EGYPTIAN JOURNAL OF ANAESTHESIA
2020, VOL. 36, NO. 1, 147–152
https://doi.org/10.1080/11101849.2020.1804816

Paravertebral versus single shot epidural blockade for neonates undergoing thoracotomy

Aliaa Rabie[a], Tamer Ghoneim[b] and Ahmed El-Rouby[c]

[a]Lecturer of Anesthesia and Surgical Intensive Care, Alexandria Faculty of Medicine, Alexandria, Egypt; [b]Lecturer of Anesthesia, Alexandria Faculty of Medicine, Alexandria, Egypt; [c]Lecturer of Pediatric Surgery, Alexandria Faculty of Medicine, Alexandria, Egypt

ABSTRACT

Background and Aims: Postthoracotomy pain in neonates has negative physiological consequences include impaired ventilation and vasoconstriction of both systemic and pulmonary vascular beds leading to compromised organ function. This study aimed to compare the effect of paravertebral blockade to single shot epidural blockade on postthoracotomy pain control.
Methods: A prospective study was conducted in El Shatby University Hospital, from April 2018 to March 2020 where forty neonates scheduled for a trachea-esophageal fistula (TOF) repair via thoracotomy were randomized to Group A (thoracic epidural single injection with 0.5 ml/ kg of 0.25% of L-Bupivacaine and 2 μg/kg of fentanyl) or Group B (Paravertebral blockade will be done by probe transverse – Needle In-Plane approach with 0.25% L-Bupivacaine, 0.5 ml/kg and 2 μg/kg of fentanyl). The primary objective was to compare the effect of paravertebral blockade to single shot epidural blockade on postthoracotomy pain control, the length of stay (LOS), supplemental analgesic requirements, and the incidence of adverse respiratory events were also measured.
Results: Forty neonates completed the study. Group A remained hemodynamically stable in the intraoperative period with good quality of analgesia for 8 hours postoperative with a lesser doses of rescue opioids required to maintain adequate analgesia, while in group B, paravertebral analgesic effects continued for about 4 hours postoperative with multiple dosage of rescue opioids (fentanyl) was required to maintain adequate analgesia which increased length of hospital stay
Conclusion: Very efficient postoperative analgesia can be achieved via single shot epidural blockade compared to paravertebral blockade in neonatal postthoracotomy pain.

ARTICLE HISTORY
Received 27 June 2020
Revised 22 July 2020
Accepted 27 July 2020

KEYWORDS
Analgesia; single shot epidural; paravertebral; postthoracotomy pain; neonates

1. Introduction

The prevention of pain in neonates should be the goal of all caregivers, because repeated painful exposures have the potential for deleterious consequences. Neonates at greatest risk of neurodevelopmental impairment as a result of preterm birth are also those most likely to be exposed to the greatest number of painful stimuli in the NICU [1]. Postthoracotomy pain has negative physiological consequences include impaired ventilation and vasoconstriction of both systemic and pulmonary vascular beds leading to compromised organ function [2]. Regional anesthesia provides profound analgesia with minimal hemodynamic effects, even in the presence of comorbidities [3].

Neuroaxial blockade may diminish abdominal and intercostal muscle activity, particularly in the compliant chest wall of neonates. On the other hand, it may improve diaphragmatic activity and excursion [4].

Paravertebral blocks are an alternative to epidural blockade for pain relief following thoracotomy, results in ipsilateral analgesia for unilateral surgeries, and has been found to be of better quality as compared with other alternatives for postoperative analgesia [5].

2. Methods

This randomized prospective controlled that was conducted in El-Shatby university hospital from April 2018 to March 2020 after the approval by the Ethics Committee of the Alexandria Main University Hospitals. A written informed consent was obtained from the parents for the participation of their infants in this study. Forty neonates of either sex, aged 1 day to 30 days, weighing 3–5 kg, scheduled for trachea-esophageal fistula (TOF) repair via thoracotomy were included for the study. The sample size is approved to be sufficient by the Department of Statistics, Medical Research Institute, Alexandria University, Egypt.

