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Outcomes of heart valve surgery during pregnancy: A single institute experiences

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ABSTRACT

Objective: Cardiac surgery during pregnancy often carries a high risk of death for both mother and baby. Herein, we report our experience of valvular surgery in pregnant patients. *Methods:* We retrospectively reviewed the cases of all pregnant patients that had valvular surgery performed on them between 1998 and 2018 at the Ho Chi Minh City Heart Institute, Viet Nam. Both fetal and maternal outcomes have been assessed to determine the effectiveness of surgical treatment. *Results:* The total number of patients

was 63, including 27 patients who had valvuloplasty and 36 patients who had valvular replacement. The maternal and fetal mortality rates were 4.7% and 14.3% respectively. Adverse maternal outcomes occurred in 25% of patients (n=16), including low cardiac output, cardiac arrhythmia, and acute pulmonary edema. Adverse fetal outcomes occurred in 41.2% of patients (n=26) including termination by cesarean (4), miscarriage (5), threatened abortion (12), pre-term delivery (3), and still birth (2). Factors that affect maternal mortality include pre-operative NYHA (p= 0.037) and the type of operation (p =0.034). Factors that affected fetal mortality included cardiopulmonary bypass time (p = 0.003) and clamp time (p= 0.01). The average follow-up was 103.94 ± 73.9 months (range 1- 259) with 95% completion of follow-up. *Conclusions:* Surgical treatment for pregnant patients with valvular heart disease remains a challenge. The coordination of many medical specialists, the use of CPB and the timing of surgery should be optimized where possible to achieve the best outcomes for both mother and fetus.

Keywords: pregnancy, valvular surgery, feto-maternal outcomes

1. INTRODUCTION

Pregnant patients with pre-existing heart disease are uncommon but they experience many complications when undergoing treatment for their cardiovascular disease during pregnancy. Risk assessment classifications such as ZAHARA, CARPREG studies (Siu, 2001), and most recently the guidelines of the European Society of Cardiology 2018 (Regitz-Zagrosek, 2018) have helped identify risks for mother and fetus as well as a treatment method for this pathology group. The most complex group of pregnant patients comprises of those with valvular disease and there are many complications for both mother and fetus. Cardiovascular complications occur in up to 13% of pregnancies and fetal complications in up to 20% according to the CARPREG study. The type of heart disease, whether or not there are existing cardiovascular complications, the gestational age of the fetus, the capacity and diagnostic facilities of the heart center as well as the experience of the cardiologists all influence a multi-disciplinary team's ability to be able to devise an appropriate treatment plan. The feto-maternal risk of valvular surgery during pregnancy is strongly related to the severity of maternal valve disease as well as whether it is performed as an elective or emergent operation (Siu, 2001; Regitz-Zagrosek, 2018). It is also necessary to distinguish between two different groups of patients; pregnant patients with pre-existing valvular heart disease and separately, patients who have had previous valvular heart surgery and then have become pregnant.

The aim of this study is to evaluate the effectiveness of surgical treatment in pregnant patients with valvular heart disease. The 30-day mortality and morbidity of mother and fetus are two outcomes that we will assess in our study.

2. METHODS

We performed a retrospective study of all pregnant patients with concomitant valvular heart disease from January 1998 to December 2018 at the Heart Institute of Ho Chi Minh City, Vietnam. This study focused on pregnant patients who had an intervention performed on a heart valve according to the flow chart below (figure 1).

