Management of the Parturient with Cardiovascular Disease

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Introduction

The incidence of clinically significant cardiac disease in the pregnant population ranges from 0.1-4%, unchanged in decades; however, the most frequently seen etiology is now congenital heart disease (70-80%)\(^1\) due in part to advances in surgical techniques for these patients and advances in medical therapy, allowing these women to survive into childbearing age.\(^2\) Ischemic heart disease is also seen more commonly today due to both the increasing number of women of advanced maternal age who are electing to undergo pregnancy and childbirth as well as advances in medical therapy for ischemic heart disease, allowing women with this condition to carry a pregnancy to term. While the incidence of cardiac disease in pregnant patients has remained relatively unchanged, the maternal mortality from congenital heart disease has decreased from 6% in the 1930s to 0.5-2.7% today.\(^1\) The last decade has shown a decline in maternal mortality from congenital heart disease, and now acquired heart disease has risen to be the leading cardiac cause of maternal death, with myocardial infarction, aortic dissection, and cardiomyopathy as the main processes.\(^3\) Unfortunately, the cardiovascular changes of pregnancy may place additional stress on patients with underlying cardiac disease, increasing the risk of peripartum morbidity and mortality when compared with the general population, with the actual risk depending on the underlying cardiac disease process.\(^1,2\) Taking the altered physiologic processes into account, women with congenital heart disease and those with a history of ischemic heart disease require special attention and a multidisciplinary cooperation for optimal outcome during vaginal delivery or cesarean section. The decision to perform regional or general anesthesia will ultimately depend on a thorough understanding of the cardiac condition and condition-specific hemodynamic goals.\(^2\)

In the United States between 1991 and 1999, 34% of maternal deaths that were attributable to medical conditions other than embolism, hemorrhage, and pregnancy-induced hypertension (the leading causes of death) were from cardiovascular problems.\(^4\) During this same time frame the percentage of maternal deaths attributable to cardiomyopathy increased from 6% to 9%.\(^4\) Seventy percent of maternal deaths from cardiomyopathy between 1991 and 1997 were from peripartum cardiomyopathy (PPCM), a form of dilated cardiomyopathy.\(^5\) PPCM may present itself unexpectedly in the otherwise healthy parturient and may quickly become life-threatening, with exceedingly high rates of morbidity and mortality. Early recognition of the signs and symptoms of PPCM is critical, with rapid diagnosis and treatment crucial. Even in the best of circumstances maternal mortality is a very real concern in the presence of PPCM.

Congenital Heart Disease

Congenital heart disease is now the major etiology of cardiac disease in pregnant women in the United States.\(^7\) Many more women with congenital heart disease are now reaching child-bearing age, giving rise to the need for novel approaches to labor analgesia and anesthesia for cesarean section in this high-risk population. There are now over one-half million American adult women with congenitally malformed hearts.\(^6\) Many of the women with congenital heart disease have undergone successful surgery to correct the cardiac defects, however some women may present with uncorrected or only partially-corrected lesions.\(^4\) Management of these patients may present some interesting challenges for both the obstetrician and the anesthesiologist, and it is imperative to have the involvement of an adult congenital cardiologist and neonatologist, as well.\(^6,7\)

