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Erector Spinae Plane Block: A New Twinkling Star Ready To Create Wonders in Toddler's Spine Surgeries - A Case Report

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Authors' contributions

This work was carried out in collaboration among all authors. Author KS designed manuscript content and co-wrote the paper. Took the lead in manuscript writing. Involved in the clinical management of the case. Designed table and figure contents. Author AR involved in the clinical management of the case. Co-wrote the manuscript writing. Author HD co-wrote and proofread the manuscript. Second lead in manuscript writing. Authors CS approved idea by KS and provided scientific guidance for manuscript writing. Provided guidance for the content of the manuscript and Co-wrote the paper. Approved final version of the manuscript. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

Aims: The expanded horizon of the ultrasound-guided erector spinae plane block (ESPB) shows promising results in various surgeries involving the thoracic, abdominal, pelvic, joint, and spine regions. We aimed to administer ESPB in spine surgery of the early pediatric age group patient to reduce the overall requirement of the intraoperative general anesthetic drugs and postoperative opioids due to high analgesic demands.

Presentation of Case: We report the application of ultrasound-guided bilateral ESPB as multimodal analgesia (MMA) component in the spine surgery of the youngest (2-year old) age group.

Discussion: Spine surgeries, especially scoliosis surgeries, are associated with extensive surgical dissection, leading to significant postoperative nociception causing high analgesic demands and necessitating high opioid consumption. It further leads to opioid-related side effects, delay in discharge, late ambulation, and prolonged hospital stay.

The ESPB potentially helps control polypharmacy by providing wide multisegmented analgesic coverage due to its multidirectional drug spread pattern. There are upcoming concerns regarding anesthesia-induced developmental neurotoxicity and the detrimental effect of general anesthesia in developing children. Such concerns can be addressed by cutting down the requirement of general anesthetic agents to a minimum level with the help of modalities like MMA incorporating regional analgesia (RA) as an adjunct.

Conclusion: The ESPB can be a safe and effective adjunct to the MMA in providing opioid-free optimal analgesia in spine surgery of the youngest population.

Keywords: Erector spinae plane block; paediatric pain management; paediatric spine surgery; regional anesthesia in children; multimodal analgesia; erector spinae plane block in toddlers.

1. INTRODUCTION

The application of ultrasound-guided erector spinae plane block (ESPB) has expanded its horizon and started showing promising results in various types of surgeries, including thoracic, abdominal, pelvic, joint, and spine. It has been successfully used as a pre-emptive analgesic option in various adult spine surgeries from the cervical to the sacral level. However, its use in the spine surgery of toddlers (1-4 years of age) has not been described yet in the literature. Apart from spine surgery, the ESPB has been used in thoracic surgeries [1,2,3], vascular ring repair [4], abdominopelvic surgeries [5,6], and hip surgeries [7], among the pediatric population [8].We report applying ultrasound-guided bilateral ESPB as an adjunct to multimodal analgesia (MMA) in the early pediatric age group. To our knowledge, this is the first report of the application of ESPB in spine surgery of the toddler age group. The patient's parents provided written consent to publish this case report.

2. PRESENTATION OF CASE

A two-year-old female patient (of 10 kg body weight) with congenital heart disease (patent ductus arteriosus and atrial septal defect) was diagnosed with right lumbar scoliosis with L2 hemivertebra. In February 2021, she was scheduled for posterior instrumented deformity correction with hemivertebra excision. On the day of surgery, her vital parameters included heart rate of 120/min, respiratory rate of 24/min, and blood pressure of 90/60 mm of Hg. All standard monitors (electrocardiogram, non-invasive blood pressure, and SPO2) were connected inside the operating room (OR). She was premedicated with intravenous glycopyrrolate 100 μg and ondansetron 1 mg. The general anesthesia (GA) was administered using intravenous propofol 10 mg, ketamine 10 mg, fentanyl 15 μg, and atracurium 5 mg. She was intubated with a flexometallic 4.0 cuffed endotracheal tube. After securing the tube and padding her eyes, she was positioned prone on padded bolsters (Fig. 1A, B).

Each vertebral level was marked by palpating the patient's spinous processes (Fig. 1B) in the prone position. After cleansing the back area with a sterile antiseptic solution, a high-frequency (13-6 MHz) linear ultrasound probe (Sonosite Edge II; Fujifilm SonoSite, Bothell, WA) was placed 2 cm lateral to the midline in the longitudinal parasagittal plane at L1 vertebral level. The hyperechoic tip of the L1 transverse process was identified under ultrasound. After optimizing the ultrasonographic image, 5 ml of local anesthetic

(LA) solution containing ropivacaine 0.2% (Ropin, Neon Laboratories Ltd, India)and dexamethasone 2 mg (Dexona, Zydus Cadila, India) was injected over the tip of the L1 transverse process under the erector spinae muscle using an out-of-plane approach (Fig.1C, D). The same procedure was repeated on the other side.

