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RESEARCH ARTICLE

Cesarean Section and Emergency Operations in Pregnant Women With Cardiac Disease, 10-Year Results

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ABSTRACT

Objectives: Cardiac disease complicates 1–4% of pregnancies, necessitating careful management and birth planning. This retrospective study examines anesthesia practices and outcomes in pregnant women with heart disease undergoing cesarean section (C/S) and emergency surgery at our cardiac center.

Methods: This retrospective study included all pregnant women with heart disease who underwent C/S or emergency surgery. Electronic and medical records of the patients were reviewed.

Results: The study included 74 pregnant patients, all of whom received general anesthesia. The most common cardiac condition was mitral valve replacement, followed by isolated pulmonary hypertension. Emergency C/S was performed in 23 patients, and one required emergency cardiopulmonary bypass. Maternal hospital mortality was 8.1%, with 72 live births. Extubation in the operating room was achieved in 24% of cases, while 22% remained in the ICU for more than a day. Two patients required ECMO, one of whom died postoperatively.

Conclusion: Close monitoring of pregnant women with cardiac disease throughout pregnancy is essential. Multidisciplinary management in specialized centers can significantly reduce perioperative morbidity and mortality.

Keywords: Anesthesia, cesarean section, heart disease, mortality, pregnancy

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Introduction

Approximately 1–4% of pregnancies are complicated by cardiac disease.[1] The most common cardiovascular disorder during pregnancy is hypertensive disorder (5–10% of all pregnancies). Among the other cardiovascular conditions, congenital heart diseases are the most common during pregnancy in the Western world (75–82%), while rheumatic valve diseases are common in non-Western countries (56–89%).[2] Maternal mortality is reported at 0.6%.[3] However, there are limited data regarding the incidence of pre-existing cardiac conditions during pregnancy in many countries.

Pregnant women with cardiac disease require careful clinical management and birth planning based on the type of cardiac lesion. In these patients, both anesthesia induction and maintenance pose significant risks. Hemodynamic changes caused by cardiac disease during labor should be well understood.

In this study, we aimed to retrospectively investigate the anesthesia practices and outcomes during cesarean sections (C/S) and emergency surgeries performed on pregnant women with heart disease at our cardiac surgery center.

Methods

This retrospective study was conducted with the approval of the Ethics Committee (reference number: 2023-16-731). This study was conducted in accordance with the principles of the Declaration of Helsinki. It included all pregnant women with heart disease who underwent C/S or emergency surgery at Koşuyolu High Specialty Training and Research Hospital, a cardiac surgery center, between 01.06.2013 and 31.06.2023. Patients whose data were incomplete or inaccessible were excluded from the study.

Data collected included: patients' age, weight, gestational age, intensive care unit (ICU) stay, total hospital stay, type

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of cardiac disease, echocardiographic findings, emergency or elective C/S or cardiac surgery, cardiac ejection fraction (EF), anesthetic, narcotic, and muscle relaxant drugs used intraoperatively, intraoperative central venous catheter placement, intraoperative hemoglobin (Hb) levels, need for inotropic support during cesarean section, extubation status (in operation room or ICU), live/stillbirth outcomes, intraoperative and postoperative maternal mortality, and intraoperative fetal mortality. Since our hospital does not have a neonatal intensive care unit, all newborns were transferred to NICUs under pediatric supervision.

Statistical Analysis

Statistical analyses were performed using SPSS version 26 software. The Kolmogorov–Smirnov test was used to assess the distribution of variables. Mann-Whitney U Test was used to compare the groups. A p value below 0.05 was accepted as a statistically significant difference. Variables that did not follow a normal distribution were presented as median (minimum–maximum), while normally distributed variables were expressed as mean±standard deviation. Demographic characteristics that were not categorized were recorded as frequencies, both numerically and as percentages.

Results

This study included 74 pregnant patients who underwent emergency or elective C/S or surgery, all receiving general anesthesia. No regional anesthesia was administered. The demographic characteristics of the patients and preoperative echocardiographically measured ejection fractions are shown in Table 1.

The most common cardiac condition was mitral valve replacement (n=13), followed by isolated pulmonary hypertension (n=10) and mitral stenosis (n=9) (Table 2). Fifty-one patients underwent elective C/S, 22 had emergency C/S, and one patient required emergency cardiopulmonary bypass (Table 3). Two elective C/S patients also had tubal ligation, while one emergency C/S patient with a mechanical tricuspid valve required a hysterectomy due to uterine atony.