Patients suffering from local infection, neurological disorder, history of allergic reaction to local anesthetics, sacral/vertebral abnormalities, prematurity, and coagulation disorders were excluded from the study. During the preoperative visit, all patients were assessed.

CONTACT Aliaa Rabie rabie.abdelaziz@gmail.com Department of Anesthesia and Surgical Intensive Care, Alexandria Faculty of Medicine, Alexandria 21615, Egypt

Complete history was obtained from the parents, and all patients were subjected to thorough clinical examination and routine laboratory investigations. No premedication was done. All patients were fasting according to the American Society of Anesthesiology fasting rules [6].

In the operation theatre, all patients were attached to a multichannel monitor in the form of continuous electrocardiogram, heart rate, pulse oximeter and non-invasive arterial blood pressure End-tidal capnography was attached after insertion of the endotracheal tube (ETT). Anesthesia was induced with incremental concentrations of inhalational agent sevoflurane (2%–4%) and oxygen (3 L/min) using a silicone face mask size 0 connected to a Jackson-Rees circuit while maintaining spontaneous ventilation.

Infants were in the supine position with a small pillow in-between their shoulders. An intravenous line was secured in place bolus fluids 10 ml/kg *Lactated Ringer's* administered.

Tracheal intubation was attempted with a Miller blade size 00–0 without muscle relaxation. ETT advanced to the right main bronchus and gradually pulled back until breath sounds can be heard both left and right.

Anesthetized neonates were placed into the left lateral position. Under complete aseptic sterile technique with drapes, US cover, and sterile gel identification and mark the T6 spinous process was done. Patients were randomly allocated into two equal groups using a random number generating software (Research Randomizer Version 4.0), in group A neonates had thoracic single injection 0.5 ml/ kg of 0.25% of L-Bupivacaine and 2 µg/kg of fentanyl.

The probe was oriented in a sagittal direction and placed at the level of the marked spinous process of T6 in a parasagittal plane 2 cm from the midline. The probe then directed medially to identify the dura matter at the T6–T7 intervertebral space. The puncture performed via paramedian approach, at the T6–T7 interspace in all patients, with a 22 G needle (B. Braun Melsungen AG). The epidural space identified by the loss of resistance technique (Figure 1) [7].

While in group B paravertebral blockade was done by probe transverse – Needle In-Plane approach with 0.25% L-Bupivacaine, 0.5 ml/kg and 2 µg/kg of fentanyl.

After identifying the spinous process (SP) of T6, moved the transverse probe laterally in this plane and view the lamina and lateral to this the hyperechoic transverse process (TP) with acoustic shadow beneath. Identify the rib and intercostal muscles lateral to the transverse process (Figure 2).

Identify the pleura beneath, then 22 G sharp needle 40–50 mm length should pass through the intercostal muscles and the needle tip should end in a hypoechoic triangular space formed by the acoustic shadow underneath the transverse process medically, pleural antero-laterally, and the lower border of the intercostal muscles posteriorly.

Correct placement of the needle in the thoracic paravertebral space should be confirmed by the anterior displacement of pleural upon injection of a small bolus of saline or local anesthetic [8].

Surgery begun under general anesthesia maintained with sevoflurane. Thoracotomy was done while maintained autonomous respiration. Instead of routine exposure and fistula ligation, the surgeon immediately clamped the lower end of esophagus just above the stomach with a bulldog clamp.

The whole procedure was accomplished within 5 min. Then 0.1 mg/kg cisatracurium muscle relaxant and normal PPV were given. All patients received paracetamol (15 mg/kg/6 hrs) starting immediate postoperatively. At the end of surgery they were reversed with 50 µg/kg neostigmine and 20 µg/kg of atropine and were extubated.