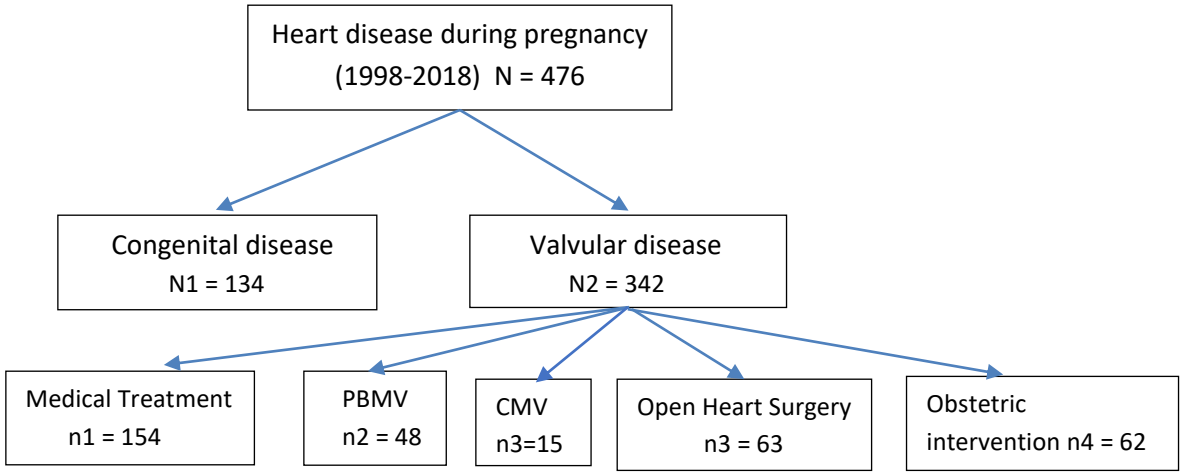

Figure 1 Flowchart of study

The study excluded pregnant patients with congenital heart disease, vascular disease, and patients with peripartum cardiomyopathy. The study also excluded all pregnant patients who had either a percutaneous balloon mitral valvotomy (PBMC) or a closed mitral valvotomy (CMV). Maternal cardiovascular outcomes included death, low cardiac output, pulmonary edema, severe arrhythmia, thrombo-embolism, endocarditis, aortic dissection, acute coronary syndrome, and hospitalization for other reasons. Fetal outcomes included abortion and threatened abortion, premature birth, stillbirth, neonatal death, and termination of pregnancy. All patients in study were divided into two groups: group A, without fetal outcomes and group B, with fetal outcomes.

Surgical summary: After a multi-disciplinary consultation between cardiologists, cardiac surgeons, obstetricians, and neonatologists, patients were treated depending on the progression and severity of valvular heart disease and gestational age. During surgery, patients were monitored with invasive hemodynamics (with Swan-Ganz catheter or FLOTRAC system) and uterine contractions and fetal heart rate were monitored with specialized equipment (figures 2 and 3). After surgery, the patient and the fetus continued to be monitored in the Intensive Care Unit (ICU). The patient was treated with MgSO4, Salbutamol and progesterone supplementation drugs to inhibit and prevent abnormal uterine contractions. Open heart surgery was performed by cardiopulmonary bypass (CPB) as usual with normothermia, glucose supplementation, high systemic pressure (>70 mm Hg), pulsatile flow and high flow rate (>2.5 L/min/m2). Vasoconstrictors (phenylephrine) were used cautiously to maintain mean systemic pressure ≥ 70mmHg. Emergent surgery was defined as hemodynamically unstable patients requiring hospitalization and surgery within 3-6 hours.

Statistical Analysis: quantitative variables are expressed as mean ± standard deviations. The qualitative variables are expressed as a percentage Using 2-tailed independent T test to compare of means. A multivariate analysis for independent variables was performed in order to identify risk factors correlating with feto-maternal mortality. A P value of ≤ 0.05 is considered statistically significant. Data entry and data analysis was performed using the IBM SPSS Statistics software, version 20.0. The research design was approved by the Ethics Committee of our Institute.

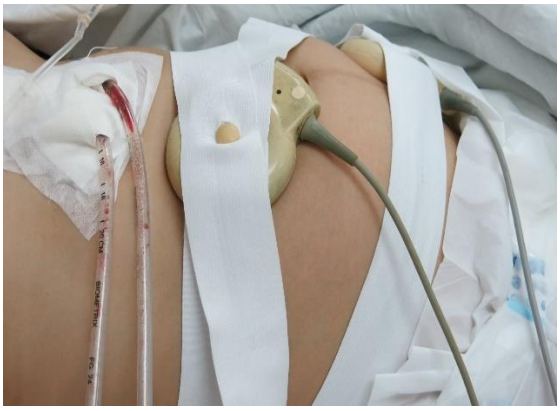

Figure 2 Doppler monitor *fetal heart* rate and uterine contractions

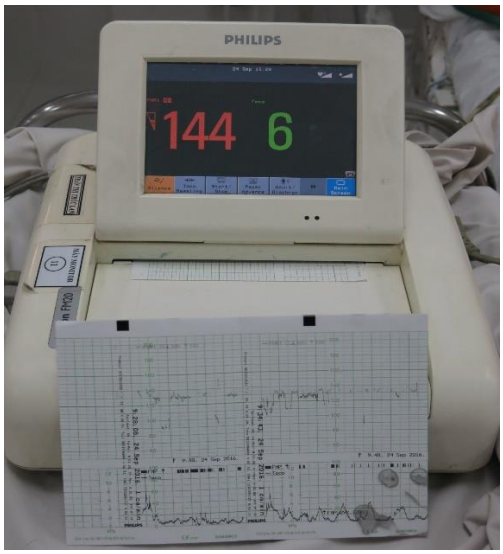

Figure 3 Monitoring fetal heart and uterine contractions

3. RESULTS

Between 1998 and 2018, according to the flow chart above, a total of 63 patients underwent surgery. The majority of cases were for mitral stenosis (66.6%) and mitral regurgitation (12.7%). Some pre-operative criteria of all patients are presented in table 1. The mean time of CPB was 63.7 ± 31.5 minutes (range from 24 to 167) and the mean time of aortic clamp was 43 ± 19 minutes (range from 15 to 113). The mean time of mechanical ventilation was 30.76 ± 51.25 hours (range from 3 to 237) and the mean time of stay in ICU was 2.8 ± 3.76 days (range from 1 to 24).

