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Posted Date: July 26th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-687143/v1>

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Cardiac surgery under cardiopulmonary bypass in pregnancy: report of four cases

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Abstract

Background: Open heart surgery during pregnancy is relatively rare at home and abroad, with high risk and high probability of maternal and infant death. How to carry out heart valve replacement under cardiopulmonary bypass (CPB) under the condition of ensuring the safety of mother and child is a focus of attention at home and abroad.

Case introduction: We reported four cases of pregnant women who underwent cardiac surgeries under CPB during pregnancy in our hospital. Three cases had infective endocarditis (IE), who underwent heart valve placement with mechanical mitral valve, and one case with ascending aortic aneurysm underwent Bentall surgery. The operations of four cases were successful, and further follow-up evaluation of the pregnant women and fetus showed no abnormality. Patients' details are available in the following table.

Conclusion: Actively and proactively for heart disease during pregnancy with obvious symptoms. Cardiac valve replacement under CPB will be the first choice, and this may become the primary surgical treatment for symptomatic heart diseases during pregnancy.

Keywords

Heart valve diseases, Cardiac surgical procedure, Cardiopulmonary bypass, Pregnancy, Multidisciplinary team, Perioperative management

Background

The incidence of heart disease in pregnant women is approximately 1% to 4% [1]. Heart disease complicates more than 1% of pregnancies and accounts for 15% of maternal mortality, the leading cause of indirect obstetric deaths [2-3]. Even in the developed countries, maternal mortality has not declined either [2]. Pregnancy may be an important factor in exacerbating undetected heart disease and showing obvious symptoms in pregnant women. Due to the lack of medical awareness, heart

disease in pregnant women is often not detected until the hemodynamic decompensation stage. At this point, cardiac surgical intervention can not be avoided [4]. In principle, cardiac surgical procedure should be avoided during pregnancy, preferably at 6 weeks postpartum. However, when these pregnant women develop obvious symptoms, cardiac surgical procedure during pregnancy is inevitable. Cardiac valve replacement under CPB will be the first choice. Setting up multidisciplinary team (MDT) for management is a crucial step, which is consistently recommended in the guidelines developed by the European Society of Cardiology (ESC). As a countrywide intensive maternal care center in China, our hospital often has such special cases of heart diseases during pregnancy, but only a small number of patients have cardiac surgery under CPB during pregnancy. To provide more clinical experience in treatment, as well as related to preoperative, intraoperative and postoperative points of concern, we reported these four cases, which successfully underwent cardiac surgery under CPB in pregnancy.

Case report

Patient's general information

The four patients were aged between 24 and 34 years old, with a gestational age of 23 to 34 weeks. Three patients had IE with vegetation formation and severe mitral valve regurgitation, which all had bacteria cultured from blood. The patient's characteristics are listed in Table 1.

Table 1 Patient's characteristics

Patient No.	Age(y)	Weeks of gestation during surgery(w)	Type of heart disease	The type of bacteria (Blood culture)
1	34	27	IE(Vegetation formation, mitral valve prolapse, perforation, and SMVR)	Oral streptococcus, Staphylococcus haemolyticus
2	24	23	IE(Vegetation formation, mitral valve prolapse, perforation, and SMVR)	Streptococcus parasanguis
3	29	33	aneurysm of ascending aorta (about 10 cm in diameter), SAVR	-
4	28	34	IE(Vegetation formation, mitral valve prolapse, perforation, and SMVR)	Hemostreptococcus

y Year, w Week, IE Infective endocarditis, SMVR Severe mitral valve regurgitation, SAVR Severe aortic valve regurgitation

Cardiac surgical procedure, intraoperative parameters and postoperative treatment management

All these four patients underwent cardiac surgical procedure under CPB, including three mitral valve replacement (MVR), one Bentall procedure, and two concurrent with cesarean section, and another two continued pregnancy after cardiac surgical procedure. According to the particularity of the patients - pregnancy, close

intraoperative monitoring was performed, such as aortic cross-clamp time, CPB time, CPB minimum temperature and CPB maximum flow, as shown in Table 2. Of course, attention should also be paid to the treatment and management after the procedure, for example, the treatment and monitoring program of the two patients who continued to have pregnancy after cardiac surgical procedure, the selection of anti-infective drugs, the course of anti-infective treatment and so on, which are presented in Table 3.

