvement in techniques of post-thoracotomy analgesia in recent years, the ideal method has yet to be developed. Unfortunately, the best regimen may never be agreed because each patient and therefore their perception of pain and anaesthesist are different. Paravertebral block appears like an effective and easy method for analgesia after thoracic surgery. However no ideal regional anaesthetic block exists; they require careful, randomized, prospective comparative studies. From this point of view continuous thoracal paravertebral block is comparable to thoracic epidural analgesia- the gold standard-and should be considered as an alternative. We recommend that this simple but useful method should be learned and willingly performed by every anesthesiologist.

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