Maternal hospital mortality was 8.1% (n=6), all in emergency cases. One patient with infective endocarditis suffered cardiac arrest in the ICU, and emergency C/S under CPR was unsuccessful. The remaining five deaths occurred in ICU patients with infective endocarditis (n=1), untreated VSD with Eisenmenger syndrome (n=1), pulmonary hypertension (n=3), and acute myocardial infarction (n=1). Two pulmonary hypertension patients also had Eisenmenger syndrome.

A 27-year-old, 26-week pregnant patient with acute myocardial infarction underwent emergency three-vessel CABG under CPB. Fetal heart sounds were monitored, maternal hemodynamics remained stable, and the pregnancy continued until a successful C/S three months later.

Of the 74 C/S, 72 (97.3%) resulted in live births. Two stillbirths occurred: one in a patient with infective endocarditis who underwent emergency C/S under CPR, and another in a myocardial infarction patient who suffered cardiac arrest during emergency angiography, underwent CABG, and later developed fatal cerebral edema.

Table 1. Demographic and clinical characteristics of the patients

	Mean±SD	Max	Min
Age (year)	31±6	42	17
Weight (kg)	74±10	103	50
Gestation (weeks)	36±3	40	26
Intensive care duration (days)	5±9	48	1
Length of hospital stay (days)	11±18	138	2
Ejection fraction (%)	62±8	65	30

Max: Maximum; Min: Minimum

Table 2. Distribution of preoperative cardiac diseases (n)

	n
Operated MVR	13
Operated AVR	5
Operated AVR+MVR	2
Operated TVR+ICD	1
Isolated PAH	10
PAH+ congestive heart failure	1
PAH+TR	1
PAH+ASD	3
Cardiomyopathy	4
Arrhythmia (VES, AF)	3
MS	9
AS	2
MS+AS	2
MS+ MR+AR	1
MR	3
AR	1
PS	1
Acute myocardial infarction	3
Previous myocardial infarction	1
Eisenmenger syndrome	3
ASD + Pulmonary embolism	1
Infective endocarditis +MR +AR	2
ARDS+ECMO	1
Operated CABG	1

MVR: Mitral valv replacement; AVR: Aortik valv replacement; TVR: Tricuspit valve replacement; ICD: İmplantable cardiac defibrillators; PAH: Pulmonary arterial hypertension; TR: Tricuspit regurgitation; ASD: Atrial septal defect; VES: Ventricular extrasystole; AF: Atrial fibrillation; MS: Mitral stenosis; AS: Aortic stenosis; AR: Aortic regurgitation; MR: Mitral regurgitation; PS: Pulmonary stenosis; ARDS: Acute respiratory distress syndrome; ECMO: Ekstracorporeal membran oxygenation; CABG: Coronary artery bypass graft.

Table 3. Perioperative characteristics of patients

	n	%
Emergency surgery	23	31.1
Elective surgery	51	68.9
Surgery performed		
S/C	73	98.6
Coronary artery bypass grafting	1	1.4
EF (%)		
30	3	4.1
40	2	2.7
55	3	4.1
65	61	82.4
No	5	6.8
İntraoperative CVP (mmHg)		
≤12	23	31.1
>12	10	13.5
No	41	55.4
Labor		
Alive (70 single-1 twin)	71	96
Exitus	2	2.7
Continuing pregnancy	1	1.3
Maternal hospital mortality		
İntraoperative	1	1.3
Postoperative	5	6.8
Extubation in the operating room	18	24.3
İntraoperative Hb mean (min-max) (mg/dL)	11.3 (7.2–16)	

n: Number of cases; S/C: Sectio caesarea; EF: Ejection fraction; CVP: central venous pressure.

Among the 74 patients, 22 had previously undergone open-heart surgery (Table 2). All underwent elective C/S and were extubated within 4 hours postoperatively. Their median ICU stay was 1 day (range: 0.3–2.5 days), and median hospital stay was 7.5 days (range: 2–13 days). Three patients with mitral valve thrombosis received preoperative heparin infusion without regression. Postoperatively, they continued heparin or low molecular weight heparin.

Three patients were admitted with acute myocardial infarction (MI) (Table 2). The first, in cardiogenic shock after a failed stent procedure, underwent emergency C/S with IABP and inotropic support, delivering a live baby. A postoperative stent was placed in the left anterior descending artery (LAD), and despite gastrointestinal bleeding, the patient was discharged in good health. The second, at 26 weeks, underwent emergency three-vessel CABG, delivering a healthy baby via C/S three months later. The third, admitted with anterior MI, experienced cardiac arrest during angiography and underwent on-pump LAD bypass under CPR. Ventricular fibrillation and intrauterine fetal demise occurred postoperatively, leading to emergency C/S. The mother developed hypoxic-ischemic brain injury and died on postoperative day 38.

