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Research Article

A Comparative Study of 0.125% Bupivacaine Infusion and 0.125% Bupivacaine with Fentanyl Infusion for Thoracic Epidural in Paediatric Post Thoracotomy Pain Relief

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ABSTRACT

To compare the analgesic efficacy, postoperative haemodynamic stability and complications of bupivacaine and fentanyl as an adjuvant with bupivacaine in continuous thoracic epidural infusion in paediatric post thoracotomy pain relief

Material and Methods: Study population: Sixty children of ASA Grade I & II physical status between 1 to 12 years of age group of either sex posted for thoracotomies. All cases underwent clinical assessment, laboratory investigations and written informed consent was taken preoperatively.

Study Design: Patients allocationd to one of the two groups by simple random sampling method.

- Group B- Patients received a bolus dose of 0.2 ml/kg of 0.125% of bupivacaine and continuous infusion at 0,125% bupivacaine 0.3ml/kg/hour.
- Group BF (fentanyl)- Patients received a bolus dose of 0.2ml/kg of 0.125% bupivacaine with 1 mcg/kg fentanyl and continuous infusion of 0.3ml/kg/hour 0.125% bupivacaine with 1 mcg/ml of fentanyl.

Results: Fentanyl as an adjuvant in post thoracotomy epidural infusion provided excellent quality of analgesia than bupivacaine alone with excellent hemodynamic stability in both the groups, better in fentanyl group without complications in either group with no additional analgesic drug requirement in group BF in first 24 hours. The demographic parameters eg. age, sex, weight and type of surgery, duration of surgery were comparable in both the groups.

Conclusion: Thoracic epidural is safe, effective and necessary part of post thoracotomy dynamic analgesia in paediatric patients. Incision congruent thoracic epidural catheter placement gives advantage of using minimum optimal concentration and doses of the local anaesthetic and opioids with good pain relief without complications. We recommend fentanyl as an adjuvant to local anaesthetic infusion for thoracic epidural analgesia in paediatric post thoracotomy pain relief.

Keywords: Paediatric thoracotomy; Postoperative analgesia; Epidural infusion; Fentanyl

INTRODUCTION

Thoracotomy is a very painful surgical procedure [1,2]. The importance of post –thoracotomy pain relief is to achieve dynamic analgesia -a freely mobile patient who can cough effectively with low pain score [1]. A child becoming sick disturbs the whole family. Postoperative pain can lead to non-cooperation, continuous crying and restlessness in children and parents. Hence it is always preferable to prevent the onset of pain rather than to relieve its existence. This is pre-emptive analgesia [3]. To replace the term pre-emptive analgesia by preventive analgesia we must try for pain free experience in the postoperative period [4]. If the child is pain free he/she is cooperative during physiotherapy. Parents are also comfortable when the children are calm. Multimodal analgesia or balanced analgesia is the best approach for postoperative pain relief. It combines drugs from different classes- opioids, non-opioids and regional analgesic techniques with different mechanisms of action in the pain pathways in the central and peripheral nervous system leading to their synergistic actions relieving maximum pain in low doses thereby reducing the risks of adverse drug effects [5]. The development of pain pathways and stress response in children is same as adults. So pain should be treated effectively in children of all age groups to avoid the metabolic and psychological effects of untreated pain [6]. Inadequate pain relief in paediatric patients may lead to long term psychological effects like disrupted sleep and eating, harmful neuroendocrine responses, hyperalgesia and allodynia, various physiologic responses including immobility, hemodynamic instability, lack of rest affecting the healing leading to anxiety and depression like symptoms. The worst of it all is acute pain changing into chronic pain [3].

Nowadays the anaesthesiologist is considered to be a perioperative physician and supposed to relieve pain not just during surgeries but also during postoperative period. The peripheral nociceptive stimuli get transmitted to the central nervous system leading to the neuroendocrine stress response. The supra-segmental reflex response to pain leads to increased sympathetic tone, increased catabolic hormone secretion, decreased secretion of anabolic hormones and increased catecholamine secretion. Attenuation of post-operative pain with certain analgesic drugs decreases the perioperative morbidity and mortality. Postoperative analgesia not only improves quality of life of the patient but also results in fast recovery and hence reduces the medical costs [3,7,8].

The different modalities of analgesia commonly used in multimodal approach are –a) pharmacological –NSAIDs (non-steroidal anti-inflammatory drugs), α 2 agonists, opioids, b) neuraxial blocks– intrathecal or epidural analgesia with opioids or α 2 agonists, c) intra-articular and wound infiltration with local anesthetic drug and d) peripheral nerve blocks. The NSAIDs are used to reduce the peripheral activation/sensitization of nociceptors, local anesthetics to block sensory inflow, and centrally acting opioids to prevent central sensitization throughout the postoperative period [5,9].

Most of the pediatric patients presenting with empyema are otherwise healthy, chronic morbidity after surgery and death is extremely rare in this age group. Instead the adult patients are elderly, frail and with significant morbidity and mortality [10]. Paediatric thoracotomy for empyema requires a posterolateral incision in the 5th intercostal space involving 3 - 6 dermatomes. This is very painful because of cutting of multiple muscle layers, ribs retraction, stripping out of the densely innervated parietal pleura, intercostal drainage tube causing pleural irritation and continuous motion because of breathing. Post thoracotomy good pain relief is very important for early ambulation of the patient who is comfortable, can cough and deep breathe without splinting. This helps to minimize pulmonary complications like hypoxia, retention of secretions, atelectasis leading to consolidation, infections and for early extubation of the patient. Thoracic epidural analgesia has been the gold standard for post thoracotomy pain relief [11]. Effective pain relief from epidural analgesia facilitates early recovery, reduces levels of circulating stress hormones and catabolic state time leading to rapid weaning from ventilators and reduced paediatric intensive care costs [12,13].

In children from 2 to 10 years of age the thoracic spines are almost horizontal and the mean distance of the spinal cord from dura is more than 4 mm at T 9- T 10 level as per imaging studies. This gives safe midline approach to the thoracic epidural space. In children epidural catheters can be easily threaded to higher levels from lower thoracic and lumbar spaces because the epidural space contains less fat and fibrous tissue. Therefore insertion of epidural catheter at lumbar level is safe compared to direct thoracic approach in infants [14].

