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Changes in echocardiographic parameters and hypertensive disorders in pregnancies of women with aortic coarctation

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ABSTRACT

Objectives: Pregnancy can be well tolerated after the repair of aortic coarctation. However, a higher incidence of hypertensive disorders during these pregnancies was reported. We analyzed the perinatal changes in echocardiographic parameters in women with aortic coarctation and investigated the risk factors of gestational hypertension (GH).

Methods: We retrospectively identified 15 pregnancies in nine Japanese women with aortic coarctation between 1982 and 2015. We categorized the patients according to the presence/absence of GH as the group with GH(n = 3) and that without GH(n = 12). The echocardiographic parameters were compared between groups.

Results: Our analysis revealed that a pre-pregnancy Doppler-measured pressure gradient $\geq$ 20 mmHg and a left ventricular mass index $\geq$ 95 g/m^2 were significant risk factors for GH. The left ventricular end-diastolic diameters at the first and the third trimesters, the left ventricular end-systolic diameters at the first trimester, and the left ventricular ejection fraction at the third trimester were also significantly higher in the pregnancies with GH. All of these findings had been obtained before the patients' GH occurred.

Conclusions: Hypertrophy of the left ventricle with a lower ejection fraction and a high pressure gradient across the coarctation were risk factors for GH in the patients with aortic coarctation. Thus, serial measurements using echocardiography are important for predicting GH in women with aortic coarctation. However, further research investigating this finding with a larger sample size is needed.

1. Introduction

Aortic coarctation accounts for 6–8% of patients with congenital heart disease. Most females born with aortic coarctation can be expected to reach childbearing age after intervention for this defect, and some pregnant women with aortic coarctation may have recurrent coarctation or a residual obstruction after intervention. As cardiovascular changes occur during pregnancy, serial echocardiographic examinations are important for the evaluation of maternal heart function.

It has been demonstrated that pregnancy can be well-tolerated in women with aortic coarctation after its repair, although high rates of miscarriages and hypertensive disorders of pregnancy have been reported in such pregnancies [1–3]. There is also an increased risk of aortic dissection in these mothers [4]. Pregnant women with high Doppler pressure gradients across coarctation had gestational hypertension (GH) more frequently than those with low pressure gradients [2]. However, little is known about the relationship between other echocardiographic findings and hypertension during pregnancy with aortic coarctation. Here we analyzed GH in pregnancies with aortic coarctation and the perinatal changes of echocardiographic parameters.

Abbreviations: GH, gestational hypertension; LVPWd, the left ventricular posterior wall thickness in diastole; LVDd, the left ventricular end-diastolic diameter; LVDs, the left ventricular end-systolic diameter; LVEF, the left ventricular ejection fraction; LVMI, the left ventricular mass index.

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2. Methods

We defined GH as the new onset of hypertension (systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg) at ≥20 weeks of gestation. We defined chronic hypertension as hypertension first detected before the 20th week of pregnancy or persisting ≥12 weeks postpartum.

We retrospectively identified 15 pregnancies in nine Japanese women with aortic coarctation diagnosed between 1982 and 2015, with/without repair, at the Department of Perinatology, National Cerebral and Cardiovascular Center, Osaka, Japan. We categorized the patients into two groups (GH group or non-GH group) according to the occurrence of GH.

The following echocardiographic parameters at the first trimester during pregnancy were examined as the maternal background data set: LVPWd, LVDd, LVDs, LVEF, LVMI and the Doppler-measured pressure gradient. The LVEF was measured by a Teichholz method. The LVMI were calculated using the following equation.

$$\mathrm{LVMI}(\mathrm{g/m^2}) = \textit{Left Ventricular mass}(\textit{LVM})/\textit{Body Surface Area}(\textit{BSA}) \quad (1)$$

$$\mathrm{LVM} = 0.8[1.04\{(\textit{LVDd} + \textit{IVSd} + \textit{LVPWd})^3 - \textit{LVDd}^3)\}] + 0.6 \quad (2)$$

BSA was measured by Du Bois method [5]. LVMI ≥ 95 g/m^2 was defined to left ventricular hypertrophy [6]. The pressure gradient values were calculated using the simplified Bernoulli equation.

$$\text{Pressure gradient} = 4V^2 \quad (3)$$

where V equals the peak velocity at the coarctation. We defined a high pressure gradient as ≥20 mmHg.

