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Case Report

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Continuous Erector Spinae Plane Block for Pain Management Following Thoracotomy for Aortic Coarctectomy

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Abstract

Pain following thoracotomy is one of the most severe forms of postoperative pain. Post-thoracotomy pain may increase the risk of postsurgical pulmonary complications, postoperative mortality, prolong hospitalization, and increase utilization of healthcare resources. To mitigate these effects, anesthesia providers commonly employ continuous epidural infusions, paravertebral blocks, and systemic opioids for pain management and improvement of pulmonary mechanics. We report the use of a continuous erector spinae plane block (ESPB) via a peripheral nerve catheter for postoperative pain management of an 18-year-old patient who underwent complex aortic coarctation repair via lateral thoracotomy, aided by cardiopulmonary bypass. Continuous ESPB proved to be an acceptable alternative for postoperative pain control, producing a substantial multi-dermatomal sensory block, resulting in adequate pain control, reduced opioid consumption, and a potentially shorter hospital stay.

Keywords: Intracranial pressure; Lumbar drain; Epidural catheter; Paravertebral block; Erector spinae plane block; Thoracotomy

Introduction

Thoracotomy is associated with severe postoperative pain, which can give rise to a range of respiratory complications and have detrimental effects on patient outcomes [1]. These complications can increase morbidity and mortality rates, extend hospital stays, and increase utilization of healthcare resources [2, 3]. Patients undergoing thoracotomy experience pain from various sources, including incisional pain, compression of intercostal nerves, irritation of the parietal pleura, manipulation of costovertebral joints, and insertion of chest tubes [2-4]. Inadequate postoperative pain control in this population can adversely affect ventilatory mechanics, leading to insufficient tidal volumes, impaired mucociliary clearance, impaired cough, atelectasis, ventilation-perfusion imbalance, hypoxemia, and an increased risk of pulmonary infections [2-4]. To address these challenges, anesthesia providers employ a range of techniques to provide analgesia including thoracic epidural anesthesia, paravertebral nerve blockade, intercostal nerve blockade, cryoanalgesia, and the administration of systemic opioids, each with its own risk-benefit considerations [1-4].

An emerging technique gaining traction for postoperative pain management following thoracotomy is the erector spinae plane block (ESPB) [4-12]. This approach involves the administration of a local anesthetic agent deep to the erector spinae muscle, adjacent to the tip of the transverse process, typically near the fifth thoracic vertebra [6]. Local anesthetic then spreads throughout the fascial plane and costotransverse foramen to ultimately act on intercostal nerves, and the dorsal and ventral rami of the thoracic spinal nerves, similar to a paravertebral block [6, 7]. Clinical experience has demonstrated that the ESPB produces a multi-dermatomal sensory blockade, providing effective analgesia with minimal requirement for additional adjuncts in patients undergoing sternotomy or thoracotomy [4-12]. When compared to the traditional gold standard of thoracic epidural anesthesia, ESPB is less invasive and executed as a simpler procedure, with a potentially lower risk of complications such as dural puncture, pneumothorax, and bleeding risks including hematoma formation [4-13].

We present the successful use of a continuous ESPB, instead of thoracic epidural anesthesia or paravertebral blockade, in an 18-year-old patient who underwent aortic coarctation repair via thoracotomy with heparization and cardiopulmonary bypass (CPB). This alternate technique of analgesia was chosen due to the presence of a pre-existing lumbar drain used to drain cerebrospinal fluid (CSF) and decrease intracranial pressure (ICP), as well as the need for anticoagulation while on CPB.

Review of this case and presentation in this format is in accordance with the guidelines of the Institutional Review Board of Nationwide Children's Hospital (Columbus, OH).

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Case Report

Investigations

An 18-year-old male with mild cerebral palsy, chronic back pain, hypertension, and coarctation of the aorta was scheduled to undergo coarctectomy repair via a left thoracotomy with CPB.

Diagnosis

Past surgical history included repair of critical coarctation of the aorta at 2 years of age, revision of the repair with a stent at 8 years of age, and a stent replacement a few years later. Recently, the patient began experiencing lower extremity claudication and worsening hypertension. Further evaluation with echocardiography revealed narrowing of the pre-existing stent in the descending aorta, resulting in worsening coarctation. Given this history, surgical intervention was deemed necessary.