The insertion of the epidural catheter congruent to the incisional dermatomes is called catheter-incision-congruent analgesia. The placement of the epidural catheter between T4-T8 dermatomes is recommended for thoracotomy pain relief. This gives superior post-operative analgesia by infusing analgesics to the incisional dermatomes with minimal side effects like urinary retention, lower extremity motorand sympathetic blockade, maintain level of consciousness and cough reflex [7,8,13]. Continuous epidural analgesia gives constant degree of analgesia [8]. If the catheter tip is placed congruent to the incisional dermatomes low concentration and volume of local anaesthetic can produce a band of analgesia minimizing the side effects [8]. Use of only bupivacaine without adjuvant can cause problems in children in spite of good analgesia because of lack of sedation. Opioids can be added in small doses to the epidural solution to overcome this problems [6]. The mixture of bupivacaine and fentanyl provides superior analgesia because of combined effects of afferent neural blockade by bupivacaine and fentanyl's opioid receptor agonist action in the central nervous system [8]. The combination of local anaesthetic and opioid prolongs the sensory blockade and improves the quality of dynamic pain relief [8]. The epidural local anaesthetic increases segmental bio-availability of opioids in the cerebrospinal fluid and increases the binding of opioids to μ receptors.

Fentanyl is a synthetic, lipid soluble opioid agonist. Lipophilic opioids have faster onset of action and faster elimination compared to hydrophilic opioids. High lipid solubility of fentanyl limits its cephalad spread. The principal effect of opioid receptor activation is a decrease in neurotransmission at presynaptic site. Pruritus, nausea and vomiting, urinary retention, depression of ventilation, sedation are some of the common side effects of fentanyl [15].

This study was undertaken to investigate the analgesic efficacy of fentanyl with bupivacaine in thoracic epidural infusion in paediatric patients for post-thoracotomy pain relief, to observe postoperative haemodynamic stability and complications of thoracic epidural infusion with opioid.

MATERIALS AND METHODS

Study population

The present study was conducted on 60 children of ASA Grade I & II physical status, between 1 to 12 years of age group of either sex posted for thoracotomy for decortication or lobectomy.

Sample Size Formula and Calculation:

$$n(\text{Per Group}) = [\frac{z_{\alpha/2}\sqrt{2pq} + \sqrt{p1q1 + p2q2}}{p1 - p2}]2$$

p1 = 0.36 (Approximate incidence of excellent intra-op quality of analgesia in group I (Bupivacaine)),

p2 = 0.72 (Approximate incidence of excellent intra-op quality of analgesia in group II (Bupivacaine + Fentanyl)), q1 = 1 – p1 = 0.64, q2 = 1 – p2 = 0.28. $Z_{\alpha/2}$ = 1.96 (score at 95% confidence interval), Zβ = Cut-off value for Power (1 - β). = 0.8416 n (Per Group) = ((1.96*SQRT (2*0.54*0.46) +0.8416*SQRT (0.36*0.64+0.72*0.28))/ (0.36-0.72)) ^2 = 28.88 per group Thus, the minimum sample size required according to this formula was 29 per group (58 totals in 2 groups).

An additional 10% subjects were included to cover for any potential drop outs that may occur post operatively due to reasons such as administration of antipyretics (in febrile children) which also have analgesic effect and hence would interfere with the trial results.

Statistical data analysis

Excellent quality of analgesia was defined by patient's calm and quite expressions and absolute hemodynamic stability. The data on categorical variables presented as n (% of cases) and the values on continuous variables presented as Mean ± Standard Deviation (SD). The significance of difference of distribution of prevalence of clinical outcome across two study groups tested using Chi-Square test of Fisher's exact probability test. Independent sample't' test was used to test the significance of difference in the continuous variables across two study groups. The underlying assumption of normality was tested before subjecting the study variables to t test.

P-values less than 0.05 were considered to be statistically significant. The entire hypothesis was formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data was statistically analysed using Statistical Package for Social Sciences (SPSS version 21.0, IBM Corporation; NY, USA) for MS Windows. The results obtained in the study were presented in tabulated manner, statistical analysis was done by student's "t" test. Chi square test was performed for non-parametric values and corresponding P was computed. P value < 0.05 was considered statistically significant.

Study design

Prospective, interventional, double blinded, randomized controlled comparative study. Double blind study – the study drug infusion was prepared by the attending anaesthesiologist. Intraoperative and postoperative monitoring was done by the blinded anesthesiologist.

Inclusion criteria

Consent, ASA grade I & II, Age: 1 to 12 Years, type of surgery: thoracotomies including lobectomy and decortication, weight 3- 40 kgs (kilograms).

Exclusion criteria

Refusal of consent, ASA physical status 3 or 4, bleeding disorders, patient with known hypersensitivity to bupivacaine or fentanyl, history of seizures, patients with mental retardation / neurological deficits , history of urinary retention, history of major systemic illness , infection at the site of needle placement, BMI>30kg/m2, bony abnormalities of the vertebral coloum.

Study groups

Group B: 0.125% bupivacaine plain, Group BF: 0.125% bupivacaine + 1microgram (mcg)/ml fentanyl

Global assessment of anesthesia

Defined as the time from extubation to the first administration of rescue analgesia. This time was recorded for both the groups. Heart

rate, NIBP, oxygen saturation and body temperature were monitored continuously. Any side effects in terms of hemodynamic alterations, respiratory depression, vomiting, urinary retention and sedation were noted. Sampling Technique: Simple Random Sampling Method (using coin method).

Pre anesthetic assessment

The cases were selected after pre anesthetic check up with detailed history, clinical examination and relevant laboratory investigations. The spine was examined for any evidence of vertebral column anomalies, skin infection, bony landmarks, movements and previous operations. Once the preanaesthetic evaluation was done well informed and written consent was taken. All patients were kept nil per orally- for solid food 6 hours, breast milk 4 hours and clear liquids 2 hours before surgery.

Investigations

Haemogram with PT and INR, urine- routine/microscopic, Chest X-ray.

Methodology

Premedication: All our patients had intravenous line secured with No. 22 or 20 intracath. Inj ceftriaxone50 mg/kg was given intravenously 30 minutes before induction of anesthesia.

