Case Report: Ostium secundum atrial septal defect with unilateral lung hypervascularity revealing associated right pulmonary artery stenosis [version 1; peer review: 2 approved with reservations]

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Abstract

Background: Atrial septal defect (ASD) is often an isolated disease, but its association with other abnormalities can make diagnosis challenging. Careful analysis of simple complementary exams can help precise anatomical diagnosis ensuring suitable treatment. The aim of this article is to report, from a case report and literature review, diagnostic challenges and the contribution of simple complementary exams, such as chest X-ray, for the diagnostic orientation of an ASD associated with peripheral pulmonary artery stenosis, as well as therapeutic particularities.

Case report: We report the case of a girl born in 2007, with history of dyspnoea and recurrent bronchitis in whom a loud systolic murmur was detected fortuitously at the age of 2 years. Her clinical examination was otherwise normal. The electrocardiogram recorded sinus rhythm, incomplete right bundle branch block, and right ventricular hypertrophy. Chest X-ray showed moderate cardiomegaly and hypervascularity of the left lung field contrasting with reduced blood flow to the right lung. Doppler echocardiography revealed a wide ostium secundum ASD, right chamber volume overload and right pulmonary artery stenosis. The latter was confirmed by CT angiography and right cardiac catheterization. The patient underwent percutaneous right pulmonary artery dilation with stent placement. Control chest X-ray noted bilateral hypervascularity of the lung. The ASD was closed percutaneously one year later. The outcome was uneventful.

Conclusion: The combination of ASD with pulmonary artery stenosis limits pulmonary hyperflow. In our case, this stenosis was tight and sat on the right branch of the pulmonary artery reducing significantly blood flow to the ipsilateral lung. Careful chest X-ray analysis may suggest diagnosis, which can be confirmed by ultrasounds and if necessary, by further examination, allowing treatment adaptation.
our knowledge, this association is very rare and no similar case has been reported.

**Keywords**
Atrial septal defect, pulmonary stenosis, echocardiography, angioplasty, cardiac catheterization.
Introduction

Atrial septal defect (ASD) is a very common congenital heart disease\(^1\),\(^2\). It can be associated with other cardiovascular abnormalities; the most common is pulmonary stenosis\(^2\). The latter usually concerns the valve or the right outflow tract but rarely pulmonary artery branches. This unusual association can be suspected by careful analysis of complementary exams. Currently, advances in interventional treatment make possible reliable and effective treatment of ASD even when associated with other lesions, in particular pulmonary stenosis\(^3\).

The aim of this article is to report, from a case report and literature review, diagnostic challenges and the contribution of simple complementary exams, such as chest X-ray, for the diagnostic orientation of an ASD associated with peripheral pulmonary artery stenosis, as well as therapeutic particularities.

Case report

We report the case of a girl born in 2007, with history of dyspnoea and recurrent bronchitis in whom a systolic murmur was detected in our outpatient office at the age of two years. The physical examination at this age noted a non-dysmorphic child with normal growth and psychomotor development. Auscultation of the pulmonary area noted loud 3/6 systolic ejection-type murmur, splited second heart sound with a marqued pulmonary component. An electrocardiogram recorded sinus rhythm, incomplete right bundle branch block and right ventricular hypertrophy.

Chest X-ray showed moderate cardiomegaly with cardio-thoracic ratio of 0.53, convex mid-left arch, and above all marked hypervascularity of the left lung contrasting with reduced blood flow to the right lung (Figure 1).

Doppler echocardiography noted a 20 mm diameter ostium secundum ASD with right chamber volume overload associated with right pulmonary artery (RPA) stenosis. Diagnostic confirmation of peripheral pulmonary branch stenosis was made by CT scan and right heart catheterization (Figure 2).

A two-step percutaneous treatment for these lesions was decided. RPA stenosis was treated firstly with 8 mm × 2 cm balloon in 2012 with poor initial result. A novel attempt in the same year with a balloon and stent placement (Express\(^\text{TM}\) Vascular LD 10\(^*\)37mm) was successful (Figure 3).

This result was optimized 6 months later through a 18 mm × 20 mm balloon leaving mild residual gradient of 10 mm Hg between pulmonary trunk and RPA. The ASD was closed successfully 1 year later in July 2013 with a 24 mm Figulla Flex II prosthesis. The procedure was uneventful and fluoroscopic control at the end noted ASD prosthesis in place and stent at RPA level (Figure 4). Control chest X-ray showed symmetrical bilateral vascularisation of the two lungs (Figure 5). Outcome was favourable. Control echocardiography performed at 4 years of regular follow-up noted mild residual pulmonary stenosis (maximal residual gradient of 15 mmHg), no stent restenosis and a well-sealed ASD prosthesis (Figure 6). Systolic right ventricle function indices were normal.

Figure 1. Chest X-ray of the patient. Cardiomegaly, convex middle arch and unilateral left lung hypervascularity contrasting with reduced blood flow to the right lung is shown.

