RESEARCH PAPER

Neonatal Outcomes in Pregnant Women With Repaired and Unrepaired Congenital Heart Disease in Zhejiang, China

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Objective: To compare the neonatal outcomes in pregnant women with repaired vs unrepaired congenital heart disease (CHD). **Methods:** Data on pregnant women with CHD was retrieved from our hospital records for the duration April, 2014 to December, 2021. Pregnant women with CHD were divided into two groups: simple CHD and moderate-to-complex CHD. **Results:** In simple CHD group, neonatal outcomes were similar in pregnant women with repaired and unrepaired CHD. By contrast, in moderate to complex CHD group, the offspring of women with unrepaired CHD had smaller gestational age [mean (SD) 34.3 (2.7) vs 36.8 (2.1) week; *P*=0.016] and lower birth weight [mean (SD) 2126.8 (711.9) vs 2720 (645.7); *P*=0.037]; than those with repaired CHD. Infants of women with unrepaired moderate-to-complex CHD had a higher risk of premature delivery (87.5% vs 45.5%, *P*=0.013), low birth weight (81.3% vs 36.4%, *P*=0.04) and neonatal intensive care unit (NICU) admission (68.8% vs 27.3%, *P*=0.034). **Conclusions:** Surgical repair before pregnancy in women with moderate to complex CHD significantly minimized the risks of neonatal complications.

Keywords: *Cardiac intervention, Pregnancy outcome, Surgical repair*.

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With advances in surgical intervention and intensive care, more and more women with congenital heart disease (CHD) are surviving to childbearing age. Women desirous of pregnancy might face various challenges during pregnancy and child birth. For women with simple CHD, who are free of symptoms, pregnancy and delivery could be well tolerated [1], but for women with complex CHD, pregnancy presents a challenge with numerous alterations in cardiovascular physiology [2]. Pregnancy with CHD is associated with a high risk of premature delivery and small for gestational age (SGA) [3,4]. The risks of adverse neonatal events are influenced by types of cardiac defects and surgical repair. Women with complex CHD who undergo cardiac surgery, seem to well tolerate pregnancy, which may reduce the risks of neonatal complications. Data on benefits of aggressive surgical intervention before pregnancy with different severity of CHD are unknown. The present study was conducted to compare neonatal outcomes among women with CHD cardiac surgery before pregnancy.

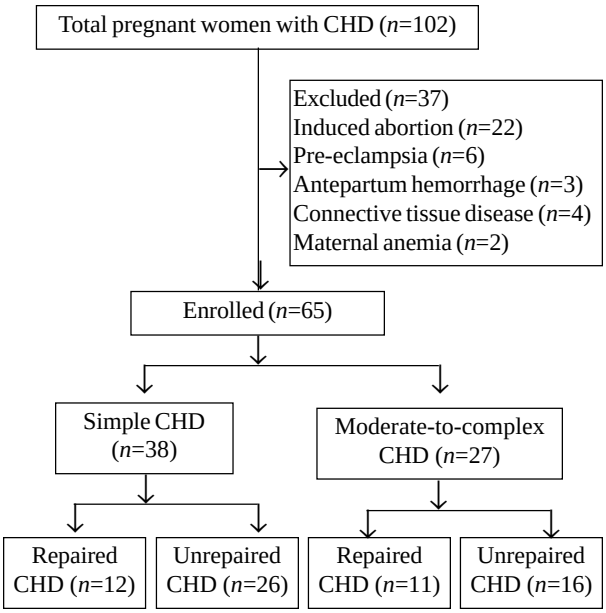
METHODS

This was a retrospective study that retrieved records of women with CHD between April, 2014 and December, 2021 at First Affiliated Hospital, College of Medicine. The patients diagnosed with CHD and concurrent diseases such as pregnancy induced hypertension (PIH), antepartum hemorrhage (APH), pre-eclampsia, maternal anemia, nephropathy, liver disease, pulmonary disease, connective tissue disease and with induced abortion were excluded. Data were collected using medical records. Information about mothers included age at inclusion, type of heart defects, prior surgical procedures, severity of disease as per New York Heart Association (NYHA) class, left ventricular eject fraction (LVEF), pulmonary artery pressure, oxygen saturation, gestational diabetes (GDM), thyroid function and drug exposures. Information about neonatal outcome as obtained from the medical records included gestational age at birth, type of delivery, birthweight, Apgar score and neonatal complications.

