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Review Article

Diagnostic and Treatment Features for Pregnancy in a Case of Complex Maternal Cyanotic Cardiac Malformation-Review of Literature and Our Experience

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Received: April 15, 2020, 2020; **Published:** May 11, 2020

Abstract

Pregnancy in women with cyanotic heart disease is considered to be a high risk for both mother and fetus, as there are some possible complications that can occur during and after the pregnancy that can affect the mother, fetus or both. We present the effects of pregnancy on maternal cardiac function and the effects of heart disease on the fetus. We present the result of a successful case for both mother and baby, as well as the effects of pregnancy on maternal cardiac function and hemodynamics. In this case, the patient presented with postpartum pulmonary vascular disease, cyanosis and heart failure. Regarding the fetal development, the child was born prematurely at 32 weeks, by caesarean section due to the modification of the Doppler parameters, a live birth, with a Mass of 1100 grams, grade l tricuspid regurgitation and intrauterine growth delay due to hypoxia.

Keywords: *Atrial Septal Defect with Bidirectional Shunt; Maternal Common Arterial Trunk; Valve Hypoplasia and Maternal Pulmonary Artery*

Introduction

This article gives detail on a rare case single congenital ventricle cardiac malformation. A single ventricle or a uni-ventricular heart is a complex congenital heart defect with anatomical features that cannot be subjected to ventricular surgical repair. Deformations include: ventricular hypoplasia, atrioventricular valve atresia, ventricle with two ejection channels with a distant ventricular septal defect, or atrioventricular canal. These are all rare disorders affecting one of the ventricles. The ventricle may be smaller, underdeveloped or a valve may be missing. The following forms of congenital heart malformation involving the single congenital ventricle have been described:

1. Hypoplastic left heart syndrome (HLHS). In the case of hypoplastic left heart syndrome (HLHS), the left side of the heart-including the aorta, aortic valve, left ventricle and mitral valve-is underdeveloped. In HLHS, the blood that returns from the lungs must circulate through an opening in the inter-atrial septum (atrial septal defect). The right ventricle pumps blood into the pulmonary artery and the blood reaches the aorta through a ductus arteriosus. Until an operation is performed, the duct is kept open by intravenous medication. These operations are complex and must be adapted to each case.

2. Pulmonary atresia/Ventricular septum intact - pulmonary valve does not exist.

3. Tricuspid atresia: There is no tricuspid valve in the heart. Thus blood cannot circulate from the body into the heart normally. Blood is not properly oxygenated, so it does not complete the normal circuit of the body - heart chambers - lungs - the heart organ [12].

Cardiac surgery improves fertility and reduces the maternal and fetal risk in pregnancy for women with congenital heart disease. As a result, after performing restorative cardiac surgery, women who have intentions of baring children are presented for symbiotic consultations between Obstetrics and Cardiology consultants. In a report by the European Society of Cardiology, congenital heart disease was the most widespread form of structural heart disease (66%) affecting the prognosis of pregnancy worldwide. Congenital heart disease remains an important cause of maternal mortality and morbidity during pregnancy. In a report of maternal deaths from 2000 to 2002 in the United Kingdom, heart disease was the second most common cause of maternal death, with congenital heart disease accounting for 20% of cardiac deaths. Pregnant women with congenital heart disease are at higher risk than pregnant women without this pathology, but the risk is not cumulative with each pregnancy, so if they survive the first pregnancy, the risk is the same as the next pregnancy. Studies are limited in terms of risk stratification in the future for this group of pregnant women, so new studies are needed [7].

Discussion

There are 2 questions to ask when a woman with complex cyanotic heart disease becomes pregnant: (i) What is the effect of pregnancy on heart disease? (ii) What is the effect of heart disease on pregnancy?

Cardiovascular changes in the pregnancy of patients with congenital cardiac disease

Hemodynamic changes: In patients whose fraction of cardiac ejection is limited by myocardial dysfunction or valvular injury (e.g. mitral stenosis), volume overload is poorly tolerable and may lead to heart failure, this is important because major fluctuations in cardiac blood volume occur during labor and normal birth. Cardiac ejection increases progressively from the first stage of labor, sometimes reaching up to 50% of the initial value by the end of the second stage of labor. The potential for dramatic volume change is intensified at the time of birth in response to physiological transfusion, which occurs when the infant is birthed which takes away uterine compression in the cavity, this then allows re-perfusion in the uterine circulation. Postpartum hemorrhage may exacerbate these changes in volume, which are poorly tolerated by women whose cardiac ejection is largely dependent on the pre-pregnancy status.

