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Review

Thoracic epidural analgesia in a child with multiple traumatic rib fractures

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Abstract The morbidity and mortality associated with blunt thoracic trauma are significant and can be multisystem in nature. Of these, pulmonary complications, including ventilatory impairment secondary to pain, have been recognized to be the most consequential. Although several analgesic strategies have emerged, thoracic epidural analgesia (TEA) has arguably demonstrated superior efficacy and is used frequently in adults. Unfortunately, TEA is rarely used in children after blunt thoracic trauma, but may be of considerable benefit. This low rate of use likely reflects one or more of several factors potentially encountered when considering the use of TEA in pediatric chest wall trauma. Among them are (1) uncertainty regarding safety and efficacy; (2) the technical challenges of pediatric thoracic epidural placement, including technique and equipment concerns; and (3) drug selection, dosing, and toxicity. The following case review describes the successful application of TEA in a 4-year-old boy after multiple traumatic rib fractures and associated pneumothorax and pulmonary contusion.

1. Introduction

The morbidity and mortality associated with blunt thoracic trauma and subsequent rib fracture in adults are significant [1–3]. Pulmonary complications, primarily due to pain and its associated ventilatory impairment, occur in more than a third of cases, with the incidence of pneumonia as high as 30% [1–3]. In one study, 6% of patients with multiple traumatic rib fractures died, and 54% of these deaths were directly attributable to secondary pulmonary complications [3]. Risk factors for worsened outcome include advanced age, increased number of fractured ribs, and common comorbid conditions such as diabetes mellitus, atrial fibrillation, and chronic lung disease [1–4].

The consequences of blunt thoracic trauma in children tend to be different. Children's ribs are less mineralized and therefore more pliable than adult ribs and confer less protection to the underlying lung [5–8]. As a result, rib fracture is less likely, whereas injuries such as pulmonary contusion, traumatic wet lung, pneumothorax and hemothorax occur more commonly [5–8]. When death occurs, it is usually associated with concomitant central nervous system and hemorrhagic injuries rather than as a result of pulmonary complications [5–8].

The presence of pneumothorax may represent an inflection point in regard to injury severity and risk of morbidity in children [6]. These injuries, with or without rib fracture, have been shown to significantly prolong hospital stay [6], possibly indicative of a greater transfer of energy during the injury and, consequently, greater morbidity. Although chest tube care likely contributes to this difference

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in length of stay, children with pneumothorax are at greater risk for increased morbidity and should be cared for as such [6].

Treatment for injuries to the bony thorax in adults has varied over the years, ranging from various forms of mechanical and surgical stabilization to varying degrees of ventilatory support [2]. However, it is now generally recognized that adequate analgesia, chest physical therapy, and mobilization are the preferred modes of management and yield the best outcomes [1,2].

In regard to analgesia, several different strategies have been identified [2,9]. Among them are patient- and nurse-administered intravenous narcotics, intercostal nerve blocks, paravertebral blocks and thoracic epidural analgesia (TEA), each offering its own unique set of advantages [2,9]. Of these, TEA has arguably demonstrated superior efficacy [2,9–12] and is used frequently to assist with the prevention of secondary pulmonary complications after traumatic rib fracture in adults. Unfortunately, TEA is rarely used in children after blunt thoracic trauma, but may be of considerable benefit. The following case report describes the successful application of TEA in a 4-year-old boy after multiple rib fractures and pneumothorax.

2. Case report

A 4-year-old, 16-kg boy with past medical history significant for congenitally absent left kidney presented in significant respiratory distress after sustaining a horse-stomp injury to his right chest. Oxygen saturation on pulse oximetry ranged from 55% to 80%, and breath sounds were absent on the right side (Fig. 1). No blood gases were able to be attained given the child's high level of distress. After stabilizing the child with emergent chest tube thoracostomy, chest x-ray revealed fracture of right ribs 2-11, right pulmonary contusion, and a small residual right pneumothorax (Fig. 2). Computed tomography scans of the chest, abdomen, pelvis, cervical spine, and head were negative for other injuries. Laboratory tests were normal. Electrocardiogram and rhythm monitoring revealed no cardiac dysrhythmias. Vital signs demonstrated elevated blood pressures (BPs) ranging from 123 to 145 systolic over 78 to 94 diastolic, with heart rate (HR) ranging from 118 to 157 and labored respirations ranging from 28 to 45 with marked splinting. The child was afebrile and had an O_2 requirement of 4 L/min via nasal cannula to achieve an Spo_2 of 90%. He was admitted to the pediatric intensive care unit for monitoring, pain control with parenteral morphine, and incentive spirometry. However, FLACC scores (face, legs, activity, cry, consolability) remained in the 7 to 9 range, and our service was consulted to assist with analgesic management.

Fig. 1 Admission chest radiograph showing fracture of right ribs 2-11, right-sided pneumothorax with mediastinal shift.

After examining the child, reviewing his medical record, and discussing the various analgesic modalities available with his parents, we concluded that TEA would be the best option. The risks and benefits of the procedure were explained, parental consent was attained, and with the parent's assurance, the child assented.

On the basis of our assessment of the child's temperament, he appeared to be a good candidate for attempting epidural placement under conscious sedation. Pulse oximetry, noninvasive BP monitoring, and electrocardiogram were verified, and premedication with 0.1 mg/kg midazolam was administered intravenously. Vital signs before the procedure were as follows: BP of 120-140/60-80, HR of 110-130, and respiratory rate of 30-40.

Sonographic imaging was attempted to approximate the depth of the epidural space in preparation for needle placement. The child was placed in left lateral decubitus position with his parents at bedside facing him. The ultrasound probe was then held on the skin overlying the T6-7 interspinous area, yielding a transverse view of the neuraxis (Fig. 3). Because the depth of the epidural space was expected to be in the range of 1 to 3 cm, high-frequency imaging, which also allows for better resolution of the visualized structures, is adequate. However, as noted in Fig. 3, the epidural space was not readily identified sonographically, and the more traditional loss of resistance technique was used for placement.

A PERIFIX continuous epidural anesthesia tray (B. Braun Medical Inc, Bethlehem, PA) was used. The skin over the thoracic spine was wiped clean and subsequently prepped and draped in sterile fashion using povidone-iodine. Plain 1% lidocaine (1 mL) was administered slowly via a 27-gauge skin wheal needle to the skin over the T7-8 interspinous area in preparation for a midline approach. After 2 to 3 minutes has passed, an 18-gauge, 9-cm Hustead needle was introduced gently through the skin and paused. A glass Luer lock loss-of-resistance syringe containing 2 mL of normal saline was attached. Advancement of the syringe and needle was then continued in a midline/cephalad