

Maternal-Fetal Outcome and Prognosis of Cardiac Surgery During Pregnancy

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Summary

Background: Cardiac surgery improves the maternal prognosis in cases refractory to medical therapy. However, it is associated with risks to the fetus when performed during pregnancy.

Objectives: To analyze maternal-fetal outcome and prognosis related to cardiac surgery performed during pregnancy and puerperium.

Methods: The outcome of 41 gestations of women undergoing cardiac surgery during pregnancy and puerperium was studied. Fetal cardiocography was performed throughout the procedure in patients with gestational age above 20 weeks.

Results: Mean maternal age was 27.8 ± 7.6 years; there was a predominance of patients with rheumatic valve disease (87.8%), of whom 15 (41.6%) underwent reoperation due to prosthetic valve dysfunction. Mean extracorporeal circulation time was 87.4 ± 43.6 min and hypothermia was used in 27 (67.5%) cases. Thirteen (31.7%) mothers experienced no events and gave birth to live healthy newborns. Postoperative outcome of the remaining 28 (68.3%) pregnancies showed: 17 (41.5%) maternal complications and three (7.3%) deaths; 12 (29.2%) fetal losses, and four (10%) cases of neurological malformation, two of which progressed to late death. One patient was lost to follow-up after surgery. Nine (21.9%) patients underwent emergency surgery, and this variable was correlated with maternal prognosis ($p < 0.001$).

Conclusion: Cardiac surgery during pregnancy allowed survival of 92.7% of the mothers, and 56.0% of the patients who presented cardiac complications refractory to medical therapy gave birth to healthy children. Worse maternal prognosis was correlated with emergency surgery. (Arq Bras Cardiol 2009;93(1):8-13)

Key Words: Thoracic surgery; pregnancy; clinical evaluation; prognosis; maternal-fetal relations.

Introduction

Heart diseases are estimated to occur in 0.5 to 1.0% of pregnancies, and they contribute to increase the maternal-fetal morbidity and mortality rate¹. In Brazil, among other types of heart diseases, rheumatic heart disease is still the most frequent in women during pregnancy and is associated with high complication rates²⁻⁴.

The functional deterioration that results from the physiological circulatory overload observed in the gestational period^{5,6} in patients with a reduced functional reserve is frequently refractory to medical therapy.

Cardiac surgery has provided a favorable maternal prognosis^{7,8} in these cases. However, this procedure is associated with high obstetric and fetal risks, with emphasis on the impact of extracorporeal circulation (ECC) and anesthetic

agents. Thus, surgical treatment of heart diseases during pregnancy and puerperium is performed only in selected cases.

We present our experience with cardiac surgery performed after it was considered the only therapeutic method able to revert the poor prognosis in a specific clinical circumstance.

Methods

From 1986 to 2007, 41 patients followed up by the Department of Heart Disease and Pregnancy of the Heart Valve Diseases Team of *Instituto do Coração* (InCor) underwent surgery during pregnancy and puerperium.

During surgery, cardiocography continuously recorded the uterine contractions and fetal heart beats in patients with gestational age above 20 weeks. Surgical and anesthetic techniques followed the recommendations established for cardiac surgery. Additional care in relation to conventional operations was taken regarding the patient's position, heparinization, ECC priming content, degree of hypothermia, and myocardial protection⁹.

The following maternal variables were studied: a)

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preoperative variables, including age, heart disease, gestational age at the time of operation, and reason for surgical indication; b) intraoperative variables, including type of procedure, ECC duration (in minutes) and temperature; and c) postoperative variables, including cardiac complications, hemorrhage, infection and death.

We also analyzed the occurrence of fetal losses, which included spontaneous abortion (up to 20 weeks of gestation), stillbirth or neonatal death (up to 28 days after birth), and prematurity (birth up to 37 weeks of gestation); birth weight; incidence of congenital malformation; and late death, defined as those occurring after the first year of life.

Prevention of premature labor was made using natural progesterone (50-mg capsules every 12 hours in the intra and postoperative periods) in place of indometacin due to the risk of the latter causing intrauterine ductus arteriosus closure.