Treatment

One day prior to the scheduled surgery, the patient was admitted to the hospital for administration of intravenous fluids, and placement of a lumbar drain. The lumbar drain was necessary for controlled CSF drainage and ICP monitoring, due to the risk of paralysis associated with the planned procedure. Recognizing the importance of postoperative pain control following the thoracotomy, the presence of the lumbar drain, and planned use of anticoagulation for CPB, the acute pain service, anesthesia, and surgical teams collaborated to develop a coordinated plan for postoperative analgesia using an ESPB via a continuous catheter. Additionally, the multimodal analgesia approach to pain management would also include hydromorphone delivered by patient-controlled analgesia (PCA). Premedication included 2 mg of intravenous midazolam. The patient was transported to the operating room and routine American Society of Anesthesiologists monitors were placed. Anesthesia was induced with lidocaine (30 mg), fentanyl (250 µg), and propofol (150 mg). Rocuronium (100 mg) was administered for neuromuscular blockade. The trachea was intubated with a cuffed 37 double lumen endotracheal tube. The patient was positioned in the right lateral decubitus position to facilitate the placement of a left-sided erector spinae plane catheter. The posterior midline and paramedian areas at the T5 level were prepared using standard sterile technique. Ultrasound guidance was used to identify the T5 transverse process. A 2-inch, 18-gauge Tuohy needle was inserted perpendicular to the skin, approximately 2 - 3 cm off the midline and advanced 3 cm until the transverse process of T5 was contacted. To ensure proper fascial plane spread, 3 mL of sterile 0.9% normal saline was injected. A 20-gauge catheter was then threaded and secured, 11 cm at the skin. The aspiration of the catheter was negative for blood. A test dose of 3 mL of 0.5% ropivacaine with 1:200,000 epinephrine was administered and then observed for 90 s. The test dose yielded no significant changes in heart rate, blood pressure, or T wave morphology, indicating a negative response. The catheter was then covered with a standard dressing. A bolus dose of 20 mL of 0.5% ropivacaine with 1:200,000 epinephrine and 0.2 mg/mL of dexamethasone was administered. A left thoracotomy was then performed to carry out the repair of the aortic arch. CPB time was 92 min with a cross-clamp time of 68 min. The aortic coarctation was excised, and the previously placed stents were replaced with a 24 mm Dacron stent. A chest tube was inserted, and following the reversal of neuromuscular blockade with sugammadex, the patient's trachea was successfully extubated in the operating room. Throughout the case, the patient received intravenous acetaminophen (1,000 mg), fentanyl (400 µg), hydromorphone (0.5 mg), and a dexmedetomidine infusion at 0.5 µg/kg/h. Blood products administered intraoperatively included 480 mL of cell saver, two units of platelets, and two units of cryoprecipitate.

Follow-up and outcomes

In the post-anesthesia care unit (PACU), the erector spinae catheter was connected to an infusion pump to administer 0.2% ropivacaine at 8 mL/h. Postoperatively, acetaminophen (1,000 mg) was administered every 6 h and PCA hydromorphone was administered with a 0.25 mg bolus every 10 min as needed. The hydromorphone PCA was increased to 0.3 mg every 10 min as needed during the immediate postoperative period due to pain. This was transitioned to an oral regimen that included 5 mg of oxycodone every 4 h and 3 mg of diazepam every 6 h with intravenous ketorolac. Pain scores were assessed every 4 h using a 0 - 10 numerical rating scale. From postoperative day 0, the patient reported pain scores ranging from 4 - 8, with the most frequently reported scores falling within the range of 4 - 5. Scores of 7, 1, and 8 were considered outliers and were attributed to documented activity, the presence of a chest tube, and chronic back pain reported as 4 out of 10 at baseline. On postoperative day 1, both the lumbar drain and chest tube were removed. Subsequently, the PCA was discontinued, and the regimen of oxycodone and diazepam was transitioned to as-needed (PRN) dosing. The patient received two oral doses of 3 mg of oxycodone on postoperative day 2 and a single 3 mg dose of diazepam on postoperative day 3. The ESPB catheter remained in place until postoperative day 3, coinciding with the patient reporting a pain score of 0. The patient was also successfully transitioned from a nasal cannula to room air on postoperative day 3. There were no postoperative respiratory complications noted. The patient was discharged home on postoperative day 6, after completion of a secondary workup for possible stroke-like symptoms.