As echocardiographic parameters during pregnancy and delivery, we evaluated the changes in the women's LVDd, LVDs and LVEF. We analyzed the correlations between GH and these echocardiographic parameters. Serial measurements were performed more frequently in the pregnancies of the women with high pressure gradients, and we therefore analyzed the changes in pressure gradients in these pregnancies.

The Fisher exact probability test and *t*-test were used for the statistical analysis. P-values < 0.05 were considered significant.

This study was approved by the local institutional review board and written informed consent was obtained from all patients at follow up visit to our hospital for aortic coarctation.

3. Results

3.1. Maternal background data

The maternal background data are summarized in Table 1. Five patients (7 pregnancies) were diagnosed as aortic coarctation when they were in early childhood (age 0–4 yrs), and four patients (8 pregnancies) were diagnosed when they were older children or adults. One patient with chronic hypertension had two pregnancies; the patient had taken no medication before the pregnancies because her hypertension was mild. During her pregnancies, neither deterioration of hypertension nor proteinuria occurred.

Three patients were treated with a beta adrenergic blocking agent to prevent aortic dissection. The other patients were not taking any medication.

3.2. Cardiovascular outcomes

In one patient, arrhythmia (non-sustained ventricular tachycardia) occurred at 36 weeks' gestation. This arrhythmia was resolved after her delivery. Neither heart failure nor aortic dissection occurred in any of the pregnancies.

Table 1
Maternal background data.

No. of pregnancies:	n
1	3
2	6
Age at diagnosis(yrs):	
0–4	5
5–9	2
≥10	2
Associated cardiovascular defect:	
None	1
Atrial septal defect	2
Ventricular septal defect	3
Bicuspid valve	2
Mitral stenosis	1
Type of first intervention:	
Subclavian flap aortoplasty	4
Other types of aortoplasty in childhood	1
Operation in adult (patch plasty)	1
Balloon angioplasty	1
None	2
Re-intervention:	
Operation in childhood	1
Operation as an adult	0
Balloon angioplasty	2

3.3. Obstetrical outcomes

GH occurred in three pregnancies. In these pregnancies, mild hypertension without proteinuria occurred at 37 or 38 weeks, and the hypertension was improved soon after the deliveries. The mean number of weeks of gestation at delivery for all 15 pregnancies was 37.5 ± 0.4. The mode of delivery was cesarean section in eight pregnancies (53%). Cesarean section was performed for a maternal cardiovascular indication in two pregnancies. In the two pregnancies, balloon angioplasties for native aortic coarctation had been performed. Echocardiography during the two pregnancies showed separation of the vascular endothelium in proximal portion of descending aorta. We therefore performed a cesarean section for the prevention of aortic dissection. Preterm labor was induced in two pregnancies due to maternal ovarian cancer and fetal growth restriction respectively. In the fetal growth restriction case, the karyotype of the infant was 21 trisomy.

3.4. Neonatal outcomes

The mean birth weight was 2785 ± 135 g. Low-birthweight infants were born in two pregnancies. Neither neonatal death nor neonatal asphyxia occurred in the GH or non-GH group.

3.5. GH and echocardiographic parameters

The echocardiographic parameters as maternal background of the groups with (n = 3) and without (n = 12) GH are shown in Table 2. The rates of patients with a high Doppler-measured pressure gradient and with large LVMI were significantly higher in the GH group. The LVDd and LVDs values at the first trimester were significantly larger in the GH group compared to the non-GH group.

The perinatal changes of the echocardiographic parameters in both groups are illustrated in Fig. 1. In the non-GH group, the LVDd and LVDs values gradually increased toward the third trimester of pregnancy and the LVEF was progressively reduced as the pregnancies advanced. In the GH group, the LVDd and LVDs values were already high at the first trimester and the LVEF increased gradually as the pregnancies advanced. However, none of these changes were significant. The comparison of each parameter between the two groups revealed that the LVDs at the first trimester, the LVDd at the first and the third trimester, and the LVEF at the third trimester were significantly larger in the GH group.

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