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Case Report

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Epidural-Like Effect of a Continuous Right-Sided Erector Spinae Plane Blockade for Complicated Pediatric Abdominal Surgery

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Abstract

The erector spinae plane block (ESPB) is increasingly gaining popularity in pediatric anesthesiology as it provides an alternative to neuraxial anesthesia in those with relative and absolute contraindications. Recent studies show craniocaudal spread in cadavers and multi-level spread impacting neural structures in live subjects. We present a case report of a pediatric patient with a history of abdominal surgeries, contraindication to neuraxial anesthesia, and thoracic vertebrae fractures. Bilateral ESPB catheters were initially placed but the left catheter was accidentally dislodged. Each ESPB catheter was initially programmed to flow at rate of 2 cc/h of ropivacaine 0.1% for a max combined rate of 4 cc/h. Once the left ESPB catheter was dislodged, the right ESPB catheter was programmed to flow at 4 cc/h which surprisingly continued to provide adequate bilateral analgesia for the patient without the need for additional narcotics. In cases where a unilateral ESPB catheter is the only option due to catheter displacement or contamination, administering a higher volume of local anesthetic may still yield satisfactory pain relief for managing postoperative discomfort following abdominal surgery.

Keywords: Erector spinae plane block; Pediatric abdominal surgery; Regional anesthesiology; Epidural

Introduction

Postoperative pain can be difficult to manage in children with a history of multiple abdominal surgeries due to previous narcotic exposure and extensive lysis of adhesions required for these specific patients. In cases where patients are tolerant to narcotics, continuous neuraxial infusions provide excellent analgesia if there is no contraindication. With contraindications, continuous abdominal wall blocks, such as the transversus abdominis plane (TAP) and quadratus lumborum (QL) blocks, are often employed. However, multiple abdominal surgeries can disrupt fascial planes, limiting the route of local anesthetic (LA) blockade and the subsequent effectiveness of these fascial plane blocks.

The ultrasound-guided erector spinae plane block (ESPB) is a novel technique for abdominal analgesia and serves as a simple and safe alternative to cases where anatomy and coagulation have relative and absolute contraindications. In the ESPB, a LA is injected into the fascial plane beneath the erector spinae muscle, spreading in a craniocaudal fashion over considerable dermatome levels. LA may also penetrate anteriorly through the intertransverse connective tissue and enter the thoracic paravertebral space, potentially blocking the ventral and dorsal rami of spinal nerves. We describe a case report that illustrates the efficacy of an unintentional unilateral ESPB performed at the level of the T7 transverse process, relieving somatic and visceral abdominal pain following abdominal surgery.

Case Report

Investigations

A 5-year-old 18.5 kg male (ex 24-week premature newborn) with an extensive history of abdominal surgeries was scheduled for another exploratory laparotomy. His history was remarkable for short-gut syndrome, osteopenia, prior multi-level thoracic fractures, superior mesenteric vein thrombus, and left common femoral vein thrombus managed with prophylactic enoxaparin twice daily. Previous surgeries were complicated by uncontrolled pain and prolonged hospital stays. Hematology held the enoxaparin 12 h prior to the procedure with the plan to restart postoperatively.

Diagnosis

The preoperative physical exam revealed a midline laparotomy scar with approximate length of 5 cm. Imaging of the spine revealed a thoracic vertebral fracture in addition to daily usage

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of enoxaparin for venous thromboembolism (VTE) prophylaxis. The cardiac and respiratory examinations were unremarkable. Given his previous abdominal surgeries, thoracic vertebral fractures and use of enoxaparin, erector spinae catheter was implemented for postoperative pain control.

Treatment

Intraoperatively, bilateral ESPBs were inserted at the level of the T7 transverse process. After placing a linear ultrasound probe (Fujifilm Sonosite, Inc., WA, USA) parallel to the vertebral axis, we located the left T7 transverse process and the three associated muscles of the ESPB (trapezius, rhomboid major, and erector spinae muscles). From this point, an 18-G Pajunk needle was inserted through these three muscles above the transverse process of T7 in a cephalad-to-caudal direction. We administered 2 mL of saline to confirm the location of the needle (beneath the ESP plane). After positive confirmation of the appropriate location, 10 mL of 0.25% bupivacaine was injected for surgical analgesia and to open the space for catheter placement. We then placed a Pajunk 20-G 51-mm regional catheter in the desired plane and secured the catheter with Tegaderm (Supplementary Video 1, www.journalmc.org). We repeated this ESPB and catheter placement on the right side with the same technique.