Discussion

We report the use of a continuous ESPB as part of a multimodal analgesic technique following complicated aortic coarc-

Table 1. Reports of ESPB Following Thoracotomy or Sternotomy in the Pediatric Population

Authors and reference	Study type and demographics	Treatment and outcomes
Kaushal et al, 2020 [5]	Prospective, randomized study. Study cohort of 80 children with acyanotic CHD for surgery with sternotomy and CPB.	Bilateral ESPB versus no block (control). Patients who received an ESPB had reduced MOPS, required significantly less, and had a prolonged time to postoperative fentanyl needs, and a lower postoperative sedation score. Ultrasound-guided bilateral ESPB was a reliable and effective postoperative analgesic modality for pediatric cardiac surgery through a midline sternotomy.
Macaire et al, 2020 [8]	Randomized, double-blind, placebo-controlled trial. Study cohort included 50 children following cardiac surgery with midline sternotomy.	Bilateral ESPB with 0.2% ropivacaine infusion versus saline infusion. Morphine requirements and intraoperative sufentanil were reduced in the ESPB group. Time to chest tube removal, first mobilization, pain scores (VAS) 2 h after chest tube removal, pain scores (VAS) at rest 1 month after surgery, and postoperative adverse events were decreased in the ESPB group. ESPB resulted in a decrease in intraoperative and postoperative opioid consumption, optimized rapid patient mobilization, and chest tube removal after cardiac surgery.
Singh et al, 2022 [10]	Prospective randomized controlled trial. Study cohort included 40 children, 2 - 7 years of age, scheduled for right or left thoracotomy under general anesthesia.	TEA versus ESPB analgesia. Intraoperative fentanyl requirements were greater in the TEA group when compared to the ESPB group while postoperative fentanyl requirements were comparable. The median FLACC score was equivalent between both groups. Higher incidence of adverse effects with TEA. ESPB provided similar postoperative analgesia to TEA with a lower incidence of adverse effects in pediatric patients undergoing thoracotomy.

CHD: congenital heart disease; CPB: cardiopulmonary bypass; ESPB: erector spinae plane block; MOPS: modified objective pain score; VAS: visual analogue scale; TEA: thoracic epidural anesthesia; FLACC: Face, Legs, Activity, Cry, Consolability.

tation repair via thoracotomy with CPB. The continuous ESPB block provided a multi-dermatomal sensory blockade, resulting in adequate pain control and reducing opioid requirements. Anecdotal experience has demonstrated the potential applications of the ESPB for managing pain following cardiothoracic surgery procedures in both pediatric and adult patients undergoing sternotomy or thoracotomy (Tables 1, 2) [4, 5, 8-15]. The lower risk profile of ESPB makes it an appealing option in situations where contraindications to neuraxial techniques may exist.

In our patient, a continuous ESPB was chosen due to the presence of a lumbar drain and the associated risks of performing a neuraxial technique in the presence of anticoagulation involved with CPB [16, 17]. The ESPB catheter provided continuous analgesia and allowed for titration of the local anesthetic infusion. This approach provided effective pain control while reducing the need for systemic opioids. The ability to achieve optimal pain management with reduced reliance on opioids is particularly important, given their potential adverse effects, including respiratory depression, sedation, and gastro-

Table 2. Reports of ESPB Following Thoracotomy or Sternotomy in the Adult Population

Authors and reference	Study type and demographics	Treatment and outcomes
Sun et al, 2021 [4]	Propensity score matched, retrospective cohort study. Study cohort included 452 consecutive adults for cardiac surgery through a lateral mini-thoracotomy.	Intermittent bolus ESPB via a catheter for 3 days versus no regional anesthesia. ESPB group had a lower oral MME, received fewer doses of antiemetic agents, and had a lower modified CPIS. Intermittent bolus ESPB is safe and resulted in a reduction of opioid use and decreased need for antiemetic agents following cardiac surgery through a lateral mini-thoracotomy.
Fang et al, 2019 [14]	Randomized, controlled, double-blind study. Study cohort included 94 adult patients who underwent thoracotomy for lung surgery.	Preoperative single-injection ESPB versus preoperative single-injection TPVB. Patients in both groups were also provided with a sufentanil PCA. There were no significant differences in VAS, sufentanil use, or PONV following surgery. There was significantly less hypotension, bradycardia, hematoma formation, and a higher single attempt success rate with ESPB. Preoperative single-injection ESPB plus postoperative sufentanil PCA provided similar pain relief for patients undergoing thoracotomy when compared to TPVB.
Cavaleri et al, 2021 [15]	Retrospective case series, eight adults who underwent an elective RATS procedure.	ESPB was performed after surgery with an initial bolus of local anesthetic agent followed by catheter insertion for continuous infusion. Based on NRS score, ESPB reduced postoperative opioid needs.

