www.jpnim.com Open Access eISSN: 2281-0692
Journal of Pediatric and Neonatal Individualized Medicine 2020;9(1):e090137
doi: 10.7363/090137
Received: 2019 Oct 03; revised: 2019 Dec 8; accepted: 2020 Feb 02; published online: 2020 Mar 13

Answer

Respiratory distress after ductus arteriosus ligation – Answer

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The questions can be found in the following article:
Gorito V, Rocha G, Salgueiro E, Santos Éden P, Guimarães H.
Respiratory distress after ductus arteriosus ligation – Question.
J Pediatr Neonat Individual Med. 2020;9(1):e090136. doi: 10.7363/090136.

Keywords

Diaphragmatic paralysis, patent ductus arteriosus, respiratory distress, preterm.

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How to cite

Gorito V, Rocha G, Salgueiro E, Éden Santos P, Guimarães H. Respiratory distress after ductus arteriosus ligation – Answer. J Pediatr Neonat Individual Med. 2020;9(1):e090137. doi: 10.7363/090137.

Answers

1. Left diaphragmatic paralysis due to patent ductus arteriosus (PDA) surgical closure.
2. Yes. An elevated hemidiaphragm on an anteroposterior chest radiograph is suspicious of diaphragmatic paralysis. Atelectasis on the affected side and shift of the mediastinum away from the affected side have to be excluded. To confirm the diagnosis, echocardiography or fluoroscopy should be performed.

3. On physical examination, we usually find an asymmetric chest motion – limitation of the rib cage expansion on the affected side and paradoxical movement on the other side. We may also find an asymmetric air entry.
4. The first-line treatment is supportive, with the recovery of diaphragmatic function in the majority of cases. The conservative approach includes oxygen supply and invasive ventilation in selected cases. If the patients maintain persistent respiratory distress, surgical plication should be considered. The appropriate timing is unknown. Some authors consider at least two months on mechanical ventilation and others recommend earlier intervention to prevent further complications, particularly if the paralysis occurs after cardiothoracic surgery. Plication is associated with a quick respiratory improvement, even in preterm infants.

Introduction

PDA varies according to gestational age and birth weight; it is more frequent among girls too. According to some series, about 30% of preterm infants with a birth weight below 1,500 g present a hemodynamically significant PDA (HS-PDA) in the first days of life [1]. The diagnosis of HS-PDA is made from a combination of ecographic parameters according to our national guidelines. These include a ductus diameter measured in Color-coded Doppler > 1.5-2 mm or > 1.4 mm/kg of weight; non-restrictive left-right flow (maximum transductal velocity < 2 m/s); left auricle/aorta ratio > 1.4; dilation of the left ventricle and mitral regurgitation; diastolic flow absent or retrograde in the descending aorta; as a complement, systemic perfusion can be evaluated echographically in various organs by determining resistance index (RI), particularly at the cerebral, anterior cerebral artery or pericalosa (an RI equal to 1 translates absence of telediastolic perfusion, and greater than 1 is synonymous with diastolic flow inversion) [2, 3]. Although there is still controversy about the necessity of therapeutic approach in preterm infants, persistent HS-PDA in neonates may have adverse outcomes including prolongation of assisted ventilation and higher rates of death, bronchopulmonary dysplasia (BPD), pulmonary hemorrhage, necrotizing enterocolitis (NEC), impaired renal function, leukomalacia and cerebral palsy [4, 5]. These facts reinforce the necessity of pharmacological or surgical treatment in selected cases. Mortality and morbidity associated with surgical management of PDA in neonates have been reported to vary from 0% to 44% and nowadays it is typically reserved for patients with contraindications for NSAIDs, and for those in whom medical treatment fails [6, 7]. Complications like pneumothorax, pleural effusion, recurrent nerve, and phrenic nerve injury may occur. In low birth weight infants, diaphragmatic paralysis following phrenic nerve injury during surgical closure of PDA has already been reported [8, 9].

Clinical course

On day 25 (D25) of life, a fluoroscopic exam confirmed the diagnosis of left hemidiaphragmatic paralysis. Due to the increase of the respiratory work despite support with NCPAP for 18 days and X-ray repetition, we decided to perform the plication. She had a good recovery after surgery and came out of respiratory support after 4 days. She was discharged off the NICU on D63. A comparative image showed the left hemidiaphragm in a neutral position (**Fig. 1**). She maintains follow-up in Neonatology and Cardiology Outpatient Department, with a favourable clinical evolution.