Intraoperatively, the patient was hemodynamically stable with no additional intravenous (IV) analgesic requirements. The emergence from anesthesia was uneventful, and the patient was easily extubated. In the post-anesthesia care unit (PACU), the two ESPB catheter infusions were connected to a dual lumen On-Q pump. Each catheter was started at a fixed rate of 2 cc/h with ropivacaine 0.1%, for a total rate of 4 cc/h. Sensory testing in PACU revealed bilateral dermatomal coverage T6-T11. On the floor, multimodal analgesia consisted of scheduled IV acetaminophen, IV Toradol, and IV Valium.

The patient was comfortable overnight and received only two doses of IV Dilaudid. Unfortunately, the left-sided ESPB catheter was leaking the next morning and appreciated to be dislodged accounting for the overnight narcotic usage. As a result, the left side of the abdomen was initially more sensitive to touch based on sensory assessment while the right was unchanged. The left lumen on the On-Q pump was clamped and the ESPB catheter was removed. The right catheter continued with the On-Q pump running at a rate of 4 cc/hr as the patient received the the LA unilaterally on the right.

Follow-up and outcomes

Dermatomal assessment on day of surgery revealed T6-T11 coverage bilaterally prior to left catheter discontinuation for a large transverse abdominal incision. After discontinuation of the left catheter on postoperative day 1, daily sensory testing of the abdomen continues to be bilateral per exam. The patient did not receive *pro re nata* (PRN) IV narcotics for three consecutive days while the right-sided ESPB catheter was in place at the higher rate of 4 cc/h of 0.1% ropivacaine. Bilateral dermatomal coverage with the right ESPB catheter was maintained despite loss of the left ESPB catheter. The remaining right-sided ESPB catheter was removed on postoperative day 4 and the patient was able to transition to oral pain medications for the remainder of the hospital course. The patient was discharged home on postoperative day 5 without utilization of narcotics.

Discussion

This case reports describes the incidental application of a unilateral continuous ESPB catheter to achieve bilateral dermatomal coverage after abdominal surgery in a complicated pediatric patient with contraindications to neuraxial anesthesia due to anticoagulation usage and thoracic vertebrae fractures.

ESPBs and catheters have been increasingly utilized in the pediatric population for intra- and postoperative pain control [1]. Studies have demonstrated the efficaciousness of the ESPB in many surgeries including thoracic, abdominal, orthopedic, and urological [2-4]. However, the utility of the ESPB in providing adequate analgesia in the pediatric population remains in question compared to more invasive regional methods, such as the neuraxial and paravertebral regional blocks.

In the ESPB, LA, under ultrasound guidance, is deposited beneath erector spinae muscle and superficial to the tip of the transverse process thus dissecting the fascial plane of the muscle [3, 5]. LAs are thought to spread from within the fascial plane into the paravertebral space at the level of injection as well as craniocaudally dermatomes. However, the exact diffusion pathway remains disputed [4].

Our patient underwent preoperative bilateral ESPB and continuous catheter placement for postoperative pain control after an exploratory laparotomy. Initially, each ESPB catheter was programmed to flow at a rate of 2 cc/h with ropivacaine 0.1%, for a total of 4 cc/h. Despite the loss of one of the catheters, the patient maintained adequate pain control throughout the abdomen viscerally and across various dermatomes bilaterally with the remaining catheter programed at 4 cc/h. This suggests that the minimally invasive ESPB and catheter may provide epidural and paravertebral spread craniocaudally, especially at higher flow rates.

A 2020 cadaveric study demonstrated craniocaudal spread of methylene blue dye in freshly un-embalmed neonatal cadavers receiving an ESPB. Furthermore, dye spread was detected via ultrasound in the epidural and paravertebral spaces as well as the dorsal and ventral rami [6]. More so, multiple studies have demonstrated multi-level paravertebral and epidural spread of radiocontrast in living subjects receiving ESPBs [7-10]. The 2021 systematic review of ESPBs concluded that the most likely mechanism of action involves direct spread and diffusion of the LA within the ESP as well to the intercostal spaces, paravertebral spaces, and neighboring neural structures (e.g., spinal nerve roots, dorsal, and ventral rami) [7]. Blockade of these neural structures, including sympathetic nerves, is thought to interrupt somatic and visceral pain as in epidural analgesia [7, 11, 12]. More so, it is thought that LA may reach the epidural space via branches of the dorsal rami and accompanying blood vessels that perforate the posterior thoracolumbar fascia and inter-transverse connective tissue complex [7].

