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Case Report

Continuous Cardiac Doppler of the Fetus Guiding an Aortic Valve Replacement in an Eighteen Weeks Pregnant Woman with Active Endocarditis

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Abstract: Two percent of pregnant women experience some type of cardiac pathologic disease. In some cases surgery becomes mandatory to save the mother's life. The maternal mortality rate in pregnant women undergoing open heart procedures is around 2.9% while the fetal mortality rate ranges between 9.5 to 29%. Many papers have advanced measures in order to decrease fetal morbidity and mortality such as tepid to normothermic cardiopulmonary bypass, good oxygenation, high hematocrit, pulsatile flow, alpha stat management, mean arterial pressure around 70mmhg and a pump flow above 2.4l/min. They recommend also a close monitoring of the fetal heart rate, uteroplacental blood flow and uterine contractions We report in this paper, the case of a 26 year old pregnant female who underwent at 18 weeks an aortic valve replacement. Severe fetal bradycardia occurred 30 min after going on bypass lasted for 20 min and was refractory to a further increase in pump flow, mean arterial pressure and hematocrit. The fetal heart rate returned to its baseline only after rewarming the patient to 35.5 degrees Celsius. The post-operative course was uneventful and a close follow up revealed a normal fetal status. At 38 weeks the mother delivered a healthy normal baby girl. Since fetal bradycardia occurred despite respecting all the recommendations and only reversed after rewarming the mother to 35.5 degrees Celsius, we would suggest not lowering the temperature during cardiopulmonary bypass below 35.5 degrees in pregnant patients undergoing cardiac procedures. Thus more reports and papers are mandatory in order to further elucidate the factors responsible of the adverse events that occur in such cases.

Keywords: Pregnant Woman, Cardiac Surgery, Fetal Bradycardia, Continuous Fetal Cardiac Doppler

1. Introduction

Two percent of all pregnant women have some type cardiac disease. In some of these patients, cardiac surgery is necessary in order to save the mother's life [1]. The maternal mortality rate is around 2.9%, while the fetal mortality rate is higher and reaches in some cases 29% [2]. Many recommendations, derived mostly from case reports, have been advanced in order to optimize the physiologic conditions of the fetus.

We describe in this paper, the case of an eighteen weeks pregnant patient who underwent an aortic valve replacement and delivered at 38 weeks a healthy baby girl.

2. Case Report

A 26 years- old woman was admitted at 18 weeks gestation for progressive dyspnea, orthopnea and episodes of hypotension.

Seven months earlier, she was hospitalized for fever and abdominal pain. Investigations revealed an aortic valve endocarditis with multiple splenic infarcts. She was successfully treated for six weeks by appropriate antibiotics. A follow up echocardiography done two months later showed a bicuspid aortic valve with moderate insufficiency and a marked decrease of the vegetations size.

One month ago, she returned for progressive dyspnea and orthopnea. To note that she was 14 week pregnant at the time. An echocardiography showed a bicuspid aortic valve, prolapse of the posterior cusp, severe aortic regurgitation and presence of a large mobile aortic vegetation. The ejection fraction was in normal range and the pulmonary systolic pressure was estimated at 44mm Hg.

A multidisciplinary team was consulted. It included the cardiologist, anesthesiologist cardiothoracic surgeon, infectious disease physician and the feto-maternal specialist. It was decided to proceed with an aortic valve replacement (AVR) since the patient's condition was worsening and to try to save the pregnancy.

An aortic valve replacement was planned in order to avoid any maternal complication.

The patient's body weight was 53kg the BSA 1.56m^2. The hematocrit was 35%.

The night before surgery she received indomethacin and duphaston.

She was premedicated with glycopyrrolate 0.2mg and promethazine 25mg intramuscularly one hour before surgery. In the operating room and before induction two 18 gauge intravenous lines and one left radial artery cannulation were inserted. Two grams of magnesium sulfate were given intravenously over 20mn.