Figure 2. Chest CT scan of the patient. (A) Tight stenosis at the origin of the right pulmonary artery (red arrow); (B) small right pulmonary artery (15 mm) contrasting with (C) dilated left artery (27 mm).
Discussion

Our case emphasizes perfectly the importance of careful basic semiology analysis in the diagnosis process of congenital heart disease. In fact, heart murmur characteristics and asymmetric pulmonary vasculature in chest X-ray oriented the diagnosis of ASD associated with pulmonary branch stenosis. Confirmation was made by appropriate investigations, particularly Doppler echocardiography, thoracic CT angiography and finally cardiac catheterization with selective angiograms. Chest roentgenogram still retains great value for the diagnostic process in cardiology. Thus in our patient, the finding of an unbalanced pulmonary vasculature especially when associated with an intense pulmonary murmur oriented the diagnosis of pulmonary artery branch stenosis. RPA stenosis caused pulmonary flow deviation mainly to the healthy side resulting in increased...
vascularisation of the left lung contrasting with a hypovascular-
ity of the right one. This unilateral hyper-flow was quite marked
because of its association to relevant left to right shunt related
to wide-associated ASD. This suspicion of RPA stenosis was
easily confirmed by echocardiography, CT scan, and right-heart
catheterization with measure of pressure in right heart cham-
bers, pulmonary branches and finally selective pulmonary
artery branches angiographies.

Conventionally, treatment of this condition was surgical with
ASD closure and pulmonary artery branch plasty. Currently,
balloons dilatation with stent placement has revolutionized
management of pulmonary stenosis especially those involving
branches. Pulmonary artery stenosis can complicate the course
of many congenital heart diseases. Percutaneous treatment can be
performed as a surrogate or adjunct to surgery and it is considered
as standard of care for proximal stenosis. For distal stenosis, it
allows treatment of lesions inaccessible to the surgeon, often
in addition to repair surgery of right ventricular outflow tract.
Angioplasty of the pulmonary arteries has evolved considerably
since its introduction in the early 1980s. High pressure bal-
loons usually are 2 to 4 times larger than the diameter of the
stenosis are used. Stents used are still currently most often not
premounted and have the advantage of being expandable to a
diameter sufficiently close to vessel size in adulthood. This type
of stent was successfully used in our patient and allowed rest-
oration of pulmonary vasculature by removing the peripheral
pulmonary stenosis. The success of pulmonary dilatation author-
ized percutaneous closure of the ASD, which was performed
successfully one year later by prosthesis. Percutaneous closure is
currently the standard treatment for ostium secundum ASD
with adequate rims and diameter less than 38 mm with a success
rate close to 100% and lower morbidity compared to surgery.

Our case is very rare and to our knowledge, no similar cases
have been reported. It proves feasibility and reliability of
percutaneous treatment for such a case. The sequence of the
lesion treatment is dictated by lesions complexity whose failure
can shift the case to surgery. This is the reason why we waited
obtaining a satisfactory and stable result on pulmonary artery
stenosis before treating ASD.

Conclusion
Pulmonary stenosis can be associated with ASD limiting
pulmonary hyper-flow. In our case, this stenosis was tight and
sat on the origin of the right branch, which resulted in reducing
significantly blood flow to the ipsilateral lung. Therefore, ASD-
related pulmonary hyperflow was directed to the left lung
field, explaining the radiological aspect particularly unilat-
eral hypervascularity. Careful chest X-ray analysis can allow
suspicion of pulmonary artery branch stenosis. Confirmation
can be made by Doppler echocardiography and, if necessary,
by further examination allowing treatment adaptation.
Management of this association benefited from interventional
techniques progress allowing successfully treatment with stable
long-term outcome. Indeed, with a follow-up of four years, the
atrial septum was tight and there was no residual pulmonary
stenosis with a normalized RV function.

Consent
Written informed consent for publication of the clinical details
and images was obtained from the patient’s father.

Data availability
All data underlying the results are available as part of the article
and no additional source data are required.

Grant information
The author(s) declared that no grants were involved in supporting
this work.

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Open Peer Review

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I congratulate authors for the successful management of this case. This case report is well written still I have some comments for the same.

1. It requires editing by someone who is proficient in English.

2. Can authors describe what would be the probable reason for narrowing of right pulmonary artery ostia? what was the position of the arch of aorta, right or left?

3. Looking at follow up image the stent seems to be protruding into the main pulmonary artery. Does there are any signs of hemolysis?

4. Can authors explain about the approach to the patients with ostial right pulmonary artery stenosis and advantage vs disadvantages of surgery vs stent?

5. I also have doubt of considering the lesion as peripheral branch stenosis of pulmonary artery. I think better word would be right pulmonary artery stenosis or RPA ostial stenosis.

6. Why authors have decided to do two stage approach? why not single stage approach?

Is the background of the case’s history and progression described in sufficient detail?  
Yes

Are enough details provided of any physical examination and diagnostic tests, treatment given and outcomes?  
Partly

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?
Yes

**Is the case presented with sufficient detail to be useful for other practitioners?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Pediatric and Adult Cardiac Surgery

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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P. Syamasundar Rao
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The paper reports a rare co-occurrence of atrial septal defect and branch pulmonary artery stenosis and is worthy of eventual indexing.

The expression and syntax should be improved by editing, by someone who is proficient in English.

The assertion that "no similar case has been reported" should be removed. In the past, the association of atrial septal defect and branch pulmonary artery stenosis was reported (Lloyd et al., 1994\(^1\) and Rao et al., 1995\(^2\)), although the subject of these papers did not allow for detailed description.

**References**


**Is the background of the case's history and progression described in sufficient detail?**
Yes

**Are enough details provided of any physical examination and diagnostic tests, treatment**
given and outcomes?
Yes

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?
Yes

Is the case presented with sufficient detail to be useful for other practitioners?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Congenital heart disease and Interventional Pediatric cardiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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