Anesthesia technique

Monitoring: ECG (Electrocardiogram)., NIBP (Non-Invasive Blood Pressure Monitoring) and pulse oximeter were attached to the patient. Temperature probe was inserted after induction of anaesthesia.

Induction: Inj fentanyl 2 mcg/kg, Inj midazolam 0.05 mg/kg, Inj glycopyrrolate 5 mcg/kg and Inj ondensetron 0.1 mg/kg were given intravenously. Induction of anaesthesia was done with Injpropofol 2 mg/kg and Inj Vecuronium 0.1mg/kg intravenously to facilitate endotracheal intubation. Microcuff endotracheal tube of proper size was used for intubation.

Maintenance: Maintenance of anesthesia was done with oxygen, nitrous oxide and sevoflurane: Injection vecuronium bromide was used for maintenance of muscle relaxation. Intraoperative inadequate analgesia was supplemented by 1 mcg/kg intravenous doses of fentanyl. After induction of general anaesthesia epidural catheter was inserted in left lateral position in the lower thoracic or upper lumbar spaces taking all aseptic precautions. The length of the catheter was measured from the puncture site of the epidural needle to the 5 th thoracic vertebra and the tip of the epidural catheter was placed incision congruent i.e. at the level of the 5 th thoracic vertebra. The patient was monitored using standard monitoring i.e Electrocardiogram (ECG), heart rate, pulse oximeter, temperature and noninvasive blood pressure during the course of surgery. The neuromuscular blockade was reversed with inj. Neostigmine 50mcg/kg and inj. glycopyrrolate 8 mcg/kg at the end of surgery. Intravenous fluid management was done according to Holliday Segar formula. Complete replacement of fluid was done for starvation period and intraoperative losses. Blood loss was replaced by blood wherever necessary. In our study the thoracic epidural catheter was inserted under general anaesthesia so a test dose of 0.5 % lignocaine 0.08 ml/kg was given slowly. A loading dose -0.2 ml/kg of 0.125 % bupivacaine or 0.125% bupivacaine with fentanyl 1 mcg/kg was given before the incision. After 15 minutes after confirming hemodynamic stability infusion of 0.125 % bupivacaine or 125% bupivacaine with 1 mcg fentanyl /ml was started with the dose of 0.3ml/kg/hour.

Postoperative monitoring: Postoperative monitoring was done in the post-anaesthesia care unit (PACU). None of our patients had motor blockade in the lower extremities. Modified Bromage scale was used for monitoring of motor power in the lower extremity. Patients were shifted to the ward after 3 hours when the Modified Bromage score was 0 or 1 and monitored in the ward using a standard monitoring for next 24 Hours. The assessment of pain relief was done by using the objective pain scale. Patients were observed for other complications namely - nausea, vomiting, respiratory depression, hypotension and bradycardia, sedation and urinary retention. At the onset of pain, rescue analgesia was given and the total duration of analgesia was noted. The rescue analgesia was given when pain score was more than or equal to 6. Inj paracetamol 15 mg/kg intravenous was used as rescue analgesic.

RESULTS

The demographic parameters eg. age, sex, weight and type of surgery, duration of surgery were comparable in both the groups.

DISCUSSION

Objective pain score though inferior to self-assessment is probably good tool for assessment of postoperative pain and need for analgesia in younger children [16]. In the literature review we found study conducted by Joseph D. Tobias et al in the age group 3 months to 18 yrs., posted for lateral thoracotomy for metastatic lesion excision, biopsy, lobectomy, primary tumour resection, diaphragmatic hernia repair and pneumonectomy. Thoracic epidural catheter was inserted and left in place for 48 to 72 hrs at T6-11 level, after inducing general anaesthesia. After giving test dose of 1 to 3ml of 0.25% bupivacaine with epinephrine (1:200,000) post-operative analgesia was provided by an initial bolus of 0.2-0.3ml/kg of bupivacaine 0.25% with 0.5-1 mcg/kg fentanyl followed by a continuous infusion of bupivacaine 0.1 to 0.125% with fentanyl. The concentration of fentanyl was adjusted to deliver 0.5 to 0.75 microgram/kg/hour with an infusion rate of 0.3ml/kg/hour. Supplemental analgesia was provided by either epidural fentanyl 1 mcg/kg or PCA epidural device. They concluded that administration of epidural fentanyl at the thoracic level is advantageous over either the administration of larger dose at lumbar level or the use of epidural morphine and direct placement of thoracic epidural catheter is feasible even in infants and small children [17]. In our study the doses of bupivacaine and bupivacaine with fentanyl were same like this study. We noticed good analgesia with no side effects in fentanyl with bupivacaine group even during physiotherapy. In bupivacaine group 6 children had pain during physiotherapy and required rescue analgesia.

A Ganesh, et al conducted a study in full term infants of age 0-6 months with ASA grade 1 to 3 scheduled for thoracotomy for lung resection of bronchopulmonary sequestration divided in two groups. Group B – received continuous epidural infusion of solution containing 0.1% bupivacaine, Group BF – received 0.1% bupivacaine with fentanyl 2 microgram/ml. The thoracic epidural catheter was inserted under general anaesthesia through a caudal or lumber approach and catheter was advanced up to mid thoracic level T5 -T10. Test dose of 0.08ml/kg of 1.5% lignocaine with 1:200000 epinephrine was given followed by initial bolus dose of 0.5ml/kg of 0.25% bupivacaine and infusion started with 0.25ml/kg/hour. Intraoperative inadequate pain relief was supplemented by increasing concentration

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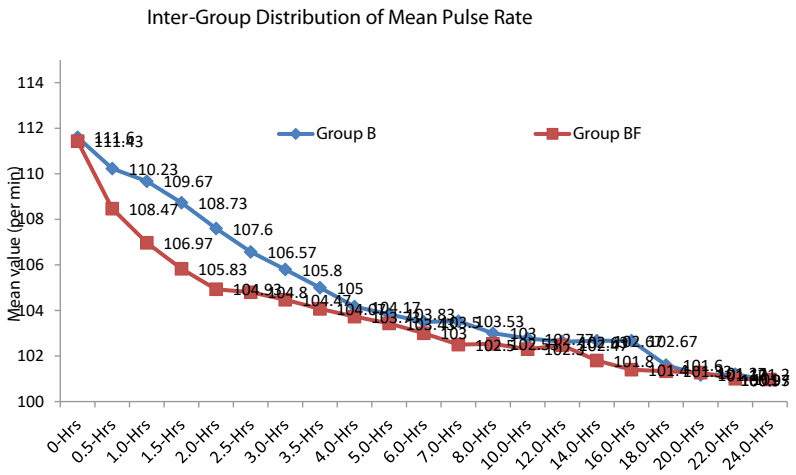

Figure 1: Inter-group distribution of mean pulse rate distribution of mean pulse rate was monitored for first 24 hours among the cases studied did not differ significantly between two study groups (*p*-value > 0.05 for all).