Table 2 Cardiac surgical procedure and intraoperative parameters

Patient No.	Therapeutic schedule	Cardiac surgical procedure	Aortic cross-clamp time (minutes)	CPB time (minutes)	CPB minimum temperature (°C)	CPB maximum perfusion (ml/min)
1	Cardiac surgery and cesarean section were performed in stages	MVR+TVP	74	126	34.1	3.07
2	Cardiac surgery and cesarean section were performed in stages	MVR+TVP	87	135	34.8	2.91
3	Cardiac surgery was performed at the same time as the cesarean section	Bentall procedure	72	113	31.5	-
4	Cardiac surgery was performed at the same time as the cesarean section	MVR+TVP	76	125	34.1	2.80

CPB Cardiopulmonary bypass, ml Mini Litre, min Minutes, MVR Mitral valve replacement, TVP Tricuspid valvuloplasty

Table 3 Postoperative treatment management

Patient No.	Maintenance treatments	Anti-infective drugs	Duration of anti-infective treatment	Maternal and fetal outcomes
1	atosiban, magnesium sulfate	vancomycin, imipenem	6 weeks after surgery	alive, preterm birth
2	atosiban, magnesium sulfate	vancomycin, meropenem	6 weeks after surgery	alive, term birth
3	-	-	-	alive, preterm birth
4	-	vancomycin, meropenem	6 weeks after surgery	alive, preterm birth

Fetus-neonatal and maternal outcomes

After treatment, all the four patients survived and successfully delivered their fetuses, including three cesarean sections and one vaginal delivery. Mode of delivery and

neonatal outcomes are presented in Table 4.

Table 4 mode of delivery and neonatal outcomes

Patient No.	mode of delivery	neonatal outcomes
1	vaginal delivery	The baby was delivered at 36 weeks gestation and weighed 2,370 g.
2	Cesarean section	The baby was successfully delivered at 40 weeks gestation, weighing 2,350 g.
3	Cesarean section	The fetus weighed 1860 g.
4	Cesarean section	The fetus weighed 2020 g.

g Gram

Discussion

IE is a fatal disease, which is relatively rare in clinical, but with a high mortality and disability rate [5]. Especially in pregnant women, IE has a high incidence of adverse maternal outcomes, as well as infant loss. Treatment and management of pregnancy-related infective endocarditis should be individualized and multidisciplinary, such as whether open heart surgery is needed, staging or concurrent surgery, the effect of CPB on the fetus in staging surgery, the operation sequence of concurrent surgery, and intraoperative monitoring points. Additionally, the type of heart disease, severity, cardiac function, gestational age, the wishes of the patients and their family should also be considered [6]. Currently, the experience of clinicians in the treatment of pregnancy-related IE is still inadequate. Here, we reported four cases with heart disease during pregnancy who both underwent heart surgical procedures, among which two patients underwent concurrent surgery, that is cardiac surgical procedures 2 or 2.5 hours after cesarean section, and another two patients underwent cardiac surgical procedures and then continued their pregnancies. In the four cases, the minimum gestational age was 23 weeks and the maximum was less than 37 weeks. Three patients with IE underwent MVR, and one patient with ascending aortic aneurysm underwent Bentall surgery. All the prosthetic valves replaced in 4 cases were mechanical valves. Cases 1 and 2 underwent staging heart surgical procedures for fetal protection due to their small gestational age. Postoperative progesterone was used to suppress uterine contractions, and the combination of magnesium sulfate and atosiban was used for fetal protection. After follow-up, we learned that the pregnant woman in Case 1 delivered a baby girl naturally at 36 weeks gestation, while another patient delivered a baby boy by cesarean section at 40 weeks gestation. Staged surgery requires more and more complex monitoring and evaluation, including preoperative, intraoperative, and postoperative. For example, surgical indications and timing should be evaluated according to the patient's condition; fetal heart rate (FHR) should be monitored continuously, the duration of CPB should be reduced, and the perfusion flow and pressure of CPB should be improved during the operation; anti-infection therapy should be continued until 6 weeks after operation. Cardiac surgical procedures during pregnancy is extremely risky and the fetal mortality rate is extremely high, up