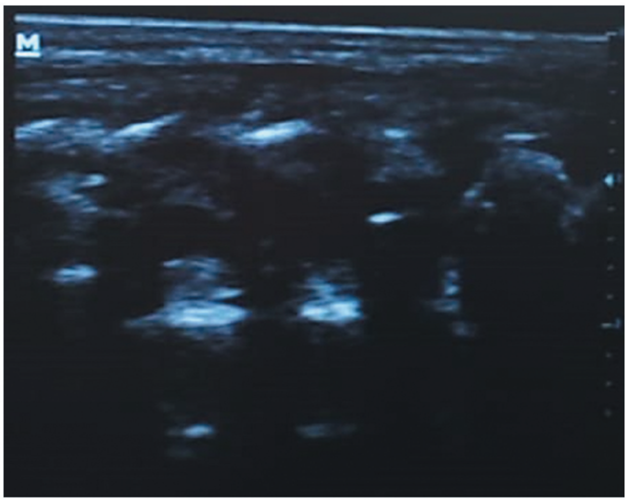

Figure 1. Ultrasound guided epidural blockade.

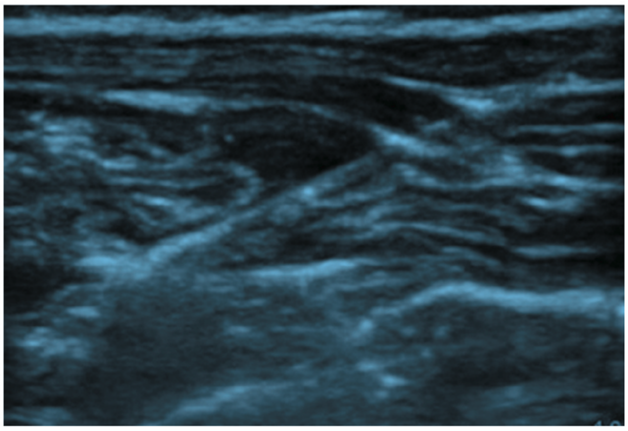

Figure 2. Needle In-Plane approach of paravertebral blockade.

Table 1. Neonatal infant pain scale (NIPS) [6].

	Score	Finding	Details
Facial expression	0	Relaxed muscle	Restful face, neutral expression
	1	Grimace	Tight facial muscles, furrowed brow, chin, jaw
Cry	0	No cry	Quiet, not crying
	1	Whimper	Mild moaning, intermittent
	2	Vigorous cry	Loud scream, rising, shrill, continuous
Breathing patterns	0	Relaxed	Usual pattern for this baby
	1	Changed	Indrawing, irregular, faster, gagging
Arms	0	Relaxed/restrained	No muscular rigidity, occasional movement
	1	Flexed/extended	Tense, straight arms, rigid, extension/flexion
Legs	0	Relaxed/restrained	No muscular rigidity, occasional movement
	1	Flexed/extended	Tense, straight legs, rigid, extension/flexion
State of arousal	0	Sleeping/awake	Quiet, peaceful, sleeping, or alert and settled
	1	Fussy	Alert, restless, and thrashing

Hemodynamic measurements including heart rate, mean arterial blood pressure, and oxygen saturation were recorded preinduction (basal value), immediate postinduction, at starting of surgical manipulation, mean of intraoperative readings with 15 min interval, and at the end of the operation.

Block execution time was calculated from the time of initial scanning to the removal of the needle, postoperative pain also assessed every 30 min in the first 2 hrs then every 1 hr for the next 10 hrs using Neonatal Infant Pain Scale (NIPS) Scale [9] (Tables 1, 2), and need for rescue opioid (fentanyl) analgesic use1 µg/kg/ dose (first time of rescue and total opioid consumption). Length of hospital stay (LOS), incidence of respiratory depression, and other complications as pneumothorax, hypotension, bleeding, infection, and nerve injury.

Table 2. NIPS interpretation [7].

