

## Case Report

# Multimodality imaging in diagnosis and management of patent ductus arteriosus in an adult: a case report

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**Abstract:** Patent ductus arteriosus (PDA) is a congenital heart disorder in which a vascular structure between the pulmonary artery and the aorta remains open. PDA normally closes shortly after birth. The treatment in adults is surgical or transcatheter closure. A 47-year-old woman presented to our hospital with a diagnosis of PDA and was treated with transcatheter closure. Although the recovery period of adult patients is long, this patient recovered completely after one day.

**Keywords:** PDA, PDA closure, congenital heart disease

## Introduction

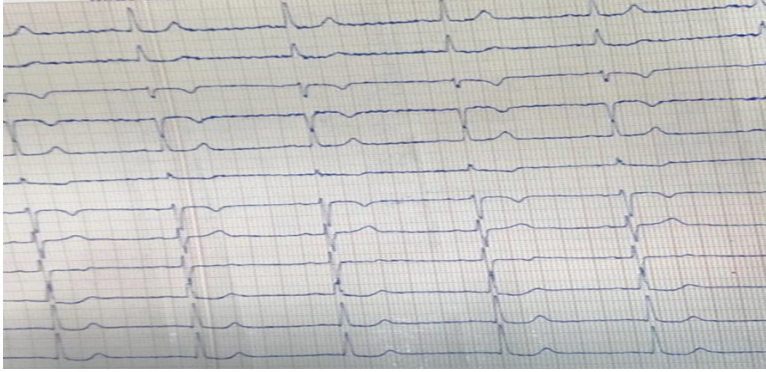
Patent ductus arteriosus (PDA) is a congenital heart disease that occurs when the duct between the pulmonary artery and the aorta does not close [1]. PDAs are commonly diagnosed and treated in infancy through childhood, but they can also be diagnosed in adulthood [2]. The main mechanism for arterial duct closure 24 to 48 hours after birth is the contraction of the intimal smooth muscle in the vessel wall, with the onset of pulmonary respiration and oxygen stimulation resulting from increased partial pressure of oxygen in the blood and decreased prostaglandin E2 (PGE2) and PGE2 receptor (EP4) levels [1, 3, 4]. With complete PDA closure, pulmonary artery pressure (PAP), left ventricular ejection fraction (LVEF), left ventricular end-systolic diameter (LVESD), left ventricular end-diastolic diameter (LVEDD) and left ventricular mass index (LVMI) decrease remarkably. After the closure of a large PDA, significant left ventricular systolic changes may occur, but LV function usually comes better within a few months [5]. Complete PDA occlusion can vary from 24 hours to several weeks in different populations. One of the

factors involved in this process is the patient's age; the recovery time is shorter in babies and longer in adults [1, 6, 7]. In premature infants, the arterial duct responds poorly to oxygen and lung metabolism of prostaglandin is delayed, so spontaneous closure of the PDA fails [2]. PDA includes approximately 10% of congenital heart diseases [8]. Its prevalence is 12.4% in children and 16.3% in adults, so it is one of the five reasons for congenital heart disease surgery [9]. Since transcatheter treatment reduces patients' hospitalization compared to surgery and does not leave a scar, it is considered the first line of treatment for PDA in adults and children if feasible [10].

## Case presentation

A 47-year-old woman referred to our hospital due to dyspnea on daily activities. Fever was not detected and she didn't complain of a cough or chills and did not mention sweating or palpitations. Her blood pressure on the first visit was 110/60 mmHg. A continuous "machinery" murmur with 4/6 intensity at the left sternal border was heard. A palpable thrill was another finding. Respiratory sounds

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**Figure 1.** ECG in PDA patient.

were clear and blood tests revealed no abnormalities.

Her electrocardiogram (ECG) showed sinus rhythm without any pathological changes (**Figure 1**).

Echocardiography is proposed as the primary and standard diagnostic method for PDA and other diagnostic methods such as CT angiography are used to determine the exact size and location of PDA, as well as angiography and catheterization to check hemodynamics and determine the best treatment method. For this purpose, the patient was examined by echocardiography, the result showed severe Left ventricle (LV) enlargement (**Figure 2**) with preserved function (Left Ventricular Ejection Fraction = 50-55%). Systolic Pulmonary Artery Pressure (SPAP) was calculated using the Bernoulli equation as 55-60 mmHg. Left Atrium (LA) was enlarged, and a small size PDA (4.7 mm diameter) was detected on echocardiography (**Figure 2**).

