Case report

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Patent ductus arteriosus

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Abstract

Patent ductus arteriosus (PDA) is a congenital disorder in heart, wherein the ductus arteriosus fails to close after birth. This leads to the generation of a left-to-right shunt, leading to pulmonary hypertension. Color Doppler echocardiography is esential for the diagnosis. The identification of a diastolic flow oriented in the opposite direction in the pulmonary artery finalizes the diagnosis.

We present the case of a 4 year old patient with systolic and diastolic left parasternal lift, echographically diagnosed with patent ductus arteriosus. The typical echographic aspects for this cardiac malformation are thoroughly detailed.

Keywords: patent ductus arteriousus, left-to-right shunt, Doppler echocardiography

Rezumat

Persistența ductului arterial este o afecțiune congenitală cardiacă caracterizată prin lipsa închiderii ductului arterial după naştere. Aceasta duce la realizarea unui şunt stânga-dreapta cu hipertensiune pulmonară. Ecografia Doppler color este esențială pentru diagnostic. Identificarea unui flux diastolic orientat în sens invers în artera pulmonară definitivează diagnosticul.

Prezentăm cazul unui pacient de 4 ani care, prezentând un suflu parasternal stâng sistolico-diastolic, a fost diagnosticat ecografic cu persistenta canalului arterial. Aspectele ecografice tipice ale acestei malformații cardiace sunt prezentate pe larg.

Cuvinte cheie: persistența ductului arterial, şunt stânga-dreapta, ecografie Doppler,

Introduction

Ductus arteriosus (DA) is a shunt connecting the descending thoracic aorta (DAo) to the pulmonary artery trunk (PA). DA ostium in PA appears in the upper part and proximal left to the PA bifurcation, near to the origin of the left PA [1]. The incidence of patent ductus arteriosus (PDA) is of 0,02-0,04% in case of a full-term pregnacy, and 0,8% in case of a preterm birth. [2,3].

During intrauterine life, DA is a vital connexion between PA and the aortic arch. Due to this shunt, most of the blood that leaves the right ventricle (RV) avoids the collapsed fetal lungs which are full of liquid. Thus, the right heart is protected and pumps blood against the lungs' strong vascular resistance. If DA closes *in utero*, the increased pressure in the right heart may cause right ventricular insufficiency [4].

Along with the newborn's first breath, the lungs fill with air, and the pulmonary vascular resistance decreases. The increased oxygen content in the blood produces the bradikinin release in the lungs, which also determines smooth muscle contraction in DA walls, leading to its closure [5,6]. In the first 12-24 hours after birth, DA is already almost closed, its complete closure occuring after 2-3 weeks. [4].

If the new born is hypoxic (mostly in case of premature birth), the blood has a low oxygen content, and the level of released bradykinin is insufficient for DA closure [5]. Due to the fact that after birth, the systemic circulation pressure is higher than the pulmonary one, a shunt inversion occurs, becoming a left-to-right shunt. Due to the high pressure gradient between the aorta and the pulmonary artery,

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the blood volume which flows through the shunt is usually high. This leads to a right heart volume overload, causing resistance pulmonary hypertension (PHT). Eventually, the Eisenmenger syndrome occurs, representing the final stage of all cardiopathies with left-to-right shunt, when the patient becomes cyanotic due to the shunt's right-to-left reinversion. From this moment, the disease prognosis is bad, and surgery is overdue as the shunt's ellimination will only lead to a pronounced increase of PHT level [7,8].

PDA's main complications are left cardiac insufficiency and infective endarteritis. The presence of left-to-right shunt determines the left ventriclular overload (LV), which firstly becomes hypercontractile, then during the evolution it dilates and becomes insufficient. The left atrium (LA) also dilates due to volume overload. Infective endarteritis of DA is cited as a mostly lethal complication of PDA before the introduction of antibiotherapy. The use of antibiotics has significantly changed the incidence of endateritis and its prognosis in patients wih PDA, but it still remains as a powerful complication even when PDA is clinically silent [9,10].

The clinical examination doesn't give satisfying results in PDA diagnosis. Therefore, echocardiography, especially Doppler echocardiography, is the necessary investigation for the diagnosis of PDA [11].

Case study

A 4 year old child, male gender, born after a full-term pregnancy, with a normal birth weight (3500g), came for an echocardiography, as a result of the presence of an upper left parasternal lift, both systolic and diastolic.

In parasternal long axis view, using 2D and M-mode echography, a good LV contractility has been noticed (71% ejection fraction) (fig 1) and LA diameter bigger than DAo diameter (LA/DAo)=32/21=1,52>1,3) (fig 2). 2D echography in parasternal short axis view has revealed a PA diameter bigger than DA diameter, as well as a 4 mm ostial PDA at the level of the pulmonary artery (fig 3). PDA has been confirmed by color Doppler echocardiography, examining the same section and locating a continuous flow, both systolic and diastolic, on the side-half of the PA, oriented towards the pulmonary valve, in opposite direction than the normal pulmonary artery flow (fig 4). Doppler echocardiography with the sample placed inside the PA, where the flow from the RV meets that of the DA, has detected the presence of a turbulent flow, with a maximum telesystolic speed, caused by the jet coming from the systolic and diastolic DA (fig 5).

