

PATENT DUCTUS ARTERIOSUS- A CONGENITAL HEART DEFECT AFFECTING NEWBORNS

Abstract

Patent ductus arteriosus (PDA) is a congenital heart condition that affects some babies, more often premature infants. The ductus arteriosus, a small opening, is a component of the baby's blood circulation system in mother's womb. Usually, it disappears soon after birth. But, sometimes it remains patent and leads to blood flow difficulties between heart and lungs, known as patent ductus arteriosus. PDA can occasionally resolve itself. When it doesn't, medical professionals use medication, catheterization, and surgery to treat PDA and re-establish normal circulation. Small patent ductus arteriosus is frequently trouble-free and may never require treatment. Untreated, a big patent ductus arteriosus might allow oxygen-poor blood to flow in the wrong directions. This may cause heart failure and other issues by weakening the heart muscle.

Keywords: Patent ductus arteriosus, congenital heart defects, Foetal circulation, pre mature infants.

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I. ANATOMY

The ductus arteriosus is a fetal blood vessel that allows oxygenated blood from the placenta to bypass the lungs while the baby is in the womb. After birth, the baby's first breaths cause the lungs to fill with air, leading to a decrease in resistance in the blood vessels of the lungs. This decrease in resistance, combined with higher oxygen levels in the bloodstream, causes the ductus arteriosus to constrict and reduce blood flow. In healthy, full-term babies, the ductus arteriosus typically closes functionally within 12 to 24 hours after birth. Over the following two to three weeks, it undergoes permanent anatomical closure through a process of remodeling and fibrosis, becoming a ligament called the ligamentum arteriosum. However, if the ductus arteriosus fails to close properly, a condition known as patent ductus arteriosus (PDA) can occur, requiring medical intervention to prevent complications. Treatment options include medications or surgery to close the ductus arteriosus.

The ductus arteriosus (DA) does not close quickly in premature infants, and side effects may necessitate pharmacological or surgical closure.

In Foetal circulation, the ductus arteriosus is a normal vessel that allows blood from the right ventricle to bypass the pulmonary circulation and reach the descending aorta. Embryologically, the ductus arteriosus is a remnant of the distal sixth aortic arch and connects the proximal descending aorta to the main pulmonary artery. The ductus enters the anterior pulmonary artery directly posterior to the arch of the aorta. Usually, it is conical in shape with a big aortic end and a smaller pulmonary end. The ductus's size, length, and shape can vary greatly, though.

The following forms of Patent Ductus Arteriosus (PDA) are distinguished according to their angiographic characteristics:

1. Conical, Type A
2. Type B is a window
3. Type C: Tubular and Type D: Complex
4. Type E: Extended

II. EPIDEMIOLOGY

In infants, patent ductus arteriosus is the most prevalent cardiac condition. Premature babies are more frequently diagnosed with the disease by medical professionals.

In the USA, 8 out of every 1,000 preterm newborns and 2 out of every 1,000 full-term births experience it.

The danger rises as the baby is born earlier. The incidence in Premature babies inversely related to body weight and gestational age of an infant... It is shown as

1. 10% of infants born between 30 and 37 weeks of pregnancy experience PDA.
2. Between 25 and 28 weeks of pregnancy, 80% of babies are affected.
3. 90% of babies shows PDA if born before 24 weeks of pregnancy.

III. PATHOPHYSIOLOGY

The ductus arteriosus, a normal connection between the pulmonary artery and the aorta in foetal circulation, undergoes closure after birth due to increased oxygen levels (PaO₂) and decreased prostaglandin concentration. This closure process typically begins within the first 10 to 15 hours of life. However, if the closure doesn't occur naturally, the ductus arteriosus remains open, resulting in a condition called patent ductus arteriosus (PDA). The effects of PDA depend on the size of the ductus. Symptoms are rare in cases of a small ductus, but an untreated large ductus can cause a significant left-to-right shunt, where blood flows from the descending aorta through the patent ductus arteriosus into the pulmonary arteries. When the ductus arteriosus remains open after birth, it has been associated with various complications, including bronchopulmonary dysplasia (BPD), necrotizing enterocolitis, intraventricular haemorrhage, congestive heart failure, and renal failure. These complications arise due to the continuous flow of blood through the patent ductus arteriosus. It is crucial to promptly diagnose and appropriately manage patent ductus arteriosus to prevent potential complications.

1. Signs and Symptoms: The PDA symptoms depend on the amount of the gap between a baby's aorta and pulmonary artery. If the hole is small, your infant might not show any signs. Some people don't begin to exhibit symptoms until they are adults. However, a large PDA frequently results in heart failure symptoms in children or adults like

- **Symptoms with large PDA:**

- Rapid or forceful breathing

- Dyspnoea- Shortness of breath

- Respiratory diseases that are common

- Tachycardia- Increase in heart rate than normal resting heart beat

- Heart murmurs (a "whooshing" sound caused by irregular heart blood flow)

- Poor eating and sluggish weight gain

- Inability to feed or fatigue while feeding

- Sweating or crying while feeding

2. Causes: The specific cause of PDA is unclear to experts. It is significantly more likely to affect newborns who are preterm (born more than three weeks before the projected due date). PDA affects 65% of kids who are born before the 28th week of pregnancy, according to studies. Infants who are completely formed rarely experience it, and girls experience it more frequently than boys.

Calcium channel blockers, cocaine usage, magnesium exposure, and maternal diabetes are a few of the prenatal diseases and exposures linked to PDA. Extreme preterm birth, respiratory distress syndrome, newborn infection, high altitude delivery, excessive fluid administration, loop diuretics, aminoglycosides, cimetidine, and heparin are just a few neonatal diseases and exposures that have been linked to PDA.

