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Review article

Pregnancy and Non-Valvular Heart Disease: Anesthetic Considerations

Saad I. Saad, Ahmed S. Mesaad, Dina H. Elbarbary, Genviav G. Shaker

Department of Anesthesia and Intensive Care, Faculty of Medicine; Benha University. Egypt.

Correspondence to: Genviav G. Shaker, Department of Anesthesia and Intensive Care, Faculty of Medicine; Benha University. Egypt.

Email:

rwka705@gmail.com

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Abstract

Although the incidence of cardiac disease in pregnancy remained more or less unchanged (0.1–4%), maternal mortality has decreased from 6% in the 1930s, to 0.5% to 2.7%. Pregnancy increases the maternal mortality risk in cardiac patients as compared with the general pregnant population, and actual risk depends on the underlying cardiac disease. The aim of this study was to determine the non-valvular heart disease in pregnancy and anesthetic considerations in the peripartum period. Ischemic heart disease (IHD), is the term given to heart problems caused by narrowed heart (coronary) arteries that supply blood to the heart muscle. Most people with early (less than 50 percent narrowing) IHD do not experience symptoms or limitation of blood flow. The goals of anesthetic management during labor and delivery in pregnant women with heart disease include analgesia, hemodynamic monitoring, optimizing cardiovascular and respiratory functions by manipulating various hemodynamic factors and tailoring anesthetic technique for maternal and fetal well-being, and resuscitation including airway and ventilatory management if need arises.

Key words: Pregnancy - Non-Valvular Heart Disease - Anesthetic Considerations

Introduction:

Peripartum cardiomyopathy is the heart failure in association with pregnancy. The incidence has been reported to vary by geographic location, with rates ranging from approximately 1:15,000 pregnancies in the United States to as frequent as 1:299 in Haiti. Anesthetic goals are avoidance of general anesthesia if possible, slow induction of epidural anesthesia is better, pulmonary artery pressure monitoring and reduction of preload and afterload (1).

Hypertrophic obstructive cardiomyopathy (HOCM) is a relatively common disorder. The goals of

anesthetic management are to maintain intravascular volume and venous return, avoid aorto-caval compression, maintain adequate systemic vascular resistance (SVR), maintain slow heart rate and sinus rhythm, aggressively treat atrial fibrillation and other tachyarrhythmias and prevent increase in myocardial contractility (2).

Ischemic heart disease (IHD), is the term given to heart problems caused by narrowed heart (coronary) arteries that supply blood to the heart muscle. Most people with early (less than 50 percent narrowing) IHD do not experience symptoms or limitation of blood flow. The goals of anesthetic management during labor and delivery in pregnant women with heart disease include analgesia, hemodynamic monitoring, optimizing cardiovascular and respiratory functions by manipulating various hemodynamic factors and tailoring anesthetic technique for maternal and fetal well-being, and resuscitation including airway and ventilatory management if need arises (3).

The aim of this work was to determine the non-valvular heart disease in pregnancy and anesthetic considerations in the peripartum period.

Patients and Methods

A systematic review performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using the Cochrane database of systematic reviews, the Cochrane central register of controlled trials, PubMed, and MEDLINE as database for search. We included studies published between January 2010 and October 2018.

Search key words were Pregnancy; Non-Valvular Heart Disease; Anesthetic Considerations.

Inclusion criteria:

•Clinical studies with at least 2 years of follow up.

•English literatures only.

Exclusion criteria:

•Non-human studies.

•Reviews, commentaries, and general discussion papers not presenting data on impacts.

•Articles describing techniques only.

Results

A total of 482 studies were identified in the literature, 31 were chosen based on our inclusion and exclusion criteria. There were 10 studies with Level III evidence, 18 studies with Level IV evidence, 2 studies with level II evidence and one study with level I evidence.

Statistical Analysis

Data were analyzed by the aid of software package of (SPSS) using suitable statistical test.