Intraoperative anesthesia was maintained using oxygen: N2O (50:50) mixture with titrated sevoflurane and controlled ventilation. Intravenous paracetamol 150 mg, ketorolac 6 mg, and dexamethasone 2 mg were given as a part of MMA. The hemodynamic parameters remained stable throughout three hours of surgery, with an estimated blood loss of around 100 ml.

The patient was turned supine immediately after the surgery and extubated following the reversal of the muscle relaxant. The extubation process was very smooth with the least hemodynamic changes. She was very calm and quiet following extubation, with a pain score of 0/10 on the FLACC (Faces, Legs, Activities, Cry, Consolability) scale. After seeing her mother in the postoperative holding area, she started crying for food but not for pain.

She was kept on a multimodal analgesic regimen postoperatively, including intravenous paracetamol 150 mg 8 hourly, ketorolac 6 mg 12 hourly with adequate fluids and antibiotic coverage. She was started on regular oral feeds from the second postoperative day.She was comfortable throughout the postoperative period, slept well, and did not wince or excessively cry. She did not require any additional rescue analgesics in the postoperative period (due to FLACC score <2 at all times), and her vital parameters remained stable. She was discharged uneventfully on the fifth postoperative day.

Fig. 1. Patient position, probe position, sonoanatomy, and drug spread of erector spinae plane block in toddler

A:Arrangement of padded bolsters for prone positioning, B:Baby in the prone position with marked vertebral levels on the back, C:Probe position for erector spinae plane block, D:Sonoanatomy and drug spread of erector spinae plane block

(ESM: Erector spinae muscle, L1, L3: Tips of the transverse process, Blue color area: Drug spread under the ESM, White line with the orange glow: Needle direction.)

3. DISCUSSION

Spine surgeries, especially scoliosis deformity correction surgeries in children, are associated with extensive surgical dissections that cause significant nociception. It leads to high analgesic demands, which necessitate high opioid consumption perioperatively, leading to opioid-related side effects, further delaying discharge, recovery, and mobility. All this leads to patient discomfort and decreased satisfaction.The effective analgesia provided by ESPB in our patient helped reduce additional requirements of intraoperative anesthetic drugs and perioperative opioids, avoid subsequent muscle relaxant top-ups, and maintain stable hemodynamics. Also, by providing a bloodless and clear surgical field, it helped in controlling intraoperative blood loss.

The exact mechanism of action of the ESPB is still unclear. It has been suggested that ESPB works by blocking dorsal rami of spinal nerves and sometimes ventral rami by diffusion of drug through the costotransverse foramen of Cruveilhier [9]. The multidirectional drug spread pattern along the thoracolumbar fascia leads to multisegmented analgesic coverage. The ESPB provides effective analgesia in spine surgeries due to consistent involvement of the dorsal rami, which mainly innervates the structure over the back region.

There are documented detrimental effects of GA in the pediatric age group due to the vulnerability of the developing brain to the anesthetic drug [10]. The process of widespread neuroapoptosis may be responsible for anesthesia-induced developmental neurotoxicity. Also, exposure to GA may cause the faulty formation of neuronal circuits, leading to long-lasting impairments in neuronal communication [10]. However, extensive studies are needed to prove the detrimental effect of GA. We can reduce the exposure of general anesthetics for a longer duration by cutting down its requirement to a minimum level with the help of modalities like MMA incorporating regional analgesia (RA) as an important adjunct. Due to effective intraoperative analgesia (provided by pre-emptive ESPB with MMA), we could reduce the anesthetic drug requirement and maintain the depth at lower minimum alveolar concentration values (0.4-0.6) of sevoflurane. Such practices of incorporating RA in the MMA protocol of any extensive and painful surgeries may provide long-term benefits in learning abilities by avoiding possible hazards of GA in the pediatric population along with providing optimal analgesia.

For the multifactorial origin of postsurgical pain, MMA remains the best choice. It includes modalities (pharmacological and nonpharmacological) that act synergistically on various levels of the pain pathway. RA plays an essential role as an adjunct to the MMA by reducing opioid consumption, providing adequate analgesia, and aiding faster postoperative recovery and discharge.

