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Original Research

Pregnancy outcomes in women with moderate and severe aortic stenosis

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Abstract

Background: Aortic stenosis (AS) is one of the degenerative heart lesions mainly resulting from congenital defects and rheumatic diseases. This study aimed to determine maternal and fetal outcomes in pregnant women with moderate and severe AS. **Methods**: The clinical data of 26 pregnant women with AS treated between 2007 and 2019 in Beijing Anzhen Hospital were collected and retrospectively analyzed. **Results**: AS was diagnosed before pregnancy or after pregnancy in 16 (61.5%) and 10 (38.5%) patients, respectively. Except the peak velocity and mean pressure gradient, no significant difference in baseline cardiac parameters between the patients with moderate AS and severe/very severe AS, such as AS locations, previous heart failure symptoms, and heart function was seen. Heart failure and arrhythmia were complicated in 14 (53.8%) and 6 (23.1%) pregnancies, respectively. The rate of Caesarean deliveries was 85.7% in the patients with severe/very severe AS and 58.3% in the patients with moderate AS. There was no neonatal asphyxia or neonatal death in the cohort. **Conclusions**: The results of our study indicate the pre-conceptional evaluation and counseling should be performed in women with AS and those with symptomatic and severe AS are recommend to take cardiac surgery as appropriate before pregnancy.

Keywords: Aortic stenosis; Pregnancy; Mortality; Pregnancy outcome

1. Introduction

Aortic stenosis (AS) is one of the degenerative heart lesions mainly resulting from congenital defects and rheumatic diseases. AS can occur at the valvular, subvalvular, or supravalvular level. It is rarely encountered in females of childbearing age [1]. Profound hemodynamic changes during pregnancy may have an adverse impact on pregnant outcome. AS may be aggravated by the reduced stroke volume occurring with pregnancy, and therefore results in increased maternal cardiovascular events and fetal complications [2–4]. AS has been considered as one of the high-risk factors in several classifications and risk scores to estimate the maternal cardiac and offspring risk associated with pregnancy in women with cardiovascular diseases [5,6]. Women with severe AS are more likely to experience cardiac complications during pregnancy and may require cardiac interventions during late follow-up [7]. However, recent studies also show that pregnancy in women with AS could have a favorable pregnancy outcome with low maternal mortality [8–11]. In addition, most previous studies focused on cardiac outcomes [2–4,7], with little information on maternal and fetal outcomes in patients with AS. Especially, data from China are barely available.

The European Society of Cardiology (ESC) guidelines for the management of heart disease in pregnancy advise to assess maternal risks according to the modified WHO classification (mWHO classification) before pregnancy. In order to optimize pre-pregnancy counselling and pregnancy management, a better understanding of impact of cardiac conditions on maternal and fetal outcome is essential. This study was carried out to analyze and identify factors affecting pregnancy outcomes in women with moderate and severe AS with emphasis on adverse maternal and fetal outcomes.

2. Methods

2.1 Study population

The medical databases of Anzhen hospital between January 2007 and August 2019 were retrospectively reviewed for female patients with a diagnosis of AS. Patients were included if she was pregnant for more than 20 gestational weeks, had undergone aortic valve replacement or aortic valvuloplasty before pregnancy if the hemodynamic criteria was fulfilled as described [12]. Patients were excluded, if diagnosed mild AS and comorbided with other serious heart diseases (such as valvular diseases and aortic coarcation). All patients were followed up for at least 3 months. This study was approved by the Ethics Committee of Anzhen Hospital, Beijing, China and written consent was obtained from every patient.

2.2 Study protocol

Baseline demographic and clinical data were retrieved from the hospital's databases. Echocardiographic assessments were performed before pregnancy or during the first antepartum visit. The baseline data included maternal age, medical history of any non-cardiac and cardiac disease, cardiac interventions, the New York Heart Association (NYHA) Heart Functional Classification before pregnancy, echocardiographic parameters, and obstetric history.

Table 1. Baseline clinical data of AS patients in this study.