Descriptive statistical analysis of maternal and newborn results was performed using the mean and standard deviation after performing the Shapiro-Wilk normality test. The analysis of the independent effects of maternal characteristics on the chance of complications was carried out using the Wolf method to obtain the confidence interval.

Results

Maternal age ranged between 15 and 44 years (mean of 27.8 ± 7.6 years) and, among the underlying cardiac lesions, there was a predominance of rheumatic heart valve disease, corresponding to 36 (90%) cases. Of these, 17 (42.5%) presented prosthetic valve dysfunction (15 biological and two mechanical valves) (Table 1).

Among the clinical conditions accounting for surgical

indication, heart failure and/or pulmonary congestion were the major causes, present in 25 (62.5%) cases; cardiogenic shock in five (12.5%) cases; and aortic dissection in three (7.3%) patients, of whom one had coarctation of the aorta, another had Marfan syndrome, and the third had a structurally normal heart (Table 2).

Thirty seven of the 41 operations were performed within four and 34 (mean of 21.3 ± 9.3) weeks of gestation, and four were performed during puerperium (mean 10.2 ± 8 days after delivery). Reoperation was indicated in 15 (37.5%) cases due to prosthetic valve dysfunction, followed by 14 (34.1%) cases of heart valve prosthesis implantation, seven (17.07%) mitral commissurotomies, three (7.31%) cases of correction of aortic aneurysm, one (2.43%) case of coronary artery bypass grafting, and one (2.43%) case of Blalock-Taussig procedure, which was the only intervention performed off-pump in this case series. Emergency surgery was performed in nine (21.9%) patients.

ECC time ranged from 16 to 203 minutes (mean of 87.4 ± 43.6). Hypothermia was used during ECC in 27 cases and ranged from 13.0°C to 32.2°C ($30.1^{\circ}\text{C} \pm 4.3^{\circ}\text{C}$), being classified as mild (11), moderate (11) and deep (five cases). During ECC, fetal bradycardia was recorded with a mean of 60 beats/minute (bpm), which reverted spontaneously to normal heart rate, mean of 140 bpm, after ECC (Figure 1).

Thirteen gestations (31.7%) progressed with no maternal or fetal complications (Figure 2). The outcome of the remaining 28 (68.3%) gestations showed: 17 (41.4%) maternal complications and three (7.31%) deaths in the postoperative period (Table 3); 12 (29.2%) fetal losses; and four (10%) cases of neurological malformation, two of which progressed to late death. One patient was lost to obstetric follow-up after discharge in the postoperative period of the cardiac surgery.

The mean weight of 27 (63.4%) live births was $2118.1 \pm 875.1\text{g}$; there were 14 (35%) premature deliveries, among which eight deaths occurred and four (10%) had neurological complications (cerebral anoxia associated with tetraparesis, cortical atrophy, hydrocephalus and mental retardation). These four malformations were verified in two cases of biological valve prosthesis implantation (one in the aortic position and

Tabela 1 - Maternal heart disease

| | Maternal heart disease | Absolute frequency | Relative percentage |
|----------------------|--|--------------------|---------------------|
| Mitral valve disease | Prosthetic valve dysfunction | 11 | 26.82 |
| | Mitral stenosis | 10 | 24.39 |
| | Mitral regurgitation | 6 | 14.63 |
| Aortic valve disease | Prosthetic valve dysfunction | 2 | 4.87 |
| | Aortic stenosis | 3 | 7.31 |
| | Aortic regurgitation | 2 | 4.87 |
| | Mitral + aortic prostheses dysfunction | 2 | 4.87 |
| | Aneurysm + coarctation of the aorta | 1 | 2.43 |
| | Aortic aneurysm + Marfan syndrome | 1 | 2.43 |
| | Aortic dissection in normal vessel | 1 | 2.43 |
| | Complete transposition of the great arteries | 1 | 2.43 |
| | Acute coronary insufficiency | 1 | 2.43 |
| | Total | 41 | 100 |

