Original Article

A prospective study of the quality and duration of analgesia with 0.25% bupivacaine in ultrasound-guided erector spinae plane block for paediatric thoracotomy

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ABSTRACT

Background and Aims: Pain of open thoracotomy is treated with systemic analgesics, thoracic epidural and paravertebral blocks which have associated adverse effects and complications**.** Research shows ultrasound guided erector spinae plane block (US-ESPB) as a simpler and safer alternative. As paucity of data of US-ESPB in paediatric thoracotomies exists. We aimed at studying the analgesic efficacy of US-ESPB for paediatric thoracotomy. **Methods:** In a prospective observational study, 30 children, 1-12 years age undergoing thoracotomy with decortication under general anaesthesia with US-ESPB were observed. At induction, patient received intravenous (IV) fentanyl 3 μg/kg for analgesia and standard general endotracheal anaesthesia was administered. US-ESPB was given at fourth thoracic vertebral level with 0.25% bupivacaine 0.3 ml/kg. Changes in haemodynamic parameters at skin incision, rib retraction, pleural incision, intercostal drain insertion, and skin closure were noted. Intraoperatively, additional fentanyl was administered, if required and its dose and time were noted. Postoperative pain was assessed by visual analogue scale (VAS) (0-10) for ≥6 years and by face, leg, activity, cry, consolability (FLACC) score (0-10) for <6 years at post extubation, 30 minutes and hourly postoperatively. Descriptive statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 20. **Results:** Additional analgesic was not required in 14/30 patients (46.67%) intraoperatively and within 6 hours (7.4 ± 1.26) post-operatively. Five of the remaining 16 patients, required IV 1 μg/kg fentanyl only once intraoperatively. Median pain score was 2 in first four postoperative hours. **Conclusion:** US-ESPB provided effective supplemental intraoperative and postoperative analgesia in nearly half of the paediatric thoracotomy patients.

Key words: Analgesia, erector spinae plane block, paediatric, thoracotomy

INTRODUCTION

Decortication or stripping of the fibrinopurulent pleura by open thoracotomy or video assisted thoracoscopic surgery (VATS) under general anaesthesia causes significant pain intraoperatively as well as post operatively. Post-thoracotomy pain is one of the most severe types of pain on the first day of the surgery. In paediatric patients, inadequate analgesia may lead to adverse circulatory and respiratory compromise. Systemic non-steroidal inflammatory drugs (NSAIDs) and parenteral opioids give effective analgesia but may cause gastrointestinal, renal adverse effects and respiratory depression, respectively.[1] Thoracic epidural (TE) analgesia is considered a gold standard technique but it carries a considerable risk for serious neurological complications.[2] Although, thoracic paravertebral block (TPVB) gives comparable

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analgesia, it requires more expertise and there is associated risk of spreading of infection to epidural space.[2,3] Ultrasound-guided erector spinae plane block (US-ESPB) is an interfascial plane block given beneath the erector spinae muscle and can target the dorsal plus ventral rami of the thoracic spinal nerves and effective analgesia can be obtained. Ultrasound guidance has made the block a simpler and safer alternative to thoracic epidural and paravertebral blocks. The literature available on US-ESPB in paediatric patients includes randomised or observational studies in cardiac and abdominal surgeries; nevertheless, only case reports or letters to the editor in relation to thoracic surgeries have been reported. Hence, we conducted a study to evaluate the effectiveness of US-ESPB to provide analgesia for paediatric thoracotomy including decortication. The primary objectives were to evaluate quality of analgesia using changes in haemodynamic parameters as a surrogate marker intraoperatively, pain scores postoperatively and rescue analgesic requirement. The secondary objective was to study adverse effects, if any.

METHODOLOGY

In this prospective study, 30 paediatric patients in the age group of 1–12 years of either gender scheduled for decortication and undergoing general endotracheal anaesthesia (GETA) with US-ESPB were studied in a single tertiary care hospital from January 2020 to August 2020. Approval from the institutional ethics committee was taken and the study was registered prospectively with Clinical Trial Registry, India, URL: ctri.nic.in [CTRI/2020/01/022703]. Informed consent was obtained from the patient's parents or guardian for participation in the study. The study was conducted in the paediatric surgery operation theatre under an experienced anaesthesiologist's supervision. Exclusion criteria included refusal from parents or guardian or inability to assess postoperative pain due to any reasons (patients on ventilatory support or with cognitive deficits).