Aortic Computed Tomography angiography showed 4.9 mm PDA between the proximal descending aorta and the main pulmonary artery. The ascending, arch and descending aortic parts were normal in appearance and size. There was no occlusive disease, significant stenosis, aneurysm formation, dissection or coarctation in any aortic segments (**Figure 3**).

Cardiac Catheterization and angiography showed PDA with the left-to-right shunt ( $Q_p/Q_s = 2.2$  with oxymetric method) and normal epicardial coronary arteries (**Figure 4**).

Since the accurate size of the PDA could not be determined solely by any of the imaging

modalities mentioned above, the CT angiographic, angiographic and echocardiographic records were reviewed. Multimodality imaging was used to fully evaluate the PDA and also to choose the best treatment method and the most appropriate device size to close the PDA and also to evaluate the response to treatment in the patient. Using the combination of three imaging modalities, the accurate size of the duct as well

as the appropriate device size was finally determined.

Since there are no specific diagnostic laboratory findings for PDA, it cannot be diagnosed based on laboratory information. The best treatment for PDA if it is open, is to close it, and it can be closed with the help of a catheter or by surgery and thoracotomy. Since catheter closure is a low-risk procedure compared to surgery and thoracotomy, it is used as a method to close PDA in adults. Catheter closure in adults is very useful and safe and has favorable results in the short-term, medium term, and long-term.

Actually, closure with a catheter reduces the length of stay in the hospital and complications, because it is a low-risk method, it is considered as a treatment method in many PDA cases. So, PDA device closure was done at the same session using an Occlutech PDA occluder with a diameter of 10-12-18 mm and a length of 12 mm, and the correct positioning and disappearance of the shunt after deployment was confirmed by aortography (**Figure 5**).

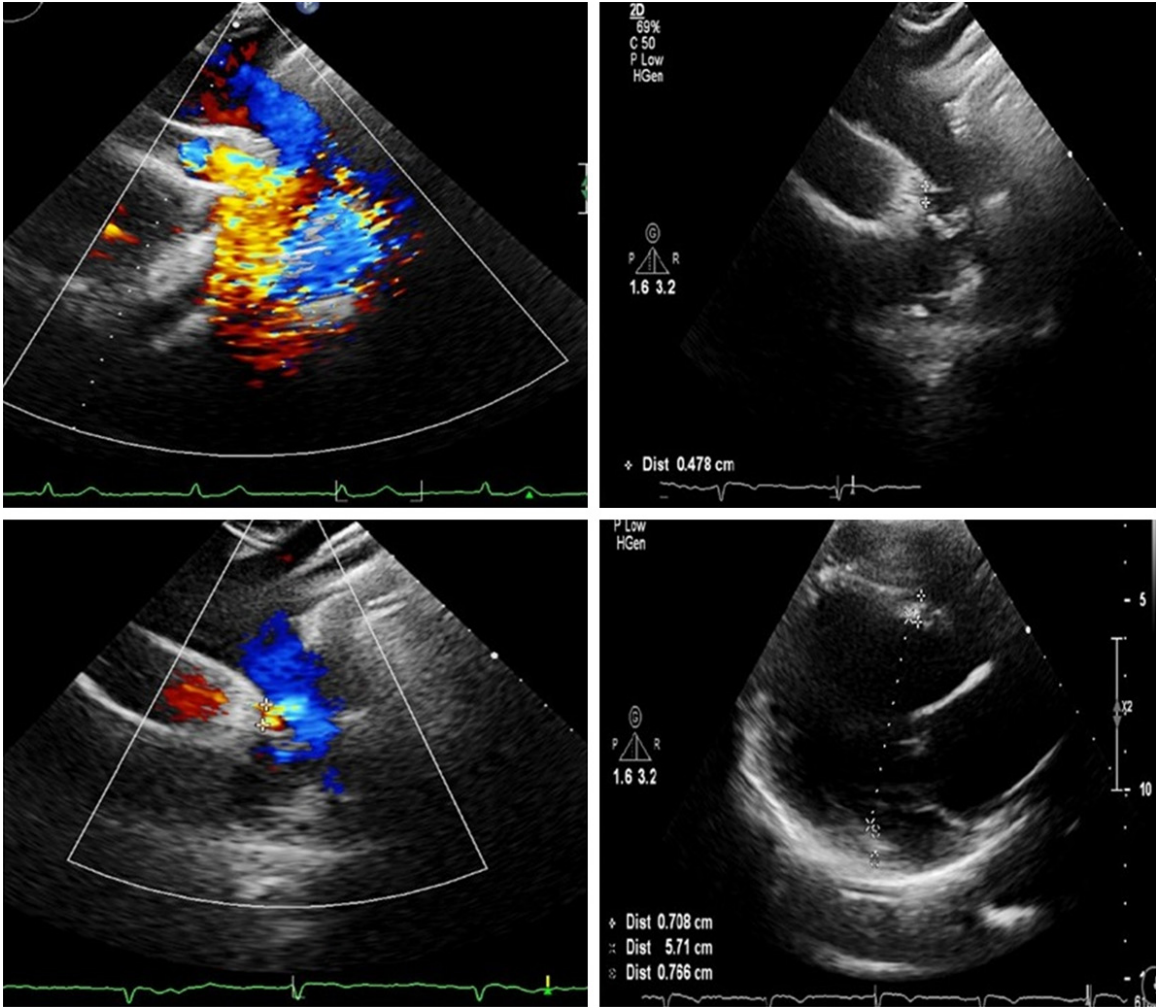
In an echocardiographic study one day after PDA closure, LV size was normal with preserved function and normal LV filling pressure. The device for PDA closure was seen in the proper site with no residual shunt. PAP was 25-30 mmHg (**Figure 6**).

