

Fetal diagnosis of isolated absent pulmonary valve with intact interventricular septum: How to counsel the parents?

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ABSTRACT

Isolated absent pulmonary valve syndrome with an intact ventricular septum (APVS/IVS) is an extremely rare lesion. The prenatal diagnosis was described in a few reports. In the current work, we report a unique fetal case with this rare anomaly. The family counseling for isolated APVS/IVS is a different challenging process than with fetal Fallot type diagnosis. Moreover, 22q11 deletion has never been found as an association. Parents must also be aware of the expected early heart failure in cases with large patent ductus arteriosus and the need for its closure as early as possible.

Keywords: Absent pulmonary valve, counsel the parents, fetal, intact interventricular septum

INTRODUCTION

Absent pulmonary valve syndrome (APVS) is a rare congenital heart disease characterized by a rudimentary, dysplastic pulmonary valve, resulting in significant pulmonary regurgitation with some degree of stenosis. It is associated with aneurysmal dilation of the pulmonary trunk as well as one or both of its branches.^[1] The most common type of APVS is the Fallot like with ductus arteriosus agenesis in most cases. Nevertheless, isolated APVS with an intact ventricular septum (APVS/IVS) is considered a distinct entity. It is a rare disease with few published fetal cases.^[2] The data on the fetal presentation and outcome of APV/IVS are still scarce. Thus, we report a unique fetal case with specific emphasis on the challenge of prenatal family counseling.

CASE REPORT

A primigravida 26-year-old with *in vitro* fertilization resulted in diamniotic-dichorionic twins. She was

referred at 29 weeks of gestation for detailed fetal echocardiography due to obstetric suspicion of abnormal four-chamber view in one of the twins. Transabdominal fetal echocardiographic examination revealed situs solitus, levocardia, concordant atrioventricular, and ventriculoarterial connection with normally related great arteries. A markedly dilated hypertrophied right ventricle (RV) was evident with significant trabeculations and intact interventricular septum [Figure 1]. The pulmonary valve was rudimentary with dilated main pulmonary artery measuring 11.7 mm (Z score: 4.12), and aorta to main pulmonary artery diameter ratio was 1:2.4. There was some dilatation of pulmonary artery branches, especially left pulmonary artery (LPA) was 5.8 mm (Z score: 3.8), and right pulmonary artery (RPA) was 4.7 mm (z score: 2.2), but a patent ductal arch was seen. The rudimentary pulmonary valve was further confirmed on the three-dimensional (3D) fetal echocardiography. On color flow mapping, moderate pulmonary stenosis, and severe pulmonary

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regurgitation [Figure 2a-d]. Doppler tracing of the pulmonary valve showed accelerated flow across the pulmonary annulus (300 cm/s) with a reversal of flow on diastole [Figure 2e]. The Cardiovascular Profile Score was 7/10 points. The other twin had no detected abnormal cardiac findings. The family counseling step was the most challenging part given the rarity of the lesion. We informed the parents about the need to deliver in

a tertiary center and surgery postnatal. Nevertheless, we had to do a significant literature review to perform further counseling.

Follow-up fetal echocardiogram after 4 weeks (at 33 weeks gestation) did not reveal additional findings. At 36 weeks gestation, the main PA diameter was 13.5 mm (Z score: 5.03) and evident absent end-diastolic flow in the umbilical artery was detected. An elective cesarean section was arranged at 37 weeks gestation. The twin with the abnormal heart was a female newborn weighing 2180 g with to and fro murmur on the pulmonary area and normal oxygen saturation. Transthoracic Echocardiography on the day of birth confirmed the antenatal findings with absent pulmonary valve, moderate pulmonary stenosis, and severe regurgitation with normal coronaries anatomy [Figure 3]. The main pulmonary artery diameter was 14.2 mm (z score: 5.08) with LPA 9.51 mm (z score 5.48) and RPA 6.53 mm (z score 3.18). The interventricular septum was intact with mildly depressed right ventricular function and large patent ductus arteriosus (PDA) 5 mm in diameter. The cardiac CT angiogram was performed as a further confirmatory tool [Figure 4]. On the 2nd day of life, the baby was in respiratory distress and was put on