Based on guidelines from the European Society of Cardiology, isolated atrial septal defect (ASD), ventricular septal defect (VSD) and patent ductus arteriosus (PDA), were classified as simple CHD and other heart defects were considered as moderate-to-complex CHD [5]. Pulmonary arterial hypertension (PAH) was defined hemodynamically by the presence of a mean pulmonary artery pressure of at least 25 mmHg with a pulmonary capillary wedge pressure or left ventricular end diastolic pressure of up to 15 mmHg. Patients were stratified by pulmonary artery systolic pressure into three grades: 36-50 mmHg, 50-70 mmHg and >70mmHg [6]. Neonatal complications included: preterm

birth (<37 weeks of gestation), moderately preterm birth (32-36 weeks), very preterm birth (26-31weeks), low birth weight (<2500 g), very low birth weight infant (<1500 grams), extremely low birth weight (<1000 g), small for gestational age (below tenth percentile from the mean weight corrected for gestational age and gender, SGA), cardiac birth defects and other birth defects, necrotizing enterocolitis (NEC), intracranial hemorrhage (ICH), and neonatal asphyxia.

Data analysis: Data were summarized by descriptive statistics. Data were analyzed using SPSS V. 21. Mean (SD) were presented for normally distributed continuous variables and were compared using Student *t*-test. For non-normal continuous variables, Median (IQR) were computed and were compared using Mann-Whitney *U* test. Categorical variables were expressed as proportions and compared using Chi-square test or Fisher exact test. Multivariate logistic analysis was utilized to assess the relationship between surgical repair and adverse neonatal outcomes. Two-tailed probability values <0.05 were considered statistically significant.



CHD: congenital heart disease.

Fig. 1 Flow of the participants in the study.

RESULTS

A total of 65 pregnant women diagnosed with CHD were enrolled (**Fig.1**); of which, 35 (58.5%) women had simple CHD. In the simple CHD group, cardiac defects were surgically repaired in 12 (31.6%) women. The obstetric characteristics based on complexity of CHD and surgical repair is shown in **Table I**. The neonatal outcomes of women as per the type of CHD and surgical repair are shown in **Table II**.

Multivariate analysis demonstrated that pregnant women with unrepaired moderate to complex CHD had a higher risk of premature delivery [OR (95%CI) 8.4 (1.26–56.07); *P*=0.028], low birth weight [OR (95%CI) 7.58 (1.31–

Table I Baseline Characteristics of Pregnant Women With Congenital Heart Disease (*N*=65)

Characteristics	*Simple CHD*		*Moderate-to-*	*Complex CHD*
	Surgically repaired (n=12)	*Unrepaired (n=26)*	*Surgically repaired (n=11)*	*Unrepaired (n=16)*
Age (y)[a]	27.7 (3.2)	28.2 (4.8)	28.4 (3.5)	31.5 (7.1)
CHD diagnosis				
Prior to pregnancy[b]	11 (91.6)	10 (38.5)	11 (100)	12 (75)
During pregnancy	1 (8.4)	16 (61.5)	0	4 (25)
LVEF (%)[b]	59.2 (7.5)	63.5 (5.5)	67.1 (4.8)	66.2 (5.6)
Oxygen saturation (%)[a]	98.7 (0.5)	98.1 (1.9)	98.5 (0.7)	94.5 (6.6)
PAH (mmHg)				
≥35-<50	2 (16.7)	6 (23.1)	0	2 (12.5)
≥50-<70	1 (8.3)	4 (15.4)	0	4 (25)
≥70	0	2 (7.7)	1 (9.1)	1 (6.3)
NYHA functional class				
Class I-II	11 (91.7)	21 (80.8)	11 (100)	14 (87.5)
Class III-IV	1 (8.3)	5 (19.2)	0	2 (12.5)
Drug exposures				
Corticosteroids	1 (8.3)	0	1 (9.1)	0
Warfarin	0	0	6 (54.5)[b]	0

Data provided as no (%). [a]mean (SD). [b]P<0.05. CHD-congenital heart disease; LVEF-left ventricular eject fraction; PAH-pulmonary arterial hypertension.

41.92); *P*=0.024], and neonatal intensive care unit (NICU) admission [OR (95%CI) 5.87 (1.08–32); *P*=0.041].

DISCUSSION

The present study showed that women with simple unrepaired CHD had similar neonatal outcomes as compared to simple repaired CHD. In contrast, neonatal outcomes were adverse in women with moderate-to-complex CHD with unrepaired lesions than the required group. Women with simple CHD, who did not receive surgical intervention before pregnancy had similar cardiac function to women who received surgical interventions before pregnancy.

Women with CHD experience longer life expectancy and improved general health with diagnostic and therapeutic advances in recent years. Consequently, more and more women with CHD are reaching reproductive age and are considering pregnancy. CHD increases the incidence of neonatal complications such as premature delivery and SGA, in women without surgical repair of shunt lesions [7]. A few women with CHD were unaware of their heart defects before pregnancy and had not received any surgical repair but tolerated pregnancy and labor well.