She was positioned supine. The left lateral supine displacement was achieved by elevating the right hip with a pillow (wedge) and by tilting the operating table slightly to the left. A continuous cardiac Doppler of the fetus was performed throughout the procedure by the feto-maternal specialist. To note that the uterine contractions monitoring was not possible due to the relative early gestational age.

Preoxygenation was achieved with 100%oxygen for 3 minutes. Anesthesia was induced by etomidate 3m/kg, midazolam 2 mg and sufentanyl 20micrograms, A cricoid pressure was applied and 100 mg of succinylcholine was given The trachea was intubated with 7.5mm orotracheal cuffed tube.

A central line and a swan ganz were inserted through the right internal jugular.

Ventilation was controlled throughout the procedure using 100% oxygen. Anesthesia was maintained with 1-1.5% sevoflurane, cisatracurium 6mg/h, midazolam 2mg/h and sufentanyl 30microgram/h.

The blood pressure (BP) of the patient was maintained around 120/70mmHg, the heart rate (HR) around 70 beats per minute (bpm), The pulmonary artery (PA) around 33/12 mmHg, the post capillary wedge pressure (PCWP) around 13 mmHg, the cardiac output (CO) around 3.3liters /min and cardiac index (CI) around 2. The fetal heart rate (FHR) fluctuated between 120 and 130bpm (figure 1).

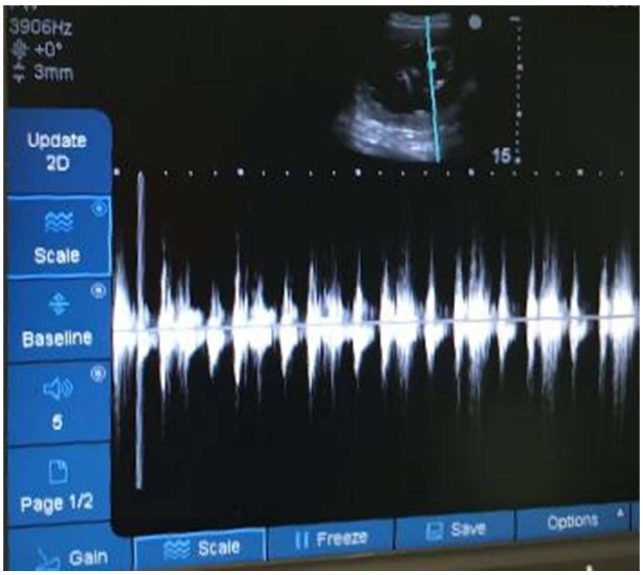

Figure 1. *Normal fetal heart rate.*

The extracorporeal circuit was primed with 1700 cc of ringer solution and one vial of albumin (10g). No blood was added.

Heparin 300UI/kg were given intravenously before cannulation. On bypass the perfusion pressure was maintained around 80mmhg, the flow around 4.5-5l/min, hematocrit around 27% after adding two units (700cc) of RBCs.

A systemic tepid hypothermia was allowed in order to achieve a rectal temperature of 34-34.5degrees Celsius. Alpha stat management of carbon dioxide homeostasis was used during hypothermia. The blood gas values were: PH: 7.45, PO_2: 400 mmhg, PCO_2: 34mmhg, BD: -4. Metabolic acidosis was corrected by administering sodium bicarbonate.

Thirty minutes after going on bypass, the FHR dropped to 70-80 bpm the bradycardia lasted for 20mn approximately and was refractory to 1 mg atropine and 0.1 mg of epinephrine given intravenously (figure 2). The perfusion pressure was increased to 100mmhg, the pump flow to 6l/min. One unit of red blood cells was added on bypass and rewarming the patient was started.

Figure 2. *Severe fetal bradycardia.*

The aortic valve was replaced by a pericardial valve size 25. The aortic cross clamp which lasted for 51mn was then released. The patient was rewarmed to 36 degrees Celsius and weaned from the cardiopulmonary bypass. To note that when temperature reached 35.5C, the FHR increased to its baseline value of 120-130bpm (figure 3).

