Comparison of thoracic paravertebral and epidural blocks for pain relief after thoracotomy

Torakotomi sonrası uygulanan dorsal paravertebral ve epidural bloğun ağrı kontrolü açısından karşılaştırılması

Oğuzhan Cücü[1] Pelin Karaca[1] Yavuz Enç[2] Okan Yücel[2] Tamer Aksoy[1] Şahin Şenay[2] Sevim Canik[1]

Departments of [1]Anesthesiology and Rehabilitation, [2]Cardiovascular Surgery, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Center, İstanbul

Background: The aim was to compare the effects of thoracic paravertebral and epidural blocks on pain relief and respiratory function after thoracotomy.

Methods: 50 patients (38 males, 12 females; mean age 49.8±17.7; range 15 to 78 years) were included in the study. Patients were randomly divided into two groups to be applied epidural (group I), paravertebral (group II) block. Patients had supplementary doses of morphine by a patient-controlled analgesia (PCA) device. Postoperative total morphine consumption was noted by the PCA device. During the first 24 hours using visual analoque scale (VAS) patients were asked to assess their pain at rest; 1 hour after being in the intensive care unit and every 2 hours

Results: There were no significant differences between the groups regarding morphine consumption and VAS scores. Additionally, on the first postoperative day FEV1 and FVC measurements were not significantly different.

Conclusion: Paravertebral block may be an effective and safe altenative for the pain relief after thoracotomy.

Key words: Analgesia/methods; pain, postoperative/physiopathology/prevention & control/therapy; thoracotomy/adverse effects.

Amaç: Dorsal paravertebral ve epidural bloğun torakotomi sonrası ağrı kontrolü ve solunum fonksiyonları üzerine etkilerini karşılaştırmaktı.

Çalışma planı: Çalışmaya 50 hasta (38 erkek, 12 kadın; ort. yaş 49.8±17.7; dağılım 15-78) alındı. Hastalar rasgele epidural (grup 1) ve paravertebral (grup 2) blok uygulanacak şekilde iki gruba ayrıldı. Hastalara, hasta kontrollü analjezi (PCA) cihazıyla ek morfin uygulaması yapıldı. Ameliyat sonrası birinci günkü total morfin kullanımı PCA cihazının hafızasından not edildi. Görsel analog skalası (VAS) kullanılarak ilk 24 saatte, dinlenme sırasında; cerrahi yoğun bakım ünitesine gelişten bir saat sonra ve ardından her iki saatte bir hastalarda ağrı değerlendirilmesi yapıldı.

Bulgular: İki grup arasında; VAS skoru ve morfin tüketimi açısından istatiksel olarak anlamlı fark bulunamadı. Ek olarak ameliyat sonrası birinci gündeki FEV1 ve FVC değerleri istatiksel olarak anlamlı derecede farklı değildi.

Sonuç: Paravertebral blok torakotomi sonrası ağrı kontrolü için uygun ve etkili bir alternatif olabilir.

Anahtar sözcükler: Analjezi/yöntem; postoperative ağrı/fizyopatoloji/koruma ve control/tedavi; torakotomi/yan etki.

Post-thoracotomy pain is considered to be the most severe type of postoperative pain.[1,2] Among the several methods being tried for the relief of pain following thoracotomy, systemic opioid administration is used commonly. Unfortunately, this kind of medication has potential to cause respiratory depression.[3] Additionally, greater doses of opioids are required for the relief of post-thoracotomy pain than the other analgesic agents.[4]

Although various types of local anaesthetic techniques have been used for post-thoracotomy pain control, there are not enough randomized studies comparing those regimens.[5] Since the rib trauma results in a great pain experienced in the post-thoracotomy period, intercostal analgesia might control pain originating from these somatic structures. However, concerns have been raised regarding the systemic absorbtion of local anaes-

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Correspondence: Dr. Şahin Şenay. Dr. Siyami Ersek Göğüs Kalp ve Damar Cerrahisi Merkezi Kalp ve Damar Cerrahisi Kliniği, 34668 Haydarpaşa, İstanbul. Tel: 0216 - 349 91 20 / 1019 e-mail: sahinsenay@gmail.com

thetic given intercostally. High plasma levels of local anaesthetics have been reported after intercostal nerve blocks.[6,7] Continuous thoracic epidural analgesia is considered to be the gold standard by most of the anaesthesiologists, but it is associated with high incidence of complications such as hypotension and motor block.[8,9]

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

The aim of this study was to compare continuous thoracic epidural block and continuous paravertebral block for the treatment of pain after thoracotomy.

