
Cardiopulmonary Bypass Combined with Fetal Monitoring for Removal of a Left Atrial Myxoma During Pregnancy

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Introduction

Atrial myxomas are uncommon tumors and are reported to occur in approximately 8 to 250 cases per million autopsies (1-4). Prompt surgical treatment of myxomas after diagnosis is recommended because of their potentially fatal obstructive and embolic complications (5,6). Recently a 26-year old pregnant female was admitted and found to have a left atrial myxoma. Open-heart surgery with cardiopulmonary was recommended even in view of the fact that she was in her second trimester of pregnancy. During the twenty-third week of gestation open-heart surgery was performed using cardiopulmonary bypass and the tumor was removed.

Fetal heart rate monitoring during cardiopulmonary bypass has been utilized and described in the past (7-9). In addition, alterations in the fetal heart rate pattern, particularly persistent fetal bradycardia, have been found to be indicators of acute fetal hypoxia in both the third trimester and during parturition (10). Fetal monitoring was performed during this patient's cardiac surgical procedure with the aid of an external Doppler ultrasonic transducer (Corometrics Medical Systems, Inc. Model 101). Persistent fetal bradycardia was observed during cardiopulmonary bypass despite acceptable maternal oxygenation and acid-base balance.

Case Report

A 26-year old white woman (grava 2, para 1, abortus 0) was noted by her obstetrician to have a systolic

murmur consistent with mitral regurgitation on two routine prenatal visits. The patient had no prior history suggestive of rheumatic fever nor had the murmur been detected during any previous examination. A previous chest x-ray taken over one year prior to pregnancy was interpreted as normal. The patient was referred to a cardiologist for evaluation of the murmur.

The admission laboratory data included a hematocrit of 33 volumes percent and a white blood cell count of 9,600/mm³ with a normal differential. The erythrocyte sedimentation rate was elevated to 43.0 mm/hour. Serum protein electrophoresis showed no hyperglobulinemia. Chest radiography was not done because of the patient's pregnancy. Electrocardiography was normal except for terminal inversion of the P wave in lead V-1, suggestive of left atrial enlargement.

One-dimensional echocardiography (Fig. 1) demonstrated multiple echoes in the left atrium during systole with the echoes appearing behind the anterior mitral leaflet in diastole, consistent with a pedunculated and mobile left atrial mass. In addition the left atrium was moderately dilated to 5.4 cm.

Due to the potential for obstructive or embolic complications with this large, mobile tumor mass, it was decided to operate and surgery was performed at 23 weeks' gestation. The fetal heart rate was monitored before and during the entire surgical procedure as well as postoperatively by an external Doppler ultrasound transducer. General anesthesia was maintained with 40% nitrous oxide in oxygen with 1% halothane by assisted ventilation via endotracheal tube. The bypass circuit consisted of a Harvey H-1000 oxygenator, Harvey H-500 cardiectomy reservoir, Pall arterial line filter, and a Johnson & Johnson cardiectomy line filter. Since the patient's hematocrit was only 33% preoperatively, the decision was made to use blood in the prime. The prime consisted of 1000 cc of whole blood, 500 cc

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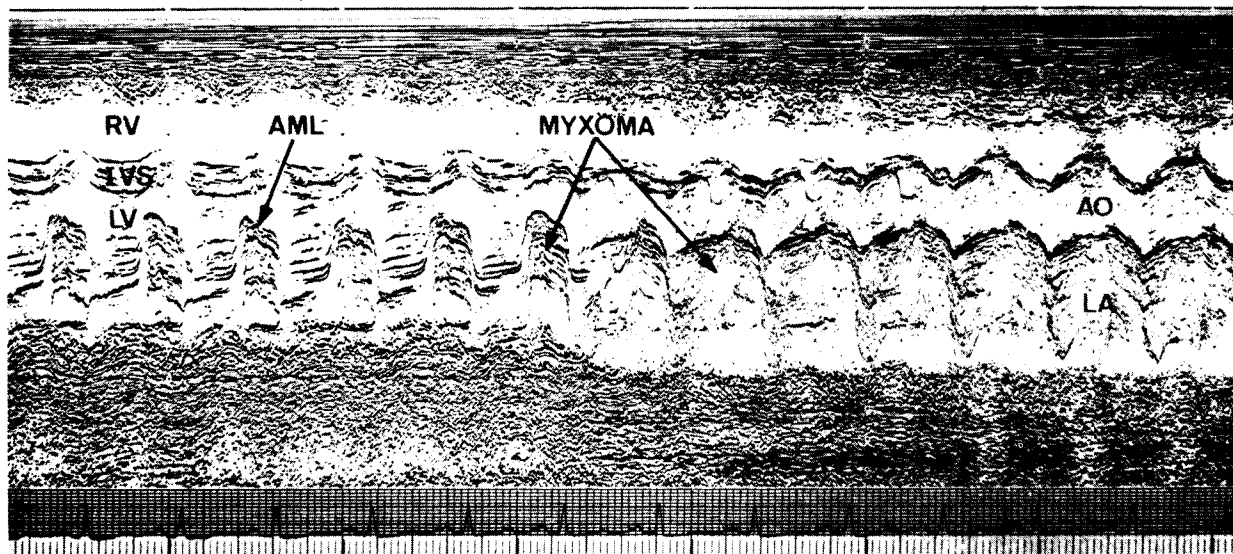