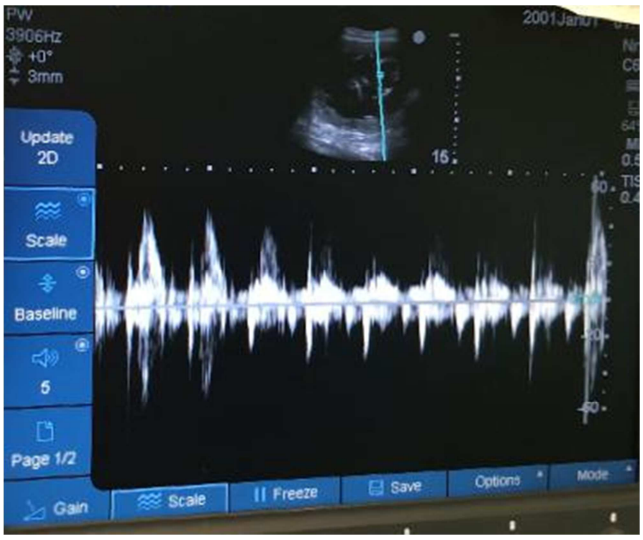

Figure 3. *Return of the fetal heart rate to its normal baseline value.*

The maternal hemodynamics after going off bypass were within normal range: The blood pressure around 100-110/70 mm Hg, the HR around 90bpm, the PA around 24/12, the PWCP around 10 and the CO increased to 4.6l/min and the CI to 3l/min.

The patient's hematocrit increased to 30% after administering the cell saver volume and the blood transfusion The ABG's were within normal range.

She was transferred to the coronary surgery unit where she was extubated few hours later. To note that the patient received postoperatively indomethacin (100mg) (Four doses), dexamethasone 8mg q6 hours for two days and one dose 250mg proluton (progesterone) intramuscularly.

The fetal monitoring that was achieved regularly and frequently (by ultrasound) in the first 48 hours revealed normal fetal status.

The patient was discharged seven days postoperatively and was followed closely by the cardiologist, cardiac surgeon and the obstetrician. She was discharged on daily aspirin 100mg, proluton (hydroxyprogesterone caproate) 500 mg intramuscularly once a week and duphaston (dydrogesterone).

A detailed fetal ultrasound done at 23 weeks showed a well-being fetus with a normal fetal morphology, normal brain anatomy with a fetal heart rate around 145bpm.

At 38 weeks, she delivered by cesarian section a normal healthy baby girl with an Apgar score of 9 and 10 at one and 5 minutes respectively. An ultra sound of the brain (of the baby girl) done the next day showed normal features.

3. Discussion

Two percent of pregnant women experience some type of cardiac pathologic disease. In some cases medical therapy is not enough and surgery becomes mandatory to save the mother's life [1].

The maternal mortality rate in pregnant women undergoing open heart procedures is around 2.9% while the fetal mortality rate is higher and ranges between 9.5% and 29% [2]

Cardiovascular maternal morbidity and mortality during pregnancy correlates strongly with maternal functional status. Four major risk factors predict adverse maternal events and outcomes: Transcient ischemic attack, stroke, arrhythmias, NYHA class IV before onset of pregnancy, left heart obstruction, left ventricular ejection fraction less than 40% [3, 4, 5, 6].

In our case, the patient was treated for bicuspid aortic valve endocarditis and subsequent severe aortic insufficiency. She was NYHA class III, did not experience any neurologic events and had a normal cardiac function. All these data explain the excellent maternal outcome who had an uneventful postoperative course. She was discharged seven days after surgery.

In contrast to a low maternal mortality and morbidity, the fetal mortality rate remains relatively high and ranges from 9.5 to 29% [3]. In fact the fetoplacental circulation can be affected by many factors encountered during cardiac surgery which may lead to fetal distress and demise if not managed promptly.

The cardiopulmonary bypass per se results in hemodilution, hypotension, alteration in the cellular and protein components of the blood, coagulation protein changes, activation of the immune system, particulate and air embolism, release of vasoactive substances. In addition most of the extracorporeal circulation are achieved with a non pulsatile blood flow and under hypothermic conditions [3].