PATIENTS AND METHODS

After the study protocol has been approved by the local ethics committee, written informed consent was obtained from 50 American Society of Anesthesiologists (ASA) physical status I-III patients (38 males, 12 females; mean age 49.8±17.7; range 15 to 78 years), undergoing elective anterolateral thoracotomy. Before surgery, patients were randomly assigned to receive either thoracic epidural or thoracic 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 cooperate 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 subjects received midazolam 0.08 mgkg-1 and atropine 0.01 mgkg-1 intramuscularly 1 h before surgery. General anaesthesia was induced by sodium pentothal 5-7 mgkg-1 and propofol 2 mgkg-1. Muscle relaxation was achieved by vecuronium bromur 0.1 mg kg-1. Anaesthesia was maintained with 50% nitrous oxide and 1-2% sevoflurane in oxygen. During one-lung ventilation patients received 100% oxygen. Continuous electrocardiogram, invasive blood pressure, central venous pressure, endtidal carbondioxide and oxyhemoglobin saturation were monitored throughout surgery. Arterial blood-gas tensions were measured every hour during procedure and every two hour thereafter.

Patients were randomized in to two groups for the pain relief: epidural group (group 1)- 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)- after outlining the midline at the level of T5 and T7 we drawn the needle insertion line 2.5 cm laterally to it. During needle insertion, after the transverse process is contacted, we have withdrawn the needle to skin level and redirected superiorly or inferiorly to "walk off" the transverse process[10] and gently advanced until there was a loss of resistance to the injection of air. Thereafter a thoracic 20-gauge catheter was inserted through the Tuohy needle and was advanced 2 to 3 cm into the paravertebral space. All blocks were performed by the same anaesthesiologist before anaesthesia induction.

Patients in the epidural group were given a bolus dose of 10 ml of 0.25% bupivacaine before wound closure and a continuous infusion of 0.25% bupivacaine was started at 0.1 mlkg-1.hr-1 immediately after the patient had arrived in surgical intensive care unit (SICU). The infusion was continued for 24 h.

Patients in the paravertebral group were given a bolus dose of 15 ml. of 0.25% bupivacaine before wound closure and a continuous infusion of 0.25% bupivacaine was started at 0.1 mlkg-1.hr-1 in SICU for 24 h.

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. All patients stayed in SICU during the first postoperative night. The total dose of morphine consumed were read from the history of the device 24 h after operation.

Evaluation of pain in the postoperative period was done by using a 10-cm visual analogue scale (VAS) (0=no pain; 10=maximal pain) on emergency from general anesthesia (time 0) and every 2 h for the first 24 hours. At the same time, the level of patient's sedation were 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. The upper and lower levels of analgesia were evaluated by the loss of pinprick sensation on arrival to SICU and 24 h after arrival.

Hemodynamic parameters were recorded before the anaesthesia and 20 min after the bolus dose of local anaesthetics in both groups. Arterial blood-gas tensions were measured every hour during procedure and every two hour in SICU until 6 after operation,and again 12 and 24 h after operation. Oxygen saturation was monitored continuously by pulse oximetry until the first postoperative morning.

Table 1. Patient characteristics

	Epidural (n=25)	Paravertebral (n=25)	*p*
Age (year)	50.36±16.46	49.40±19.16	0.856
Height (cm)	171.32±5.45	171.72±4.94	0.787
Weight (kg)	71.08±6.23	69.80±5.45	0.443
Duration of operation (min)	200.40±74.86	207.60±50.21	0.691
Duration of anesthesia (min)	226.20±76.59	237.20±53.60	0.559
Duration of OLV (min)	108.96±50.08	97.60±47.86	0.416
Sex			
Male	19 (76.0%)	19 (76.0%)	
Female	6 (24.0%)	6 (24.0%)	

Data expressed as a mean±SD.