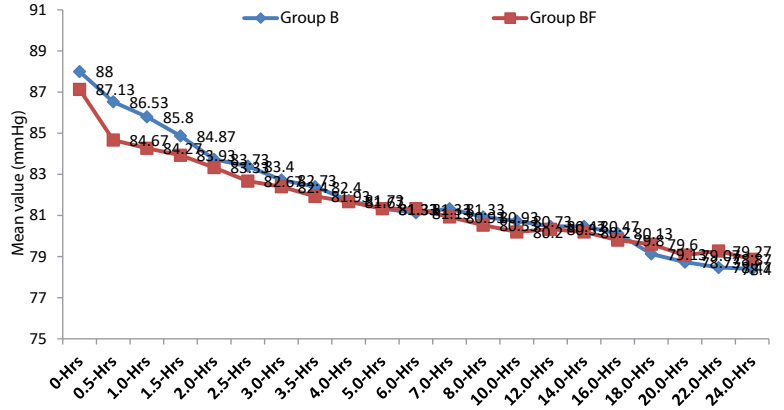

Figure 2: Inter-group distribution of mean systolic
BP. Distribution of mean systolic BP monitored for first 24 hours among the cases studied did not differ significantly between two study groups (p-value > 0.05 for all).

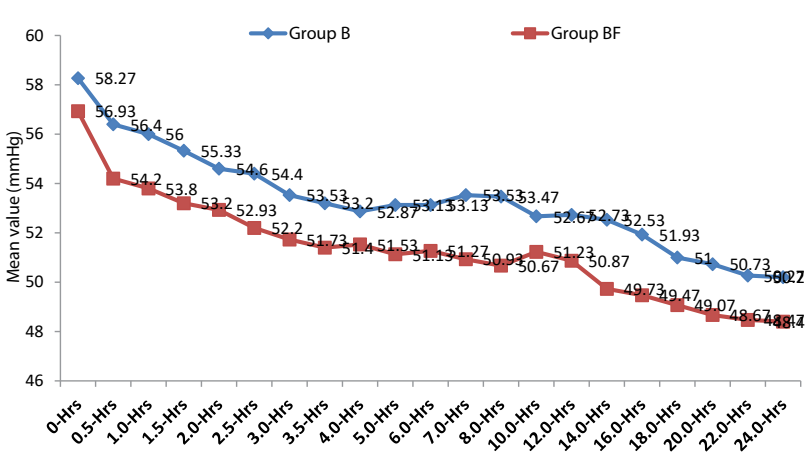

Figure 3: Inter-group distribution of mean diastolic BP:
Distribution of mean diastolic BP monitored for first 24 hours among the cases studied did not differ significantly between two study groups (*p*-value > 0.05 for all).

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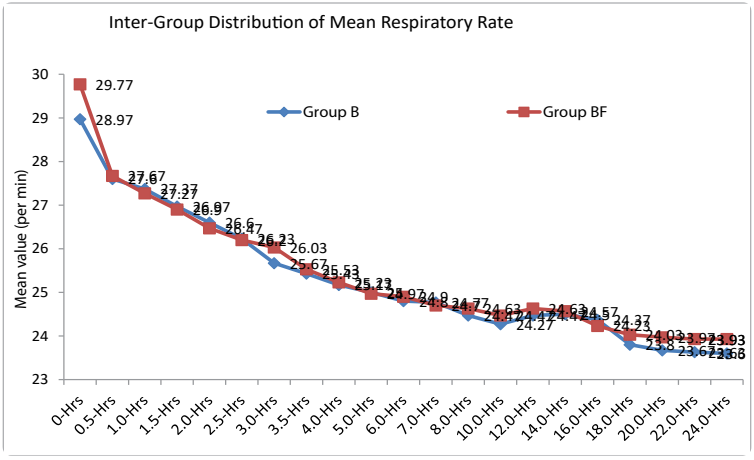

Figure 4: Inter-group distribution of mean respiratory rate
Distribution of mean respiratory rate monitored for first 24 hours among the cases studied did not differ significantly between two study groups (p-value > 0.05 for all).

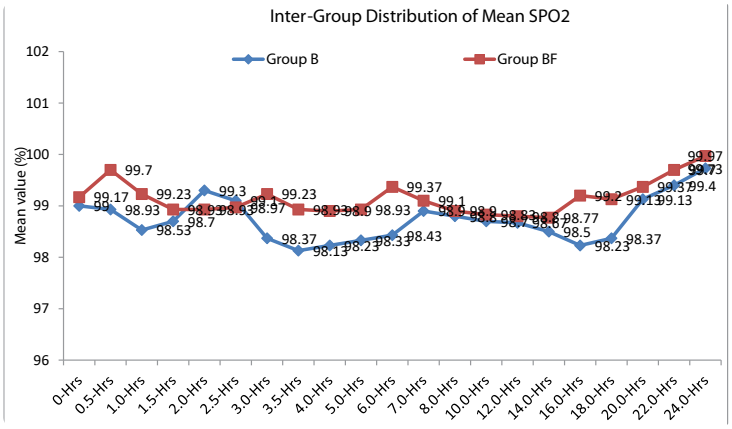

Figure 5: Inter-group distribution of mean SPO2 distribution of mean oxygen saturation (SPO2) monitored for first 24 hours among the cases studied did not differ significantly between two study groups (*p*-value > 0.5 for all).