Discussion

Physiological and general changes in pregnancy

The hemodynamic changes of normal pregnancy have profound effects on preexisting cardiac function, so counseling of and care for this subset of patients are challenging for the obstetrician, cardiologist, anesthesiologist and, sometimes, the intensivist to optimize maternal and neonatal survival (4).

Non-valvular heart disease in pregnancy

The prevalence of cardiac disease in pregnancy has remained relatively constant over the past decades and ranges from 0.4-4.1%. In the developed world, congenital heart disease has supplanted rheumatic heart disease as the major cause of cardiac disease in pregnancy because, with the improvement in outcome in surgery for congenital heart anomalies, patients are increasingly likely to survive up to the child-bearing age (5).

Counseling of women with cardiac diseases is best performed prior to conception. This will allow for a thorough history taking and evaluation that includes invasive procedures like cardiac catheterization with fluoroscopy, if needed. These procedures are better performed during non-pregnant state to avoid potential fetal risks (6).

Primary Pulmonary Hypertension (PPH)

Primary pulmonary hypertension (PPH) is defined as persistent increase in mean pulmonary artery pressure (PAP) of 25 mmHg or more with pulmonary occlusion pressure <15 mmHg. Idiopathic or primary PPH is relatively rare and in other common forms is associated with HIV infection, drug exposure (fenfluramine), sleep apnea, chronic liver disease (especially portal hypertension), and collagen disorders (systemic lupus erythematosus, scleroderma). The blood vessels in the lungs narrow (constrict) and the pressure in the pulmonary artery rises far above normal levels. The pulmonary arteries carry blood from the body to the lungs, where carbon dioxide is traded for oxygen. Pulmonary hypertension is a serious, ongoing (chronic) disease. It can lead to heart failure if not treated (7).

Peripartum Cardiomyopathy (PPCM)

Peripartum cardiomyopathy, or heart failure in association with pregnancy, was noted as early as the 1800s. The first report of cardiac failure in

pregnancy was made in 1849 by Ritchie, but was first attributed to cardiomyopathy by (8) in 1937.

Anesthetic management of ischemic heart disease (IHD)

Pregnancy is a prothrombotic state. The coalescence of venous stasis and hypercoagulability results in nearly a 5-fold increase in the risk of venous thromboembolism (VTE) during pregnancy. This risk remains elevated until 12 weeks post-partum. The goal of anticoagulation during pregnancy is to safely balance the maternal risk of thromboembolism and hemorrhage with the fetal risk of exposure to oral vitamin K antagonists (VKAs). The continuously changing pharmacokinetics of low molecular weight heparins (LMWH) during the various stages of pregnancy adds an additional challenge. The risks of various anticoagulation strategies must be acknowledged, and the choice of anticoagulant agent must be individualized on the basis of maternal and fetal factors (9).

Anesthetic management of the parturient with ischemic heart disease:

Hemodynamic changes that occur in pregnancy represent a significant stress test. Hence, most women with cardiac disease who remain asymptomatic throughout pregnancy tolerate labor and delivery well. Conversely, women who are breathless with less than ordinary activity or at rest usually tolerate pregnancy, labor, and delivery poorly. In these cases, when general anesthesia (GA) has to be given for operative procedures such as lower segment cesarean section (LSCS), immediate reversal from anesthesia may not be possible or desirable after surgery. Hence, postoperative ventilatory support with hemodynamic monitoring or planning of corrective procedure for the underlying cardiac lesion such as severe natural or bio-prosthetic valvular dysfunction, aortic or pulmonary artery (PA) aneurysm, and Takayasu arteritis should be considered before reversal and extubation of the parturient (10).