Table 1 pre-operation patient's characteristics

Characteristics	Valve Surgery (N= 63)
Maternal age (years)	29,3 ± 5 (21-42)
Gestational age (weeks)	24,5 ± 5 (8-34)
1st pregnancy	51%
Urgent operation (12-24h)	35%
Valve Pathology	
- Pure mitral stenosis	25
- Mitral regurgitation	26
- Aortic stenosis/regurgitation	3
- Multi-valvular disease	3
- Mitral valve thrombosis	5
Echocardiography	
- Mitral orifice area (cm2)	
- Severity of mitral regurgitation	0,72 ± 0,06*
	3,5 ± 0,5#
- Systolic pulmonary artery Pr pressure (mmHg)	77,5 ± 21 (35-130)

*mitral stenosis; #mitral regurgitation

Of 36 patients who had valvular replacement, 32 patients had their mitral valve replaced, 1 patient had her aortic valve replaced and 3 patients both their mitral and aortic valves replaced. 11 of the 36 patients had their valves replaced with biological valves. There were 8 patients that required a re-operation due to mechanical valve thrombosis, all of whom had required emergent or urgent surgery. Mitral valve repair was performed successfully for 27 patients, of which commissurotomy and splitting of sub-valvular apparatus was performed in 10 patients; and annuloplasty with artificial ring (Carpentier-Edwards- USA) combined with other techniques in the remaining 17 patients. The 30-day mortality in the mitral valve group was 3 patients (4.7%), of which two cases had to undergo emergent surgery in the context of acute pulmonary edema (the first case due to mitral valve thrombosis and the second case due to severe isolated mitral stenosis). The cause of death for the 3 cases was irreversible heart failure accompanied by multi-organ failure. Other maternal cardiovascular complications were as follows: arrhythmias in 10 cases (new atrial fibrillation in 5, sinus bradycardia in 1 and ventricular ectopia in 4 patients), low cardiac output in 12 patients and in one patient, pulmonary edema continued after replacement of the mitral valve. No cases suffered from endocarditis, acute coronary syndrome, or thrombo-embolism during their hospital stay. 9 fetuses died (including 3 fetuses died as a result of maternal death). Adverse fetal outcomes occurred in 41.2 % of cases including 5 cases of miscarriage (7.9%), 12 cases (19%) of threatened miscarriage, 3 cases (4.7%) of premature birth (and 2 resultant deaths), 2 cases (3.2%) of still birth and 4 cases that were required to undergo cesarean section from 12 to 48 hours after cardiac surgery (of which one case died). After analysis of the data to determine all factors that could affect fetal outcomes, we have found that fetal age ($p = 0.27$), mechanical ventilation time ($p = 0.076$), and duration of ICU stay ($p = 0.053$) do not affect fetal outcomes. However, mitral orifice area in patients with isolated mitral stenosis ($p = 0.047$), CPB time ($p = 0.003$) and clamp time ($p= 0.01$) negatively affected fetal outcomes. In contrast, maternal mortality was not affected by the maternal age ($p = 0.7$), CPB time ($p = 0.23$), clamp time ($p = 0.67$), mechanical ventilation time ($p = 0.16$), and duration of ICU stay ($p = 0.26$), but pre-operative NYHA ($p=0.037$) and the type of operation performed ($p= 0.034$) were influential in maternal mortality outcomes.

95.3% of patients had completed follow-up with the average follow-up time found to be 103.94 ± 73.9 months (from 11 to 259 months). The total follow-up time was 6 548 patient-years. Late maternal mortality occurred in 2 cases, both due to progressive heart failure after surgery.