Table 2 - Clinical indications for surgery

| Complication | Absolute frequency | Relative percentage |
|---|--------------------|---------------------|
| Heart failure and/or pulmonary congestion | 25 | 62.50 |
| Cardiogenic shock | 05 | 12.50 |
| Aortic dissection | 03 | 7.50 |
| Mechanical prosthesis thrombosis | 02 | 5.0 |
| Post-myocardial infarction angina | 01 | 2.5 |
| Infective endocarditis | 01 | 2.5 |
| Hypoxia | 01 | 2.5 |
| Elective | 03 | 7.5 |
| Total | 41 | 100.00 |

Table 3 - Case distribution according to maternal outcome

| Complication | Absolute frequency | Relative percentage |
|------------------------|--------------------|---------------------|
| Death | 03 | 7.3 ⁽¹⁾ |
| Complications | 17 | 41.5 ⁽²⁾ |
| Heart failure | 07 | 41.2 |
| Stroke | 02 | 11.7 |
| Bleeding | 03 | 17.6 |
| Infective endocarditis | 02 | 11.7 |
| Cardiac arrhythmia* | 03 | 17.6 |
| Total | 41 | 100.00 |

1 - Relative to the total case series; 2 - Relative to the total complications that did not progress to death; Arrhythmia (atrial fibrillation in 3 cases and atrioventricular block in 2).

the other in the mitral aortic position), and in two cases of reoperation for replacement of a biological valve prosthesis in the aortic and mitral positions, respectively.

The emergency nature of surgical indication was the only variable that significantly correlated maternal characteristics with postoperative complications (Table 4).

Discussion

Results of the worldwide experience on cardiac surgery during pregnancy are controversial¹⁰⁻¹³. Studies are predominantly retrospective and the procedures used are heterogeneous; additionally, it is difficult to standardize the surgical techniques. Thus, judicious analysis of prognostic variables and their effects on the management of these patients during pregnancy is impaired.

The present study included 41 patients followed up by the same multidisciplinary team during pregnancy, according to a standardized clinical, surgical and obstetric management.

The predominance of mitral valve disease, 27 (65.8%) cases, particularly stenotic lesions (24.3% in native valves and 26.8% in biological prostheses), is one of the consequences of rheumatic disease which has not yet been eradicated in our country and affects mainly the mitral valve of female individuals, with clinical manifestations during childbearing age.

The progressive increase of cardiac output in the beginning of the second trimester of pregnancy facilitates New York Heart Association (NYHA) functional class (FC) progression from I/II to III/IV, which is common in patients with heart valve diseases and demands constant clinical reassessment and treatment of occasional complications including surgical intervention in refractory cases.

In Arnoni et al¹⁴ study, the major cause for indication of surgery during pregnancy in 49 (84.4%) cases of heart valve disease was progressive hemodynamic deterioration, acute pulmonary edema, and persistence of FC III/IV, despite medical treatment.

Another relevant aspect is the gestational age at which cardiac surgery is performed. The earlier the onset of complications in patients with severe lesions, the greater the tendency to indicate surgery, even in the cases in which there is immediate favorable response to medical treatment, because the likelihood of progression to hemodynamic deterioration throughout pregnancy and during delivery and puerperium is potentially very high, thus favoring recurrence of complications and maternal death. This reasoning justifies the mean gestational age of 20 weeks found in our study.

The need for reoperation in 17 (41.4%) cases of heart valve disease that progressed to heart failure and cardiogenic shock illustrates the poor clinical outcome of prosthetic valve