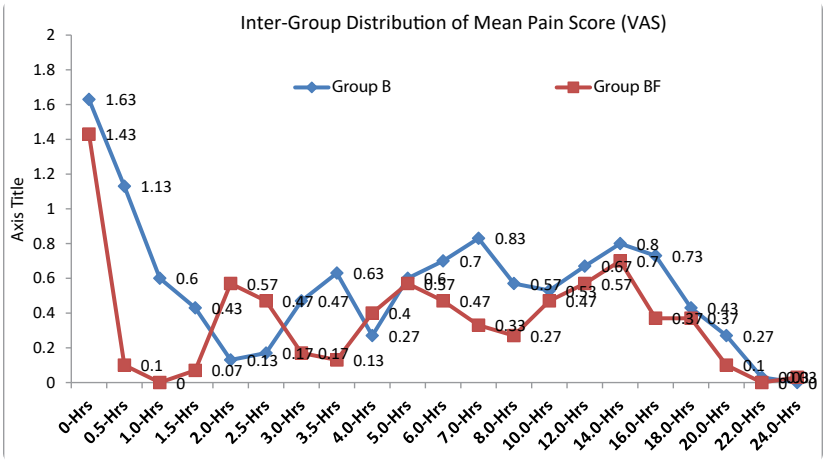

Figure 4: Inter-group distribution of mean pain score.
Distribution of mean pain score (OPS) monitored for first 24 hours among the cases studied did not differ significantly between two study groups (*p*-value > 0.5 for all).
Distribution of mean pain score (OPS) at 0.5 hours, 1 hours, 1.5 hours, 3 hours, 3.5 hours, 7 hours among the cases studied is significantly higher in Group B compared to Group BF (*p*-value < 0.5 for all).
Distribution of mean pain score (OPS) at 2.5 hours among the cases studied is significantly higher in Group BF compared to Group B (*p*-value < 0.5). Of the 30 cases studied in Group B, 24 (80.0%) did not require additional analgesics and 6 (20.0%) required rescue analgesia during physiotherapy in first 24 hours. None of the 30 cases in group BF required additional analgesics in the 24 hours.

of desflurane. Pain intensity was assessed by CRIES (Crying, Required Oxygen for Spo2 < 95%, Increased Vital Signs, Expression, And Sleepless) for 24 hours postoperatively. At the onset of pain bolus dose of 1 ml of 1% lignocaine was injected through epidural catheter and continuous epidural infusion rate was increased up to 0.3 ml/kg/hour. If no pain relief then study solution was stopped and replaced with 0.1% bupivacaine solution and intravenous infusion of morphine at the initial rate of 0.02 mg/kg/hour after 8 hours. The time to first rescue analgesia was significantly longer in group BF (516+or-524 min.) then in group B (126 + or-89). Pain score in patients of group BF were significantly less than those in group B. The CRIES score in first 24 hours was significantly decreased in group BF (1.5 + or-1.9) compared with group B (2.9 + or-2.3). Conclusion of this study indicates that addition of 2 microgram/ml fentanyl to 0.1% bupivacaine results in improved analgesia after thoracotomy when compared with 0.1% bupivacaine alone administered epidurally in infants up to 6 months of age [18]. In our study the children were above 1 year of age, bupivacaine concentration was 0.125% and fentanyl was 1 mcg/ml. The infusion rate was 0.3 ml/kg/hour. Our patients in fentanyl group also had less pain scores compared to bupivacaine group.

Karnik PP, et al. conducted a study in patients between the age group of 1-12 years, ASA physical status 2 undergoing videoscope assisted thoracic surgery and decortication for empyema thoracis who were divided into two groups to compare analgesic efficacy and safety of continuous thoracic epidural infusion (group E) versus local infiltration and systemic opioids (group L). After induction of standardised general anaesthesia thoracic epidural catheter was inserted between T4 and T8 using paramedian approach. After test dose of 1% lignocaine with adrenaline 0.1ml/kg group E patients received bolus epidural dose of 0.5 ml/kg of o.25% of bupivacaine before incision and postoperative continuous epidural infusion of bupivacaine and fentanyl up to 48 hours via Baxter multi rate infuser with the rate of 0.4 ml/kg/hour of 0.0625% solution of bupivacaine in age group of 12-18 months and 0.25-0.3 ml/kg /hour of a 0.125% bupivacaine solution with fentanyl concentration of 2 microgram/ml. Group L patients received local infiltration of injection bupivacaine and injection lignocaine 2 mg/kg and 5 mg/kg respectively divided into two doses at port site one dose before incision and another dose after surgery. Both groups received injection fentanyl 2 microgram/kg at time of induction of general anaesthesia and 1 microgram/kg intra-operatively as supplemental analgesia. They received injection tramadol 1mg/kg intravenously thrice a day, daily postoperatively for adequate pain relief. During postoperative period all patients were assessed for adequacy of pain relief by using FACES scale (face, leg activity, cry, consolation) for 1-3 years of age group patients, and Wong Baker FACES scale for patients of >3 years. They watched for rescue analgesia time and adverse events. They noticed difference in pain score was statistically significant 20 hours postoperative, urinary retention in 2 patients in epidural group and nausea, vomiting in 5 patients in local infiltration group. They concluded that epidural analgesia is an effective, safe and important part of pain relief in VATS decortication for paediatric thoracic empyema patients [19]. The dose of fentanyl infusion in our study was less- 1 mcg/ml compared to this study and no tramadol was used. This may be the reason for no nausea and vomiting in our study.