Pain Level	Intervention
0–2 = mild to no pain	None
3–4 = mild to moderate pain	Nonpharmacological intervention with a reassessment in 30 min
>4 = severe pain	pharmacological intervention with reassessment in 30 min

Data were analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). The Kolmogorov-Smirnov test was used to verify the normality of distribution of variables, Comparisons between groups for categorical variables were assessed using Chi-square test (Fisher or Monte Carlo). Student *t*-test was used to compare two groups for normally distributed quantitative variables while ANOVA with repeated measures and post hoc test (Bonferroni) was assessed for comparison between different periods. Mann-Whitney test was used to compare between two groups for not normally distributed quantitative variables, while post hoc test (Dunn's) for Friedman test was used for comparison between different periods. Significance of the obtained results was judged at the 5% level.

3. Results

A total of 48 patients were screened for eligibility; 42 patients met inclusion criteria and were approached to participate, and two parents refused to engage their children in the study (Flowchart 1). Data were normally distributed within the two groups.

Flowchart 1. Flow diagram.

There was no statistically significant difference between the two groups regarding age, gender, and weight (Table 3). Regarding hemodynamic measurement there was statistically significant differences between two groups (Table 4).

While according to NIPS pain score, both blocks had the same analgesic efficacy for 4 hrs postoperative (Table 5), the time for first rescue fentanyl dose of group B was in 5.4 ± 0.5 hrs (Table 6), while the analgesic effect of single shot epidural blockade continued for 8 hrs postoperatively which was comparable to group B, and the time of first rescue analgesic requirement was in 8.3 ± 1.1 hrs. The percentage of patients required two rescue doses of fentanyl was significant higher in group B compared to group A (Table 6).

Furthermore length of hospital stay was longer in group B compared to group A (Table 6), but there was no statistically significant differences between two groups regarding incidence of complications (Table 6). Regarding block execution time was statistically significant longer in epidural group compared to paravertebral blockade (Table 6).

Table 3. Demographic data of the two groups.

Patients' characteristics	Group A (*n* = 20)	Group B (*n* = 20)
Age (days)	7.1 ± 2.5	6.2 ± 2.6
Weight (kg)	2.9 ± 0.5	3 ± 0.6
Gende		
Male	8 (40.0)	11 (55.0)
Female	12 (60.0)	9 (45.0)

Data are presented as mean±SD or *n* (%). SD – Standard deviation.

Table 4. Comparison between the two studied groups according to hemodynamic measurements.

	Group A (*n* = 20)	Group B (*n* = 20)	*t*	*p*
Heart rate				
Preinduction	146.9 ± 6	146.8 ± 5.6	0.055	0.957
Postinduction	126.2 ± 6.3	123.7 ± 2.5	1.642	0.109
Start	126.7 ± 5.6	124.7 ± 2.1	1.492	0.144
Intraoperative	126.5 ± 7.1	123.9 ± 1.7	1.559	0.127
End	118.6 ± 25	125.5 ± 2.6	1.218	0.238
Mean blood pressure				
Preinduction	52.1 ± 3	52.0 ± 3.1	0.051	0.959
Postinduction	39.4 ± 5.9	42.2 ± 2.9	1.897	0.065
Start	40.9 ± 6.8	40.8 ± 2.4	0.062	0.951
Intraoperative	38.4 ± 4.6	40.2 ± 2	1.598	0.122
End	38.0 ± 4.9	39.9 ± 1.8	1.621	0.118
Oxygen saturation				
Preinduction	95.1 ± 0.8	94.9 ± 1	0.857	0.397
Postinduction	98.8 ± 0.8	98.9 ± 0.9	0.185	0.854
Start	98.9 ± 0.9	98.8 ± 0.8	0.185	0.854
Intraoperative	92.4 ± 1.8	92.7 ± 2	0.419	0.678
End	98.9 ± 1	99.0 ± 0.8	0.529	0.600

***t*: Student *t*-test**, *p*: *p* value for comparison between the two studied. Data expressed by using **mean ± SD.**

Table 5. Comparison between the two studied groups according to postoperative pain (NIPS).