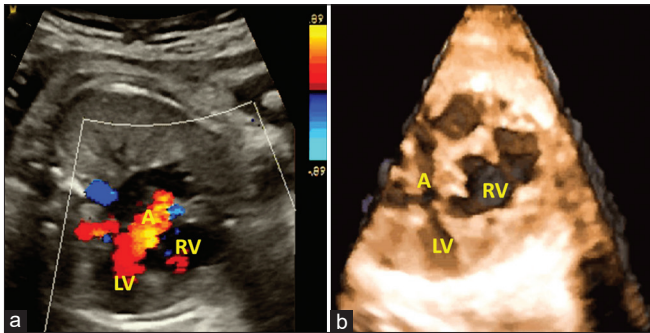


Figure 1: Left ventricle outflow view of fetal echocardiogram (a) Color flow Doppler demonstrating no overriding of the aorta with intact outlet septum (b) three-dimensional dimensional echocardiogram confirming intact interventricular septum. A: Aorta, LV: Left Ventricle, RV: Right Ventricle

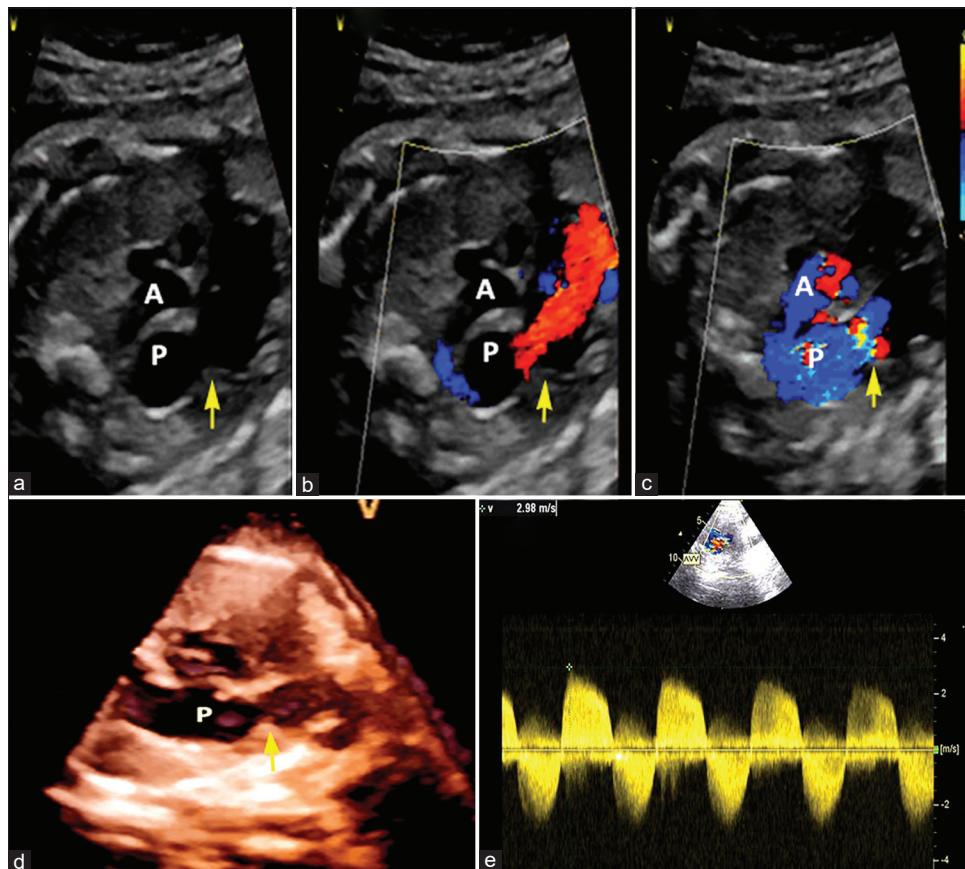


Figure 2: Three vessel view of fetal echocardiogram (a) two-dimensional echocardiogram showing constriction of PA at the pulmonary valve level with rudimentary pulmonary valve, (b) color flow Doppler showing severe pulmonary regurgitation (c) color flow Doppler showing the turbulent flow of pulmonary stenosis (d) three-dimensional echocardiogram showing the absent pulmonary valve (e) Doppler tracing of the to-and-fro flow across pulmonary artery. A: Aorta, P: Pulmonary, Yellow arrow: Constriction at the level of pulmonary annulus with absent pulmonary valve