The echographic diagnosis was of PDA with hemodynamically significant shunt, but without left cardiac insufficiency or severe PHT.

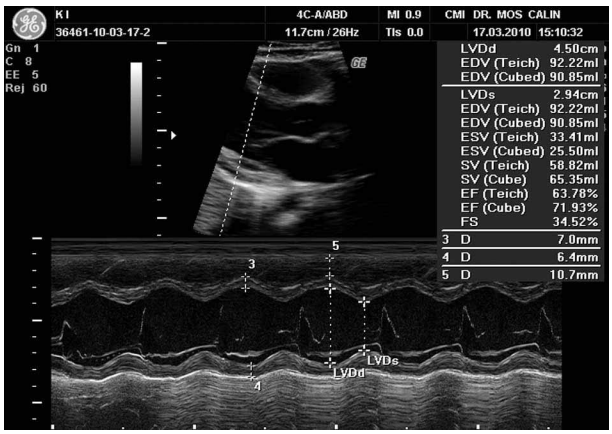


Fig 1. M-mode echocardiography, parasternal long axis view with the sample placed at the level of the LV, perpendicular to the interventricular septum (IVS) and left ventricular posterior wall (LVPW), for the asessment of the ejection fraction (EF) – it reveals a slight hypercontractility of the LV (71% ejection fraction)

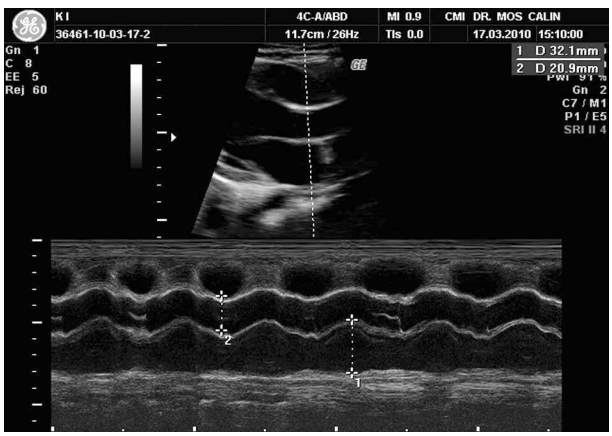


Fig 2. M-mode echocardiography, parasternal long axis view with the sample placed perpendicular to the DAo and LA for the assessment of DAo and LA diameters - it reveals an increased DAo/LA=1,52 ratio (normal value bellow 1,3)



Fig 3. 2D echocardiography, high parasternal short axis view – the 4 mm diameter pulmonary ostium of the DA is being visualized