ESPB: erector spinae plane block; CPIS: clinical pulmonary infection score; MME: morphine milligram equivalents; TPVB: thoracic paravertebral block; VAS: visual analogue scale; PCA: patient-controlled analgesia; PONS: postoperative nausea and vomiting; NRS: numeric rate scale; RATS: robotic-assisted thoracic surgery.

intestinal dysfunction.

Although the use of continuous ESPB via catheter in this case was successful, it is important to acknowledge some limitations and potential complications associated with this technique. Proper placement of the catheter requires ultrasound guidance to ensure accurate placement and appropriate spread of the local anesthetic in the desired fascial plane. There is a learning curve associated with performing ESPB, and expertise in ultrasound-guided techniques is necessary to minimize the risk of complications, such as infection, local anesthetic toxicity, nerve damage, and pneumothorax, although the reported incidence is low [16]. Furthermore, while ESPB provides analgesia, it may be inadequate, unreliable, and difficult to reproduce due to the high spatial variability of local anesthetic distribution secondary to asymmetric spread [7, 18]. Thus, many patients may still require additional analgesic therapies [18-20]. In this case, the patient received a multimodal analgesic regimen that included a hydromorphone demand PCA, intravenous acetaminophen, ketorolac, and diazepam. Combining these analgesic techniques and medications allowed for synergistic effects, improving pain control, and reducing the potential of adverse effects of systemic opioids.

Learning points

Thoracotomy is associated with severe postoperative pain that can lead to respiratory complications and poor patient outcomes.

Common anesthetic techniques for post-thoracotomy pain include thoracic epidural anesthesia, paravertebral nerve blockade, intercostal nerve blockade, cryoanalgesia, and systemic opioids. Each is associated with specific adverse effects and benefits.

ESPB is an emerging technique for post-thoracotomy pain management that involves the administration of local anesthetic deep to the erector spinae muscle, adjacent to the tip of the transverse process, typically near the fifth thoracic vertebra.

The ESPB mechanism of action involves the intercostal nerves, as well as the dorsal and ventral rami of the thoracic spinal nerves, similar to a paravertebral block.

Compared to thoracic epidural anesthesia, ESPB is less invasive, and has fewer potential complications, making it an appealing option when neuraxial techniques are contraindicated.

Although rare, potential complications associated with ESPB include localized infection at the insertion site, local anesthetic toxicity, damage to underlying nerves, pneumothorax, and unreliable analgesic effect due to the variability of local anesthetic distribution within the fascial plane.

The use of additional analgesic agents is often necessary as an adjunct to ESPB.

Conclusions

The presented case demonstrates the use of a continuous ESPB via a catheter for postoperative pain management following thoracotomy and repair of aortic coarctation using CPB and a lumbar CSF drain. Benefits included effective pain control, decreased reliance on opioid medications, and a potentially shorter hospital stay in a patient where neuraxial (epidural) anesthesia was not feasible. However, while it is important to recognize that ESPB is an important analgesic therapy, its efficacy can be variable, and the incorporation of adjunctive analgesic agents is generally necessary [7, 17-20]. Future prospective studies are warranted to compare the overall efficacy of ESPB with other well-established regional anesthetic techniques such as epidural anesthesia or paravertebral blockading.

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Financial Disclosure

None to declare.

Conflict of Interest

None to declare.

Informed Consent

Informed consent, consistent with written Health Insurance Portability and Accountability Act (HIPAA) authorization, was obtained from the patient for anesthetic care and use of deidentified patient data for publication and research purposes.

Author Contributions

JDH provided clinical care for the patient, wrote and reviewed the manuscript. CM provided clinical care for the patient and reviewed the manuscript. OON helped review the manuscript. JDT reviewed and edited the final draft of the manuscript. RJB provided clinical care for the patient, wrote and edited the manuscript.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Abbreviations

ESPB: erector spinae plane block; CPB: cardiopulmonary bypass; CSF: cerebrospinal fluid; ICP: intracranial pressure;

PCA: patient-controlled analgesia; PACU: post-anesthesia care unit; PRN: as-needed

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