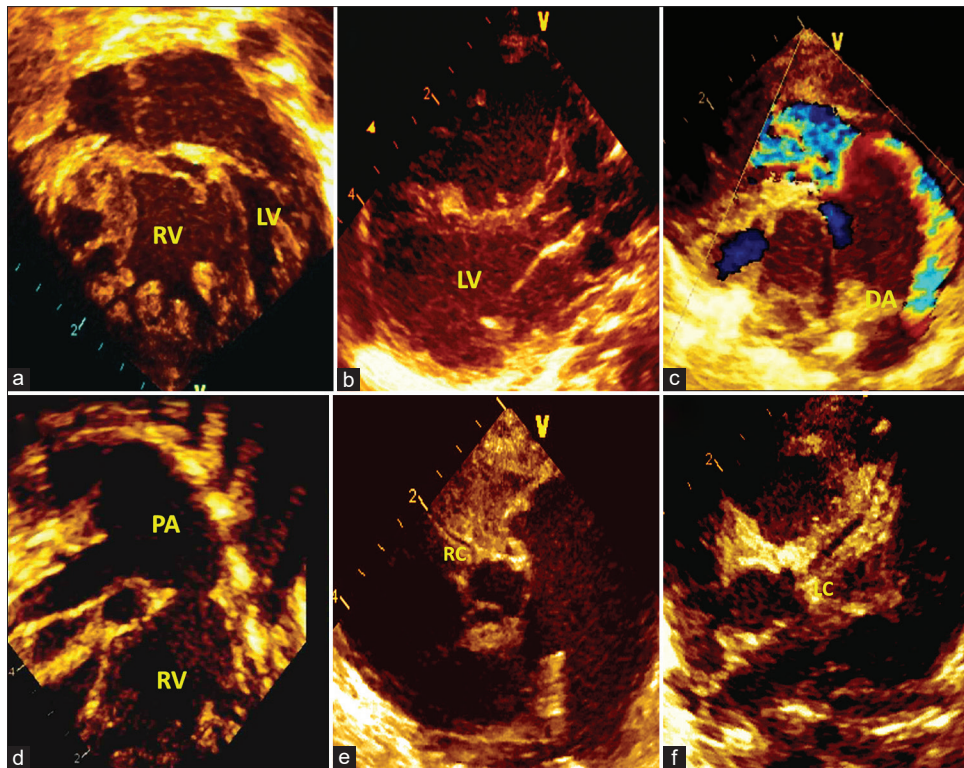


Figure 3: Postnatal echocardiogram showing (a) markedly dilated trabeculated right ventricle; (b) intact interventricular septum; (c) large patent ductus; (d) absent pulmonary valve with pulmonary stenosis and regurgitation, (e) right coronary artery, (f) left coronary artery. LC: Left coronary artery, LV: Left ventricle, DA: Patent ductus arteriosus, PA: Pulmonary Artery, RC: Right coronary artery, RV: Right ventricle