The correct position of the disk also was seen in aortic CT angiography after PDA closure (**Figure 7**).

### Discussion

The arterial duct is a central vascular shunt that connects the pulmonary artery to the aorta

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**Figure 2.** PDA with dilated LV in echocardiography.



**Figure 3.** PDA between proximal descending aorta and main pulmonary artery in Aortic CT angiography.

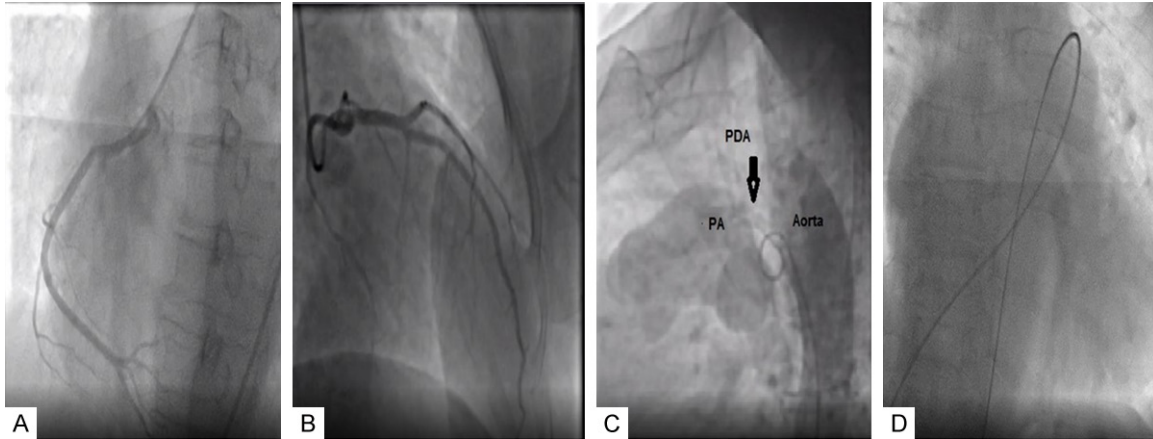
and closes immediately after birth [11]. However, by the day 4 after birth, this closure does

not occur in approximately 10% of preterm infants born in 30 to 37 weeks of gestation, 80% of those born in 25 to 28 weeks of gestation, and 90% of those born in 24 weeks of gestation [11, 12]. On the seventh day after birth, these percentages decrease significantly [11]. PDA may be diagnosed as an accidental finding in adults who have been referred for echocardiography due to another reason [13]. Since there is no laboratory diagnostic method for this disease, echocardiography is the first standard diagnostic method for PDA.

