

## CASE REPORTS

# General anesthesia combined with erector spinae plane block for ductus arteriosus closure: two case reports



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Received 29 May 2019; accepted 3 January 2020  
Available online 7 February 2020

### KEYWORDS

Newborn;  
Neonatal intensive  
care unit;  
Local anesthetics;  
Surgery;  
Regional anesthesia

### Abstract

**Background:** Failure of ductus arteriosus closure in preterm neonates results in a left-to-right shunt that leads to variable severities of hemodynamic and respiratory distress. When medical therapy fails, surgical ligation via left lateral thoracotomy remains an alternative approach and can be performed in the operating room or at the bedside with a low mortality rate. Opioid-based anesthesia is a frequent choice among anesthesiologists who manage patent ductus arteriosus cases based on the suppression of the stress response and maintenance of hemodynamic stability. This rationale suggests that regional anesthesia may also be an advantageous technique and may benefit earlier weaning from ventilation. Blocking afferent signals before incision may also modulate the long-term consequences of altered sensory perception and pain responses.

**Case report:** We present two cases of general anesthesia combined with erector spinae plane block as part of multimodal anesthesia in premature twins undergoing patent ductus arteriosus closure.

**Discussion:** In these cases, the use of erector spine plane block combined with general anesthesia was efficient to minimize the negative impact of surgery and allowed a reduction in the amount of intraoperative opioid use for patent ductus arteriosus closure.

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**PALAVRAS-CHAVE**

Neonato;  
Unidade de terapia  
intensiva neonatal;  
Anestesia local;  
Cirurgia;  
Anestesia regional

## Anestesia geral associada a bloqueio do plano do músculo eretor da espinha para encerramento de persistência de canal arterial: dois relatos de caso

**Resumo**

**Justificativa:** A persistência do canal arterial em neonatos prematuros resulta em *shunt* esquerdo-direito com alterações hemodinâmicas e desconforto respiratório de gravidade variável. Quando o tratamento clínico não é bem sucedido, o encerramento cirúrgico via toracotomia lateral esquerda continua sendo a abordagem alternativa, e pode ser realizado no centro cirúrgico ou à beira leito com baixa taxa de mortalidade. Anestesia baseada em opioides é frequentemente escolhida pelos anesthesiologistas nos casos de encerramento de canal arterial devido à supressão de resposta ao estresse e manutenção da estabilidade hemodinâmica. Essa justificativa sugere que a anestesia regional também pode ser uma técnica vantajosa e que promove desmame mais precoce do ventilador. O bloqueio dos estímulos aferentes antes da incisão também pode modular os efeitos a longo-prazo, tanto da percepção sensorial, quanto das respostas à dor.

**Relato de caso:** Apresentamos dois casos de anestesia geral associada a bloqueio do plano do músculo eretor da espinha como parte de anestesia multimodal em gêmeos prematuros submetidos a encerramento de canal arterial persistente.

**Discussão:** Nos dois casos descritos, o bloqueio do plano do músculo eretor da espinha associado à anestesia geral foi eficiente para minimizar o impacto negativo da cirurgia, e possibilitou a redução na quantidade de opioide usado durante cirurgia para encerramento de persistência canal arterial.

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**Introduction**

The Ductus Arteriosus (DA) is a normal fetal blood vessel connection between the aorta and pulmonary artery that normally constricts soon after birth and becomes closed within 72 hours. Failure to closing it results in a left-to-right shunt through the DA and may cause congestive heart failure. Delayed occlusion of the DA is a common finding in preterm newborns, as it remains open in approximately 80% of those born from 25 to 28 weeks gestation.<sup>1</sup>

In newborns, when medical therapy with nonsteroidal anti-inflammatory drugs fails to close the DA, surgical closure via left lateral thoracotomy is a common procedure that can be performed either in the operating room or at the bedside in the intensive care unit with a low mortality rate.<sup>2</sup> The aim of surgical closure is to decrease the pulmonary vascular overload.