Macias A, et al. conducted a clinical study for comparison of thoracic epidural infusion of ropivacaine, ropivacaine with fentanyl and bupivacaine with fentanyl for post thoracotomy analgesia. Patients aged 18-80 years, ASA physical status 1 and 2 posted for elective lung surgery via a posterolateral mid thoracic incision were divided in 3 groups: Group BF received continuous epidural infusion at the rate of 0.1 ml/kg/hour 0.1% bupivacaine with fentanyl 5 mcg/ml. Group R received continuous epidural infusion at the rate of 0.1 ml/kg/hour 0.2% ropivacaine. Group RF received continuous epidural infusion of o.15% ropivacaine with fentanyl 5 mcg/ml. All patients underwent a standardized combined general epidural anaesthesia, thoracic epidural placed at T3-4 interspace. Test dose of 3 ml of 2% lignocaine with 1:2000,000 epinephrine was injected through catheter then general anaesthesia was induced. Epidural bolus dose of 0.1 ml/kg of 0.175% bupivacaine with fentanyl 5 mcg/ml was administered during surgical incision followed by continuous infusion of 0.1 ml/kg of 0.125% bupivacaine with fentanyl 10 mcg/ml at the rate of 0.1 ml/kg/hour, in group BF. Intraoperative inadequate pain relief was supplemented by incremental dose of intravenous fentanyl. All patients received paracetamol 2 grams intravenously every 6 hours and ondansetron 4 mg I.V. every 4 hour if nausea, vomiting was present. Postoperative pain was measured by VAS score and titrated with I.V. morphine 2mg as bolus when VAS>40. They concluded that continuous thoracic epidural infusion of 0.1 ml/kg/hour of 0.15% ropivacaine with fentanyl 5 mcg/ml provided adequate pain relief and similar analgesia to 0.1% bupivacaine with fentanyl 5 mcg/ml during the first 2 postoperative days after posterolateral thoracotomy. Ropivacaine 0.2% does not give adequate pain relief during movements. The requirement of intravenous doses of morphine is more leading to increased incidence of postoperative nausea and vomiting. The infusion of epidural ropivacaine/fentanyl offers no clinical advantage over bupivacaine/fentanyl for post thoracotomy analgesia [20].

Patil SS, et al conducted a study on ASA grade 1 or 2 patients between 18-65 years of age undergoing major abdominal surgery divided in two groups. Group B received 0.125% bupivacaine with 1 mcg/ml fentanyl Group R received 0.125% ropivacaine with 1 mcg / ml fentanyl postoperatively.

Epidural catheter was inserted at lumber level (L1-2, L2-3), then general anaesthesia was induced. Intraoperatively group B received 0.25% bupivacaine with 1 mcg /ml fentanyl 8ml bolus after induction. After 1 hour of bolus patients received continuous epidural infusion of 0.25% bupivacaine with 1 mcg/ml fentanyl at the rate of 6ml/hour in group B and group R received ropivacaine in the same concentration and rate instead of bupivacaine. Infusion was stopped before 30-45 min. before reversal in both groups. Postoperatively group B received 0.125% bupivacaine plus 1 mcg/ml fentanyl at the rate of 6 ml/hour and group R received ropivacaine in place of bupivacaine in the same concentration and rate. Postoperatively pain score was observed by Visual Analogue Scale (VAS), motor blockade by Bromage score, sensory blockade by pin prick, and hemodynamic parameters were noted. Whenever the VAS was more than 3 the infusion was stepped up by 2 ml/hr to 10 ml/hr. If there was no relief after 10 ml/hr rescue analgesia was given with 50 mg intravenous tramadol. They concluded that both ropivacaine and bupivacaine in the concentration of 0.125% with fentanyl 1 mcg/ml are equally safe, offer good pain relief, and cause minimal motor block [21]. Our study has same concentration of bupivacaine and the dose of fentanyl. The study population in our study was paediatric but the results were same.

Lucyna Tomaszek, et al. [22] conducted a study in patients aged 7-17 years, undergoing elective thoracic surgery divided into 2 groups. Group RF (0.2% ropivacaine with 5 mcg/ml fentanyl) and

group BF (0.125% bupivacaine with 5 mcg/ml fentanyl). All patients underwent standardised combined epidural general anaesthesia, an epidural catheter was inserted in to the anaesthetised patient at T4 and T7 level. All patients were monitored for hemodynamic parameters, pain intensity by Numeric rating scale and 3-step method at rest and during deep breathing, sedation by sedation scale, and motor blockade by Bromage score in the postoperative period. They concluded that the results were comparable in both the groups, and analgesia was excellent. Continuous thoracic epidural of 0.2% ropivacaine with 5 mcg/ml fentanyl provided adequate pain relief similar to 0.125% bupivacaine with 5 mcg/ml fentanyl in children after the Ravitch procedure and thoracotomy. The complications were minor and easily reversible. The dose of fentanyl in epidural infusion is high compared to our study.

Dawood Agamohammdi, et al. [23] conducted a clinical trial on patients having traumatic multiple rib fracture to compare continuous thoracic epidural analgesia between bupivacaine and bupivacaine with dexmedetomidine for pain control. These patients of age more than 18 years, with GCS >14 were randomly selected and assigned in to two similar groups, spine and head injury patients were excluded from the study. Thoracic epidural catheter was inserted two level below the rib fracture. Primary bolus dose of (1.5ml/segment) of 0.125% bupivacaine was injected after test dose. Group 1 patients received continuous thoracic epidural infusion of 0.125% bupivacaine at the dose of 1-2 ml/kg/hour (5 mg/hr) with 200 mcg/ml of dexmedetomidine. Group 2 patients received 0.125% bupivacaine alone using the same technique for 4 days. Every day ABG (arterial blood gas) analysis and oxygenation and ventilation parameters were recorded along with VAS pain score. VAS score improved in both groups, but was better in group receiving dexmedetomidine along with bupivacaine. They concluded that thoracic epidural infusion of bupivacaine and dexmedetomidineis an excellent combination for control of rib fracture pain in patients of trauma. There are no pulmonary side effects and the haemodynamic stability is maintained. It is better than only bupivacaine in these patients.

C.N.H. Tan, et al. [24] conducted a trial on patients between 2-70 years of age to investigate analgesia and adverse effects of three commonly used concentrations of thoracic epidural containing fentanyl with bupivacaine in patients undergoing thoracotomy for lung resections. The patients were divided in three groups- fentanyl 2 mcg/ml (group 2), fentanyl 5 mcg/ml (group 5), fentanyl 10 mcg/ml (group 10) with 0.1% bupivacaine via a thoracic epidural. Postoperatively pain on coughing was assessed using a Visual Analogue Scale (VAS) and an Observer Rating Score (OVRS) for 24 hours, at the same time sedation, pruritis and nausea were assessed. Their conclusion is- thoracic epidural with fentanyl 5 mcg/ml with 0.1% bupivacaine provides good pain relief without side effects following thoracotomy. Increasing the dose of fentanyl from 5 to 10 mcg/ml increases side effects like pruritus and sedation. This study is conducted in adult patients. Ours was paediatric study and so to avoid complications we have used 1 mcg/ml fentanyl in epidural infusion with good pain relief.