FIGURE 1. Cardiopulmonary bypass combined with fetal monitoring for removal of a left atrial myxoma during pregnancy.

of 5% albumin in saline, 500 cc of Lactate Ringers solution, and 50 cc of fifty percent dextrose solution. Our normal technique for determining patients blood volume is to utilize the Hepcon heparin analyzer computer which once a patients weight, height, and sex is entered will automatically calculate the estimated blood volume. However, in the case of a pregnant patient, allowance must be made for the additional blood volume due to the pregnancy. According to her obstetrician, in the second trimester this is equal to approximately a 30% increase. This patient was 5 feet 8 inches tall (160 cm) and weighed 126 pounds (56 kilos). Her normal blood volume was calculated to be 3650 cc (using the Hepcon as stated above). Adding the 30% factor to this, we used 4745 as her estimated volume for the case. The flow rate calculations must be changed due to the effects of pregnancy. Here again we must add approximately 30% to our calculations. This made our estimated flow approximately 4500 cc per minute instead of the normal 3400 cc that a female patient this height and weight would need. Normothermic bypass was instituted and cardiac arrest achieved using cardioplegia. The left atrium was opened and a large myxoma along with a ellipical portion of the atrial septum was removed. Blood flow rate averaged 5650 cc per minute. A combination of 97% oxygenation and 3% carbon dioxide was blended with 100% oxygen for the oxygenating gas. The average gas flow during bypass was 10.75 liters per minute. This represents a gas to blood flow ratio of 1.9/1. This is notable in that in

many previous studies that we have done with this oxygenator it required an average gas to blood flow ratio of only 1.3/1 to obtain simular arterial pO₂ values in a normothermic patient. This higher gas ratio was required due to the increased oxygen demand of the pregnancy (7). Bypass time was 35 minutes. The baseline fetal heart rate prior to and during general anesthesia was between 130 and 140 beats/min. When cardiopulmonary bypass was started, the fetal heart rate decelerated over a two-minute period to 80-100 beats/min and remained there for the duration of bypass (Fig. 2). Maternal arterial and venous blood gases along with mean arterial pressure were continually monitored during cardiopulmonary bypass. The pO₂ ranged from 141-202 mm/Hg and pH varied from 7.39 to 7.44. Arterial gases were measured continously using an in-line pO₂ sensor and these were checked frequently against complete laboratory blood gas samples. The range of the arterial pressure after the initiation of bypass was 61-82 mm/Hg, with a mean of 70. Despite these variations, no effect on fetal heart rate was observed. Heparin dose was calculated to give an overall circuit level of 2.8 mg/kilo. Halothane was maintained between 0.5% and 1.0% during most of bypass. When bypass was discontinued, the fetal heart rate gradually and progressively accelerated over the next eight minutes to a tachycardia of 160-180 beats/min and remained at that level for approximately 15 minutes before returning to the preoperative baseline level.