Postoperative pain (NIPS)	Group A (*n* = 20)	Group B (*n* = 20)	*U*	*p*
30 min	1 (0–2)	1 (0–2)	158.0	0.265
60 min	1 (0–2)	2 (0–4)	151.0	0.192
90 min	1 (0–2)	1 (0–3)	141.5	0.114
2 hrs	1 (0–2)	1 (0–4)	150.5	0.183
3 hrs	2 (1–2)	2 (1–4)	146.0	0.149
4 hrs	2 (2–3)	4 (3–4)	32.0*	<0.001*
5 hrs	3 (2–4)	5 (4–5)	16.0*	<0.001*
6 hrs	2.5 (1–4)	4 (3–5)	48.0*	<0.001*
7 hrs	4 (3–5)	3 (2–4)	84.0*	0.001*
8 hrs	4 (3–6)	4 (2–4)	102.5*	0.007*
9 hrs	4(3–5)	4(4–6)	144.5	0.134
10 hrs	4 (3–6)	3 (2–6)	128.5	0.052
11 hrs	4 (2–5)	4 (2–6)	143.5	0.127
12 hrs	4 (3–6)	4 (3–4)	170.5	0.429

U: Mann-Whitney test *p*: *p* value for comparison between the two studied groups. Data expressed by using **median (Min. – Max.)**

4. Discussion

Neonates' postoperative have a significant stress response measured by metabolic and hormonal indicators which in turn has an adverse circulatory and ventilator effects [10]. Severe postthoracotomy pain can result from pleural and muscular damage, costo-vertebral joint disruption, and intercostal nerve damage during surgery [11].

Poor pain relief after surgery can impede recovery and increase the risks of developing complications such as lung collapse, chest infections, and blood clots due to ineffective breathing and clearing of secretions [12] .Effective management of acute pain following thoracotomy may prevent these complications and reduce the likelihood of developing chronic pain [13].

A multimodal approach to analgesia is widely employed by thoracic anesthetists using a combination of regional anesthetic blockade and systemic analgesia, with both nonopioid and opioid medications and local anesthesia blockade [14].

In agreement with this study Joshi et al. [15] found that PVB provided analgesia after thoracotomy that was comparable with TEA using LA only, but possibly less effective than TEA using LA with opioid.

On the other hand Tarek Sarhan, Adrian, Karmakar, and their associates studied the effectiveness of thoracic paravertebral blockade using ropivacaine in comparison to thoracic epidural blockade in 24 neonates scheduled for tracheosophageal fistula repair and concluded that the thoracic paravertebral block has a longer duration of analgesia than thoracic epidural group [16].

5. Conclusion

From the present study, we conclude that thoracic epidural block using bupivacaine with fentanyl provided longer effective postoperative analgesia compared to thoracic paravertebral block however, result in lesser required rescue doses of fentanyl and shorter length of hospital stay.

Table 6. Comparison between the two studied groups according to different parameters.

	Group A (n = 20)	Group B (n = 20)	Test of sig.	p
Length of hospital stay in days	6.2 ± 1	7.4 ± 1.2	t = 3.618*	0.001*
Rescue opioid analgesic use				
First time of rescue (hours)	8.3 ± 1.1	5.4 ± 0.5	t = 10.498*	<0.001*
Total opioid consumption (n of doses)				
1	8 (40%)	2(10.0%)	χ^2 = 4.800*	0.028*
2	12 (60%)	18(90.0%)		
Incidence of complications				
No	17 (85%)	18 (90%)	χ^2 = 0.012	0.900
Nerve injury	0(0%)	0 (0%)		
Sympathetic blockade	0 (0%)	0 (0%)		
Bleeding	1 (5%)	0 (0%)		
Hypotension	0 (0%)	2 (10%)		
Pneumothorax	2 (10%)	0 (0%)		
Block execution time (min)	13.1 ± 2.1	6.8 ± 1.2	t = 11.779*	<0.001*

Furthermore ultrasound guided techniques used in the present study had less complications with more hemodynamic stability.