Anticoagulation in pregnancy:

They advocated 2 anticoagulation strategies. Warfarin continued throughout pregnancy offers the best thromboembolic protection to the mother, but carries a higher risk of fetal loss and complications (11). Nevertheless, due to suboptimal alternatives, current American College of Cardiology/ American Heart Association (ACC/AHA) valvular heart disease guidelines supported use of warfarin at doses < 5 mg/day throughout pregnancy. At these doses, the risk of fetal toxicity is much lower than at

higher doses, a finding further supported by a recent meta-analysis (12).

Thrombophilia and venous thromboembolism (VTE):

Women with thrombophilia or a history of VTE who take anticoagulant agents before pregnancy should continue anticoagulation during pregnancy. LMWH offers advantages over unfractionated heparin (UFH), including a longer half-life, efficacy with once-daily dosing, and weight-based dosing. Importantly, there are no documented fetal or neonatal risks to maternal use of LMWH during pregnancy (13).

Anesthetic management of Primary pulmonary hypertension (PPH)

Pregnancy in women with PPH is known to be associated with significantly high mortality rates between 30% and 56%. The physiologic changes that occur during pregnancy and the peripartum period are poorly tolerated in these patients. Majority of maternal deaths occur during labor or within 1 month postpartum (14).

Physical examination may reveal a split S2 with a loud second component, right ventricular heave, tricuspid regurgitation murmur, prominent pulmonic component of the second heart sound with elevated jugular venous pulse, ascites, hepatomegaly, jugular venous distention, and peripheral edema (15).

Perioperative anesthetic management and its goals:

A variety of intraoperative events, both surgical and anesthetic, can affect the right ventricular oxygen supply–demand relationship. The transition from spontaneous breathing to intermittent positive pressure ventilation, addition of positive end-expiratory pressure (PEEP), patient positioning, and diaphragmatic compression can significantly increase right ventricular afterload and precipitate pulmonary hypertensive crisis.

In addition to the pulmonary vascular effects of hypoxia and hypercarbia, patients may also be subjected to venous emboli arising from air, thrombi, or particulate matter forced into the circulation. Right ventricular contractility can be affected directly or indirectly by either depression from anesthetic drugs or acute changes in the sympathetic or parasympathetic balance. Patients with PPH have a high rate of perioperative morbidity and mortality. Mild pulmonary hypertension rarely affects anesthetic management, but moderate-to-severe disease increases the risk of right heart failure (16).

Anesthetic management of Peripartum Cardiomyopathy (PPCM)

The anesthetic considerations for a patient with heart failure presenting for caesarian section are similar regardless of etiology. Hemodynamic goals include maintenance of normal to low heart rate to decrease oxygen demand, and prevention of large swings in blood pressure. Achievements of these goals have been undertaken by giving general and regional anesthesia. During general anesthesia important factors to keep in mind are;

- Volatile agents that decrease LV contractility without dramatic vasodilatation is desirable.
- Avoid agents that decrease preload and after load, e.g., hypovolemia, nitroglycerine, nitroprusside.
- Avoid agents that directly or indirectly increase heart rate, and contractility (e.g., pancuronium, atropine, epinephrine, and ephedrine).
- Blood loss to be replaced promptly.
- Hypotension better treated with volume expansion and pure alpha adrenergic agonist.
- Remember that insertion of central venous catheter (CVC) / Pulmonary artery catheter (PAC) may induce atrial or ventricular dysrhythmias (17).

General anesthesia:

General anesthesia carries the advantages of securing the airway and in case of necessity the opportunity of performing transesophageal echo-cardiography and it can be performed easily if there is not any chance of performing regional anesthesia. Inhalathional anesthetics and total intravenous anesthesia (TIVA) (propofol and remifentanil) can be used for general anesthesia, but all inhalathional anesthestics cause myocardial depression ranging from mild to severe form and intravenous agents can pass the fetoplacental barrier causing fetal depression. In the literature it has been reported that there were cases of myocardial depression and cardiac arrest due to general anesthesia (18).