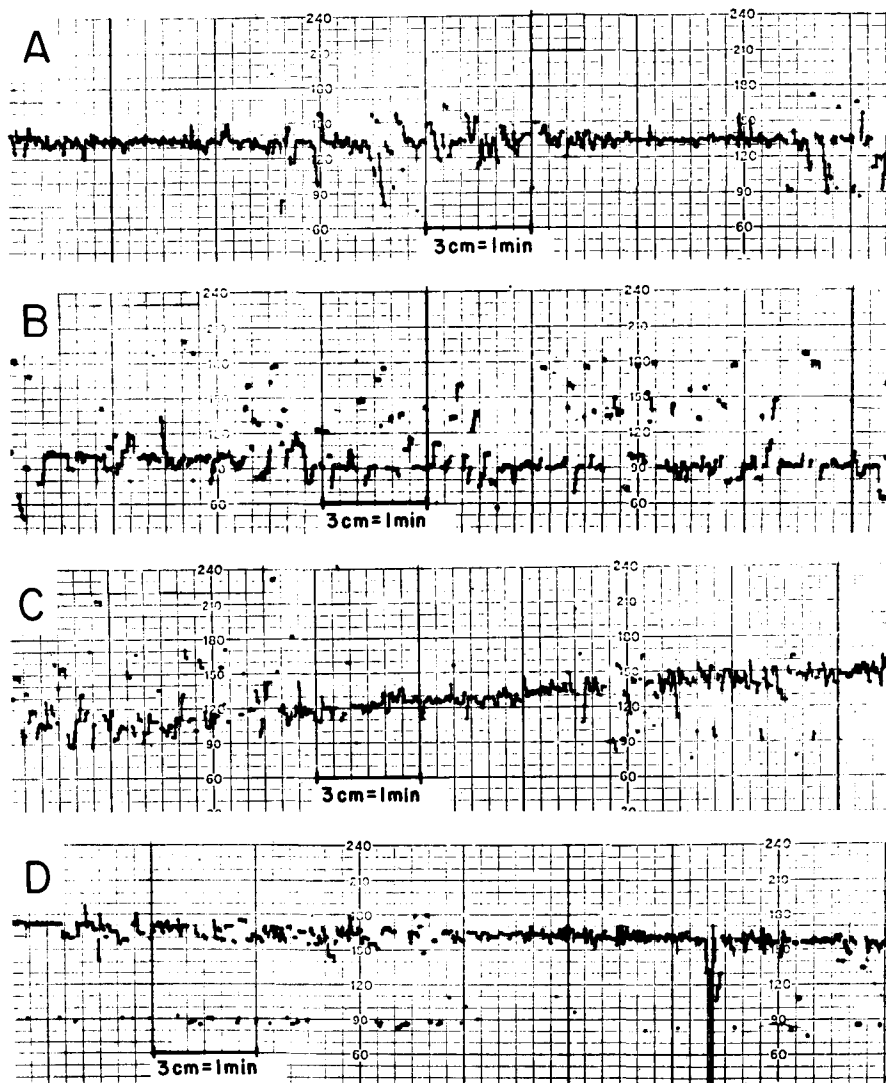


FIGURE 2. Cardiopulmonary bypass combined with fetal monitoring for removal of a left atrial myxoma during pregnancy.

The postoperative course of both mother and fetus was uneventful. No heart murmur or other cardiac abnormalities were present in the mother during a nine month follow-up period. She went into spontaneous labor at 39 weeks' gestation and delivered a healthy 6 lb. 10 oz. male infant with Apgar scores of seven and nine at one and five minutes. The infant exhibited normal milestones at six months of age.

Discussion

Cardiac surgery during pregnancy has been reported as early as 1952 when 11 cases of closed mitral commissurotomy were reported (11-14). In that group of patients, there was one maternal death and one pre-

mature delivery. The first successful open-heart surgery reported was in 1959 and was done on a woman with Fallot's triad in her third month of gestation (15). Zitnik reported in 1968 on a group of 20 patients that the maternal mortality rate was 5% and concluded that pregnancy per se does not increase the mothers risk in open-heart surgery (16). The fetal mortality rate was high; however, being about 33%. In that study, no correlation was made between outcome and maternal oxygenation, mean arterial pressure, or acid-base balance.

Over recent years, open-heart surgery has been used more frequently to treat severely compromised pregnant patients with surgically correctable cardiac lesions. The use of fetal monitors during cardiac surgery

was first reported in 1975. Persistent fetal bradycardia following deceleration has long been considered a classic sign of acute hypoxia (10). Koh monitored the fetal heart rate in two patients undergoing mitral valve surgery (replacement and valvuloplasty) during the second trimester of pregnancy (7). Both operations were associated with fetal bradycardia during cardiopulmonary bypass; the bradycardia was more marked in the case of the valvuloplasty and it was partially corrected with an increase in the perfusion rate.

In our patient, continuous fetal monitoring was performed with the aid of an external ultrasonic transducer. The induction and maintenance of general anesthesia had no effect on the baseline fetal heart rate. However, within the first two minutes after going on bypass, the fetal heart rate decelerated from a baseline of 130–140 beats/min to 80–100 beats per minute. This deceleration persisted during the entire 35 minute course of cardiopulmonary bypass despite acceptable maternal oxygenation and acid-base balance. Termination of cardiopulmonary bypass resulted in the gradual and progressive development over an eight minute period of fetal tachycardia (160–180 beats/min) which persisted for 15 minutes before the fetal returned to preoperative baseline level.

Several causes for the fetal bradycardia can be postulated. A significant decrease in oxygen delivery to peripheral muscle tissue during nonpulsatile bypass has been described (17), and similar decrease in the delivery of oxygen could result in fetal hypoxia with subsequent deceleration of the fetal heart rate. The fetal tachycardia present after bypass could represent a compensatory mechanism for oxygen debt and metabolic imbalance incurred during cardiopulmonary bypass. Hon and associates have raised the possibilities of particulate or bubble emboli, sludging of the blood, or direct obstruction during cannulation of the inferior vena cava as causes of compromise of the uteroplacental circulation. Clearly there is need for further

clinical investigation into the effects of extracorporeal circulation of the fetal cardiopulmonary physiology. While our case is an example of the feasibility of performing open-heart surgery in pregnant women, in terms of immediate successful outcome for mother and apparent short-term lack of harm to the infant, the long-range effects on the developing fetus are presently unknown.

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