The risk of thromboembolism: Women with pre-existing heart disease have an increased risk of thromboembolism during pregnancy. Pregnancy is associated with an increased risk of thromboembolism due to the blood stasis in the veins of the lower limbs resulting from the compression of the vena cava by the pregnant uterus and also due to a hypercoagulable state caused by growth factor. This together with other minor things like Vitamin K-dependent coagulation and a reduction of free S proteins. Conditions in this minor category may include severe mitral stenosis, symptomatic severe aortic stenosis, bicuspid aortic valve with aorta diameter > 50 mm, Marfan syndrome with a dilated aorta > 45 mm, severe ventricular systemic systolic dysfunction (left ventricular ejection fraction < 30% (e.g. resting systolic pressure > 25 mmHg at rest or > 30 mmHg with exercise), severe coarctation and significant pulmonary arterial hypertension for any cause (i.e. systolic pulmonary artery pressure > 25 mmHg at rest or > 30 mmHg with exercise) [4].

Individual risk factors: The following risks and predictors for maternal or fetal complications have been identified in women with congenital heart disease during pregnancy:

- Pulmonary hypertension (pulmonary vascular disease)
- Maternal cyanosis
- NYHA Class II

- History of arrhythmia
- Maternal anticoagulant.

Pulmonary hypertension: The most serious risk for the mother is pulmonary hypertension, especially Eisenmenger's syndrome, which also includes the risk of maternal cyanosis. Pulmonary hypertension limits adequate adaptive responses to circulatory changes in pregnancy and gas changes during labor and postpartum. Women with Eisenmenger syndrome may develop hypoxemia with potentially lethal potential during pregnancy or postpartum. Maternal mortality in women with Eisenmenger syndrome is 50% [11]. In addition to significant fetal morbidity and mortality, patients with Eisenmenger weakly tolerate the hemodynamic changes associated with pregnancy and birth and are especially susceptible to complications such as preeclampsia and postpartum hemorrhage. Premature birth and IUGR occur in at least 50% of cases, only 15 - 25% of pregnancies progressing to term. Most maternal deaths occur during birth or in the first week postpartum. The decrease in systemic vascular resistance during pregnancy increases the right-left shunt through a nonrestrictive ventricular septal defect. A sudden decrease in systemic resistance can cause intense cyanosis, and a sudden increase in resistance with a decrease during labor may suddenly decrease cardiac output and cause fatal syncope. Women with Eisenmenger syndrome should be advised to avoid pregnancy due to high maternal mortality, appreciable fetal risk and increased risk of thromboembolism. When pregnancy occurs and pregnancy is denied, heparin is recommended as early as 20 weeks by some authors [1,14].

Cyanosis: Arterial oxygen saturation before pregnancy is one of the most important predictors of fetal and maternal prognosis. Arterial oxygen saturation above 80% reduces this risk. A problem associated with patients with congenital cyanotic congenital disease is secondary erythrocytosis.

Phlebotomy is not indicated, except for women with hematocrit ≥ 65% and for symptoms of hyperviscosity, such as headache, loss of concentration, fatigue and myalgia. Symptoms of hyperviscosity are often particularly difficult compared to symptomatic iron deficiency anemia, because absolute hematocrit is often very high and anemia is "relative" to the cyanotic patient. Significant relative anemia is not well tolerated and may manifest as hypervolemia in space 3 [4,13].

Maternal class of heart failure: Maternal morbidity and mortality varies directly with the NYHA functional classification.

Natriuretic peptide levels: An increase in NT-proBNP level (> 128 pg/ml) at 20 weeks of gestation may be an independent risk factor for cardiovascular events during pregnancy in women with congenital heart disease. Increased levels of NT-proBNP were found in all eight women who developed adverse cardiac events (defined as arrhythmias requiring treatment, stroke, cardiac arrest or cardiac death, pulmonary edema, decreased NYHA function class with at least two classes for urgent invasive cardiac procedures during pregnancy or within six months postpartum). High BNP level preceded cardiac complication in four women. One third of women with BNP > 100 pg/mL had a heart complication. Some experts recommend achieving the initial levels and dynamics of BNP during pregnancy in women with congenital heart disease considered to be at risk of developing heart failure [3,4].