Regional anesthesia:

Regional techniques reduce after load with minimal effect on contractility, thus improving cardiac output and reducing myocardial work. Regional anesthesia may minimize the incidence of venous stasis emboli, spinal and epidural narcotics are also useful for post-operative analgesia prior to reimplementation of anticoagulant therapy, which should be withheld before delivery (19).

It consisted of a simple incision in the prominent muscular ridge in the septum (myotomy) (20). His procedure: Surgical myectomy became the gold standard for treatment of HCM patients with left ventricular outflow tract obstruction (LVOTO) (21). Other surgical procedures were also described and include left atrial approach for septal myectomy; right ventricular approach with thinning of the ventricular septum, mitral valve replacement, modified Konno's procedure, and left ventricular (LV) apicoaortic conduit. Minimally invasive left atrial approach for septal myectomy was described by (22).

Conduct of anesthesia:

In patients of HCM, increased myocardial contractility, decreased preload and afterload, exacerbate the degree of LVOTO. Anesthetic induction should be performed carefully by titration of induction agents to avoid hypotension as well as sympathetic activation. Either propofol or thiopentone sodium can be used; both have myocardial depressant properties and can lower the afterload. Etomidate has little untoward effect on the cardiovascular system and is an attractive option provided sympathetic ablation is provided by adequate doses of opioids. Any decrease in blood pressure should be treated by judicious preloading and by increasing the afterload (23).

Anesthesia for non-cardiac surgery:

In general, all considerations mentioned above apply. However, the management of a parturient patient with HCM presents several unique challenges. Several hemodynamic changes occur during various trimesters and stages of delivery. The major hemodynamic changes during pregnancy are decreased SVR, an increase in blood volume, and aortocaval compression during later stages of pregnancy. Increased blood volume can offset aggravating LV outflow tract obstruction (LVOTO) effect of decreased SVR. The effect of aortocaval compression is variable depending on their effects on preload and afterload. Uterine contraction of labor increases preload and afterload, increased preload and afterload are beneficial for LVOTO, but has potential to precipitate pulmonary edema by increasing the left ventricular end-diastolic pressure (LVEDP). Patients with obstructive physiology poorly tolerate the Valsalva maneuvers associated with the second stage of labor (24).

Mitral regurgitation:

Systolic anterior motion causes a gap in the coaptation of leaflets (inter-leaflet gap). The gap is created between the leaflets because of the failure of the PML to move toward the outflow tract as much as the AML. The gap directs the MR jet laterally and posteriorly and occurs during mid and late systole. This finding is highly suggestive of an obstructive HCM. The MR in HCM is a secondary phenomenon. If the MR jet is directed anteriorly, or toward the center, then other causes of MR should be sought such as mitral valve prolapse, ruptured chordae, chordal elongation or thickening and infective endocarditis. The severity of MR in dynamic obstruction varies with the severity of LVOTO; an increase in LVOTO causes an increase in severity of MR (25).

Post-cardiopulmonary-bypass assessment:

Transesophageal echocardiography is used to assess the adequacy of repair and detect postoperative complications. With adequate repair, the LV outflow tract (LVOT) is widened, the systolic anterior motion (SAM), MR and outflow gradient are greatly improved. Color flow Doppler of the LVOT should reveal laminar flow (26).

Outflow tract gradient and MR are assessed only after the postcardiopulmonary bypass (CPB) hemodynamics has been optimized. Two important causes of persisting LV outflow gradient are missing a concomitant mid-cavity obstruction and failure to correct mitral valve/papillary muscle abnormalities. Detection of mid-cavity HCM should be carefully assessed especially in the ME views. It may be associated with an akinetic chamber in the apex (27).

Anesthetic management of ischemic heart disease (IHD)

Management of pregnant women with heart disease remains challenging due to the advancement of innovations in cardiac surgery and correction of complex cardiac anomalies, and more recently, with the successful performance of heart transplants, cardiac diseases are not only likely to coexist with pregnancy, but will also increase in frequency over the years to come (28).