Spirometric measurements of FEV1, FVC and FEF were done before operation and 24 h after operation.

On the first postoperative day, patients were questioned for adverse effects (i.e. drowsiness, nausea, vomiting, itching, difficulties with breathing or allergic reactions).

Blood hemoglobin and hematocrit concentrations were measured before operation, on arrival to SICU, 12 and 24 h after operation. Packed red blood cells were transfused if the hemoglobin concentrations were below 9-10 gr dl-1.

SPSS (Statistical Package for Social Sciences for Windows version 10.0 Chicago, IL, USA) was used for all statistical analysis. 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 differences.

RESULTS

Fifty, ASA physical status I-III, patients completed the study. Patient characteristics are presented in Table 1. There were no statistically significant differences between the study groups in demographic aspects.

There were no significant differences between the groups with respect to VAS scores. The mean pain scores were 5.2±2.2 and 4.4±1.9 in epidural and paravertebral groups respectively in the immediate postoperative period whereas at 4 th hour they were decreased to 3.0±1.4 and 2.7±1.3. In both groups pain scores were significantly lower compared to immediate postoperative period on all occasions of measurement (Table 2).

There were no statistically significant differences between the groups in morphine consumption, 37.6±25.9 mg and 36.8±18.6 mg (p=0.903) for epidural and paravertebral groups respectively. However, there was a wide variability in patient requirements in both groups.

In epidural and paravertebral groups 3 and 2 patients experienced at least one nausea and vomiting episode (p=1.000). 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 between the groups in respiratory and hemodynamic parameters. FEV1, FVC, FEF, mean arterial pressure decreased significantly in both groups compared to basal values. The heart rate was significantly decreased in the epidural group, this decrease was not significant in paravertebral group (Table 3). Respiratory frequency was similar in both groups (Fig. 1). There were no significant differences with respect to arterial partial pressure of oxygen (PaO_2) at any point of measurements between the two groups (Table 4).

No patient had hypercapnia ($PaCO_2$ higher than 6.5 kPa) during first 24 h following surgery and consequently no patient had respiratory acidosis.

Table 2. Visual analoque scores

	Groups		
	Epidural (n=25)	Paravertebral (n=25)	*p*
0.h	5.24±2.15	4.44±1.94	0.162
2.h	3.56±1.50**	3.64±1.63*	0.759
4.h	3.00±1.41**	2.72±1.34**	0.527
6.h	2.80±1.12**	2.96±1.54**	0.976
12.h	2.64±1.15**	2.84±1.43**	0.776
18.h	2.44±1.04**	2.80±1.29**	0.320
24.h	2.40±1.04**	2.44±0.96**	0.780

Data expressed as a mean±SD; *: Compared with basal values p<0.05; **: Compared with basal values p<0.01.

Table 3. Respiratory and hemodynamic variables

	Epidural	Paravertebral	*p*
Preoperative	75.81±16.23	67.44±18.15	0.092
Postoperative	27.51±10.83	31.13±11.59	0.260
p	0.001**	0.001**	
Preoperative	68.81±14.90	61.10±17.56	0.101
Postoperative	23.98±9.27	27.18±9.81	0.242
p	0.001**	0.001**	
Preoperative	82.06±25.62	75.18±27.09	0.361
Postoperative	43.06±16.91	45.91±18.95	0.577
p	0.001**	0.001**	
Preoperative	81.32±13.06	79.80±13.86	0.692
Postoperative	77.08±12.13	77.48±13.56	0.913
p	0.019*	0.183	
Preoperative	89.72±13.20	90.24±9.48	0.874
Postoperative	81.20±13.40	86.68±9.77	0.105
p	0.017*	0.019*	

Data expressed as a mean±SD; *: p<0.05 significant; **: p<0.01 significant.

There were no significant differences in 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.

Altough we did not measure plasma levels of bupivacaine, 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.