The analgesia duration provided by the ESPB (up to 24 hours) with continuous MMA was sufficient to deal with acute and severe immediate postsurgical pain.

Subsequent analgesic demand in the rest of the postoperative period was fulfilled by MMA alone. Thus, effective analgesia in the perioperative period helps keep the patient comfortable and improves active participation in postoperative physiotherapy. Our patient was comfortable throughout the postoperative period without any additional or rescue analgesic requirements due to effective analgesic coverage provided by ESPB in the immediate postoperative period and subsequently by MMA.

Compared to other RA techniques (paravertebral or epidural block) used in spine surgeries, ESPB Children should not be considered small adults due to anatomical, structural, and physiological differences (Table 1). These differences should be taken into consideration while performing ESP in the pediatric age group. The distance between the transverse processes is less in this age group, resulting in a more extensive drug spread with a relatively small volume than adults. We calculated LA of sufficient volume to ensure multisegmented analgesic coverage and of diluted concentration. Initially, we determined the extent of the spinal segments (T12-L4) to be covered for the surgery then calculated the required volume (5 ml on each side) of the LA needed to cover those segments as 1 ml/segment. The calculated maximum allowable dose of ropivacaine (3mg/kg) in our patient (of 10 kg) was 30 mg, corresponding to15 ml of 0.2% ropivacaine. In our patient, we used 10 ml of LA (5ml of each side) with 2 mg of dexamethasone as an adjuvant for bilateral ESPB.is relatively easy to perform (due to better echogenicity) and safe to administer (due to less risks) [3]. The complications like motor weakness due to a drug spread to the epidural space or lumbar plexus

Table 1. Various concerns and clinical implications for erector spinae plane block in children

Concerns	Characteristics	Clinical implications
Anatomical	• Thinner muscle layer • Loose connective tissues • Sliding fascial planes • Less distance between adjacent transverse processes • Intercristal line corresponds to L5-S1 as compared to adult (L4-L5)	• Superficial location of the target structures • Extensive interfascial drug spread as per volume used • Less drug volume is sufficient to cover adjacent spinal segments
Physiological	High cardiac output in children leads to, • Increased systemic absorption of LA • High proportion of cardiac sodium channels are in open state with a high affinity to LA • Poorly developed sympathetic system	• Doses should be calculated for small weight patients in volume-dependent blocks like ESPB • Maximum allowable dose of the LA should be calculated • Low-concentration or diluted LA should be used to avoid motor-effect • Less prone to develop hypotension in case of the intrathecal or epidural drug spread
Positional	• ESPB in children can be given in lateral and prone position	• Prone approach: For spine surgery in the prone position. The prone position is suitable for bilateral blocks • Lateral approach (AKSU): For spine surgery in lateral position. Suitable only for unilateral blocks.
Technical	• Depth from the skin to the transverse process may be <1cm, depending on the age	• Placing the needle tip immediately beneath the ESP may constitute a significant challenge requiring a fine needling technique and stable patient position
Ultrasonography	• Better echogenicity of structures	• Easy to differentiate structures • Better resolution with a high-frequency ultrasound probe can be possible due to the superficial location of target structures

(LA: Local anesthetic, ESP: Erector spinae plane, ESPB: Erector spinae plane block)

depend on the concentration/volume of the drug used and the proximity to the neuraxis. In our patient, we used optimal volume (5 ml on each side) and optimal concentration (0.2% ropivacaine) to cover estimated spinal segments without causing motor weakness. Complications like pneumothorax in thoracic ESPB can be avoided by keeping the needle tip under vision throughout the procedure and determining the dangerous depth beyond which the needle should not go.

The lack of knowledge of exact dermatomal coverage of the ESPB, especially in pediatric patients under GA, is the limitation of this case report. ESPB coverage depends on the injected volume of the drug and its spread into the various available areas under the erector spinae muscle groups.

4. CONCLUSION

Based on our current clinical experience, we found ESPB a safe and effective adjunct to the MMA in providing opioid-free optimal analgesia in a toddler undergoing spine surgery. Our patient is the youngest to receive single-shot ESBP in spine surgery. In order to recommend ESPB in pediatric spine surgeries, more prospective randomized clinical trials are needed to evaluate its efficacy and safety, determine exact application levels, and define the maximum safe dose and optimal LA volume.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

CONSENT

All authors declare that 'written informed consent was obtained from parents of the patient for publication of this case report and accompanying images.

ETHICAL APPROVAL

Ethical approval for this case report was obtained from the Institutional Review Board (IRB) of Ganga Medical Centre and Hospitals Private Limited, Coimbatore, Tamil Nadu, India.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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