

Multi-level Intercostal Block with Bupivacaine Helps in Early Extubation and Shortens Intensive Care Unit Stay in Pediatric Patients Undergoing Thoracotomy

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ABSTRACT

Materials and Methods: All patients undergoing a thoracotomy in the department of Pediatric cardiothoracic Surgery from January 2010 to March 2011 were included in the study. The charts and records were reviewed. The demographics, co morbidities, procedure details, anesthetic management, ICU stay, extubation time and administration of an intercostals block for all the patients were recorded and then included in a structured database.

Results: The total number of patients included in the study was 208. The majority of patients, 201, were operated on for a cardiac cause while the remaining seven underwent surgery for a non- cardiac thoracic pathology. Bupivacaine was administered to all patients in the dose of xmg/kg. The block was done to include the space of entry and two spaces above and below. There were 115 males and 93 females. The mean age was 17.01 months (0.5-180 mo.) The mean weight was 7.07 kg (2-40 kg). The overall mortality was 6.25%. The average ICU stay was 2.36 days (0-39). Early extubation, defined as being within 24 hours of surgery, happened in 142 (68.2%) of the patients while 31 (15.3%) were extubated within 48 hours of surgery. The remaining patients required prolonged intubation and ICU stays secondary to their underlying cardiac lesion and co morbidities. No patient in the early extubation period required re-intubation, and no patient who was extubated in the first 48 hours required prolonged >24 hours of narcotic analgesics.

Conclusions: Multilevel intercostals block with bupivacaine helps in early extubation and shortens ICU stays in pediatric patients undergoing a thoracotomy for cardiac and non cardiac etiologies.

Keywords: Bupivacaine, Intercostal nerve block, thoracotomy

INTRODUCTION

Thoracotomy incisions are painful and significantly alter respiratory mechanics. Children experience pain and are handicapped by not being able verbalize this in many situations. Different institutions have developed different protocols for the management of pain for post thoracotomy patients. Epidural anesthesia, intercostals nerve (ICN) blocks and post operative opioids, combinations of opioid and non opioid analgesics all have been used with varied degrees of success. No single perfect strategy for all clinical situations has been defined yet and one technique or the other is used depending on the underlying clinical situation. A significant portion of our pediatric thoracotomies are for cardiac causes and we use a Bupivacaine based multi-level intercostal block that is administered by the surgeon in the field as our primary form of post operative

analgesia. Opioid and non opioid intravenous analgesics are used in the intensive care unit (ICU) as adjuncts.

METHODS

This a retrospective review conducted in compliance with standard guidelines of the institutional review board. We retrospectively reviewed patients undergoing thoracotomies in the Department of Pediatric at Cardiothoracic Surgery at Children's Hospital Lahore from January 2010 to March 2011. All patients had undergone a thoracotomy under general anesthesia and received a multi- level Bupivacaine intercostal nerve block. The thoracotomy had been performed for cardiac as well as non cardiac thoracic etiologies (Table 1).

Table 1: Operative procedures:

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|--------------------|-----|
| PDA ligation | 111 |
| Coarctation repair | 26 |
| BT shunts | 45 |
| PA bands | 19 |
| Thoracic | 7 |

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A standard technique of administering the multi level ICNB had been developed. Bupivacaine (0.5%) solution is taken and diluted with sterile water and a multi- level injection is done in each space starting at a level two spaces above the space of entry into the chest and finishing two spaces below. A 25 gauge needle is used to feel the rib and the drug is administered over the top edge of the rib either from the inside of the thorax or the outside, depending on individual surgeon preference. This is done to avoid a direct intra vascular injection as the intercostal neurovascular bundle runs in the groove along the bottom aspect of the rib. Special care is taken to avoid an intravascular injection as this can induce a fatal arrhythmia. A total dose of Bupivacaine given does not exceed 2-3 mg/kg.

The available patient charts, operative and anesthesia reports, ICU records were reviewed. Preoperative risk factors and demographics, intraoperative variables, and postoperative outcomes for these patients were tabulated from prospectively collected data from our institutional cardiothoracic surgery database. All patient demographic information, duration of ICU stay, time of extubation, and other pertinent information was entered into a structured database designed for this study.

The time of extubation, duration of ICU stay was analyzed. Early extubation was defined as extubation within 24 hours of surgery. The duration of ICU stay was also assessed and these parameters were compared with previously published international studies. All authors had full access to the data under consideration and take responsibility for its integrity.

RESULTS

The total number of patients included in the study was 208. The majority of patients, 201, were operated on for a cardiac cause while the remaining seven underwent surgery for a non- cardiac thoracic pathology. Bupivacaine was administered to all patients using the technique previously described to a maximum dose of 2-3mg/kg. The block was done to include the space of entry and two spaces above and below. There were a total of 115 males and 93 females in the study. The mean age was 17.01 months (0.5-180 mo.) There were 4 neonates in the studied population. The number of infants was 125 patients and the remaining 79 were children. The mean weight was 7.07 kg (2-40 kg). 61 patients were less than 5 kg. in weight. The overall mortality surgical mortality was 6.25%. No complication or mortality was due to the administration of the ICNB.