Table 4. Characteristics of patients undergoing emergency or elective surgery

	Urgent			Elective		
	M±SD	Max	Min	M±SD	Max	Min
Age (years)	30±5	41	21	31±6	42	17
Weight (kg)	72±11	103	50	75±8	95	58
Gestational duration (weeks)	35±3	39	26	37±2	40	28
Intensive care duration (days)	10±14	48	1	3±4	25	1*
Length of hospital stay (days)	17±28	138	1	9±9	52	1*
Ejection fraction (%)	60±12	65	30	64±5	65	40

*: $p<0.05$ (Mann–Whitney U test). M: Mean; Max: Maximum; Min: Minimum; SD: Standard deviation.

Among 16 patients with pulmonary hypertension, 10 had primary pulmonary hypertension (Table 2), and 9 required emergency surgery. None needed intraoperative inotropes or vasopressors. Perioperative treatments included iloprost (n=3), sildenafil (n=4), and diltiazem infusion (n=2). Median preoperative pulmonary artery pressure was 96 mmHg (range: 30–118 mmHg).

Of the 5 patients with low ejection fraction (EF≤40%), 4 were extubated within 2 hours and discharged in a median of 2 days (range: 1–6 days). The fifth, admitted with acute MI and cardiac arrest, underwent emergency CPB under CPR but did not survive, along with the fetus.

All C/S procedures involved invasive arterial monitoring. Central venous access was obtained in 34 patients (Table 3), but pulmonary artery catheterization was not performed intraoperatively in pulmonary hypertension cases. No intraoperative inotropic infusions were required.

Anesthesia induction included propofol+ketamine (n=21), propofol alone (n=50), etomidate (n=2), and sodium thiopental (n=1). Rocuronium was used for muscle relaxation. Maintenance included midazolam (n=2), desflurane (n=2), and sevoflurane (remaining patients). Analgesia was achieved with remifentanil (n=2) or fentanyl (others).

Twenty-four percent of patients were extubated in the operating room, while 52% were extubated within 4 hours in the ICU (Table 3). The mean ICU stay was 5±9 days, with 22% staying over a day (Table 1).

Two patients required ECMO: one with COVID-19-related ARDS received preoperative venovenous ECMO, underwent C/S under ECMO, and was discharged after 48 ICU days with a tracheostomy. The second, with severe postoperative pulmonary hypertension, received postoperative veno-arterial ECMO but died on postoperative day 17 due to multi-organ dysfunction and sepsis.

The age, gestational duration, ICU stay, hospital stay, and left ventricular ejection fraction of patients who underwent surgery either urgently or electively are shown in Table 4. The length of stay in the intensive care unit was significantly longer in patients undergoing urgent surgery (10±14 days) compared to those undergoing elective procedures (3±4 days) (Mann–Whitney U test. [p<0.001]). Similarly, total hospital stay was also significantly prolonged in the urgent group (17±28 days) compared to the elective group (9±9 days) (Mann–Whitney U test. [p=0.002]).

Discussion

In our study, 68.9% of pregnant women with cardiac disease underwent elective C/S, 29.7% had emergency C/S, and 1.3% required emergency cardiopulmonary bypass. Maternal hospital mortality was 8.1% (1.3% intraoperative, 6.8% postoperative), and fetal mortality was 2.7%. Among emergency surgery patients, 48% had pulmonary hypertension (PHT), and 6% had an ejection fraction of ≤40%.

Pregnancy induces significant cardiovascular changes, including a 50% increase in blood volume by term, a 30–50% rise in cardiac output due to increased stroke volume and heart rate, and a reduction in systemic vascular resistance. Systolic and diastolic blood pressures decrease by 10%. These adaptations impact maternal outcomes depending on the type and severity of cardiac disease.[2]

Cardiac disease is a leading global cause of maternal mortality, responsible for 26.5% of pregnancy-related deaths.[4] In a cohort of 306 pregnant women with cardiovascular disease, the most common conditions were arrhythmia (28.8%), congenital heart disease (23.5%), and cardiomyopathy (23.5%). Despite these risks, 98% of pregnancies resulted in live births.[5] In our study group, patients with a history of mitral valve replacement, pulmonary arterial hypertension, or mitral stenosis ranked in the top three. The live birth rate in our cohort was 97.3%.