A Rabie, et al. [25] used single shot thoracic epidural analgesia for neonates undergoing thoracotomy. They used inj fentanyl 2 mcg/kg intravenous in one group and inj fentanyl 2 mcg/kg with L bupivacaine 0.25% 0.5 ml/kg in single shot thoracic epidural in the second group. Thoracic epidural was given under ultrasonography guidance at T 6 level. Their conclusion is- thoracic epidural analgesia with fentanyl provides longer duration of analgesia compared to intravenous bolus dose of fentanyl. It reduces doses of rescue analgesia, incidence of respiratory depression and duration of hospital stay.

Girish Joshi, et al. [26] conducted a systemic review of randomized trials of regional techniques for adult post-thoracotomy analgesia. In this review thoracic epidural, paravertebral block, intercostal block, intrathecal and interpleural techniques of analgesia were compared to each other and to systemic analgesia. They concluded that thoracic epidural with local anaesthetic plus opioid or continuous paravertebral block with local anaesthetic can be recommended for post-thoracotomy pain. If these techniques are contraindicated or not possible intercostal block or intrathecal opioids are recommended. But these techniques give incomplete duration of analgesia with increased requirements of systemic analgesics. Thoracic epidural analgesia with local anaesthetic plus fentanyl is better than local anaesthetic alone with reduced requirement of supplementary analgesics.

Schnabel A, et al. [27] conducted a database analysis of age and procedure specific differences of epidural analgesia in children. Their conclusions are- regional analgesia is an important part of multimodal analgesia, pain scores are high in older children and children undergoing spine and thoracic surgeries compared to abdominal and extremity surgeries, the pain scores are high during movements. They suggested multimodal pain management with epidural analgesia, nonopioidal analgesics like dexmedetomidine systemically and opioid as rescue analgesic on demand under monitoring.

In our set up we teach deep breathing exercises and incentive spirometry preoperatively to children above 4 years of age. So we could start physiotherapy as early as 6 -8 hours postoperatively once patients were haemodynamically stable and wide awake. The patient was made to sit upright in the bed first. Small children up to 3 years of age were made to sit in their mother's lap. Once the children were stable, could manage upright sitting position they were made to sit on the edge of the bed with support and their legs hanging. Bigger children were made to sit in the chair first. Deep breathing exercises and incentive spirometry was started within 24 hours in children above 4 years of age. All children in BF groups in our study were painless and comfortable during physiotherapy compared to group B children [27]. Six children in group B needed rescue analgesia after physiotherapy.

We got satisfactory and good analgesia in our both the groups in terms of Objective pain score, better in group BF with the optimal use of fentanyl (1 mcg/ml). We started the epidural as pre-emptive analgesic i.e. before the skin incision and continued the epidural infusion throughout the surgery and in the postoperative period. The intraoperative combination of general anesthesia with epidural gave haemodynamic stability with minimal requirement of inhalational anesthetic and muscle relaxant. We did not find any side effects or complications in both groups like hypotension probably because of proper fluid and blood replacement with blood where ever necessary. Haemodynamic stability was excellent in our both groups, even better in fentanyl group in early postoperative period. The infusion rate of 0.3 ml/kg/hour was an optimal dose for maintenance of analgesia without side effects in our study [Figure 1-6].

CONCLUSION

In paediatric patients thoracic epidural is safe, gives good pain relief and should be considered an important part of post thoracotomy dynamic analgesia. Incision congruent thoracic epidural catheter placement is advantageous in paediatric patients. It gives advantage

of using minimum optimal concentration and doses of the local anaesthetic and opioids with good pain relief without complications. The analgesia can be continued for 3 to 4 postoperative days compared to regional blocks which are effective for 24 hours or have to be repeated. We recommend fentanyl as an adjuvant to local anaesthetic thoracic epidural infusion for paediatric post thoracotomy pain relief.