Patients with existing small left-to-right shunts often tolerate pregnancy quite well. This category of patients includes those with small atrial septal defects, small ventricular septal defects, or patent ductus arteriosus. Anesthetic management of patients with left-to-right shunts needs to include attention to several important factors. Care must be taken to remove all air bubbles from the intravenous tubing to avoid systemic air embolization and epidural needle placement should be performed using a loss-of-resistance to saline rather than air to avoid systemic air emboli.\(^6\) Epidural anesthesia is preferred in these patients to avoid pulmonary hypertension and right heart failure that can occur with an increase in the left-to-right shunt fraction. Increased shunting may be seen with the increased maternal systemic vascular resistance (SVR) that occurs with increased maternal catecholamine production in response to pain during contractions.\(^6\) Early epidural analgesia may help to blunt this response by preventing the
Remifentanil has been used successfully for general anesthesia in parturients with aortic coarctation, facilitating for cesarean section in patients with aortic coarctation, both with and without palliative surgery. However, several reports in the literature describe the safe use of epidural and combined spinal-epidural techniques in these patients. The added stress of the physiologic changes of pregnancy result in a maternal mortality rate of 3% in patients with an uncorrected aortic coarctation. These patients have a fixed obstruction to aortic outflow and distal hypoperfusion, manifested by a difference between left-sided and right-sided blood pressures, upper extremity and lower extremity blood pressures, and may present with hypertension of an unknown etiology. Hypotension will compromise not only the maternal myocardium, but also the placental blood flow to the fetus. The hemodynamic goals in the patient with an uncorrected aortic coarctation include maintaining normal to slightly elevated SVR, normal to slightly increased heart rate, and adequate intravascular volume, with invasive blood pressure monitoring being helpful in maintaining these goals.

Postductal arterial pressures (left radial) may be a better indicator of uterine perfusion pressure than preductal arterial pressures (right radial). Postductal systolic blood pressure should be maintained greater than 100 mmHg in order to avoid compromising uterine blood flow. Neuraxial anesthesia for labor should be administered with caution since agents leading to a decrease in SVR can be devastating. Fetal mortality approaches 20% due to the inability to provide adequate uterine perfusion. General anesthesia is recommended for cesarean section, however several reports in the literature describe the safe use of epidural and combined spinal-epidural techniques for cesarean section in patients with aortic coarctation, both with and without palliative surgery. Remifentanil has been used successfully for general anesthesia in parturients with aortic coarctation, facilitating the...
maintenance of hemodynamic stability with minimal neonatal respiratory depression. Ephedrine and dopamine are the vasopressors of choice in patients with uncorrected aortic coarctation with their ability to maintain SVR and heart rate.

Marfan’s syndrome is an autosomal dominant condition affecting the skeletal, ocular, neurologic, pulmonary, and cardiovascular systems. Ninety-five percent of mortality in patients with Marfan’s syndrome is cardiovascular in origin and the mean survival age is 32 years. All parturients with Marfan’s syndrome are considered high-risk, as aortic dilatation and dissection can occur with the increase in blood volume and cardiac output as the pregnancy progresses. Aortic dissection occurs even in the absence of preconception aortic root dilatation, mainly during the third trimester. Neuraxial analgesia for labor has been shown to be safe, as well as general anesthesia for cesarean section. Of greatest importance is reducing the shear force from blood ejected by the left ventricle, which may be attenuated by ß-adrenergic blockade therapy in order to decrease the cardiac rate and contractility. Phenylephrine would appear to be the vasopressor of choice in parturients with Marfan’s syndrome, as ephedrine produces the untoward side effect of tachycardia.

Ischemic Heart Disease

The incidence of myocardial infarction (MI) during pregnancy is on the rise as more women with multiple risk factors for ischemic heart disease are becoming pregnant. The incidence is now estimated at 1:10,000 deliveries, accounting for nearly 2000 deaths annually in women under age 45. Risk factors for ischemic heart disease in parturients are: 1) increasing maternal age, as the number of women finishing their education or beginning their careers before starting a family is increasing, 2) increasing number of women smokers, 3) increasing incidence of cocaine use in women of childbearing age, 4) experiencing stress in the workplace, 5) oral contraceptive use after the age of 35, 6) increased prevalence of obesity and type II diabetes. The maternal mortality rate of peripartum MI is 19% with a perinatal mortality rate of 17%. If the MI occurs within two weeks of delivery, mortality may be as high as 45%-50%.

Myocardial ischemia during pregnancy may be attributable more to coronary vasospasm than to coronary artery disease. Coronary atherosclerosis is found in less than half of patients who have an MI during pregnancy. Other etiologies of ischemia in this population include coronary artery injury from vasospasm, dissection, aneurysm, or hematoma; severe hypertension from pregnancy-induced hypertension, pheochromocytoma or cocaine use; severe tachycardia in patients with left ventricular hypertrophy, hypotension, and anemia; and severe aortic stenosis.