3. Risk Factors: PDA can occasionally coexist with other heart conditions. Congenital heart abnormalities like PDA may become more common as a result of:

Specific genetic disorders- eg: Down syndrome (Trisomy 21), Loeys–Dietz syndrome (LDS), an autosomal dominant genetic connective tissue disorder seen in other heart defects also.

A history of congenital heart disease in the family.

Unborn foetal distress.

Pregnancy-related infections in the mother or foetus, including rubella.

Other risk factors for pregnancy, such smoking or taking certain medications.

IV. DIAGNOSIS

The symptoms of PDA may be identified by a medical professional immediately after birth. They listen for a heart murmur or lung congestion during a physical examination. They also measure the infant's blood pressure and pulse.

PDA can be detected using a variety of non-invasive testing, which may include...

An echocardiogram is an ultrasound examination that records the heart's movements.

Electrocardiogram: a test that assesses the heart using electrodes.

Heart size and blood flow to the lungs are revealed via an X-ray of the chest.

1. Complications: Small ductus arteriosus patents may not result in complications. Larger, unattended faults may result in

- **Pulmonary Hypertension:** Eisenmenger syndrome is a medical disorder characterized by elevated blood pressure in the lungs resulting from a specific congenital heart defect called a patent ductus arteriosus (PDA). When a large PDA is present, it disrupts normal blood flow to the heart and lungs, leading to increased pressure in the pulmonary artery. Over time, this increased pressure damages the small blood vessels in the lungs, causing irreversible lung injury. Eisenmenger syndrome is a severe and potentially fatal complication of pulmonary hypertension associated with a large PDA. It causes a reversal of blood flow within the heart, leading to inadequate oxygenation of tissues and a bluish discoloration of the skin and mucous membranes known as cyanosis. Treatment options for Eisenmenger syndrome are limited and primarily aim to manage symptoms and prevent complications, with heart and lung transplantation being a potential consideration in some cases.
- **Heart failure:** Symptoms such as rapid breathing, often with gasping breaths, and poor weight gain.
- **Endocarditis:** A patent ductus arteriosus can increase the risk of infection of the heart tissue, called endocarditis. It can be life-threatening.

2. Treatment: Infants who are gestationally more mature may be supported by cautious care of a PDA while waiting for spontaneous closure. To treat pulmonary oedema, conservative management techniques include a cautious fluid restriction (110 to 130ml/kg/d while monitoring urine output) and raising peak expiratory pressure (PEEP). Due to the paucity of evidence that diuretics enhance outcomes in very preterm infants, the possibility that they impede PDA closure, and the potential difficulty in managing electrolyte imbalances in these infants, diuretics are contentious.

The course of treatment differs whether the infant is full term or preterm infants.

- **Preterm Infants- Treatment Approach:** Restricting fluid intake may potentially facilitate the closure of the patent ductus arteriosus (PDA). In premature newborns without respiratory or other complications, a PDA is often left untreated. However, in cases where a hemodynamically severe PDA and poor respiratory status are present in preterm infants, a COX inhibitor can be considered as a treatment option to close the PDA. COX inhibitors, such as ibuprofen lysine or indomethacin, work by inhibiting the synthesis of prostaglandins.

In the case of indomethacin, three doses are typically administered intravenously (IV) every 12 to 24 hours, based on urine production. If urine output is less than 0.6 mL/kg/hour, the doses may be delayed. For ibuprofen lysine, an initial dose of 10 mg/kg is given orally, followed by two doses of 5 mg/kg spaced 24 hours apart.

It's important to note that the specific treatment approach may vary depending on the individual patient and the clinical judgment of healthcare professionals. Therefore, it is essential to consult with a healthcare provider for proper evaluation and guidance regarding the management of a patent ductus arteriosus and the use of COX inhibitors.

- **Full Term Infants- Treatment Approach:** In general, COX inhibitors are ineffective in full-term newborns. The optimal method of treatment for PDA in children older than one year is transcatheter closure. Some experts also believe that transcatheter closure is the best option for term neonates and early babies. There are several catheter-delivered occlusion devices that can be used, such as coils and septal duct occluders.

In newborns under one year old with ductal architecture unsuitable for transcatheter closure, surgical division and ligation may be preferable over the transcatheter method. Closure should be carried out following medical stabilisation in cases when the patent ductus arteriosus has a shunt large enough to result in heart failure or pulmonary hypertension symptoms. Closure is an option for persistent PDAs without heart failure or pulmonary hypertension at any time after one year. Delaying the treatment gives the wound time to heal naturally and reduces the likelihood of a vascular problem.

V. PROGNOSIS

The prognosis is favourable for newborns who just have an isolated PDA. The prognosis for preterm newborns depends on other comorbidities. Most kids have a normal life expectancy after PDA closure. Rarely does the PDA close on its own. Nearly 80–90% of neonates who get indomethacin will have their PDA successfully closed. Under the condition that the patient has not yet developed fixed pulmonary hypertension, a surgical closure is always necessary in adults. The PDA relates the blood flow rate to the morbidity and mortality. Pulmonary hypertension can develop without treatment and cause early mortality.

VI. PREVENTION

A patent ductus arteriosus cannot be prevented, as far as is known. To have a safe pregnancy, nevertheless, it's crucial to take all reasonable precautions. Here are some fundamentals:

- Eat healthy diet
- Exercise regularly
- Early prenatal care
- Avoid smoking and alcohol during pregnancy
- Get recommended vaccines before or during pregnancy
- Control of blood sugar levels

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