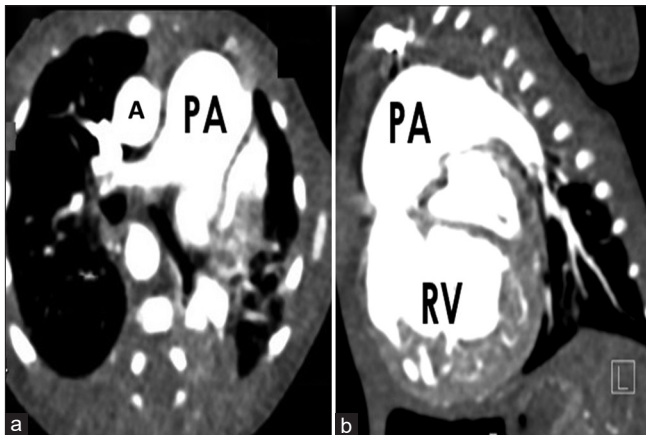


Figure 4: Postnatal cardiac CT angiogram (a) axial CT image demonstrating aneurysmal dilatation main pulmonary artery but with no significant dilatation of the pulmonary branches. (b) Sagittal CT image showing the markedly hypertrophied RV, constriction at the level of the pulmonary annulus, and aneurysmal dilatation of the main pulmonary artery. A: Aorta, CT: Computed tomography, PA: Pulmonary artery, RV: Right ventricle

nasal CPAP and later intubated. She remained intubated for 4 weeks, during which she received diuretics to improve pulmonary overcirculation. By the age of 40 days, after the patient had completed antibiotics for acquired sepsis, the patient underwent surgical closure of the PDA. Our patient had an uneventful recovery and discharged home on low dose furosemide a week later. Karyotyping

for chromosomal disorders and FISH for 22q11 deletions came out negative. After 6 months, RV was regressing in size, and the patient was thriving and stable.

DISCUSSION

APVS is characterized by severely undeveloped pulmonary valve leaflets with a restrictive ring of thickened tissue leading to marked insufficiency with to-and-fro blood flow over the dysplastic valve.^[2,3] Fallot type is considered the most common, yet the isolated APVS is a rare separate entity with different counseling aspects. In the Fallot APVS, marked dilatation of the main pulmonary artery and branches results in significant airway compression in the neonatal period and no associated PDA in most cases. These patients usually require aggressive medical and surgical therapy during infancy.^[4] On the other hand, in isolated APV, the main pulmonary artery is dilated, but the branches are not dilated to the massive size that is frequently encountered in the Fallot type, and the PDA presence is a common finding.

On counseling, it is mandatory to discuss with the parents that the clinical presentation of isolated type is dependent mostly on the PDA size. Respiratory distress and heart failure immediately after birth are expected clinical findings in the presence of a large PDA.^[5] This

could be attributed to the increased RV stroke volume associated with the pulmonary regurgitation as well as extensive left-to-right shunt through the PDA.^[6] Consequently, the RV end-diastolic pressure increases and RV dysfunction eventually occurs.^[7] On the other hand, with small or absent PDA, cases could manifest later in childhood, adulthood, and even the elderly. In childhood, it was reported that exertional chest pain and fatigue could be the initial complaint.^[8] It was also diagnosed in a 79-year-old female complaining of exertional dyspnea.^[9]

Another rare form of APVS/IVS was described with tricuspid atresia or severe stenosis. In the type as mentioned earlier, the newborn is cyanotic with markedly dysplastic RV and eventually proceeds to the univentricular pathway.^[10]

Prenatal diagnosis of isolated APVS/IVS is feasible using conventional fetal echocardiography since 1995.^[11] Moreover, it was suggested that APVS could be diagnosed in the first trimester if typical to-and-fro blood flow is detected within DA, umbilical artery or middle cerebral artery.^[12] Unlike the Fallot type, in APVS/IVS with a sizable ductal arch, like our patient, markedly dilated trabeculated RV is a key feature for diagnosis. Besides, 3D fetal echocardiography can be a confirmatory method to delineate the restrictive ring at the pulmonary valve level as in our patient [Figure 2d].