The standard protocol in our institute is as follows: Patients receive intravenous (IV) glycopyrrolate 0.004 mg/kg, midazolam 0.05 mg/kg, fentanyl 3 μg/kg 5 min prior to induction with propofol. Patients receive sevoflurane through endotracheal tube for maintenance. They receive atracurium or vecuronium for neuromuscular blockade.

US-ESPB was performed in lateral position with the diseased side up. Under all aseptic precautions, a high frequency linear ultrasound transducer (5-13MHz) was placed in the paraspinal region, longitudinally oriented and lateral to the thoracic fourth spinous process. A 21 G, 50 mm long stimuplex needle was inserted in the craniocaudal direction deeper to the erector spinae muscle. After confirming the needle position by hydro-dissection with 0.5 ml saline, injection of 0.25% bupivacaine 0.3 ml/kg was administered in the fascial plane under the erector spinae muscle (Classical approach). During surgery, if there was significant rise in heart rate or blood pressure (10% above the baseline i.e., post-induction values) in response to surgical stimuli, additional analgesic in the form of aliquots of fentanyl 1 μg/kg were administered by the attending anaesthesiologist.

Assessment of postoperative pain was done using visual analogue scale (VAS) (0 − 10) for age group ≥6 years and by face, leg, activity, cry, consolability score (FLACC) (0 − 10) in age group <6 years at following times: Post extubation, 30 min, 1 h, 2 h after surgery and 2 hourly intervals if the child was awake. If the child was sleeping comfortably, then it was assumed that the child did not have significant pain and the child was not disturbed further. The patient was observed for first 2-4 hours in post-surgery intensive care unit/recovery room and later in the wards up to requirement of first rescue analgesic. If pain score was ≥4, then the patient received IV fentanyl 0.5 μg/kg in the first 2 h or IV paracetamol 15 mg/kg. In the wards, patients received IV paracetamol 15 mg/kg as rescue analgesic and later eight hourly for the next two postoperative days.

For this study, demographic characteristics, haemodynamic parameters, postoperative pain scores, number and dosages of rescue analgesic required in intraoperative and postoperative period, and complications, if any were noted. In our historical control group who did not receive any regional blocks, 95% of children required rescue analgesic within six hours of postoperative period. We considered significant success if 40% of children receiving US-ESPB, were spared from rescue analgesic requirement in the first six hours. With an alpha error of 0.05 and power of study 80%, Power and Sample Size Calculation software (version 3.1.2, 2014, Vanderbilt University School of Medicine, Nashville, TN 37203-1741, USA) determined a requirement of 26 patients for the US-ESPB group. To keep a margin of safety, we enroled 30 subjects for the study.

The collected data were analysed using Statistical Package for Social Sciences (SPSS) version 20. International Business Machines Corporation (IBM) SPSS statistics for Windows, Armonk, NY). For normally distributed data, the results were expressed as mean and standard deviation (SD) and as a median and interquartile range [IQR] for data not normally distributed. Categorical data were expressed in number (percentage).

RESULTS

A total of 39 patients were assessed for eligibility and 30 patients (age 1 − 12 years) undergoing thoracotomy for decortication under GA and US-ESPB were further analysed [Figure 1].

Demographic details were divided as per age in sub-groups [Table 1]. There was no significant rise in pulse rate and systolic blood pressure at all stages of surgery compared to baseline that is, post-induction [Table 2]. There were no complications secondary to performance of block (hypotension, vascular or pleural puncture, local anaesthetic toxicity) in any patient during the study.

In our study, 14 out of 30 patients (46.67%) did not require any rescue analgesic intraoperatively as well as in the first six hours (7.4 ± 1.26) post-operatively.