Fetal risk

A score for the assessment of fetal risk in pregnant women with maternal congenital heart disease has not been established. A study comprising 1321 pregnant women with congenital heart disease or ischemic heart disease (66% with congenital heart disease) was found to have strong associations between WHO's proposed classification and the risk of preterm birth and low birth weight of the infants.

Maternal cyanosis: Women with cyanotic congenital heart disease, but no pulmonary hypertension, may have a relatively low maternal risk, although the fetal risk is high. Maternal cyanosis compromises the growth of the fetus and increases the risk of prematurity and loss of the fetus. In a study of 96 pregnant women with cyanotic heart disease, the following were found:

- Only 43% of pregnancies resulted in the birth of a newborn alive, 37% of these were premature
- The rate of miscarriage increased directly proportional to maternal hypoxemia
- The average long-term birth weight of infants was 2575 grams, compared to a normal birth weight of 3500 grams.

Even when pre-gestational cyanosis is mild, the incidence of fetal death is not insignificant, as right-left vascular shunts tend to increase in size during pregnancy in response to decreased systemic vascular resistance. Monitoring of the fetus should begin as soon as identified there is an increased risk of fetal death and delivering to birth will be considered based on perinatal benefit if the test results are abnormal. This is generally between 26 and 32 weeks of gestation, depending on patient-specific factors [2,3].

Pregnancy after surgical treatment of a functional ventricle

The Fontan surgery, The Fontan procedure involves redirecting blood flow from the lower body to the lungs the inferior vena cava (IVC) is disconnected from the heart and routed directly to the pulmonary artery. Usually a large tube called a "conduit" is added to make the connection. Often, a small hole or "fenestration" is created between the Fontan conduit and the right atrium. This lets some still blood to flow directly back to the heart and acts as a "pop-off" valve as the lungs get used to the extra flow from the lower part of the body. This hole can be closed later with a cardiac catheterization procedure.

Furthermore, the cardiac index in these patients can be increased up to 2 times over the baseline by isotonic exercises. The implication of these hemodynamic observations is that women who have undergone Fontan surgery and who have satisfactory systemic ventricular function and normal sinus rhythm may have adequate hemodynamic reserve to adapt to the physiological changes that occur during pregnancy. However, Patients who became pregnant after performing Fontan surgery had increased rates of miscarriage and preterm birth. This suggested that changes in the placental vascular bed following Fontan interventions where not well tolerated by the fetus. In a study conducted in the USA, which included 33 pregnant women who had undergone the Fontan operation before getting pregnant, 15 cases of live births were obtained, 13 spontaneous abortions and 5 abortions on demand. The maternal condition was not influenced in these cases. The specialized literature described in these cases the possibility of the following complications: maternal arrhythmias in 1 case, worsening of heart failure in 4 cases, premature birth in 7 cases, congenital fetal heart malformation in 1 case [5,6,10].

Pregnancy in women with cardiac malformation involving the single ventricle

Pregnancy in women with cardiac malformation involving the single ventricle, not surgically corrected, is very rare and so far no studies involving a statistically significant batch have been performed. In this article we report 1 case of a pregnant woman with a complex congenital heart malformation of a single ventricle, who did not benefit from surgical treatment in childhood, bust still managed to give birth to a new born baby at 32 weeks without major maternal complications during pregnancy but with significant hemodynamic changes in the postpartum period. In most cases, the ventricular compartment has morphological characteristics of the left ventricle and incorporates at its base a rudimentary output structure that gives rise to the aorta, while the pulmonary trunk comes from the main ventricular compartment. Patients that reach adulthood, without having undergone surgical treatment to repair the heart defect, either have the anatomy modified at this level or these defects were not considered to be repairable in childhood. Patients that reach adulthood either have pulmonary stenosis or pulmonary vascular disease, but allow pulmonary blood flow, but not excessively. There are few case reports of pregnancy with single maternal congenital ventricle and pulmonary stenosis. There are several reports of successful pregnancies with cardiac dis-formations of the single ventricle and pulmonary stenosis, but associated pulmonary vascular disease increased the risk of Eisenmenger syndrome [2].

Prenatal care

The frequency of prenatal monitoring depends on the severity of the heart disease:

a) Class I heart failure: Cardiac monitoring 2 times a year

b) Class II heart failure: Cardiac monitoring every quarter of a year

c) Class II-III heart failure: Cardiac monitoring every month

d) Heart failure class III: Cardiac monitoring 2 times a month

e) Class V heart failure: Pregnancy is contraindicated. If pregnancy is achieved, then monitoring is done for heart failure class III.