Table 1. Relative Risk of Regional Blocks in Patients With Coagulation Abnormalities

	Block category	Examples
Low risk (superficial)	Local infiltration	
	Superficial blocks	Digital nerve block, superficial cervical plexus block, Bier's block, forearm nerve block
	Fascial blocks	Erector spinae plane block, transverse abdominus plane block
	Superficial perivascular blocks	Femoral nerve block, popliteal nerve block, intercostal nerve block, interscalene nerve block
	Deep blocks	Celiac plexus block, stellate ganglion block, obturator block, supra- and infra-clavicular brachial plexus blocks
	Paravertebral blocks	Paravertebral block, lumbar plexus block, deep cervical plexus block
High risk (deep)	Neuraxial blocks	Epidural anesthesia, spinal anesthesia

However, this pathway likely only allows for gradual flow of LA with only a small fraction of ESP injectate entering the paravertebral, inter-foraminal, and epidural spaces within the first 30 - 60 min [7, 10, 13, 14]. Nonetheless, the limited concentration is likely to have specific yet notable effects on nociceptive transmission and processing. Anesthetic may continue to diffuse into the paravertebral space over a period of time and thus progressively affect multiple dermatomes [15].

Despite the studies that demonstrate epidural spread with ESPBs, some human cadaveric studies demonstrate paravertebral spread but not epidural spread [16, 17]. The absence of dye spread to the epidural space could be explained by the absence of muscle tone and tissue tension that are present *in vivo* [16]. In human studies, a minority of patients who underwent ESPB demonstrated epidural spread while the majority demonstrated neuroforaminal and paravertebral spread [9, 18]. This could be due to overt block failure, which occurs when the LA is trapped within the muscle or does not diffuse effectively into the paravertebral space, possibly due to an incorrect targeting of the desired plane [7, 19]. Other proposed mechanisms of ESPB, such as systemic effect of LA, lymphatic-based modulatory, and fascia-mediated, have been postulated but remain unlikely [7].

As a minimally invasive method of regional anesthesia, the ESPB lessens the risk of standard complications associated with any peripheral block but more commonly associated with neuraxial methods, such as epidural or spinal anesthesia, especially in anticoagulated patients such as this patient. These complications include LA systemic toxicity, hematoma, infection, pneumothorax, motor block, and meningeal injury [2, 3].

Furthermore, the ESPB and catheter serve as a safe alternative for patients with contraindications to neuraxial, such as coagulopathy. Given their proximity to the spinal cord and epidural venous plexus, paravertebral and neuraxial methods increase the risk for epidural hematomas in coagulopathic patients [4, 20]. Table 1 indicates the relative risk of regional blocks in patients with coagulation abnormalities. Catheter techniques may carry increased risk compared to single-shot blocks while ultrasound-guided techniques may decrease risk of vascular injury [21].

ESPBs and catheters represent a viable option for postoperative pain management in various surgical scenarios. While ongoing research delves into the precise mechanism and diffusion pattern, our unexpected loss of catheter potentially supports neuraxial spread. This neuraxial spread is secondary to the pressure gradient from the On-Q pump at the higher rate of flow of LA solutions while keeping under the maximal toxicity level. Despite the loss of one of the catheters, our patient maintained adequate pain control viscerally and across multiple dermatomes bilaterally without increasing the risk of hematoma formation present with anticoagulated patients.

Learning points

Neuraxial anesthesia is considered the gold standard for providing postoperative pain relief in pediatric abdominal surgery, but its application may be limited due to both absolute and relative contraindications in certain patients. The advent of fascial plane blocks, such as the ESPB, has introduced an innovative approach to managing postoperative pain, particularly in pediatric patients with coagulation issues and neuraxial contraindications.

Unlike adults, children are generally less vigilant in safeguarding catheters from dislodgment, making continuous catheter placement in this population more susceptible to such events. However, the displacement of catheters does not necessarily result in the loss of effective pain relief, as illustrated in this case report. In this report, a single continuous ESPB catheter was able to provide bilateral abdominal dermatomal coverage for abdominal surgery by increasing the infusion rate, likely generating a pressure gradient that facilitated the flow of medication into the epidural space. Human and animal studies have demonstrated epidural spread via contrast dye in literature. A prospective study may be indicated for contralateral spread of LA with erector spinae block based on infusion rate.

Supplementary Material

Suppl 1. Erector spinae plane block, 2-9-2023, Vipin Bansal MD (0:10).

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None to declare.

Conflict of Interest

None to declare.

Informed Consent

Informed consent was obtained from a parent for clinical care and use of patient data for publication purposes. The patient information was de-identified for publication.

Author Contributions

ND performed the initial case review and manuscript preparation, literature review, and editing of subsequent revisions. VB and EA provided care for the patient and was involved in the initial draft and subsequent revisions. EA contributed to literature review, manuscript writing, and editing of the manuscript.

Data Availability

The data supporting the findings of this case report are available from the authors.

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