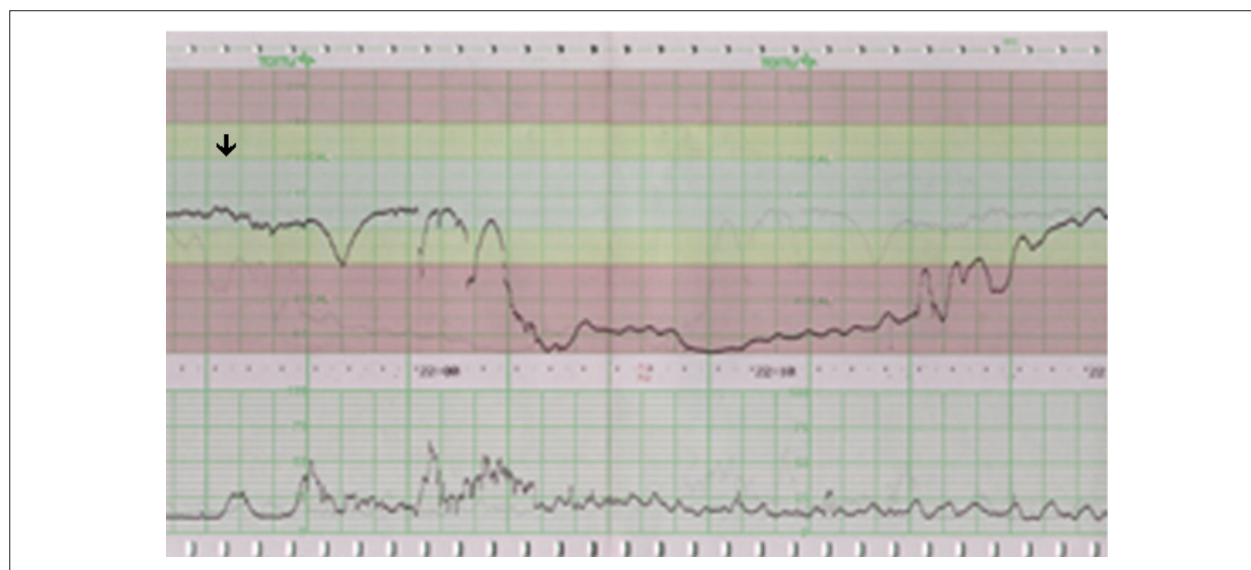


Figure 1 - Cardiotocographic record during aortic valve replacement on the 28th week of gestation. The upper tracing shows fetal heart beats, and the lower tracing shows uterine contraction recording. The arrow (↓) shows the beginning of extracorporeal circulation.

Table 4 - Correlation of maternal characteristics with the odds of occurrence of complications

| Maternal characteristic | Endpoint | p | OR ⁽²⁾ | IC(OR;95%) ⁽³⁾ |
|--------------------------------------|----------|-------|-------------------|---------------------------|
| Maternal complication ⁽¹⁾ | | | | |
| Age (years) | | 0.879 | 1.01 | (0.92 – 1.10) |
| Gestational age (weeks) | | 0.398 | 1.03 | (0.96 – 1.12) |
| ECC (minutes) | | 0.261 | 1.01 | (0.99 – 1.04) |
| ECC temperature (° Celsius) | | 0.622 | 1.05 | (0.87 – 1.27) |
| Emergency care | | 0.046 | 9.82 | (1.04 – 92.78) |
| Fetal loss | | | | |
| Age (years) | | 0.325 | 0.95 | (0.86 – 1.05) |
| Gestational age (weeks) | | 0.639 | 0.98 | (0.90 – 1.07) |
| ECC (minutes) | | 0.996 | 1.00 | (0.98 – 1.02) |
| ECC temperature (° Celsius) | | 0.945 | 1.01 | (0.80 – 1.27) |
| Emergency care | | 0.549 | 1.64 | (0.32 – 8.33) |
| NB death ⁽⁴⁾ | | | | |
| Age (years) | | 0.301 | 0.95 | (0.87 – 1.04) |
| Gestational age (weeks) | | 0.939 | 1.00 | (0.93 – 1.09) |
| ECC (minutes) | | 0.546 | 1.01 | (0.99 – 1.02) |
| ECC temperature (° Celsius) | | 0.794 | 1.03 | (0.84 – 1.26) |
| Emergency care | | 0.544 | 1.60 | (0.35 – 7.30) |

1 - Complications observed: Stroke, infective endocarditis, heart failure, bleeding, cardiac arrhythmia; 2 - Odds ratio estimate; 3 - Confidence interval obtained using the Wolf method; 4 - Fetal loss, stillbirth and neonatal death.