Stenotic lesions during pregnancy carry a higher risk of decompensation. Heart failure may develop, and adverse fetal outcomes like preterm birth or stillbirth can occur.[6] Rheumatic heart disease is the most common cardiac condition in pregnancy (88%), with isolated mitral stenosis being the most frequent.[7] In severe mitral stenosis, increased blood volume and heart rate reduce diastolic filling time, raising left atrial and pulmonary pressures.[8] Regurgitant valve lesions are generally better tolerated. Pregnant women with severe valvular disease should be followed at tertiary centers by a multidisciplinary team including cardiologists, surgeons, anesthesiologists, and maternal–fetal medicine specialists.[9]

Our study identified 19 patients with native valve lesions, 47.4% of whom had isolated mitral stenosis. Among unoperated valve lesions, 15.8% had mitral regurgitation, 10.5% aortic stenosis, and 10.5% combined mitral and aortic stenosis. No perioperative mortality occurred. Two patients with mitral stenosis and systolic pulmonary artery pressure >75 mmHg underwent successful C/S without complications. A successful C/S under VV ECMO for secondary severe pulmonary hypertension due to rheumatic mitral stenosis and placenta accreta has also been reported in the literatüre.[10]

A comprehensive evaluation should be conducted both before and during pregnancy to achieve favorable outcomes for women with prosthetic heart valves and their babies. In these patients, the status of the existing valve and the presence of myocardial dysfunction should be assessed through echocardiography. Pregnant women with mechanical heart valves should be monitored in a tertiary care center with a specialized team, including cardiologists, surgeons, anesthesiologists, and maternal–fetal medicine obstetricians, for the management of high-risk cardiac conditions during pregnancy.[9] The management and close monitoring of anticoagulation in these patients is crucial for both the prosthetic valve and the fetus. Many patients with heart disease can now be safely delivered surgically by skilled anesthesiologists.[11]

Our study included 21 pregnant women with prior heart surgery (Table 2). None experienced hemodynamic instability during or after C/S, likely due to correction of cardiac lesions. The median ICU stay was 1 day (0.3–2.5), and median hospital stay was 7.5 days (2–13). Thrombosis on mechanical valves is a major complication. At our center, patients with mechanical prosthetic valves scheduled for elective C/S receive preoperative heparin infusion. Postoperatively, after obstetric approval and bleeding assessment, low-molecular-weight heparin or heparin is restarted, followed by warfarin to reach target INR. This protocol may prolong hospital stay, with a maximum of 13 days observed. No new thrombosis developed, and in 3 patients with partial thrombus on mechanical mitral valves, no progression was detected.

A meta-analysis found that unfractionated heparin combined with vitamin K antagonists (VKA) or VKA monotherapy posed the lowest bleeding risk after C/S (8% and 12%, respectively). In contrast, LMWH with VKA (33%) or LMWH alone (22%) showed the highest bleeding risk.[12] Therefore, when planning anesthesia for C/S in women with prosthetic valves, their antiplatelet and anticoagulant regimen must be carefully reviewed.

Women with mechanical valves are at high risk of valve thrombosis, requiring individualized anticoagulation

strategies.[9] VKAs can be used in the second trimester, while LMWH is preferred outside this period. However, thrombosis remains a major concern, and close monitoring is critical. One reported case involved a pregnant woman on LMWH who developed mechanical mitral valve thrombosis, requiring emergency C/S followed by valve replacement.[13]

Congenital heart disease may also be encountered during pregnancy, with septal defects being the most common. In our study, three patients had ASD with PHT, and one had ASD with pulmonary embolism. These were not cyanotic heart diseases. A successful C/S was reported in a woman who developed sudden PHT and right heart failure five years after ASD repair. She recovered despite a temporary increase in PA pressure and cardiac dysfunction postoperatively.[14] This case highlights that correcting congenital defects does not eliminate risk, and careful monitoring post-C/S is essential.

In cyanotic congenital heart disease, maternal mortality remains high. Close collaboration among cardiologists, anesthesiologists, and obstetricians, along with invasive monitoring, is critical for hemodynamic stability. Although evidence is limited, regional anesthesia can be suggested as an option for high-risk pregnancies.[15] In a retrospective study, cesarean section was preferred in 24% of patients with congenital heart disease, and in mWHO class III, cesarean section was performed with combined spinal–epidural anesthesia.[16] No patients in our cohort had cyanotic cardiac lesions.