Pulmonary edema and marked peripheral edema must be differentiated from normal physiological edema of pregnancy. The peripheral edema commonly observed during pregnancy does not involve excessive risks and is due to an increase in the amount of sodium and water and the compression of the inferior vena cava by the pregnant uterus. Diuretics are not indicated and sodium restriction is not useful in physiological edema due to pregnancy [1,13].

The administration of antepartum oxygen to cyanotic women is debatable. There is little evidence that oxygen is beneficial to the mother and there is no evidence that it has a beneficial effect on a fetus with growth restriction, even though administration of high oxygen levels may increase arterial oxygen saturation. The antepartum administration of oxygen is not recommended [2].

Hemoglobin levels decrease during uncomplicated pregnancy, so low hemoglobin levels are used to identify anemia during pregnancy. Regular administration of iron supplements should be avoided, especially in cyanotic patients. Patients with right-left shunt have erythrocytic anemia due to increased production of erythropoietin caused by hypoxia.

Risk of thromboembolism during pregnancy. Clinical follow-up should include close monitoring of signs and symptoms of venous thromboembolic disease. Hypercoagulability is a particular problem for women at risk of thrombosis related to prosthetic heart valves, atrial fibrillation or previous thromboembolic events. These patients are candidates for anticoagulation. Considerations for choosing an anticoagulant regimen should include fetal adverse effects (e.g. warfarin embryopathy) in the first trimester, risk of bleeding, and risk of prosthetic valve thrombosis.

Evaluation of the fetus - Women with congenital heart disease should benefit from fetal echocardiography at week 19-22 of pregnancy [2].

Management during the birth and the postpartum period

During labor, the pregnant woman must be in a lateral recumbent position to minimize uterine compression of the abdominal aorta and inferior vena cava and thus attenuate the hemodynamic fluctuations associated with uterine contractions.

Continuous monitoring of fetal heart rate is recommended during labor. Reduction of uterine blood flow and oxygen release typically occurs during uterine contractions, but the fetus usually extracts enough oxygen to meet its oxygen needs. Fetal hypoxemia may occur with complications such as abruptio placenta, compression of the heart, maternal hemodynamic instability or restriction of fetal growth.

Oxygen therapy: Oxygen is often given during labor, especially in cyanotic women. However, maternal benefit has not been demonstrated and it is unclear whether and to what extent maternal oxygen uptake increases fetal PaO_2. Pulse oximetry is sufficient to monitor maternal oxygenation [1].

Premature birth is a major concern, especially in cyanotic pregnant women. Pharmacological inhibition of uterine contractions (tocolytic therapy) may involve Indomethacin, Nifedipine, a betaadrenergic agonist or atosiban, an oxytocin receptor antagonist. Potential complications of beta-adrenergic agonist therapy include volume expansion and increased maternal heart rate, which can lead to heart

failure. Nifedipine or Indomethacin are generally preferred agents. Nifedipine may be harmful in patients with significant aortic stenosis or cyanotic congenital heart disease.

Birth through caesarean section. For pregnant women with functionally significant cardiac congenital malformation, regardless of whether or not there was a surgical repair, anticipation and management of labor, birth, are essential to reduce the risk. There is a consensus that cesarean delivery should be reserved for obstetric indications, such as transverse presentation, pelvic presentation, failure to progress, placenta previa, or change in fetal heart rate. The risks of cesarean birth in such women include:

- General anesthesia that presents the risk of hemodynamic instability associated with intubation and anesthetic agent.
- The blood loss is at least twice as high as in the case of vaginal birth.
- Increased risk of postoperative infections and thrombophlebitis [9].

Breastfeeding: Breastfeeding a newborn is tiring and is associated with a low risk of mastitis. As a result, in women with congenital heart disease it is recommended that they feed the baby with bottled breast milk [2].

Our experience

A 23-year-old patient, 16-week pregnant, followed-up by an OB/GYN specialist, with normal tests and ultrasound scans up to that date, with complex congenital heart defect (double outlet left ventricle/single ventricle with double ejection, atrial septal defect with bidirectional shunt, tricuspid valve atresia, hypoplasia of the valve and pulmonary artery, rudimentary right ventricle) neglected therapeutically for 15 years until now, presented to Maternity Hospital for specialized investigation.