Women with an ASD were at an increased risk of SGA and fetal mortality in comparison to women with a repaired ASD in an earlier study [8]. Another study [9] showed that women with repaired VSD had a higher risk of premature labor and SGA births in comparison to women with unrepaired VSD. However, mechanism of a higher risk of neonatal events in women with repaired VSD are not clearly understood. The present study reported a higher risk of premature delivery, low birth weight and NICU admission in women with unrepaired compared with repaired moderate to complex CHD. The hemodynamic changes in operated women with moderate-to-complex CHD are well tolerated and appear to be stable during pregnancy. The risks of obstetric complications including hypoxemia, heart failure, arrhythmia and pre-eclampsia, and the risk of fetal and neonatal complications including preterm birth and growth retardation were reported to decrease [10]. Other studies [11,12] have likewise shown improvement in maternal, perinatal and neonatal

Table II Neonatal Outcomes in Pregnant Women With Congenital Heart Disease

Neonatal outcomes	*Simple CHD*		*P value*	*Moderate-to-complex CHD*		*P-value*
	Surgically repaired (n=12)	*Unrepaired (n=26)*		*Surgically repaired (n=11)*	*Unrepaired (n=16)*	
Gestational age (wk)[a]	36.6 (2.6)	36.8 (2.7)	0.892	36.8 (2.1)	34.3 (2.7)	0.016
Preterm birth, wk <37 wk	5 (41.7)	10 (38.5)	0.851	5 (45.5)	14 (87.5)	0.013
32-36 wk	2 (16.7)	9 (34.6)	0.454	6 (54.5)	12 (75)	0.268
<31 wk	1 (8.3)	2 (7.69)	0.946	0	2 (12.5)	0.499
Infant weight (g)[a]	2812.5 (716.1)	2831.9 (665.1)	0.935	2720 (645.7)	2126.8 (711.9)	0.037
<1000g	0	0	—	0	1 (6.3)	1
<1000-1500g	1 (8.3)	1 (3.8)	0.538	0	2 (12.5)	0.499
<500-2500g	4 (33.3)	9 (34.6)	0.938	4 (36.4)	13 (81.3)	0.04
Cesarean delivery	11 (91.7)	22 (84.6)	0.935	11 (100)	15 (93.7)	1
Small for gestational age	1 (8.3)	1 (3.8)	0.607	2 (18.2)	4 (25)	0.662
1-minute APGAR score[a]	9.3 (1.2)	9.2 (1.3)	0.683	8.5 (1.3)	8.1 (1.8)	0.461
5-minute APGAR score[a]	9.5 (1.0)	9.5 (0.9)	0.825	9.4 (0.7)	9.4 (0.8)	0.955
Respiratory distress syndrome	1 (8.3)	5 (19.2)	0.643	1 (9.1)	6 (37.5)	0.183
Intraventricular hemorrhage	0	5 (19.2)	0.158	3 (27.3)	5 (31.3)	0.824
Neonatal asphyxia	1 (8.3)	2 (7.69)	0.946	2 (18.2)	3 (18.6)	0.97
Necrotizing enterocolitis	0	0	—	0	1 (6.3)	1
NICU admission	3 (25)	6 (23.1)	0.897	3 (27.3)	11 (68.8)	0.034
Length of stay (d)[a]	13(5-58)	22.5(17-34.7)	0.437	24(11-26)	27(14-55.5)	0.405
Deformity	0	0	—	2 (18.2)	2 (12.5)	0.683
Recurrence of CHD	2 (16.7)	4 (15.4)	0.92	5 (45.5)	9 (56.2)	0.581
Neonatal death	0	0	—	0	0	—

Data provided as [a]mean (SD) or no (%). CHD-congenital heart disease; NICU-*Neonatal intensive care unit.*

WHAT THIS STUDY ADDS?

- Pregnant women operated for complex congenital heart disease have improved neonatal outcome than women who were not operated.

outcomes. Therefore, cardiac surgery could improve neonatal outcomes and should be performed before conception in CHD.

Other risk factors such as maternal PIH, APH, pre-eclampsia, connective tissue disease and other systematic diseases were reported with adverse neonatal outcomes [13-15]. The numbers of women with CHD and associated comorbidity was very small in this study and were not included for analysis. The present study was also limited by the small sample size and retrospective design.

To conclude, the decision for corrective cardiac repair should be individualized before pregnancy by weighing the risks and benefits. For women with simple CHD, surgical repair before pregnancy is not necessary unlike for women with moderate-to-complex CHD where surgical repair before pregnancy minimizes the risks of neonatal complications.

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