The effect of nonpulsatile blood flow on the fetal status is a debatable issue.

Farmakides et al studied the blood flow at 23 weeks pregnancy for open mitral commisurotomy [7]. Despite the use of a non pulsatile pump the blood flow in the uterine artery showed pulsation. In contrast other authors consider that the

non pulsatile flow is deleterious to the uteroplacental circulation and recommend the use of pulsatile pumps They suggest also intermittent clamping during normothermic bypass which allows short perfusion times with a pulsatile flow [8, 9].

In our patient the use of the pulsatile pump was not technically feasible and did not seem to affect the fetal status since bradycardia occurred 30min after initiation of the cardiopulmonary bypass.

Fetal bradycardia may be precipitated by a decrease in uterine blood flow. The uterine vasculature is not autoregulated and is maximally dilated under normal conditions. Any factor such as vasoconstrictors can lead to severe vasoconstriction resulting in a decrease in uterine blood flow. On the other hand the decrease in mean arterial pressure can be deleterious to the uteroplacental circulation [10]. Hypotension has been observed especially during the shift from the corporeal to the extracorporeal circulation. Mishra et al reported two cases of fetal bradycardia immediately with the onset of CPB. In one case the FHR returned to normal values after increasing the CPB flow while in the second case the bradycardia was refractory to such measures and affected negatively the fetal outcome [3].

In our case no decrease in FHR was observed after initiation of cardiopulmonary bypass. The blood flow was maintained around 4.5l/min and the mean arterial pressure around 80mmhg throughout the bypass.

Oxygenation and acid base status have also an impact on the fetal outcome.

Most of the reports recommend a maternal hematocrit above 27%, a paO_2 above 200 mmHg and a normal acid- base status under an alpha stat strategy. Any factor that affect fetal oxygenation may have adverse effect on the fetal status. On the other hand many reports advice to adopt the alpha-stat management of carbon dioxide homeostasis which may maintain an adequate uteroplacental autoregulation and circulation during a moderate to tepid hypothermic cardiopulmonary bypass [11, 12].

In this present case, all these recommendations were respected. The patient had a hematocrit above 27% after adding two units of red blood cells on the pump volume, The blood flow was maintained around 4.5l/min and the mean arterial pressure around 70-80mmhg. The arterial blood gases showed an excellent oxygenation and a normal acid-base status with a pO_2 above 300mmHg a pCO_2 around 34mmHg and a PH around 7.45. Despite following all the recommendations a marked decrease of the FHR occurred 30 minutes after going on bypass and lasted for 20 minutes. It was refractory to a further increase in pump flow, perfusion pressure, hematocrit and to the administration of 1mg of atropine and 0.1mg of adrenaline intravenously. It returned to the normal values after rewarming when the maternal temperature reached 35.5 degrees.

On the other hand, hypothermia usually adopted as a cardiac protective strategy can affect the maternal-placental-fetal physiology and subsequently the fetal status. Several animal studies suggested that a hypothermic placenta is not a good oxygenator. Goldstien et al found that hypothermia during CPBP had a deleterious effect on the fetus [2] while Roussow et al reported that the fetus maintains the capacity to autoregulate the fetal heart rate during moderate hypothermia due to a decrease in the metabolism requirements [13]. This hypothesis was supported by kawkabani et al who reported a case of fetal bradycardia during hypothermic (28 degrees) CPBP [11]. The heart rate returned to the normal values only after rewarming of the patient to 35 degrees Celsius. The same scenario was observed in our case, In fact despite following all the recommendations advanced in the literature, the FHR dropped to 70-80-bpm during hypothermic CPBP and returned to its baseline value only when the maternal temperature increased to 35.5 degrees Celsius.