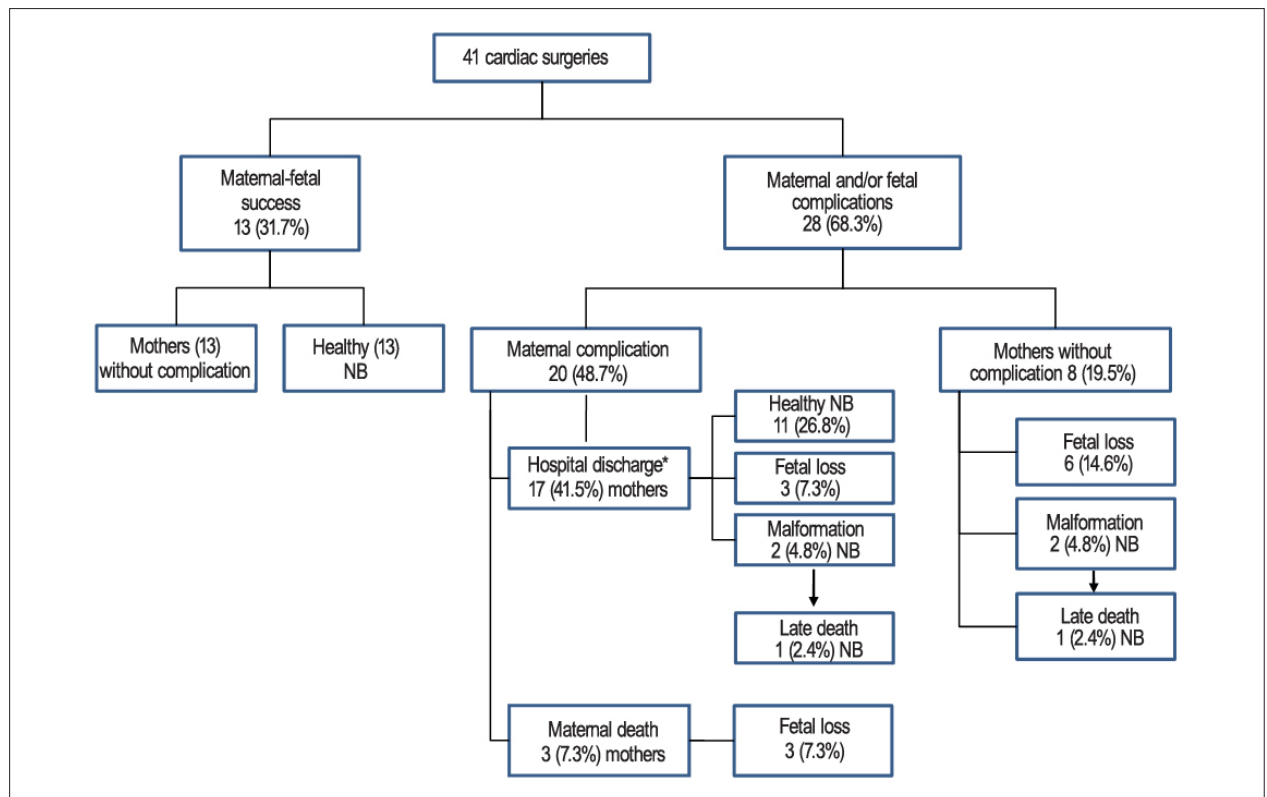


Figure 2 - Cardiac surgery during pregnancy. Maternal-fetal outcomes. * NB - newborn; * Lost to follow-up*1(2,4%) NB.

dysfunction during pregnancy, whether due to calcification in biological prostheses or to thrombosis in mechanical prostheses.