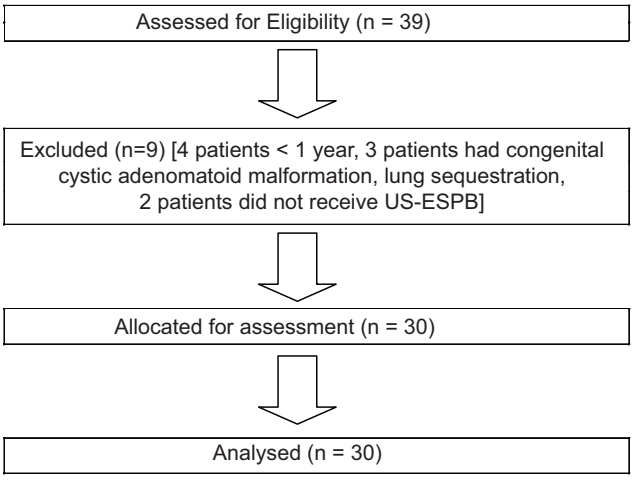

Figure 1: Flow diagram explaining the patient recruitment

Out of the remaining 16 patients, five patients required only intraoperative analgesia in the form of IV 1 μg/kg fentanyl once either at rib retraction or during pleural dissection and mean duration to first postoperative analgesia was 8.9 ± 0.89 hours [Table 3]. Median VAS scores were 2 in first four postoperative hours [Table 4]. VAS score was <4 in 19/30 patients for first 4 post-operative hours. Maximum VAS/FLACC score postoperatively in first four hours was 6/10.

DISCUSSION

ESPB was first described by Forero *et al*. in 2016 in two patients with neuropathic pain in whom it gave appreciable pain relief.[4] Good chest wall analgesia was reported in paediatric cases of rib tumour excision, funnel chest and diaphragmatic plication with ESPB and IV supplemental analgesics.[5-7] Adler *et al*. in 2019 reported ESPB as a safer alternative in a neonatal case of lobectomy to avoid thoracic epidural and opioids which have potential risk of technical difficulties, catheter migration and respiratory depression, respectively.[8]

In a prospective comparison of ESPB with TPVB in adult patients undergoing thoracic surgeries like wedge resection or lobectomies Fang *et al*. observed comparable analgesia and significantly lesser number of punctures while performing block and complications in ESPB group.[9] In a retrospective cohort study in 79 patients with multiple rib fractures, Adhikary *et al*. observed significant reduction in pain scores and improvement in incentive spirometry volumes after administration of ESPB.[10] Many case reports and letters to the editor have been published on adult or paediatric cases of laparoscopic cholecystectomy, dysplastic dislocation of hip repair, paraspinal lipoma excision, video-assisted thoracoscopic lobectomy, bilateral nephrectomy, etc.[11-15] Munshey *et al*. in 2018 published a retrospective analysis of the effective use of programmed intermittent bolus regimen for erector spinae plane block in children.[16]

Till date, only few prospective trials have been reported in paediatric patients, mainly in those undergoing

Table 1: Demographic details

Age	Male	Female	Total number of Patients	Weight in kg Mean±standard deviation	Duration of Surgery in minutes Mean±standard deviation
1-3 years	6	4	10	8.93±3.35	123±15.67
3-5 years	3	3	6	13±0.75	127±26.41
5-8 years	1	5	6	16±2.88	133±27.52
8-12 years	6	2	8	21.2±1.91	148±27.21
	16	14	30		132.5±24.70

lower abdominal surgeries or cardiac surgery. Mostafa *et al*. in 2019 reported a prospective randomised trial of US-ESPB for postoperative analgesia in 60 paediatric splenectomy patients. They found significantly lower post-operative Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) scores for the first 8 h (5 (5.0 – 6.0)) in the ESPB group compared to the control group (6 (6.0–10.0)) ($P < 0.001$). Also, 7/30 patients from ESPB group (23.3%) required intraoperative fentanyl compared to 25/30 patients (83.3%) from the control group. Time to first rescue analgesic was 508 ± 194 min (5 – 11.6 hours) in the ESP group while it was 33.6 ± 31.8 min in the control group.[17]