In developing countries with a higher prevalence of rheumatic fever, cardiac disease may complicate as many as 5.9% of pregnancies with a high incidence of maternal death. Since many of these deaths occur during or immediately following parturition, heart disease is of special importance to the anesthesiologist. This importance arises from the fact that drugs used for

preventing or relieving pain during labor and delivery exert a major influence (for better or for worse) on the prognosis of the mother and newborn. Properly administered anesthesia and analgesia can contribute to the reduction of maternal and neonatal mortality and morbidity (29).

Symptoms and signs of ischemic heart disease in pregnancy:

Severe or progressive dyspnea, progressive orthopnea, paroxysmal nocturnal dyspnea, hemoptysis, exertional syncope, chest pain related to effort or emotion, and progressive or generalized edema indicate the presence of heart disease. Physical findings strongly suggestive of heart disease include cyanosis, clubbing, persistent neck vein distension, positive hepatojugular reflux, palpable thrill, diastolic murmurs, paradoxical splitting of cardiac sounds, true cardiomegaly, documented sustained dysrhythmias, and pulmonary hypertension (loud P2) (30).

Anesthetic management of the parturient with ischemic heart disease:

Hemodynamic changes that occur in pregnancy represent a significant stress test. Hence, most women with cardiac disease who remain asymptomatic throughout pregnancy tolerate labor and delivery well. Conversely, women who are breathless with less than ordinary activity or at rest usually tolerate pregnancy, labor, and delivery poorly. In these cases, when general anesthesia (GA) has to be given for operative procedures such as lower segment cesarean section (LSCS), immediate reversal from anesthesia may not be possible or desirable after surgery. Hence, postoperative ventilatory support with hemodynamic monitoring or planning of corrective procedure for the underlying cardiac lesion such as severe natural or bio-prosthetic valvular dysfunction, aortic or pulmonary artery (PA) aneurysm, and Takayasu arteritis should be considered before reversal and extubation of the parturient (10).

Peripartum monitoring:

Noninvasive BP (NIBP), electrocardiogram (ECG) for arrhythmias and heart rate, pulse oximetry, respiratory rate, signs of persistent respiratory distress, 4 hourly temperature, and input–output fluid balance are minimum mandatory monitoring required in all cardiac patients undergoing labor and delivery (10).

In case of parturients in functional class III and IV or Clark's risk Group 2 and 3, additional invasive monitoring such as intra-arterial pressure, PA pressure, PA wedge pressure, and arterial blood gas

analysis may be required during trial of labor and vaginal delivery or LSCS. However, invasive monitoring techniques are no substitute for clinical evaluation of mental status, urine output, skin temperature, capillary filling, and pulse quality is vitally an important monitoring of tissue perfusion. Monitoring should be instituted in labor suit itself and should be continued to operative and postoperative room if need for LSCS arises. Contraindications to using a PA catheter include previous Mustard or Senning operation and parturients with Tetralogy of Fallot, and pulmonary vascular disease, particularly with intracardiac shunts (31).

Anticoagulation in pregnancy:

Anticoagulant therapy is provided in pregnancy as long-term thrombolysis in patients with a history of thromboembolism or as prophylaxis in patients with valvular heart disease or prosthetic heart valves. Oral anticoagulant therapy during pregnancy is contraindicated. Warfarin therapy in the first trimester is associated with an increased incidence of fetal death and birth defects (warfarin embryopathy), and there are reports of neonatal central nervous system abnormalities from warfarin later in pregnancy. In addition, prematurity and low birth weights are more frequent in pregnancies when the mother has received oral anticoagulants during the gestational period (32).

Conclusion

The goals of anesthetic management during labor and delivery in pregnant women with heart disease include analgesia, hemodynamic monitoring, optimizing cardiovascular and respiratory functions by manipulating various hemodynamic factors and tailoring anesthetic technique for maternal and fetal well-being, and resuscitation including airway and ventilatory management if need arises.

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