4. DISCUSSION

Minimizing mortality and morbidity for both mother and fetus is the first principle of treatment for this group of patients. It is not easy to achieve this goal; therefore, the risk should be stratified for each subgroup of valvular heart disease in combination with multidisciplinary consultation, thereby providing appropriate treatment for each stage of the disease and each individual. The modified WHO classification has 4 groups, in which pregnant patients with valvular disease in risk groups III and IV experienced adverse cardiovascular events at a rate of 19-27% in group III and 40-100% in group IV (Regitz-Zagrosek, 2018; Suwanrath, 2018). The most appropriate time for surgery to prevent adverse maternal and fetal outcomes is 13 to 28 weeks of pregnancy (Regitz-Zagrosek, 2018). All patients in this study had surgical indications when optimal severe heart failure treatment failed, in which 24.5% of patients were operated on urgently. At our institute, there are 3 interventions for pregnant patients: (1) percutaneous balloon mitral valvotomy (PBMV), (2) repair or replacement of the mitral valve with or without the replacement of the aortic valve, and (3) closed mitral valvotomy (CMV) which was only performed in the period from 1992 to 1999.

Choose PBMV or open mitral valve surgery?

Research by de Souza shows that PBMV is safer, more effective, and preferred because fetal mortality is significantly less (1 vs 8, $p = 0.025$) when compared with open mitral commissurotomy (de Souza, 2001). In Sharmaa's study, the implementation of PBMV on 24 patients with mitral stenosis due to rheumatic heart disease also showed the efficacy and safety of this method (Sharmaa, 2018). A registry study by van Hagen on patients with rheumatic mitral valve disease shows that 70% of these patients have mitral valve stenosis, 30% have mitral regurgitation and no cases of aortic valve disease were recorded. Among those with stenosis, 59% had moderate to severe stenosis. Notably, only 16/390 of these patients had an intervention performed on the mitral valve, of which 14 patients had a PBMV performed and only 2 patients had their mitral valve replaced. There was only 1 case of maternal death with severe mitral stenosis (van Hagen, 2018). Without PBMV and open-heart surgery, the maternal mortality rate as reported by Diao was 34% (Diao, 2011). However, PBMV or CMV only resolves cases of simple mitral stenosis. In pregnant patients who are not candidates for balloon valvuloplasty, mitral valve surgery should be considered. Though valve surgery is only considered if medical treatment has failed because it is associated with a high fetal mortality risk of 19% (Parry, 1996). The cause seems to be related closely to CPB, the agent that the authors claim causes increased maternal and fetal complications (Weiss, 1998). A study by John et al. showed that the feto-maternal mortality rate in pregnant patients using CPB was 14.3% and 4.8%, respectively (Jonh, 2011). A meta-analysis by Jha with 154 patients showed that the maternal mortality rate was up to 11.2 deaths per 100 pregnancies and fetal death occurred at a rate of 33.1 deaths per 100 pregnancies. 89% of the cases included in the meta-analysis had required emergent surgery. Furthermore, the risks of premature birth and cesarean section were found to be 28% and 33.8% respectively and it was also found that both the feto-maternal mortality and morbidity rate were higher than prior to January 1990 (Jha, 2018). Another meta-analysis by Sepehripour et al. proposed that CPB conducted at normothermia, with high pressure, pulsatile, high flow bypass, with monitoring of the fetal heart and uterine contractions, can greatly minimize feto-maternal risks that may occur as a result of the procedure (Sepehripour, 2012). Despite this, adverse feto-maternal outcomes in cases requiring urgent or emergency surgery are still very high. The maternal and fetal mortality rates of the valvular surgery group in our study were 4.7% and 14.3% respectively, most likely because our emergency surgery rate is lower than that of other studies and the gestational age at which we perform surgeries is within the recommended age for surgical intervention. As a comparison, Avila et al reported their maternal death rate as 7.3% and their fetal death rate as 29.2% (Avila, 2009). Hosseini reports fetal death and miscarriage of up to 43.75% on emergent surgery (Hosseini, 2015) and Elassy showed that fetal death occurred in 43.5% and maternal death in 8.7% of 23 patients with severe valve malfunction requiring emergency surgery. In 13 surviving babies; only 6 (26.1%) had full-term delivery (Elassy, 2014). Similarly, a report by Elsayed et al. presents mortality rates of 37.5% for maternal patients and 68.75% for fetal patients in a series of 16 urgent surgery cases due to acute malfunctioning mechanical mitral valves (Elsayed, 2019).

5. CONCLUSION

Surgical treatment for pregnant patients with valvular heart disease remains a challenge. The coordination of many medical specialists, the use of CPB and the timing of surgery should be optimized where possible to achieve the best outcomes for both mother and fetus.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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Conflict of Interest: The authors declare that there are no conflicts of interests.

Ethical approval

Ethics approval for the study was obtained from the Institutional Review Board of University of Medicine and Pharmacy at HCMC on 17th Oct, 2019 (N_0: 510/DHYD-HDDD).

Data and materials availability

All data associated with this study are available upon request to the corresponding author.

Peer-review

External peer-review was done through double-blind method.

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