There are limited case descriptions regarding the anesthetic management of PDA closure, and these range from inhalational to intravenous anesthesia. Most describe the use of high doses of fentanyl (10 to 100  $\mu\text{g}\cdot\text{kg}^{-1}$ )<sup>2</sup> to ensure effective analgesia and hemodynamic stability. Nevertheless, regional anesthesia techniques in extremely low birth weight (ELBW) newborns undergoing this surgery have not been described in the literature.

First described by Forero et al.,<sup>3</sup> Erector Spinae Plane (ESP) block is a paraspinal fascial plane block in which Local Anesthetic (LA) is injected between the erector spinae muscle and the underlying transverse processes. The deposit of LA in this plane allows a cranio-caudal dispersion of anesthetic that covers several dermatomes and produces analgesia via a hypothetical mechanism of anterior diffusion

of the LA to the ventral and dorsal rami of spinal nerves.<sup>3</sup> To date, ESP block has not been described in ELBW neonates.

The objective of these case reports is to describe the application of ESP block in Patent Ductus Arteriosus (PDA) closure as part of multimodal anesthesia for opioid reduction in preterm newborns.

**Reports**

Informed consent for publication was obtained from the parents.

**Case 1**

A premature newborn who was 25 weeks + 3 days old (postmenstrual age 29 weeks + 1 day), weighed 0.900 kg and had several comorbidities (infant respiratory distress syndrome, acute renal failure and hyperbilirubinemia of prematurity) was suggested to undergo PDA closure after medical therapy failure (three doses of ibuprofen). One hour before surgery, the patient was intubated with a 3.0 mm uncuffed orotracheal tube with 0.1 mg morphine in the Neonatal Intensive Care Unit (NICU) and kept under mechanical ventilation. The patient was monitored according to the American Society of Anesthesiologists (ASA) standard (except capnography, as monitor was not available in the NICU) and with cerebral Near Infrared Spectrometry (NIRS). The baseline vital signs were a Heart Rate (HR) of 140–155 beats per minute (bpm), a Mean Arterial Pressure (MAP) of 48–51 mmHg and a NIRS value of 52. In correlation with cerebral oximetry, NIRS can act as a measure of interventions that influence variations



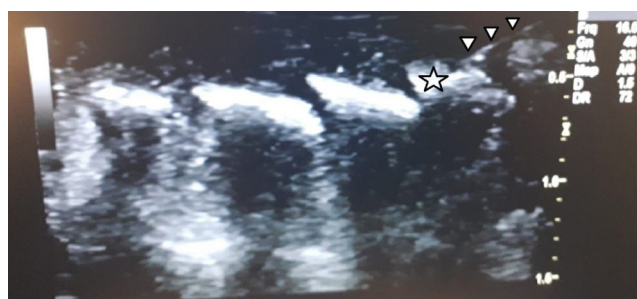
**Fig. 1** Depicts an ultrasound image of the ESP block in Case 1. The star represents a transverse process, and the triangles indicate the needle.

in cerebral oxygen saturation and cerebral blood volume changes during surgical PDA closure at the bedside. Anesthesia was achieved with 1  $\mu\text{g}$  fentanyl, 2 mg ketamine and 1 mg rocuronium. After positioning the patient in the right lateral decubitus position with a sterile technique and after having obtained parental informed consent, ESP block was performed under ultrasound control (GE Healthcare LOGIQe, 6.7–18 MHz hockey-stick probe) at the T5 transverse level; after negative aspiration, 1 mg 0.1% ropivacaine (Fig. 1) was injected to confirm the correct position of the block by visualizing the LA lifting the erector spinae muscle off the transverse process. The spread of LA between the T4 and T7 transverse processes was thereafter visually tracked with the transducer.

Twenty minutes after induction, ketamine (2 mg) and fentanyl (1  $\mu\text{g}$ ) were readministered, and 5  $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  dopamine infusion was initiated. During incision, the patient remained stable (HR 135–145 bpm and MAP 46 mmHg). Duct closure occurred 20 minutes later, with an increase in the NIRS value of 64, which was attributed to the decrease in left-to-right shunting. Surgery lasted 1 hour and 10 minutes uneventfully, without the need for opioid rescue. The patient was extubated 24 hours after surgery.