Atheromatous coronary occlusions are rare in pregnancy, but spontaneous coronary artery dissection (SCAD) may occur in previously asymptomatic women. In hemodynamically stable SCAD cases, conservative management is preferred, while unstable patients may benefit from intra-aortic balloon pump support.[17] Acute coronary syndrome (ACS) treatment during pregnancy follows standard protocols; however, maternal instability may necessitate emergency delivery.[18] A reported case of myocardial infarction due to amniotic fluid embolism during labor required successful emergency perimortem C/S, underscoring the importance of readiness and staff training.[19] In our study, three patients presented with ACS, and two had favorable outcomes.

Pulmonary arterial hypertension (PAH) poses significant obstetric risks, with maternal mortality rates reaching 26%.[20] Primary PAH is the most common type among young women,[21] and is classified as WHO class IV—making severe PAH a contraindication for pregnancy. Genetic predisposition plays a role, with at least 18 known PAH-related genes,[22] and pregnancy itself may trigger the disease.[23] The postpartum period, particularly the first week, is the highest risk for complications such as hypertensive crises and right heart failure.[1] Severe PAH is associated with higher complication rates than milder forms.[24]

In-hospital maternal mortality can be up to 85 times higher in PAH patients compared to those without PAH. Cesarean section is the preferred delivery method, and a multidisciplinary team approach is essential.[25] In our study, 10 patients had isolated PAH. Two live births occurred, but both mothers (13.3%) died postoperatively. One required ECMO and an intra-aortic balloon pump due to hemodynamic collapse and biventricular failure.

In the present study, both intensive care unit (ICU) stay and total hospital stay were significantly longer in patients undergoing urgent surgery compared to those undergoing elective procedures. Specifically, ICU length of stay was 10±14 days in the urgent group versus 3±4 days in the elective group ($p<0.001$), while total hospital stay was 17±28 days and 9±9 days, respectively ($p=0.002$) (Table 4). Preoperative instability, delayed diagnosis, and limited time for optimization may have led to this result. The increased care burden highlights the need for enhanced perioperative planning, early risk stratification, and efficient use of critical care resources in patients undergoing urgent surgery.

There are no universal recommendations on cesarean anesthesia method; however, the 2018 ESC guidelines[1] advise C/S in women on oral anticoagulants, those with severe aortic disease, persistent heart failure, or severe PAH (including Eisenmenger syndrome). Management of high-risk pregnancies should be individualized by a multidisciplinary cardio-obstetric team, ideally at a specialized center.[26]

Regional techniques are also recommended for cesarean anesthesia.[11] However, single-shot spinal anesthesia may cause hemodynamic instability or unpredictable block levels in patients with borderline cardiac function.[27] Regional anesthesia may be an option for patients with corrected cardiac defects (e.g., post-valve or congenital heart surgery), but the frequent use of anticoagulants in this population often leads to avoiding such techniques. Additionally, regional anesthesia requires experienced practitioners. In our study, all C/S and emergency surgeries were performed under general anesthesia. The choice likely reflected the anesthesiologists' assessment of bleeding risk related to anticoagulant and antiplatelet therapy.

High-risk pregnancies in women with heart disease should be managed by a multidisciplinary team including a cardiologist, obstetrician, and anesthesiologist.[1] Additional specialists may be required depending on the

case. Anesthesiologists must understand the hemodynamic impact of the patient's cardiac condition and be prepared for intraoperative changes. Continuous intraoperative vital sign monitoring is essential. In our study, CVP was monitored in 27.6% of C/S cases. Postoperative invasive pulmonary artery pressure monitoring was performed when necessary in patients with pulmonary hypertension.

Limitations

This study is retrospective with a limited sample size. As no patients received regional anesthesia, a comparison between general and regional techniques could not be made. Additionally, due to the lack of a neonatal intensive care unit at our hospital and immediate transfer of newborns, detailed evaluation of neonatal care was not possible.

Conclusion

Close monitoring of pregnant women with cardiac disease throughout pregnancy is crucial. Management should be multidisciplinary, involving specialists at experienced centers. Proper care during pregnancy, delivery, and the postpartum period can significantly reduce maternal morbidity and mortality. However, there is a lack of prospective or randomized studies addressing cardiac disease in pregnancy and its fetal outcomes. Consequently, current guideline recommendations often rely on low-level evidence. More prospective research is needed to strengthen existing knowledge and improve outcomes.

Disclosures

Ethics Committee Approval: The study was approved by the Koşuyolu High Specialty Training and Research Hospital Clinical Research Ethics Committee (no: 2023-16-731, date: 24/10/2023).

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