After informing the patient about the risks of arrhythmia, cardiorespiratory insufficiency, localized or generalized venous thrombosis, possibility of further heart dysfunction that could mean a progression from acute heart failure to maternal death, and the fetal risks associated with maternal complex cardiac disease, the patient decided to accept the possible consequence and continue with the pregnancy.

At the 32-week, pregnancy was in development, early IUGR, the patient was admitted for the purpose of monitoring and specialized assistance at birth. The ultrasound examination performed at the hospital revealed: DUM = 19.11.2018, chronological age 31weeks+6days, gestational age 28 weeks + 2 days, the length of the cervical channel = 3,31 mm, weight 1092g, Doppler on middle cerebral artery IP = 0,78; IR = 0,81, change of the Doppler examination parameters. CTG performed during the hospitalization revealed reactive routes, without decelerations, uterine contractions absent. Fraxiparine 0.4ml f l/day was administered 48 hour before the CST. The ultrasound examination performed at this time showed inverted Dopplers, Doppler AO IP = 0.68, IR = 0.91. It is decided to terminate the birth by caesarean section in a multidisciplinary team, consisting of cardiologist and gynecologist. The patient gives birth by cesarean section at 32 weeks, a single live newborn, premature, small for gestational age, G = 1100g, with GA = 32 weeks, A = 7/8, with respiratory distress due to prematurity, which is why she is admitted to NNT.

INVOS monitoring (cerebral and somatic) was established, with values within normal limits. In evolution, the newborn has moderately low hemoglobin values in the context of prematurity anemia, inflammatory syndrome present (CRP, procalcitonin, fibrinogen), negative in dynamics, moderately increased serum bilirubin values in the context of prematurity jaundice, normalized in evolution under intermittent phototherapy. Sterile blood cultures at 48 hours and 7 days after birth. The prophylaxis of rickets with iron, folic acid, vitamin C and complete erythropoietin has begun.

At 8 days after the surgery, the general condition changes, with TA 80/50 mmHg, FC = 160 BPM, accentuated dyspnea, cyanosis, SaO_2 = 15 - 25%. It is decided to administer peripheral oxygen with Noradrenaline 0.5 ml in combination with Corlentor 7.5 mg + Furosemid 10 mg, Diurex 2400 mg/12 hours. Further favorable evolution, with the improvement of the general condition.

The patient is discharged at 13 days after the surgery with SaO_2 = 82%, TA = 110/90 mmHg, peripheral cyanosis, physiologically involute uterus, serosanguinolent discharges in small quantity, supple breasts, absent lactation, intestinal transit present for gas and feces, physiological urination, supraaponevrotic hematoma in remission with local ecchymosis at the level of the abdominal wound.

Obtaining a spontaneous pregnancy is rare in women with congenital heart disease. There are currently two main problems that have to do with fertility in women with congenital heart disease: Irregular menstruation and contraception. Ovarian function in women with congenital heart disease is an important concern at present. It is not certain whether ovarian function varies with the type of heart defect and whether surgery to repair the heart defect restores ovarian function. Irregular menstrual cycles in cyanotic women with chronic heart disease are considered to be due to a chronic anovulation condition associated with hypothalamo-pituitary-ovarian axis dysfunction or due to abnormal uterine hemostasis in response to chronic hypoxemia and erythrocytosis. Women with congenital heart disease should receive information about contraception and the potential risks associated with pregnancy. However, women with congenital heart disease often do not know the most appropriate method of contraception or are given incorrect advice and thus reach a pregnancy in this group of patients [15].

When possible, women should receive preconceptional counseling and counseling so that they can make informed decisions about getting a pregnancy, after being clearly explained the risks and effects of both pregnancy on maternal heart disease and the risks of maternal heart disease on the evolution of pregnancy. These women should receive a preconceptional evaluation by a cardiologist with experience in the associated pathology in pregnancy and congenital heart disease. Risk assessment should involve careful assessment of pregnancy-induced changes in the mother and child [15]. The risks associated with pregnancy in women with congenital heart disease affect both mother and fetus. Therefore, both the obstetrician and the cardiologist are responsible for the well-being of the two patients. The focus is on the management of pregnant women with specific congenital cardiac abnormalities, before and after reparative surgery.

We present the result of a pregnancy case obtained spontaneously in a woman with rare congenital heart malformation, the single ventricle with double ejection, who did not benefit from surgical treatment to repair the cardiac defect and which led to pregnancy up to 32 SA.