## Case 2

Second twin, weighed 0.860 kg, with the same comorbidities of the first twin, was suggested to undergo PDA closure after medical therapy failure (three doses of ibuprofen). One hour before surgery, the patient was intubated with a 3.0 mm uncuffed orotracheal tube with 0.1 mg morphine in the NICU and kept under mechanical ventilation. The patient was monitored according to the ASA standard (except capnography) and with cerebral NIRS. The baseline vital signs were an HR of 140–162 bpm, a MAP of 37–50 mmHg and a NIRS value of 67. Anesthesia was achieved with 1  $\mu\text{g}$  fentanyl, 1 mg ketamine and 1 mg rocuronium. After positioning the patient in the right lateral decubitus position with a sterile technique and having obtained parental informed consent, ESP block was performed under ultrasound control with the same equipment at the level of the T5 transverse process; after negative aspiration, 1 mg 0.1% ropivacaine (Fig. 2) was injected to confirm the correct position of the block by visualizing the LA lifting the erector spinae muscle off the transverse process. The spread of LA between the T4



**Fig. 2** Depicts an ultrasound image of the ESP block in Case 2. The star represents a transverse process, and the triangles indicate the needle.

and T7 transverse processes was thereafter visually tracked with the transducer.

The absence of an adrenergic response to the incision observed in Case 1 led us to not readminister fentanyl in this case, but only ketamine (2 mg) twenty minutes after induction. No hemodynamic variation was observed during the incision. Duct closure occurred after 22 minutes with hypotension (MAP 25 mmHg) and was associated with a decrease in the NIRS value to 42. Then, 7.5  $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  dopamine was initiated with correction of the MAP and NIRS to baseline values. Vasopressor support was favored to fluid bolus administration in order to avoid further pulmonary congestion. Surgery lasted one hour uneventfully, without the need for opioid rescue. The patient was extubated 34 hours after surgery.

## Discussion

PDA is a serious condition in ELBW neonates (birth weight < 1000 g). The hemodynamic and respiratory implications of left-to-right shunting are associated with severe complications, such as intraventricular hemorrhage, pulmonary hemorrhage, edema, necrotizing enterocolitis, decreased renal function and chronic lung disease, due to increased pulmonary blood flow and shunting from the systemic circulation.<sup>1</sup>

Closure of the PDA can be performed in the operating room, but in these cases, it was performed in the NICU environment to avoid the destabilization associated with transport and to maintain adequate ventilation control and temperature.

The rationale for high-dose fentanyl use in closure of the PDA is to ensure analgesia and stable hemodynamics, allowing optimal suppression of surgical stress and adverse metabolic and hormonal responses; the use of fentanyl has been shown to have a positive impact on outcome.<sup>2</sup> However, fentanyl is also associated with adverse effects, such as chest wall rigidity, bradycardia, seizure-like activity, hypothermia, high ventilator-dependency and tolerance after prolonged therapy.<sup>4</sup>

Despite the lack of data supporting the use of NIRS in preterm neonates and during cardiac procedures, the well-recognized hemodynamic oscillations and shifts in cerebral perfusion associated with surgical closure of the DA justify NIRS monitoring both during and after surgery.<sup>5</sup> The authors consider NIRS important for managing ventilation and blood

pressure, especially in the absence of capnography monitoring and continuous monitoring of blood pressure.

ESP block is safe and simple to execute because the ultrasound visualization of the injection site guarantees that important structures, such as neuraxial, pleural and major vascular structures, remain far away from the block. The craniocaudal spread of LA along the fascial plane permits extensive, and thus multiple, dermatomal coverage from a single injection site.

Before surgery, the technical difficulties and possible complications of the block were discussed. The poor ossification of transverse processes can bias the ultrasound view in ELBW newborns; in addition, LA systemic toxicity, pneumothorax and muscle weakness due to the spread of LA were the major concerns.

In our cases, the use of ESP block combined with general anesthesia allowed a reduction in the intraoperative doses of opioids used and, thus, in the related adverse effects, while providing effective analgesia and minimizing the surgical stress response.

## Conflicts of interest

The authors declare no conflicts of interest.

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