Disclosure statement

The authors declare that they have no competing interests.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Ethics approval and consent to participate

The present study was approved by the ethical committee of Faculty of Medicine, Alexandria University (IRB no. 00007555, FWA no. 00018699). A consent to participate was obtained as well.

Consent for publication

Written informed consent was obtained from the parents for publication of this article and any accompanying tables/images. The copies of the written consents are available for review by the Editor of this journal upon request.

Availability of data and material

All data supporting the study are presented in the manuscript or available upon request.

References

[1] American Academy of Pediatrics, Committee on Fetus and Newborn and Section on Surgery, Section on Anesthesiology and Pain Medicine, Canadian Paediatric Society and Fetus and Newborn Committee, Batton DG, Barrington KJ, Wallman C. Prevention and management of pain in the neonate: an update. Pediatrics. 2006;118:2231–2234.

[2] Bouza H. The impact of pain in the immature brain. J Matern Fetal Neonatetal Med. 2009;22:722–732.

[3] Oberlander TF, Berde CB, Lam KH. Infants tolerate spinal anesthesia with minimal overall autonomic changes: analysis of heart rate variability in former premature infants undergoing hernia repair. Anesth Analg. 1995;80:20–27.

[4] Von Ungern-Sternberg BS, Regli A, Frei FJ. The effect of caudal block on functional residual capacity and ventilation homogeneity in healthy children. Anaesthesia. 2006;61:758–763.

[5] Berta E, Spanhel J, Gabrhelik T, et al. Paravertebral block in children techniques in regional anesthesia and pain management. Vol. 11. USA: Elsevier science; 2007. p. 247–254.

[6] practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the american society of anesthesiologists task force on preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration. Anesthesiology. 2017;126:376–393.

[7] Bailey PD, Rose JB, Keswani SG, et al. Does the use of fentanyl in epidural solutions for postthoracotomy pain management in neonates affect surgical outcome. J Pediatr Surg. 2005 Jul;40(7):1118–1121.

[8] Thavaneswaran P, Rudkin G, Cooter R, et al. Paravertebral block for anesthesia: a systematic review. Anesth Analg. 2010;110:1740–1744.

[9] Lawrence J, Alcock D, McGrath P, et al. The development of a tool to assess neonatal pain. Neonatal Netw. 1993;12(6):59–66.

[10] Dickson U. Pain management in children. In: Skone R, Reynolds F, Cray S, et al., editors. Managing the critically ill child: a guide for anaesthetists and emergency physicians [Online]. Cambridge: Cambridge University Press; 2013. p. 250–257.

[11] Norina W, Seth C, Christopher E, et al. A guide to pain assessment and management in the neonate. Curr Emerg Hosp Med Rep. 2016;4:1–10.

[12] Britto CD, Pn S R, Nesargi S, et al. PAIN–perception and assessment of painful procedures in the NICU. J Trop Pediatr. 2014 Dec;60(6):422–427.

[13] Yeung JH, Gates S, Naidu BV, et al. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. Cochrane Database Syst Rev. 2016 Feb;21:2.
[14] Kotze A, Scally A, Howell S. Efficacy and safety of different techniques of paravertebral block for analgesia after thoracotomy: a systematic review and meta-regression. Br J Anaesth. 2009;103(5):626–636.
[15] Joshi GP, Bonnet F, Shah R, et al. A systematic review of randomized trials evaluating regional techniques for post-thoracotomy analgesia. Anesth Analg. 2008;107:1026–1040.
[16] Sarhan Tarek M. Analgesia for tracheoesophageal fistula repair in neonates: a comparison of single shot thoracic paravertebral block and epidural block with ropivacaine. AJAIC. 2005;8(4):400–402.