to 20% or more [7]. Therefore, open heart surgery in pregnant women is usually avoided and ideally delayed until 6 weeks postpartum [8]. However, when pregnant women develop obvious symptoms, early cardiac surgical intervention is the best option, and heart valve replacement is the first choice. For example, in the four cases we reported, three of the patients developed life-threatening symptoms and the other one was a high-risk ascending aortic aneurysm, so we formed a multidisciplinary team, including departments of obstetrics, cardiac surgery, anesthesiology, intensive care, neonatology, and medical services, to discuss the treatment options that would be most beneficial to patients. CPB has a great influence on the fetus, the main influencing factors include the time of CPB heparinization, perfusion fluid temperature, perfusion flow and pressure, maternal temperature and so on. In the case that open heart operation is inevitable for pregnant women, anesthesia management, CPB management, intraoperative fetal monitoring, perioperative management are particularly important [9]. In the two cases reported in our report, with the cooperation of the surgeon, anesthesiologist and nurses in the operating room, the operation time was only about 4 hours, which greatly reduced the time of CPB and kept the perfusion fluid at room temperature of 35 °C to the greatest extent to reduce the adverse outcome of low temperature on the fetus. The perfusion was performed with high flow, high pressure and high hematocrit, and the fetal heart rate was monitored by Doppler ultrasound during the whole operation. Fetal deaths most often occur during the cooling and rewarming phases of CPB [9]. Thus, the risk of fetal death can be greatly reduced by performing the operation at room temperature and controlling the temperature changes during the diversion. In these two patients, the temperature variation during CPB cooling and rewarming was 34.1~36.2 °C in case 1 and 34.8~36.4 °C in case 2. Low molecular weight heparin was used in the early stage of the operation, and warfarin was used until about one week before parturition when the condition of the pregnant women and the fetus was stable, so that the prothrombin international ratio was maintained at 2.0-3.0. Imipenem combined with vancomycin was also given as anti-infective therapy until 6 weeks postoperatively. Of course, the fetus continues to be closely monitored postoperatively. Case 3 was a patient at 33 weeks of pregnancy, diagnosed with ascending aortic aneurysm complicated with severe aortic valve insufficiency. CTA examination indicated that the dilated diameter of ascending aorta was more than 8cm, and her immediate family members, her aunts and uncles, had a history of Marfan syndrome. Cases 3 and 4 both underwent cesarean section and heart valve replacement at the same time, and both mother and fetus survived. CPB has a greater impact on the fetus and the fetal mortality rate is high, ranging from 16 to 33 percent [9]. Therefore, the study of Chandni Patel et al. recommended that cesarean section be performed prior to CPB-MVR to improve fetal outcome [9]. Concurrent cardiac surgery and cesarean section, like cases 3 and 4 in our report, should also consider the increased risk of postpartum bleeding as an important risk factor, which may cause pregnant women to lose their uterus. In the two cases we reported, we used uterine balloon tamponade and bilateral uterine artery ascending branch ligation, combined with intravenous drops of oxytocin to prevent massive

postpartum hemorrhage. Replacement of heart valves 2 or 2.5 hours after cesarean section is also a key step in reducing postpartum bleeding in pregnant women. Reducing the aortic cross-clamp time and CPB time also do help to reduce the risk of cardiac surgical procedures and complications in pregnant women.

Conclusion

We have successfully performed cardiac surgery on four cases of heart disease during pregnancy, two of which were performed in stages and two of which were performed simultaneously, and all four survived, both mother and baby. These four cases shows that surgical intervention should be carried out actively and proactively for heart disease during pregnancy with obvious symptoms.

Abbreviations

CPB: Cardiopulmonary bypass; IE: Infective endocarditis; MDT: Multidisciplinary team; SMVR: Severe mitral valve regurgitation; MVR: Mitral valve replacement; SAVR: Severe aortic valve regurgitation; TVP: Tricuspid valvuloplasty; ml:Mini litre; min: Minutes; g: Gram; y: Year; w:Week

Acknowledgements

The authors gratefully acknowledge the physicians involved in the treatment.

Ethics approval and consent to participate

The ethics committee of The Third Affiliated Hospital of Guangzhou Medical University Hospital approved the study.

Consent for publication

All of the authors agree to the publication of the article.

Availability of data and materials

The data were presented in the main manuscript.

Competing interests

The authors declare that they have no competing interests.

Fund

Doctoral Initiation Project of The Third Affiliated Hospital of Guangzhou Medical University

Authors' contributions

Shenghua Liu participated in the surgeries as the chief surgeon, provided data and revised the manuscript. Youhao You collected the data of patients, analyzed the data and wrote the manuscript. The authors read and approved the final manuscript. Zhaohong Wu participated in the surgeries and in the postoperative management of the patients. Dunjin Chen provided relevant professional support and participated in the whole treatment of patients. Gefei Wang participated in the treatment of patients. Gangdong Chen participated in the surgeries and in the postoperative management of the patients. Youguang Pan participated in the surgeries and in the whole treatment of the patients. Xing Zheng participated in the surgeries. All authors read and approved the final

manuscript.

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