These findings are consistent with those of Salazar et al¹⁵, who showed that among 15 cases of cardiac surgery during pregnancy, 13 (86.6%) had rheumatic heart valve disease, of which eight (61.5%) presented prosthetic valve dysfunction. Therefore, prosthetic valve dysfunction should be regarded as a maternal risk during pregnancy with a potentially high need for reoperation due to hemodynamic deterioration which is sometimes irreversible.

In turn, aortic dissection, which was the reason for emergency surgery in three cases, is a less common but a high risk event during pregnancy¹⁶. Difficulties in the diagnosis, misinterpretation of symptoms (which may be mistaken for normal pregnancy) and limitations to invasive investigation (due to the potential risk for the concept) result in delayed treatment and increased mortality rate for the disease.

In our study, aortic dissection occurred in a woman with Marfan syndrome and in another with coarctation of the aorta; this condition has been already documented and is known to be related to pregnancy¹³. However, its occurrence in healthy pregnant women is unexpected, as was described in the third patient of our case series, thus leading to the hypothesis of a strong correlation between pregnancy and aortic dissection as a result of structural vascular changes of gestation¹⁷.

Surgical indication for dissection was based on the chances of maternal and fetal survival, type of dissection, maternal clinical conditions and gestational age. In the two cases in which dissection occurred with a viable fetus (32 and 33 weeks of gestation), the cesarean section that preceded the surgical repair of the aneurysm was aimed at preserving the life of the fetus, and prevented the risk of spontaneous labor in the postoperative period¹⁸.

It is assumed that the risk of maternal death due to cardiac surgery is not modified by pregnancy. However, the 7.5% maternal death rate found in our study, along with that of 8.6% reported by Arnoni et al¹⁴, and of 13.3% described by Salazar et al¹⁵ are relatively high when compared to those found for surgical treatment of heart valve disease in this age range.

According to the authors, these percentages were due to the emergency nature of the surgical indication which, in the present study, was the only variable that correlated with complications and maternal death in the postoperative period.

As regards the pregnancy outcomes, the percentages of 25% of fetal losses and 35% of prematurity recorded in our study are higher than those found in the population of pregnant women with heart diseases, estimated at 12% and 15%, respectively - and probably result from variations in blood flow and in arterial oxygen saturation consequent to anesthesia and ECC.

Hyperventilation during anesthesia results in a reduction of the uterine flow by 25% and reduction of maternal venous return and cardiac output due to the mechanical effects of the

positive pressure¹⁹. Maternal hyperventilation and respiratory alkalosis also lead to decreased fetal arterial oxygen tension and facilitate shift of the maternal oxyhemoglobin dissociation curve²⁰.

It is assumed that ECC leads to the formation of placental microemboli due to piling up of red cells and of microbubbles which, together with maternal blood pressure variations and hypothermia, aggravate hypoxia in the uteroplacental circulation and trigger uterine contractions and labor²¹.

These effects also explain the fetal bradycardia that may be attributed to placental flow changes which, during ECC, turn from pulsatile to nonpulsatile and laminar, and also to hemodilution and hypothermia^{22,23}.

Teratogenic risks that could result from anesthesia and ECC in the embryogenic phase were not observed in the three cases of elective surgery performed in the first trimester of pregnancy. However, there were four (11.4%) cases of neurologic malformation in fetuses of patients who underwent surgery after 20 weeks of gestation, probably as a consequence of intrauterine hypoxia.

Blood flow reduction in the umbilical arteries causes hypoxemia and vasoconstriction in the fetal circulation which, when persistent and prolonged, exhaust the compensatory mechanism of vasodilatation and of diastolic blood flow increase in the middle cerebral artery, thus resulting in cerebral ischemia^{24,25}.

This justifies the use of Doppler-flowmetry for monitoring flow in the uterine and umbilical arteries as a guide for the perfusionist to control the hemodynamic pattern during ECC^{26,27}.

In conclusion, cardiac surgery performed during pregnancy and puerperium permitted maternal survival in 92.7% of the patients, and birth of healthy infants in 56% of the pregnant women who presented cardiac complications refractory to other therapies. The emergency nature of the indication of surgery was significantly correlated with a worse postoperative maternal prognosis.

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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