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Review

Regional anesthesia for thoracotomy pain in newborns and infants- a systematic review

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ABSTRACT

Regional techniques at thoracic level for thoracotomy surgeries in infants are gaining wider acceptance. The principal focus is on preserving physiological stability and reducing postoperative pain and stress in these smaller individuals as they are more susceptible to impairment in pulmonary function. Knowledge about the drug pharmacokinetics, dynamics in this age group along with availability of the adequate size equipment has revolutionised anesthesia in infants. This review focusses on the various techniques of regional anesthesia for thoracotomy in neonates and infants along with local anesthetics.

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1. Introduction

Postoperative analgesia for thoracotomy is much desired to avoid the commonly described complications leading on to hypoxemia such as atelectasis, retention of secretions, decrease in the functional residual capacity, and increase in V/Q mismatch [1,2]. Regional techniques have become the recommended standard technique of anesthesia –analgesia for thoracotomy in adults and older children. These have over time trickled down to children as there is an increasing interest in regional anesthesia for pediatric population. Regional analgesia for thoracotomy in infants and neonates has been slowed due to presumed technical difficulties and fear of complications. In addition to reducing the amount of respiratory complications, there is reduction in postoperative apnea, duration of hospital stay and improvement in surgical outcomes when neuraxial anesthesia is used in neonates [3]. The incidence of complication rates has also been consistently low with neuraxial blocks and regional techniques.

There had been a substantial number of studies regarding techniques, pharmacokinetics and clinical outcomes. Local anesthetic pharmacokinetics has been characterised to different age groups in pediatric population and safe dosing guidelines are also established. This review focusses on the regional anesthesia techniques available for thoracotomy in infants and newborns and a little about the local anesthetic pharmacology.

2. Methods

2.1. Search strategy

We conducted searches in Medline (PUBMED) and Cochrane database and the relevance of the abstracts obtained in the searches were assessed. The search was conducted in English for past 20 years (1996–2016). The keywords used were Regional blocks for thoracotomy in children, Epidural for thoracotomy in infants, children, Paravertebral block for thoracotomy in children, Intercostal or Intercostal blocks for thoracotomy in children. The search was specifically done for the infants and newborns, but due to lack of relevant number search was extended to children. In the literatures which involve children of varied age group, only the population of newborn and infants were included for this review.

2.2. Study inclusion and exclusion criteria

Randomized controlled trials of regional analgesics for thoracotomy in infants reporting the importance of regional anesthesia in children were included in the study. Studies that compared two different techniques of regional anesthesia or two different local anesthetics compared in a single regional technique were included for the review. Studies published in languages other than English or using concurrent alternative multimodal anesthesia regimen were excluded. This review focusses on various regional analgesic techniques adapted for infants, technique related issues, local anesthetics used for thoracotomy.

3. Importance of neonatal pain

Infants and neonates perceive pain in the same way as adults. The anatomical, physiological and biochemical prerequisites for pain perception are present in the early intrauterine life. So even the newborns perceive pain comparable to older children [4]. The well developed endocrine system of newborns results in release of cortisol and catecholamines in response to painful stresses [5]. But there are some basic differences in the neurophysiology in infants.

Nociceptive impulses travel via unmyelinated fibres in infants

due to lack of myelination and there is a relative paucity of inhibitory neurotransmitters in them [6]. They have a lower threshold for excitation and sensitisation, resulting in central effects of nociceptive stimuli [7,8]. Their larger receptive fields and possible higher concentration of substance P receptors makes them more prone for chronic pain [9,10]. Pain experience in infants may have far reaching consequences not only in the short term, but in the long term as well. All these ill effects can be avoided by usage of regional techniques in this population as well but with undue care. Neonatal pain management is not an 'isolated' practice, but needs integration as part of developmental care to reduce stress and facilitate neurobehavioral development.

4. Respiration in thoracotomy and regional anesthesia

Thoracotomy produces most damaging surgical insults due to aberration of chest wall, damage to ribs and peripheral nerves. The chest wall cannot be immobilised for pain and it has to be in constant movement, vigorous motion if secretions had to be cleared out. Therefore pain in these surgeries can cause severe atelectasis, pulmonary infections, hypoxia, altered V/Q ratio because of difficulty in cough and negative impact on respiration [11,12]. The physiological changes in the term or preterm neonatal lungs like lack of surfactant, associated cardiac problems if any add upon to the respiratory compromise. Therefore efficient pain management in patients who undergo thoracotomy is very important to reduce morbidity and mortality.

A variety of regional anesthetic techniques have been described for intraoperative anesthesia and postoperative analgesia, including intercostal, intrapleural infusions, and epidural anesthesia in pediatric population. The most significant result by A. Di Pede et al. [13] is that regional anesthesia reduced need for postoperative ventilation and intensive care than the infants receiving systemic analgesia. This improvement in postoperative outcome has been attributed to lesser surgery related stress response and less pain leading to comfortable breathing.

5. Regional anesthesia techniques

5.1. Epidural anesthesia in infants

The clinical practice setting, resource availability, and experience of individual practitioners can have a major impact on the relative risk and benefit of neuraxial anesthesia. In developing countries the potential benefits of epidural anesthesia outweigh the risks, particularly where facilities are limited or stretched [14]. The lack of intensive care facilities in some practice settings will increase the potential benefit of neuraxial techniques that reduce the requirement for postoperative mechanical ventilation. Thoracic epidural has reduced the need for postoperative intensive care and mechanical ventilation as compared to systemic opioid analgesia due to opioid induced apneic episodes and failure to wean.

5.1.1. Advantages

Epidural anesthesia facilitates excellent intraoperative analgesia, low risk of local anesthetic toxicity and titrable postoperative analgesia. Epidural analgesia has many advantages over opioid based pain relief: reduced respiratory depression, improved coughing, less nausea and vomiting, and earlier return of bowel function. For these reasons, i.v. Opioid analgesia is not the technique of choice for pain relief after thoracotomy [15]. Epidural anesthesia provides muscle relaxation also in the intraoperative period. Duration of ventilation, ICU stay, Hospital stay are all reduced by the usage of epidural anesthesia.

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