DISCUSSION

The aim of postoperative pain relief is to provide better comfort and inhibit trauma-induced noxious impulses. But, still, there is no consensus concerning the choice of analgesic technique for post-thoracotomy pain. Many strategies to control this pain have been tried, but when the origin of the pain is considered, regional anaesthesia is the most logical approach. In literature there are not so many controlled, randomized comparisons of different regional anaesthesia techniques for post-thoracotomy pain relief.

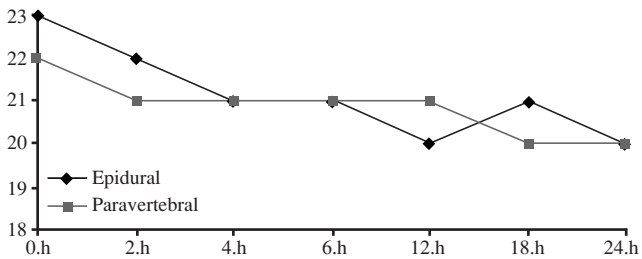

Fig. 1. Respiratory frequencies in study groups.

In the present study we compared the efficacy of continuous thoracic epidural anaesthesia and continuous thoracic paravertebral block in the treatment of pain following thoracotomy. VAS scores and total morphine consumption are the primary outcomes of the study. Since patients were titrated the dose of morphine from a PCA device, it is plausible 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 (37.6±25.9 mg and 36.8±18.6 mg for epidural and paravertebral groups respectively). This amount was surprisingly lower than the amount reported in other studies in which supplementary opioids have been given either i.m or i.v on request.[11,12] 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[13] and Richardson et al.[14] and co-workers.

Table 4. PO_2 values in study groups.

	Groups		
	Epidural (n=25)	Paravertebral (n=25)	*p*
0.h	12.44±2.05	14.90±8.59	0.171
2.h	28.04±16.97**	25.65±18.51*	0.636
4.h	18.86±10.37**	18.13±11.79	0.818
6.h	17.79±5.59**	16.92±4.82	0.558
12.h	16.21±5.05**	15.58±4.02	0.627
24.h	14.76±4.05**	13.95±4.08	0.485

Data expressed as a mean±SD 30; *: Compared with basal values p<0.05; **: Compared with basal values p<0.01.

Sabanathan et al.[15] and colleagues reported better pain relief and pulmonary function in paravertebral nerve block compared with placebo group in a double-blind, controlled study. On the contrary, Matthews and Govenden[13] did not reported any improvement in pulmonary functions in patients receiving paravertebral block. In addition to his work, Bigler et al.[16] and colleagues compared epidural morphine, bupivacaine combination with paravertebral bupivacaine in patients undergoing cholecystectomy. They have reported better pain scores in epidural group but no difference in pulmonary function. In another study Perttunen et al.[12] and colleagues comperad extradural, paravertebral and intercostal blocks for post-thoracotomy pain. Similar levels of pain, opioid requirements and pulmonary function were reported 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 the 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 epidural group there were no such patients. Depending on this data we may speculate 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 comsumption hourly, this speculation is needed to be confirmed by some other objective criteria.

The amount and concentration of local anaesthetics used in both techniques vary depending on the phycian and institude. We used the lowest concentration and amount reported in literature.[17,18] Since we do not have opportunity to monitor plasma levels of local anaesthetics we preferred this regimen. Fortunately neither group demonstrated pain-related complications and we assume that both methods of analgesia were able to provide adequate postoperative pain control.

Hypotension is a common finding after thoracic epidural analgesia due to bilateral sympathetic block.[19] Although less hypotension were reported with the paravertebral blockade,[14] it can still cause hypotension in dehydrated patients.[20] In the present study, no episode of hypotension were noted in both groups (MAP≤ 75 mmHg). This may be due to hydration of patients adequately before the bolus dosages or the lower concentration and amount of local anaesthetics given.

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 excessively high volume of the injection.[21,22] Although catheterisation of the paravertebral space was unsuccessful in two patients, paravertebral nerve block is easy and safe to perform.

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's perception of pain is different. Paravertebral block appears to be an effective, easy and safe method for analgesia after thoracic surgery, all of the regional anaesthetic agents have some withdrawals, they require careful, randomized, prospective comparative studies. From this point of view continuous thoracic 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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