After diagnosis, follow-up using fetal echocardiography is mandatory as the dilated hypertrophied RV would fail due to the significant volume as well as pressure overload. Thus, hydrops development at any time throughout gestation is possible and was reported before in literature in 5 fetuses.^[3,13]

To the best of our knowledge, about 30 antenatal diagnosed cases with isolated APVS/IVS were described in the literature [Table 1]. Unlike the APVS Fallot category, none of the reported isolated APVS/IVS patients, including our case, were associated with 22q11 deletion. Trisomy 18 was documented previously in two cases and 18 P deletion in one fetus.^[3,14] Regarding outcome, after excluding pregnancy termination (10 cases) and unknown fate (5 cases), we found that 31.2% ($n = 5$) of fetuses, with APV/IVS isolated type, had intrauterine or neonatal deaths. Meanwhile, about 68.8% ($n = 11$) of fetuses, including the current case, survived the neonatal period. Hence, we can inform the family about the expected prognosis that more than two-thirds of the fetuses survive the neonatal period and the rarity of associated disorders with such uncommon cardiac lesion.

Surgical ligation of the large PDA is the mainstay of treatment to alleviate respiratory distress and cardiac failure.^[22] In our patient, marked clinical improvement was evident after PDA ligation. Nevertheless, pulmonary homograft may be needed later to decrease right ventricular

Table 1: Antenatally diagnosed cases with isolated absent pulmonary valve

Author/years	n	GA (weeks)	Association	Chromosomes	Fate
Chenoweth-Mitchell <i>et al.</i> , 1995 ^[10]	1	23	Polyhydramnios	Unknown	Neonatal death
Yeager <i>et al.</i> , 2002 ^[7]	2	Unknown	None	Unknown	Unknown
Volpe <i>et al.</i> , 2002 ^[14]	3	30	Mild hydronephrosis	Normal	Alive after complete repair after neonatal period till 28 m FU
Razavi <i>et al.</i> , 2003 ^[2]	2	21	Megacisterna magna	18 P deletion	TOP
		19	None	Normal	TOP
		26	None	Unknown	Neonatal death (no surgery)
		19	None	Normal	TOP
Galindo <i>et al.</i> , 2006 ^[15]	1	20	None	Normal	TOP
Hajdú <i>et al.</i> , 2007 ^[16]	3	20	None	Unknown	TOP
		22	None	Normal	TOP
		18	None	Normal	TOP
Favilli <i>et al.</i> , 2008 ^[17]	1	25	Tiny apical VSD	Normal	Alive till 3 years FU on diuretics after PDA ligation, VSD closed spontaneously
Wertaschnigg <i>et al.</i> , 2013 ^[18]	1	20	None	Normal	Alive with no surgery
Grewal <i>et al.</i> , 2014 ^[19]	1	18	None	Normal	Alive on medical management
Szwast <i>et al.</i> , 2014 ^[13]	1	Unknown	LV noncompaction, hydrops	Normal	PDA ligation+RVOT reconstruction+monocusp valve at 15 days, alive till 3 years FU
Axt-Fliedner <i>et al.</i> , 2017 ^[3]	12	Mean 21	4 had hydrops	2 trisomy 18 5 normal 5 unknown	3 lost FU, 2 TOP, 3 IUFD, 4 live birth
Cadiz <i>et al.</i> , 2018 ^[20]	1	24	Dilated ascending aorta	Normal	PDA ligation, reduction and plication of MPA, LPA, ascending aorta
Zhou <i>et al.</i> , 2019 ^[21]	1	20	None	Unknown	TOP
Current report	1	29	None	Normal	Alive till 9 months FU on low dose diuretic after PDA ligation

FU: Follow up, GA: Gestational age, IUFD: Intrauterine fetal death, LV: Left ventricle, n: Number of fetuses, PDA: Patent ductus arteriosus, RVOT: Right ventricular outflow tract, TOP: Termination of pregnancy, VSD: Ventricular septal defect, MPA: Main pulmonary artery, LPA: Left pulmonary artery

volume overload; however, it could be postponed for years without clinical deterioration.^[22] To conclude, family counseling of isolated APVS/IVS is different from the Fallot type, and 22q11 deletions are never found in association. In the case of isolated APV with large PDA, parents must be informed about the expected early heart failure with PDA closure required as early as possible.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient's parents have given their consent for images and other clinical information to be reported in the journal. The patient's parents understand that his names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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