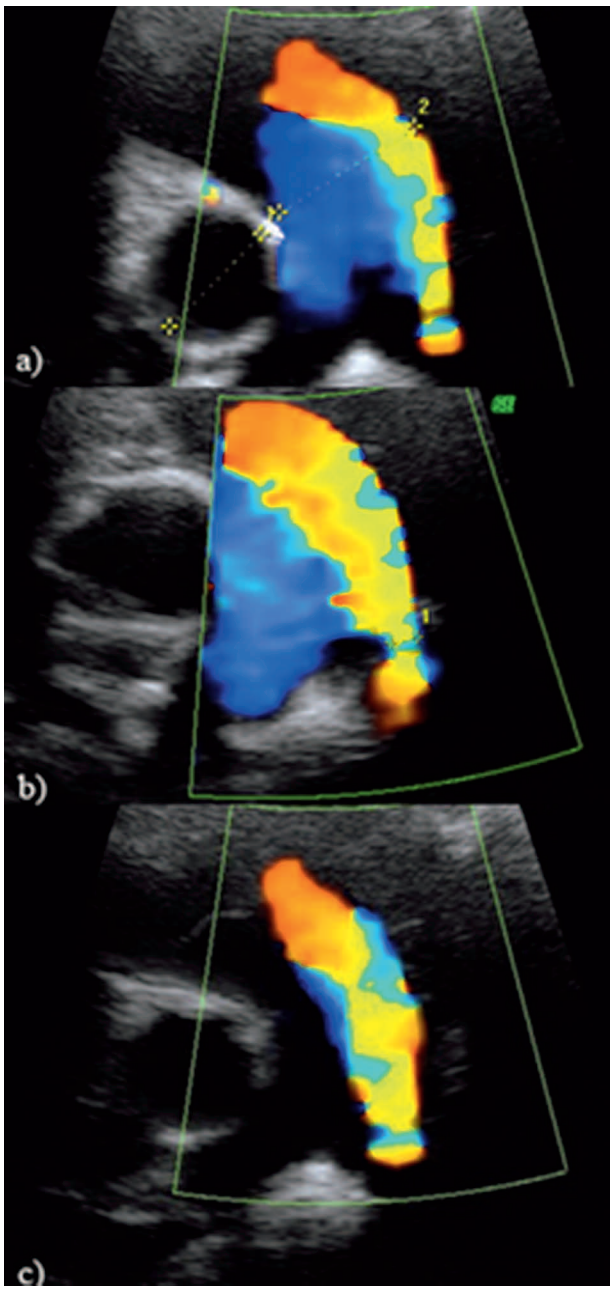


Fig 4. Color Doppler echocardiography, high parasternal short axis view – pathognomonic appearance of PDA: a turbulent flow is present at the level of the side-half of the PA, coming from the DA ostium towards the pulmonary valve, in opposite direction than the normal flow from the pulmonary artery. a) in the first part of the systole, the pulmonary flow is dominant (the blue colored area), related to the ductal flow (the yellow colored area). The flow wave has reached the PA bifurcation, without entering the PA branches; b) in the second part of the systole, the ductal flow is the dominant one. The blue colored pulmonary flow wave has enetered the right PA; c) in diastole, the pulmonary flow is completely missing, but the jet at the level of the venous duct is still present in the side-half of the PA.

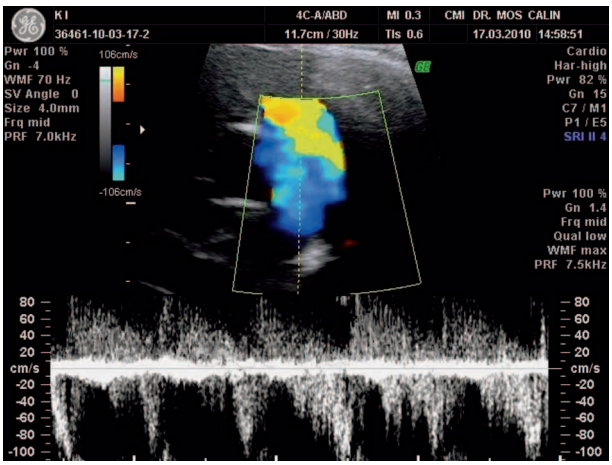


Fig 5. Doppler echocardiography, with the sample placed between the pulmonary and the ductal flow, reveals a continuous, systolic and diastolic positive flow, oriented towards the pulmonary valves, with tardy systolic peak, right after the negative jet from the right ventricle has reached the maximum speed.

Discutions

In case of patients with PDA, the main diagnosis method and the main stage assessment method is echocardiography. For the positive diagnosis, the pathognomonic view is given by DC echography. 2D, M-mode and DP or continuous Doppler echography are used for stabilization. Although cardiac echography is a very good PDA diagnosis method, neither the echocardiography nor other noninvasive imaging methods are very precise in the quantitative assessment of the ductal flow. Echographically, the seriousness of PDA is assessed indirectly according to LV contractility, the comparative dimensions of LA, DAo and PA, PHT levels, etc [12].

2D echography gives little information, it can visualize PDA only if it has notable dimensions. It can also assess PA dilatation over dA [13].

M-mode echography proves LV volume overload due to left heart volume overload. This manifests through hypercontractility, followed by LV dilatation. LA also dilates. If LA/DAo ratio exceeds 1,3, we consider the shunt as hemodynamically significant [14]. In what concerns our patient, LA/DAo=1,52, thus, it is hemodynamically significant. A very good LV contractility proves that the left heart is overloaded but not insufficient.

The use of DC echography helps identifying even very small PDA dimensions, which cannot be diagnosed using 2D echo. The doubtlessness diagnosis is given by the typical presence of a diastolic flow heading towards the pulmonary valves along the PA's side-wall. In systo-

le, the antegrade pulmonary flow may dissemble a small volume ductal flow. On the other side, a large volume ductal flow may completely absorb the PA [15]. In our situation, the ductal flow absorbs around ½ of the PA and it is continuous, systolic and diastolic. Doppler echography with the sample placed between the pulmonary flow and and the ductal flow, identifies a continuous, systolic and diastolic flow which is oriented towards the pulmonary valves, with positive peak in the tardy systole (as soon as the jet from the right ventricle has reached the maximum speed). The positive peak systolic moment given by the ductal flow in PA is assessed by the relation to the negative peak systolic given by the flow ejected by RV in PA).

When severe PHT sets in, the ductal flow firstly becomes bidirectional, and then, together with Eisenmenger syndrome occurrence, it becomes right-to-left shunt. After Eisenmenger syndrome occurrence, the surgical correction isn't possible anymore [16]. In our case, the bidirectional flow being absent, the shunt remains left-to-right but hemodinamically significant, the patient has been guided to a cardiovascular surgery center for PDA correction.

As a conclusion, routine echocardiography in children with cardiac breath, detected during the clinical examination, is necessary in all situations. The patient must be guided towards a hospital as soon as a cardiac malformation is being detected.

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