In our study we used 0.3 ml/kg 0.25% bupivacaine similar to that used in the study by Mostafa *et al* and the case report by Elkoundi *et al*. in paediatric patients.[12,17] Also, we observed, 14 out of 30 patients (46.67%) did not require additional analgesic intraoperatively or within first six postoperative hours. Considering the fact that we had administered only IV fentanyl 3 μg/kg before induction, if US-ESPB would not have been effective, children would have shown tachycardia, hypertension as surrogate markers of pain at skin incision or during rib retraction, pleura dissection, intercostal drain insertion. Five of 30 (16.66%) children required IV fentanyl 1 μg/kg once, intraoperatively. They did not require further analgesia for 8.9 ± 0.89 (8-10) hours. 40% of our study patients did require intraoperative analgesic. This is not surprising as they had received pre-induction fentanyl 3 μg/kg, the effect of which would have lasted only for 2 – 2.5 hours and would not cover extensive tissue dissection for long standing empyema in prolonged surgery. However, these children required only one dose of fentanyl 1 μg/kg; thus one can safely say that US-ESPB did reduce analgesic requirement.

In a prospective randomised comparative study, Singh *et al*. found significantly less FLACC scores at 3 and 6 postoperative hours, longer duration of analgesia and lesser morphine requirement with ESPB for paediatric lower abdominal surgeries.[18]

In 80 paediatric cardiac surgery patients with midline sternotomy, Kaushal *et al*. found lower modified objective pain score (MOPS) until 10 hours post-extubation and longer time to first rescue analgesic (4.5 ± 0.62 hours) with bilateral ESPB compared to the control group ($P < 0.0001$).[19]

In cadaveric studies, unpredictable spread of injectate in ESPB was found with dye spread to ventral, dorsal, and paravertebral space when injected at high thoracic level.[20-22] On the contrary, Adhikary *et al*. reported wide spread of local anaesthetic between erector spinae and costotransverse process and spread encompassing paravertebral, neural foramina, ipsilateral epidural space and sympathetic chain.[23] Costache *et al*. described ESPB as 'paravertebral by proxy' as it achieves thoracic nerve blockade without direct entry into the space.[24]

Thus, erector spinae plane block, an interfascial block has extensive cranio-caudad spread of the injectate along the thoracic dermatomes and shows effective but variable results.[25,26] Hence, for thoracic surgeries, it cannot be a solo analgesic technique but definitely would give better supplemental analgesia. As per our study and available data, US-ESPB can be a safe and effective regional analgesia technique with opioid sparing effect for thoracotomy with decortication. The limitations of our study were that it was a single group study with a relatively small sample size. Though craniocaudal spread of local anaesthetic was seen with ultrasound, the exact degree of spread was not noted.

Table 2: Heart rate and Systolic Blood Pressure

Stages	Heart rate (Beats/minute) Mean±standard deviation	Systolic Blood pressure (mm of Hg) Mean±standard deviation
Post-induction (Baseline)	126±11.02	96±11.36
Skin incision	115±12.34	92±8.85
Rib retraction	118±10.77	95±12.62
Pleura Dissection	117±11.03	90±13.23
ICD Insertion	111±13.63	86±12.17
Skin closure	108±13.92	89±9.12

ICD=Intercostal drain

Table 3: Analgesic need and duration of analgesia

Analgesia	Number of patients (%)	Duration of postoperative analgesia in hours (Mean±standard deviation) [Range]
No additional analgesia	14 (46.67)	7.4±1.26 [6-10]
Only intraoperative analgesia	5 (16.66)	8.9±0.89 [8-10]
Only postoperatively <2 h	4 (13.33)	1.25±0.87 [0-2]
Intraoperatively + postoperatively <2 h	7 (23.33)	1±0.96 [0-2]

Table 4: Post-operative pain scores VAS/FLACC score

Post-operative time	VAS/FLACC score median (IQR) [range]
Post extubation	2 (1) [1-6]
30 min	2 (1) [1-5]
1 h	2 (0) [1-5]
2 h	2 (1) [1-5]
3 h	2 (0) [1-5]
4 h	2 (0) [1-5]

VAS – Visual analogue scale, FLACC – Face, leg, activity, cry, consolability score, IQR – Interquartile range (25%-75%)

CONCLUSION

US-ESPB provided effective intraoperative and postoperative analgesia for 6 h in nearly half of the children undergoing thoracotomy with decortication. Considering the fact that the remaining half of the children had minimal rescue analgesic requirement, we conclude that US-ESPB is a promising regional analgesic technique for paediatric thoracotomy cases.

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.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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