

Mitral regurgitation and pulmonary hypertension accompanied by premature restriction of the foramen ovale are associated with the ductus arteriosus

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June 4, 2023

Abstract

Two cases of severe mitral regurgitation and pulmonary hypertension immediately after birth are presented. Initial echocardiographic findings showed a thick atrial septum rather than a normal flap septum. The patients were tentatively diagnosed with premature restriction of the foramen ovale and congenital mitral regurgitation. Subsequently, the mitral regurgitation resolved over time with improvement of pulmonary hypertension. The postnatal ductus arteriosus closure process was considered to be the cause of the mitral regurgitation and pulmonary hypertension.

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Abstract

Two cases of severe mitral regurgitation and pulmonary hypertension immediately after birth are presented. Initial echocardiographic findings showed a thick atrial septum rather than a normal flap septum. The patients were tentatively diagnosed with premature restriction of the foramen ovale and congenital mitral regurgitation. Subsequently, the mitral regurgitation resolved over time with improvement of pulmonary hypertension. The postnatal ductus arteriosus closure process was considered to be the cause of the mitral regurgitation and pulmonary hypertension.

Introduction

It has been noted that some neonates with premature restriction of the foramen ovale (PRFO) have severe pulmonary hypertension (PH)⁽¹⁾, and PRFO may be associated with hypoplastic left heart syndrome⁽²⁾. On the other hand, the role of the ductus arteriosus (DA) in the fetal and postnatal circulations with PRFO patients is unknown. PRFO with normal heart structure can lead to right ventricular volume loading, severe tricuspid regurgitation, and PH, which may result in congestive heart failure, hydrops, or even fetal death⁽³⁾. In the present cases, hemodynamic changes in mitral regurgitation (MR) and PH during the clinical course of the postnatal period were associated with hemodynamic changes in the DA.

Case report

Case1

This male patient was born of a normal vaginal delivery at a gestational age of 40 weeks 4 days at another hospital, and his birth weight was 3708g with Apgar scores of 9 at one minute and 10 at five minutes.

A cardiac murmur was noted 1 day after birth, and a patent DA was diagnosed. The patient was discharged from the hospital 4 days after birth. At the outpatient clinic, the echocardiogram showed severe MR, severe tricuspid regurgitation (TR), and severe PH (Figure 1), and the patient was transferred to our hospital 8 days after birth. The atrial septum was very thick, and interatrial communication was very narrow with bidirectional shunt (Figure 2). There was a very small patent DA, and bidirectional shunt was confirmed (Figure 3). A tentative diagnosis of PRFO was made based on the findings. Oxygen inhalation, continuous intravenous administration of milrinone (0.5 $\mu\text{g}/\text{kg}/\text{min}$), and a diuretic venous infusion were started and reductions to mild TR, and moderate MR, along with improvement of PH, were observed as acute effects 9 days after birth. However, MR and PH worsened again 10 days after birth, and diuretic doses were increased. MR and PH improved gradually, DA closure was confirmed 13 days after birth, and the patient was discharged 23 days after birth.

Case2

This male patient was born in a suction delivery at a gestational age of 38 weeks 1 day at another hospital. His birth weight was 2678g, and the Apgar scores were 8 in one minute and 9 at five minutes. Respiratory distress developed gradually, and oxygen inhalation was started. Respiratory distress developed, and the patient was transferred to another hospital 2 days after birth. The echocardiogram findings showed severe MR and severe PH. Furthermore, mechanical ventilation was initiated for progressive respiratory distress. The patient was then transferred to our hospital for treatment. The echocardiogram showed that the degree of MR shifted from mild to severe according to the degree of PH, which changed from mild to severe (Figure 4). The atrial septum was thick, and interatrial communication was through a very tiny left-to-right shunt (Figure 5). On the other hand, the right-to-left shunt due to DA increased with exacerbation of PH (Figure 6). Continuous intravenous injection of milrinone (0.5 $\mu\text{g}/\text{kg}/\text{min}$) and an intravenous diuretic were started. Decrease of MR to a mild level, improved PH, and DA closure were confirmed as acute effect 4 days after birth. However, a PH crisis due to infection occurred 7 days after birth. Eight days after birth, recanalization of the DA and severe deterioration of MR were confirmed, and a DA ligation procedure was performed. Subsequently, surgery was performed for gastric perforation, which had occurred as a complication. Although long time was needed for the MR and PH to improve, the patient was discharged 83days after birth.