REFERENCES

1. Richard Hughes, Fang Gao. Pain control for thoracotomy. Continuing Education in Anaesthesia, Critical Care & Pain.2005;5(2):50-60. doi: 10.1093/bjaceaccp/mki014
2. Schnabel A, Thyssen NM, Goeters C, Zheng H, Zahn PK, Van Aken H, Pogatzki-Zahn EM. Age- and procedure-specific differences of epidural analgesia in children--a database analysis. Pain Med. 2015 Mar;16(3):544-53. doi: 10.1111/pme.12633. Epub 2015 Jan 19. PMID: 25599577.
3. Gottschalk A, Smith DS. New concepts in acute pain therapy: preemptive analgesia. Am Fam Physician. 2001 May 15;63(10):1979-84. PMID: 11388713.
4. Dahl, Jorgen B, Kehlet, Henrik. Preventive Analgesia. Current opinion in Anaesthesiology. 2011; 24(3):331-338. doi:10.1097/ACO.0b013e328345afd9
5. Polomano RC, Fillman M, Giordano NA, Vallerand AH, Nicely KL, Jungquist CR. Multimodal Analgesia for Acute Postoperative and Trauma-Related Pain. Am J Nurs. 2017 Mar;117(3 Suppl 1):S12-S26. doi: 10.1097/01.NAJ.0000513527.71934.73. PMID: 28212146.
6. NS Morton. Prevention and control of pain in children. Br .J. Anaest 1999;83:118-29. doi:10.1093/bja/83.1.118.
7. Belen De Jose Maria, Luc Tielens, Steve Roberts. Pediatric Epidural and Spinal Anesthesia & Analgesia. Chapter 43. In- Hadzic's Textbook of Regional Anesthesia and Acute Pain Management,2e. 2017.
8. Wheatley RG, Schug SA, Watson D. Safety and efficacy of postoperative epidural analgesia. Br J Anaesth. 2001 Jul;87(1):47-61. doi: 10.1093/bja/87.1.47. PMID: 11460813.
9. Rajashree Godbole, Jasmeet Gill, Brishnik Bhattacharya, Shashank Shrotriya, Siddharth Shrivastava, Abhilash Bandari. A randomized controlled double blind comparative study between bupivacaine 0.25% plus fentanyl and bupivacaine 0.25% plus dexmedetomidine for caudal epidural postoperative analgesia in paediatric lower abdominal and urogenital surgeries in Indian genotype. International Journal of Recent Surgical and Medical Sciences.2020;6(01):30-37. doi: 10.1055/s-0040-1713564
10. Spencer D. Empyema thoracis: not time to put down the knife. Arch Dis Child. 2003 Oct;88(10):842-3. doi: 10.1136/adc.88.10.842. PMID: 14500296; PMCID: PMC1719317.
11. Kotzé A, Hinton W, Crabbe DC, Carrigan BJ. Audit of epidural analgesia in children under going thoracotomy for decortication of empyema. British journal of anaesthesia.2007;98(5):662-666. doi: 10.1093/bja/aem065
12. Gerner P. Post thoracotomy pain management problems. Anaesthesiology clinics. 2008 ; 26(2):355-67, vii. Doi: 10.1016/j.anclin.2008.01.007. PMID:18456219; PMCID: PMC2453516
13. Sethi N, Chaturvedi R. Paediatric epidurals. Journal of Anaesthesiology, Clinical Pharmacology. 2012;28(1):4. doi: 10.4103/0970-9185.92409
14. D Patel MB ChB FRCA. Epidural Analgesia for children journal article. Continuing Education in Anaesthesia, Critical Care and Pain. 2006;6(2);63-66. doi: 10.1093/bjaceaccp/mkl001
15. Ramírez T, Soto E, Vega R. Opioid modulation of cochlear auditory responses in the rat inner ear. Synapse. 2020 Jan;74(1):e22128. doi: 10.1002/syn.22128. Epub 2019 Oct 15. PMID: 31403743.
16. Tandon M, Singh A, Saluja V, Dhankhar M, Pandey CK, Jain P. Validation of a New "Objective Pain Score" Vs. "Numeric Rating Scale" For the Evaluation of Acute Pain: A Comparative Study. Anesth Pain Med. 2016 Jan 17;6(1):e32101. doi: 10.5812/aapm.32101. PMID: 27110530; PMCID: PMC4834447.
17. Tobias JD, Lowe S, O'Dell N, Holcomb GW 3rd. Thoracic epidural anaesthesia in infants and children. Can J Anaesth. 1993 Sep;40(9):879-82. doi: 10.1007/BF03009262. PMID: 8403184.
18. Ganesh A, Adzick NS, Foster T, Cucchiaro G. Efficacy of addition of fentanyl to epidural bupivacaine on postoperative analgesia after thoracotomy for lung resection in infants. Anesthesiology. 2008 Nov;109(5):890-4. doi: 10.1097/ALN.0b013e31818aa6cb. PMID: 18946302.
19. Karnik PP, Dave NM, Garasia M. Comparison of analgesic efficacy and safety of continuous epidural infusion versus local infiltration and systemic opioids in video-assisted thoracoscopic surgery decortication in pediatric empyema patients. Saudi J Anaesth. 2018 Apr-Jun;12(2):240-244. doi: 10.4103/sja.SJA_659_17. PMID: 29628834; PMCID: PMC5875212.
20. Macias A, Monedero P, Adame M, Torre W, Fidalgo I, Hidalgo F. A randomized, double-blinded comparison of thoracic epidural ropivacaine, ropivacaine/fentanyl, or bupivacaine/fentanyl for postthoracotomy analgesia. Anesth Analg. 2002 Nov;95(5):1344-50, table of contents. doi: 10.1097/00000539-200211000-00046. PMID: 12401624.
21. Patil SS, Kudalkar AG, Tendolkar BA. Comparison of continuous epidural infusion of 0.125% ropivacaine with 1 µg/ml fentanyl versus 0.125% bupivacaine with 1 µg/ml fentanyl for postoperative analgesia in major abdominal surgery. J Anaesthesiol Clin Pharmacol. 2018 Jan-Mar;34(1):29-34. doi: 10.4103/joacp.JOACP_122_16. PMID: 29643619; PMCID: PMC5885444.
22. Tomaszek L, Fenikowski D, Komotajtys H, Gawron D. Ropivacaine/Fentanyl vs. Bupivacaine/Fentanyl for Pain Control in Children after Thoracic Surgery: A Randomized Study. Pain Manag Nurs. 2019 Aug;20(4):390-397. doi: 10.1016/j.pmn.2019.02.007. Epub 2019 May 15. PMID: 31103498.
23. Agamohammdi D, Montazer M, Hoseini M, Haghdoost M, Farzin H. A Comparison of Continuous Thoracic Epidural Analgesia with Bupivacaine Versus Bupivacaine and Dexmedetomidine for Pain Control in Patients with Multiple Rib Fractures. Anesth Pain Med. 2018 Apr 25;8(2):e60805. doi: 10.5812/aapm.60805. PMID: 30009148; PMCID: PMC6035480.
24. Tan CN, Guha A, Scawn ND, Pennefather SH, Russell GN. Optimal concentration of epidural fentanyl in bupivacaine 0.1% after thoracotomy. Br J Anaesth. 2004 May;92(5):670-4. doi: 10.1093/bja/aeh129. Epub 2004 Mar 19. PMID: 15033892.
25. A Rabie, Tamer Ghoneim & Ahmed Saad El- Rouby. Single-shot thoracic epidural analgesia for neonates undergoing thoracotomy. Egyptian Journal of Anaesthesia.2020;36(1):282-287. https://doi.org/10.1080/11101849.2020.1848009
26. Joshi GP, Bonnet F, Shah R, Wilkinson RC, Camu F, FiscerB,et al. A Systemic Review of Randomized Trials Evaluating Regionl Techniques for postthoracotomy analgesia. Anesthesia & Analgesia.2008;107(3):p1026-1040 doi:10.1213/01.ane.0000333274.63501.ff. PMID 18713924
27. Ahmad Mahdi Ahmad. Essentials of Physiotherapy after Thoracic Surgery: What Physiotherapists Need to Know. A Narrative Review. Korean J ThoracCardiovasc Surg. 2018; 51(5):293-307. Doi: 10.5090/kjtcs.2018.51.5.293Epub 2018 Oct 5. PMID: 30402388; PMCID: PMC6200172