Svanstrom et al studied the iatrogenic etiology of myocardial ischemia after injection of intravenous oxytocin in otherwise healthy women undergoing cesarean section. Symptoms they observed included hypotension, tachycardia, chest pain, flushing, dyspnea, and ECG changes consistent with myocardial ischemia. Kulka et al describe a 31-year-old patient who developed an MI following induction of spinal anesthesia for a cesarean section, after aggressive treatment of hypotension led to significant hypertension and tachycardia. Coronary angiography in that patient revealed normal coronary vessels, however intravascular ultrasound demonstrated an atheroma in the left main coronary artery with a ruptured fibrous cap.

Diagnosis of myocardial ischemia in pregnant patients may be challenging since the symptoms of ischemia mimic complaints seen in the normal pregnant patient. These presenting complaints may include dyspnea, diaphoresis, poor exercise tolerance, chest pain, and syncope. Electrocardiogram changes seen in myocardial ischemia mimic ECG changes which occur in normal pregnancy including sinus tachycardia, a left axis deviation, ST-segment depression, flattened or inverted T waves, and a Q wave in lead III, making a diagnosis of myocardial ischemia by ECG difficult.

The anesthetic management of patients who have experienced an MI during pregnancy is challenging, requiring careful control of cardiovascular parameters utilizing invasive monitoring and optimizing the myocardial oxygen supply-to-demand ratio. Supplemental oxygen should be provided throughout labor and delivery. Tachycardia both decreases the oxygen supply to the myocardium and increases the oxygen demand, and should be prevented or aggressively treated with adequate pain control and β-adrenergic blockade as necessary. Neuraxial anesthesia, if no contraindications exist, will provide excellent pain relief, prevent hyperventilation, and reduce maternal concentrations of catecholamines, the goal of which is preventing coronary artery vasoconstriction. A dense epidural block for labor analgesia has the benefits of providing excellent pain relief during the first stage of...
Peripartum Cardiomyopathy

Peripartum cardiomyopathy (PPCM) is an idiopathic cardiomyopathy that has an onset during a six-month time frame including the last month of pregnancy to five months postpartum. Preexisting heart disease must be excluded, no determinable etiology can be present, and echocardiographic criteria must be met including a dilated left ventricular end-diastolic dimension of greater than 2.7 cm/m². Echocardiography is the gold standard for the diagnosis of PPCM. Risk factors for PPCM include advanced maternal age, multiparity, multiple gestations, black race, obesity, gestational hypertension, preeclampsia, cesarean section, alcohol, cocaine, and tobacco abuse. Initial presenting symptoms for PPCM may be limited to symptoms of a mild upper respiratory infection, dyspnea, chest congestion, palpitations, and fatigue. These early symptoms can rapidly progress to florid cardiac failure with global hypokinesis, low cardiac output, elevated filling pressures, and ventricular ectopy. Fussell et al. describe a five-week postpartum patient who presented with fulminant hepatic failure one week after becoming symptomatic from an unrecognized PPCM.

PPCM is a significant cause of maternal morbidity and mortality. Recent studies have shown a mortality or cardiac transplantation rate ranging from 12% to 18%, with a five-year survival rate of 94% with 50% of these women having complete or near-complete recovery of ventricular function. Women with a history of PPCM and normal systolic function will have a relapse rate of 20% with a subsequent pregnancy, whereas women with a history of PPCM and residual left ventricular dysfunction have a relapse rate of 50% and a mortality rate of 8% to 17% with a subsequent pregnancy. Sliwa et al. followed six patients through subsequent pregnancies after having had PPCM with their prior pregnancy. They found a reduction in the ejection fraction by greater than 10% in five of the six patients at one month postpartum and two women of the five who had impaired left ventricular function at the onset of pregnancy died within three months postpartum despite optimal medical therapy, confirming that mortality during subsequent pregnancies is high, especially in patients with persistent left ventricular dysfunction.