Discussion

Premature closure or restriction of the foramen ovale is a rare but known entity. Foramen ovale diameter <2 mm, Doppler velocity >120 cm/s, diameter <3 mm with a Doppler velocity measured gradient >5 mmHg have all been used by various authors to describe this entity⁽⁴⁾. PRFO could result in pathological conditions associated with right heart volume overload or left heart volume underload, including right ventricular failure, fetal hydrops, supraventricular tachycardia, and left heart obstructive defects. On the other hand, PRFO can also result from increased left atrial pressure due to cardiac disease with left ventricular inflow obstruction, as with aortic stenosis, mitral stenosis, or ventricular diastolic dysfunction. PRFO in hearts with normal structure can lead to right ventricular volume loading, severe tricuspid regurgitation, and PH, which may result in congestive heart failure, hydrops or even fetal death. It has been reported that whether and when fetal death occurs is influenced by the timing of PRFO. However, it is unclear when PRFO develops into hydrops or even fetal death, and other factors may be involved.

The present patients were born at full term without hydrops. The echocardiogram findings immediately after birth showed a very thick atrial septum and very small interatrial shunt and unmeasurable foramen ovale diameter. The reason for no hydrops may be the presence of a very small foramen ovale, which provided decompression in the fetal period. Initially, interatrial communication was a bidirectional shunt in case 1 and a left-to-right shunt in case 2. On the other hand, left ventricular function was poor in both cases, probably because of decreased coronary perfusion due to low cardiac output associated with left heart volume underload caused by PRFO and MR due to mitral valve deformity subsequent to left ventricular compression as a result of right ventricular dilation caused by PRFO. Interatrial communication disappeared with improvement of PH and cardiac function.

Regarding the DA, which plays an important role in the fetal circulation, in the initial period after birth, there was a small DA with a bidirectional shunt in case 1, and the right-to-left shunt of the DA increased with exacerbation of PH in case 2. PRFO inevitably causes an increase in pulmonary blood flow due to additional blood flow from the placenta that should enter the left ventricle through the foramen ovale if the foramen ovale is patent. Furthermore, oxygen content in the pulmonary artery due to more oxygenated blood from the placenta may synergistically contribute to an increase in pulmonary flow by lowering pulmonary artery resistance⁽⁵⁾. Therefore, we consider that prenatal blood flow through the DA may be increased, so that the postnatal closing process of the DA may have more impact on the clinical course of PRFO. In case 1, the small DA with a bidirectional shunt closed with improvements of MR, PH, and left heart function. In case 2, the small DA had dilated when the DA provided decompression as a right-to-left shunt compared to the left-to-right shunt of the DA. Although the DA closed temporarily due to improvement of PH, recanalization of the DA occurred with exacerbation of PH.

Hemodynamic changes in MR and PH may be related to hemodynamic changes in the DA (Figure 7). The closing process of the DA increases preload of blood flow to the left ventricle and results in volume overload of the left ventricle, subsequently inducing MR. Furthermore, mitral valve deformity caused by right ventricular dilation with PRFO adds to enhancement of MR. As a result, a vicious cycle in which MR exacerbates PH occurs.

In the present cases, acute effect was observed after initial medical treatment, however, but it took some time for MR and PH to improve. The mechanism is thought to involve insufficient left ventricular training in reducing left ventricular preload by PRFO, PH with increasing of pulmonary blood flow due to PRFO, and MR caused by mitral valve deformity due to right ventricular dilation with PRFO. Mild improvement of left ventricular function was observed as the acute effect, but it appeared to take some time for left ventricular function to adapt.

In the hemodynamics of PRFO, the mechanism of MR/PH is thought to involve the process of DA closure, which is necessary for postnatal decompression of PH. In the present cases, the very narrow interatrial communication of the PRFO and the large DA provided decompression of the right ventricular volume loading and PH in fetal period, and the postnatal process of DA closure may have been associated with MR and PH pathology.

Conclusion

MR and PH accompanied by PRFO appear to be associated with the DA.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced, or appear to influence, the work reported in this paper.

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