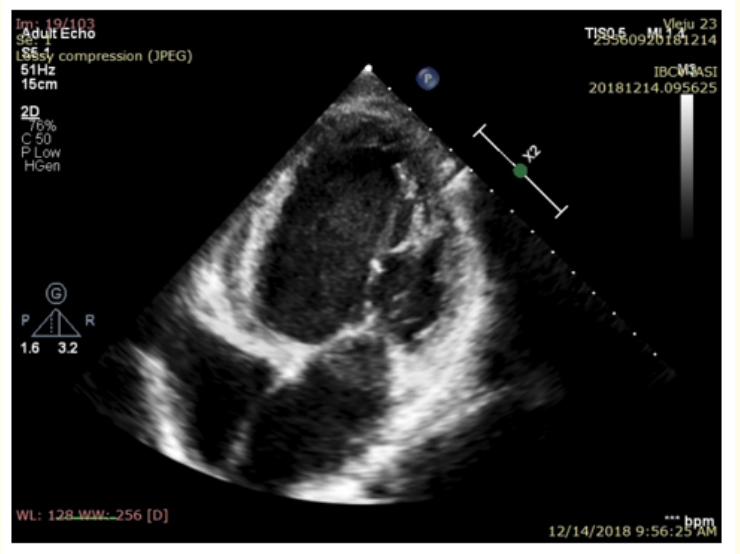

Figure 1: *4-chamber apical section with single ventricle view and atresia of the tricuspid valve, single atrioventricular valve.*

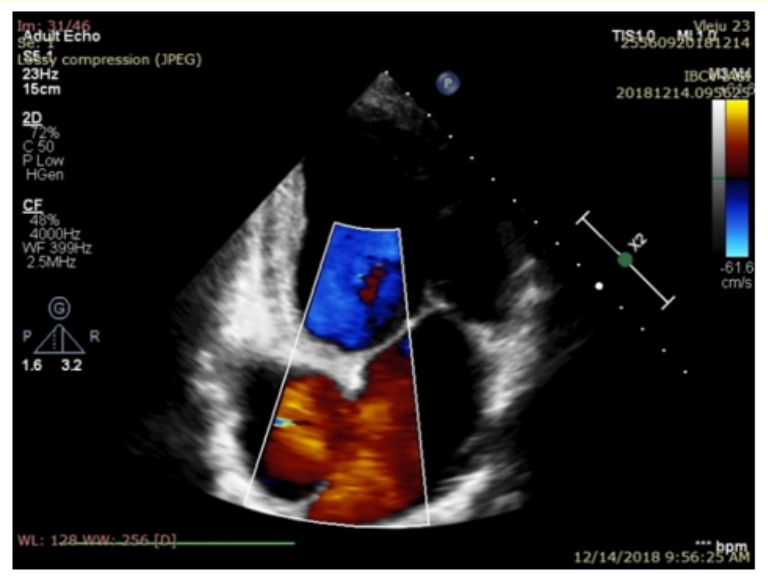

Figure 2: *4-chamber apical section with color Doppler: atrial septal defect with bidirectional shunt.*

We present the result of a successful case for both the mother and the baby and describe the effects of pregnancy on maternal heart function and the effects of maternal heart disease on the fetus. In this case the patient presented with postpartum pulmonary vascular disease, cyanosis and heart failure. Regarding fetal development, in this case, the woman gave birth prematurely at 32 weeks, through caesarean section due to the modification of the Doppler parameters, It was a successful delivery of a new single live birth, with G = 1100 g, A = 7 (1') - 8 (5'), with tricuspid regurgitation grade I, delayed intrauterine growth due to changes in placental vascularity, respiratory distress due to prematurity, anemia and jaundice of prematurity.

Conclusion

One of the best ways to simplify medical management during pregnancy is to perform the indicated cardiac intervention (Open surgery or per-cutaneous) before the time of conception. Successful surgery can improve fertility, allow the mother to better tolerate physiological changes in pregnancy and can eliminate fetal risk due to maternal hypoxemia. Women with congenital heart disease who have indications of surgical treatment are generally advised to perform the intervention before they get pregnant. Cardiac surgery during pregnancy should be avoided. Maternal risks are about the same as in non-pregnant women, but cardiopulmonary bypass during pregnancy presents risks to the fetus [16]. In the present case, the pregnant mother refused surgical treatment and decided to keep the pregnancy.

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Volume 9 Issue 6 June 2020