The average ICU stay was 2.36 days (0-39). Early extubation, defined as being within 24 hours of surgery, happened in 142 (68.2%) of the patients

while 31 (15.3%) were extubated within 48 hours of surgery. The remaining patients required prolonged intubation and ICU stays secondary to their underlying cardiac lesion and co morbidities. No patient in the early extubation period required re-intubation, and no patient who was extubated in the first 48 hours required prolonged >24 hours of narcotic analgesics.

This conclusively showed that even in this diverse subgroup of patients the use of multilevel bupivacaine ICNB helped in early extubation. Almost 85% of our patients were extubated within 48 hours and overall ICU stay was s

DISCUSSION

Pain following thoracotomy is often severe and if not treated properly, impairs respiratory function and increases post thoracotomy respiratory complications^{1,2}. Thoracic epidural is considered the "Gold Standard" for the management of post thoracotomy pain but multi- level intercostal blocks at the conclusion of surgery supplemented by intravenous opioids are an easier and safe alternative to epidural analgesia for post thoracotomy pain management³.

Fleming and Sarafian looked at children aged 6 months to 16 years (mean age 4.7 years) who underwent ligation of a patent ductus arteriosus (PDA) through a left thoracotomy. 29 received intercostal blocks with bupivacaine from the level of the second to sixth thoracic vertebrae. 60 cases constituted the control group. The patients with intercostal block had fewer doses of pain medication postoperatively, than did the control patients. The mean hospital stay was shortened in the patients with nerve block, 5.1 days versus 7.3 days for the control group. No ill effects of bupivacaine were noted. They concluded that intercostal nerve block reduces the need for postoperative analgesia and shortens hospital stay¹.

Concha, et al. (2004) compared the quality of analgesia and lung function in intercostal nerve blockade plus intravenous (IV) patient-controlled analgesia (PCA) and epidural analgesia in patients undergoing pulmonary surgery through a posterolateral thoracotomy. Resting and dynamic visual analog pain scale (VAS) measurements, forced vital capacity, and forced expiratory volume in 1 second were measured basally, on arrival in the recovery room, then hourly up to 4 hours and then 12, 24 and 48 hours later. Resting and dynamic VAS scores were slightly lower in the intercostal block patients, although only resting scores were significant. After the first hour, mean scores were below 4 in both groups. No significant difference was

observed between groups in relation to respiratory parameters or side effects. They concluded that the difference in pain scores is probably not clinically significant shows that an intercostal block with bupivacaine plus IV morphine PCA is a good alternative to epidural for post thoracotomy pain management⁴.

Intercostal nerve blocks are particularly helpful in the early postoperative period. Wurnig et al, found that pain management by intercostal block was superior during the first 24 hours after thoracotomy compared to an epidural catheter, whereas on the second day after surgery pain control was significantly better achieved by the epidural catheter⁵. Behnke et al, also found that ICB gives a better pain relief in the early postoperative phase after MIDCAB procedures compared to a PCA⁶.

Children with congenital heart disease, particularly cyanotic disease often have coagulopathy and may receive anticoagulants that preclude the use of epidural block in these patients⁷. Multiple level intercostal blocks under direct vision at the conclusion of the surgery are a safer alternative.

The intercostal nerves (ICNs) supply the major parts of the skin and musculature of the chest and abdominal wall. The block of these nerves was first described by Braun in 1907, in the textbook "Die Lokalanästhesie". Blockade of two dermatomes above and two below the level of surgical incision is required. T1 and T2 send nerve fibers to the upper limbs and the upper thorax, T3-T6 supply the thorax, T7-T11 supply the lower thorax and abdomen, and T12 innervates the abdominal wall and the skin of the front part of the gluteal region. Carrying both sensory and motor fibers, the ICN pierces the posterior intercostal membrane about 3cm (in adults) distal to the intervertebral foramen to enter the subcostal groove where it, for the most part, continues to run parallel to the rib. The complications of intercostal nerve block includes pneumothorax, local anesthetic toxicity, hematoma, nerve damage, infection, and, rarely, spinal anesthesia^{8,9}.

Blockade of two dermatomes above and two below the level of surgical incision is required. The dose of local anesthetic for intercostal block should be within the recommended range (Bupivacaine 2-3mg/kg, Lignocaine 5mg/kg) 3-5 ml per level and as they are associated with the highest plasma local anesthetic concentration compared to other nerve blocks. The addition of epinephrine does not prolong duration of action but decreases the rate of systemic absorption and risk of toxicity. The duration of analgesia with bupivacaine is 12 hours \pm 6 hours.

Hemostatic deficiencies. This contraindication is not as strong as in central neuraxial blocks but may become absolute if the degree of coagulopathy is

severe. Other contraindications typically associated with regional blocks. Local infection, lack of expertise and resuscitating equipments, and lack of any short-term plan to wean from the ventilator should discourage the use of this block.

Majority of children undergoing cardiac procedures can be extubated early < 24 hrs postoperatively with low rates of re-intubation¹⁰. Early extubation avoids complications associated with prolonged mechanical ventilation, shortens ICU stay and hospital cost.

Review of international data as shown above and our data and experience validates the practice of administering multilevel intercostal blocks. It has been shown that multilevel ICNB promote early extubation and shortens ICU stay in pediatric patients undergoing thoracotomy.

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