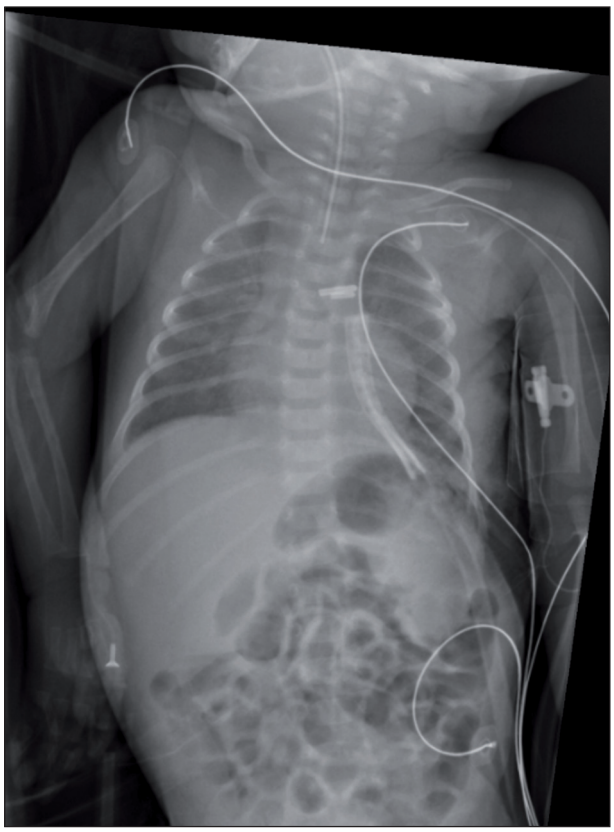

Figure 1. Postoperative X-ray showing the left hemidiaphragm in a neutral position.

Discussion

The incidence of PDA in term neonates is 1 in 2,000 births [10], but in preterm neonates is far greater, with reports ranging from 20% to 60% (depending on population and diagnostic criteria) [11]. The incidence is inversely correlated with gestational age and weight. HS-PDA is associated with significant neonatal morbidity and mortality. There are three treatment options: fluid restriction while awaiting spontaneous closure, pharmacologic intervention, and surgical ligation. In patients of more than 1,000 g birthweight with few risk factors, a PDA can generally be successfully managed conservatively, with modest fluid restriction and use of positive end-expiratory pressure to treat pulmonary edema. The indications for treatment of a symptomatic PDA include respiratory compromise heart failure, or large left-to-right ductus shunt with evidence of hemodynamic compromise, such as reversal of flow in the descending aorta during diastole, oliguria or rising serum creatinine concentration, hypotension, or wide pulse pressure [12]. Current pharmacologic treatment involves the use of nonselective COX inhibitors, namely ibuprofen lysine or indomethacin. Acetaminophen has been used in selected cases [12]. A high dose of oral ibuprofen has been recently associated with a higher likelihood of HS-PDA closure vs. standard doses of intravenous ibuprofen or intravenous indomethacin [13].

Although surgical ligation is effective in achieving rapid and complete ductal closure, it may be followed by severe hemodynamic and respiratory worsening. Surgical ligation is typically reserved for patients with contraindications for NSAIDs, and for those in whom medical treatment fails [14, 15]. Based on the current literature, there is no significant difference between the effect of surgical closure and pharmacological closure on mortality during hospital stay; however, surgical ligation is associated with increased risks of BPD, neurosensory impairment, and severe retinopathy of prematurity (ROP) [9, 15, 16]. A trial comparing pharmacological vs. surgical treatment found a significant increase in the incidence of pneumothorax (RR 2.68 [95% CI 1.45-4.93]) and ROP (RR 3.8 [95% CI 1.12-12.93]) in the surgical group. As expected, there was a decrease in the failure of ductal closure rate in the surgical group (RR 0.04 [95% CI 0.01-0.27]) [17]. Another study about HS-PDA in preterm infants showed that infants who underwent ligation had a higher frequency of morbidities before PDA closure, including sepsis, NEC, and a dependence on mechanical ventilation. After adjusting for perinatal characteristics and preligation morbidities, there was no difference in the odds of death (adjusted odds ratio [aOR], 0.83; 95% CI, 0.52-1.32), chronic lung disease (aOR, 1.36; 95% CI, 0.78-2.39) or severe ROP (aOR, 1.61; 95% CI, 0.85-3.06). Ligation was associated with lower odds of mortality (aOR, 0.09; 95% CI, 0.04-0.21) [18].

Early PDA ligation is an independent risk factor for BPD [19] and worse neurodevelopment compared with ligation at a later age [8, 16].

Diaphragmatic paralysis can occur as a complication of cardiothoracic surgery [20]. Causes include electrocauterization, stretching, blunt trauma or complete denervation of the phrenic nerve [21, 22]. Because of that, conservative management is usually the first-line approach. However, if patients maintain persistent respiratory distress or prolonged mechanical ventilation, plication generally allows rapid improvement, even in preterm infants [11, 23, 24]. Data on long-term outcomes after surgery are not fully known; however, recent studies did not show higher morbidity and mortality in children who underwent surgical ligation [13].

We present this case to highlight the complications associated with ductus arteriosus ligation and to reinforce that the surgical approach should only be considered in selected cases.

Declaration of interest

The Authors declare that there are no conflicts of interest neither any financial support.

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