Whitehead et al. reviewed 171 deaths related to PPCM from 1991 through 1997 and noted that African American women were 6.4 times as likely to die from PPCM than Caucasian women, and women 35-years-old and older had a risk of death 2.8 times greater than that of women aged 19-years and younger. Copyright © 2011 American Society of Anesthesiologists. All rights reserved.
factors for mortality from PPCM noted in their study included twin or greater gestations and parity greater than three.27

Medical management in the parturient with PPCM does not differ from the management of other patients with severe cardiomyopathy. Diuretics, vasodilators, and digoxin, as needed, should be initiated with careful attention paid to fetal safety and to excretion of the drug or its metabolites in breast milk.22,28 Angiotensin-converting enzyme inhibitors, although contraindicated during pregnancy because of teratogenicity, should be considered a mainstay of treatment postpartum.28,29 Hydralazine and nitrates are safe alternatives during pregnancy.23,28,29 The addition of bromocriptine appeared to improve LVEF in one recent small study by Sliwa et al.30 Amlodipine may have a role in the treatment of PPCM as it has been shown to improve survival in nonischemic cardiomyopathy patients.21 Beta-adrenergic antagonists may be used in the postpartum period in patients who have been refractory to other therapy and continue to have left ventricular dysfunction for more than two weeks after standard heart failure therapy.22 Thromboembolic events are not uncommon, therefore anticoagulation may become necessary, especially in patients with a LVEF less than 35% or bedridden patients with atrial fibrillation, mural thrombi, obesity, or a history of thromboembolism.22,29 Rarely, patients with PPCM fail medical therapy and require an intra-aortic balloon pump or ventricular assist device for cardiovascular support.23 These mechanical devices are considered a bridge until cardiac transplantation is able to be performed in suitable transplant candidates.23,24,31 The survival after cardiac transplant for PPCM is 75% at four years and does not differ from the survival rate of women who undergo cardiac transplantation for other forms of cardiomyopathy,23 therefore cardiac transplantation is a successful option for the treatment of severe, refractory PPCM.24

Anesthetic management in the parturient with PPCM is not significantly different from that of other patients with a severe cardiomyopathy. Invasive monitoring is warranted in the acute setting until cardiac function has stabilized. Coagulation status should be normalized prior to the performance of neuraxial anesthesia. Cesarean sections have been performed safely in parturients with PPCM utilizing both general and regional anesthesia techniques. Continuous neuraxial anesthesia is usually preferred as it decreases preload and afterload but not contractility, improving myocardial performance and reducing myocardial work.8 Velickovic and Leicht describe the successful use of continuous spinal anesthesia in a parturient with severe recurrent PPCM.32 When general anesthesia is necessary, extreme caution must be exercised in choosing drugs which do not depress the myocardium, as myocardial depression may precipitate cardiac arrest and death.8 A propofol and remifentanil combination has been described for use in general anesthesia for cesarean section in a patient with PPCM, providing good cardiovascular stability throughout the procedure.33

Summary

Encountering a patient with cardiovascular disease in the labor and delivery unit can be a harrowing experience. The patient’s likelihood of developing complications including death is increased, something we do not deal with on a frequent basis in most labor and delivery units. However, understanding the underlying physiologic processes will assist the anesthesiologist in the preparation and delivery of safe anesthetic care for the parturient with cardiovascular disease. Additional non-invasive monitoring including electrocardiography and pulse oximetry should be considered for high-risk patients undergoing vaginal delivery. Invasive monitoring with an arterial line may be warranted and slowly titrated neuraxial analgesia or anesthesia may be prudent; however, central venous monitoring and pulmonary artery catheters are infrequently used. Certain cardiac conditions mandate general anesthesia with invasive monitoring techniques including transesophageal echocardiography. In any event, preparedness and vigilance, as well as a multidisciplinary approach with good communication between the anesthesiologists, obstetricians, and cardiologists, are paramount for the safe management of the parturient with cardiovascular disease.
References
Disclosure

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