Cardiopulmonary bypass, hypothermia and rewarming can trigger uterine contractions that can compromise the uterine blood flow and affect the fetal outcome. This is mainly due to release of prostaglandins and hormonal dilution. Sustained uterine contractions have been considered among the most important cause of fetal death. Many authors recommend the use of progesterone in the pre and postoperative period since it has successfully eliminated premature labor [3, 7]. Chambers et Clark consider that tocolytic agents should be initiated only if contractions occur and must not be used prophylactically [14]. In contrast kawkabani et al used prophylactically magnesium sulfate in the peroperative period. No uterine contractions were detected despite a hypothermic CPBP. They consider also that magnesium sulfate may not only prevent uterine contractions but prevent also hypothermic induced uterine vasoconstriction and increase the uteroplacental blood flow. To note that nitroglycerine was reported also to be an effective agent for uterine relaxation [11].

In the present report, the patient received preoperatively indomethacine and progesterone. Magnesium sulfate and nitroglycerine were administered during the procedure. In the postoperative period she received progesterone orally and intramuscularly.

Anesthetic drugs may also precipitate fetal bradycardia. Most of the intravenous agents are highly lipidsoluble and cross the placenta freely. All opiods may cause fetal bradycardia and loss of beat to beat variability. However this type of bradycardia is reversible [11, 12]. In this case, the anesthetic agents did not seem to be responsible of the decrease in the FHR. In fact bradycardia was not observed after induction and administration of sufentanyl but occurred 30 min after initiation of CPBP and returned to baseline after rewarming of the patient to 35.5 degrees.

All the report discussing pregnant women undergoing cardiac procedures recommend close monitoring of the FHR, uterine contraction and utero-placental blood flow by echodoppler. Early recognition of fetal distress or uterine contractions will allow prompt management in order to avoid adverse outcome [11, 12]. In this case, a continuous cardiac echodoppler of the fetus was performed throughout the surgery. Monitoring of the uterine contractions was not possible due to the relative early gestational age (18 weeks).

On the other hand, the ideal gestational age to perform such

procedures is discussed by several authors. They established the period between 13th and 28th weeks as ideal. In fact, there is a higher trend toward fetal malformations in the first trimester and to premature delivery and maternal hemodynamic alterations and mortality in the third [8, 12]. To note that when the fetus is of advanced age and the planned maternal surgery is anticipated to be complicated or anticoagulation will be needed delivery prior to CPB must be considered. If surgery is required at less than 28 weeks fetal viability must be assessed. If there is a positive viability, multidisciplinary close observation must be performed before during and postoperatively. If no viability is detected, evacuation should be undertaken [13]. In this paper, the patient was operated at 18th weeks in order to minimize the risks on both the mother and the fetus.

Anticoagulation drugs may complicate the pregnancy course and the delivery. They must be vigourously managed by the physicians. If oral anticoagulation drugs must be given to the mother, they must be discontinued and replaced at 36 weeks by unfractionated heparin or low molecular weight heparin [1]. In the present case, the surgeon replaced the valve by a pericardial one (size 25mm) in order to avoid the intake of oral anticoagulation drugs in the postoperative period and throughout the pregnancy, knowing though that she will need a redo procedure in the future.

4. Conclusion

The mortality rate of pregnant women undergoing cardiac surgery is approximately 2.9% while the fetal mortality is higher and ranges between 9.5%and 29%.

Many papers have advanced measures in order to decrease fetal morbidity and mortality. They recommend in pregnant women undergoing cardiac procedures a normothermic or a tepid CPBP, good oxygenation, high hematocrit, alpha stat management, an increase of the pump flow above 2.4l/min and a mean arterial pressure around 70mmhg. They recommend also the use of pulsatile pump when available and a close monitoring of the fetal heart rate, uterine contractions and the uteroplacental blood flow. In addition, several authors recommend the use of prophylactic tocolytic agents. Most of all these recommendations which were respected in this case report contributed to the excellent maternal and fetal outcome.

Since fetal bradycardia only reversed after rewarming of the mother to 35.5 degrees Celsius we would suggest not lowering the temperature during cardiopulmonary bypass below 35.5 degrees. Thus more case reports and papers are mandatory in order to further elucidate the factors responsible of the adverse events which still occur at a relative high incidence in such cases.

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