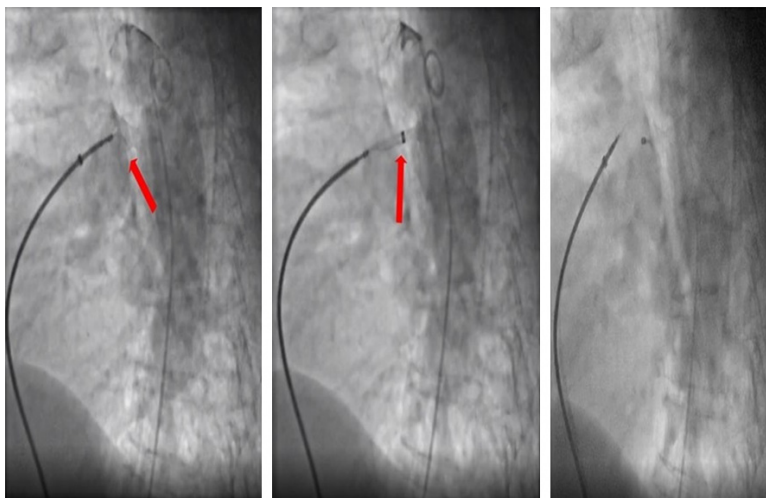
In adults with untreated PDA, the mortality rate is estimated at 1.8% per year [14]. The clinical



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**Figure 4.** Coronary arteries and PDA in Angiography and cardiac catheterization. A. Right coronary angiography. B. Left coronary angiography. C. PDA in Cardiac catheterization. D.  $\Phi$  sign in cardiac catheterization.



**Figure 5.** PDA closure with the PDA occluder device.

manifestations of this disease depend on the size and magnitude of the shunt and the patient's underlying cardiovascular status [13]. Clinically, a typical continuous murmur is heard at the higher left sternal border, which can also be associated with a wide pulse pressure due to the runoff to the pulmonary circulation [1]. Surgical and transcatheter closure is used for PDA treatment. While the second method is a less invasive approach in adults, surgery is used for very large PDAs that are not amenable for catheter intervention [6]. Considering that closure with a catheter reduces the length of stay in the hospital and complications, this treatment method is used in most cases of PDA. In the meantime, multimodal imaging methods can be used for accurate diagnosis,

determining the appropriate size of the device and improving the patient as much as possible. The allotted time for the patient to fully recover after PDA closure and return the ventricle to its normal size is one to more than 360 days, and this difference depends on the age of the patients [15]. In our case, echocardiography one day after PDA closure showed normal LV size with preserved function and normal LV filling pressure. A possible reason could be the difference in the hydration status of the patient before the procedure.

Wenhai Wu et al. and Zhan et al. reported that postoperative recovery occurred in patients with an average age of  $10.95 \pm 3.27$  years one day after transcatheter PDA closure, but in patients with an average age of  $64:31 \pm 7.5$  years, no complete recovery was seen after 360 days [15, 16].

### Conclusion

In this 47-year-old lady who came to our hospital with dyspnea and a continuous murmur, multimodality imaging using echocardiography, aortic CT angiography and catheterization and angiography helped us in diagnosis and accurate sizing of PDA, as well as optimal treatment and proper follow up. She was treated with

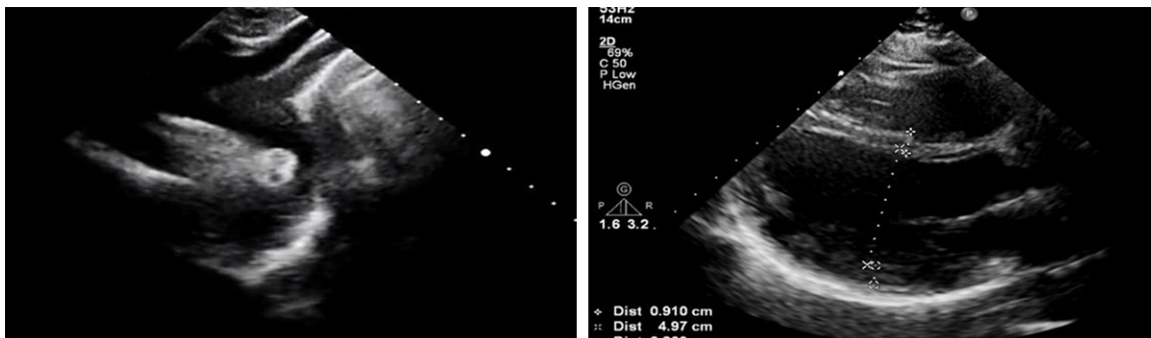


Figure 6. Echocardiography after PDA closure.



Figure 7. Aortic CT angiography after PDA closure.

transcatheter PDA closure. Considering that this patient was in his forties, she made a complete recovery after a day.

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#### Disclosure of conflict of interest

None.

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