	All AS patients	Moderate AS	Severe/very severe AS	*p*	Asymptomatic patients	Symptomatic patients	*p*
Number of patients, n	26	12	14		20	6	
Maternal age, year	31.4 ± 4.8	33.2 ± 4.7	29.8 ± 4.4	0.075	31.5 ± 5.3	30.7 ± 3.0	0.701
Nulliparous, n (%)	16 (61.5)	9 (75)	7 (50.0)	1.000	13 (65.0)	3 (50.0)	0.644
Previous cardiac operation, n (%)	5 (19.2)	2 (16.7)	3 (21.4)	1.000	5 (25)	0 (0)	0.298
NYHA class				0.645			<0.0001
I	21 (80.8)	11 (91.7)	10 (71.4)		20 (100)	1 (16.7)	
II	5 (19.2)	1 (8.3)	4 (28.6)		0 (0)	5 (83.3)	
AS location, n (%)				0.564			1.000
Valvular	23 (88.5)	10 (83.4)	13 (92.9)		17 (85)	6 (100.0)	
Subvalvular	2 (7.7)	1 (8.3)	1 (7.1)		2 (10)	0 (0.0)	
Supravalvular	1 (3.8)	1 (8.3)	0 (0)		1 (5)	0 (0)	
Bicuspid aortic valve, n (%)	17 (65.4)	8 (66.7)	9 (64.3)	1.000	12 (60.0)	5 (83.3)	0.380
Previous heart failure symptoms, n (%)	6 (23.1)	1 (8.3)	5 (35.7)	0.645	0 (0)	6 (100)	<0.0001
Echocardiographic parameters							
mean Δ*p*, mmHg	43.5 (30.0–55.8)	30 (25.3–32.0)	55 (44.8–85.0)	<0.0001	37.5 (28.5–56.8)	49.5 (40.5–63.8)	0.268
peak velocity, cm/s	442.9 ± 102.1	368.2 ± 34.1	511.3 ± 96.9	<0.0001	430.7 ± 104.0	483.7 ± 91.5	0.463
LVEF, %	67 (63.8–71.3)	68 (64.3–69.8)	65 (55.0–80.5)	0.781	67.0 (64.0–70.8)	61.5 (52.3–81.8)	0.656
Ascending aortic diameters, mm	29.0 ± 4.7	30.42 ± 7.63	30.1 ± 4.6	0.911	30.4 ± 6.8	30.0 ± 2.3	0.903
Cardiac medication, n (%)							
Diuretics	2 (7.7)	0 (0)	2 (12.5)	0.492	1 (5)	1 (16.7)	0.415
Bata-blocker	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Anticoagulation	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Non-cardiac disease, n (%)							
Hypertension	2 (7.7)	0 (0)	2 (12.5)	0.492	1 (5)	1 (16.7)	0.415
Diabetes	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Others	1 (3.8)	0 (0)	1 (7.1)	1.000	1 (5)	0 (0)	1.000

LVEF, left ventricular ejection fraction; mean △*p*: mean aortic gradient.

The diagnosis of AS in the current study was established by echocardiography. The severity of AS was assessed based on transthoracic echocardiographic data at baseline. Mild AS was defined as a mean transaortic gradient of <20 mmHg (corresponding to a peak velocity 2–2.9 m/s), moderate AS was defined as a mean transaortic gradient of 20–39 mmHg (corresponding to a peak velocity 3–3.9 m/s), severe AS was defined as a mean transaortic gradient of ≥40 mmHg (corresponding to a peak velocity ≥4 m/s), and very severe AS was defined as a mean transaortic gradient of ≥60 mmHg (corresponding to a peak velocity ≥5 m/s) [12].

For maternal outcomes, maternal mortality, deteriorations of heart function that require treatment, and arrhythmia were analyzed. Obstetric complications such as preeclampsia (PE), gestational diabetes mellitus (GDM), and postpartum hemorrhage were also collected.

For fetal outcomes, miscarriage (pregnant duration <28 gestational weeks), preterm birth (pregnant duration >28 and <37 gestational weeks), low birth weight (<2500 g), neonatal asphyxia and perinatal death (within the first month after birth) were analyzed.

2.3 Statistical analysis

Data are presented as numbers (percentage) for categorical variables or mean values and standard deviations (SD) or median (interquartile range [IQR]: 25th to 75th percentile) for continuous variables, depending on data distribution. Comparison of continuous variables between groups was made by independent *t*-test, or nonparametric Mann-Whitney U tests, respectively. When comparing frequencies, Fisher exact test was applied. All analyses were two-tailed. Analyses were performed using SPSS software (version 20.0, SPSS Inc., Chicago, IL, USA).

3. Results

3.1 Baseline characteristics

Using the hospital's databases, we identified 26 women with AS, of whom 12 were moderate and 14 were severe and very severe. Eleven (42.3%, 11/26) patients were transferred to Anzhen hospital from hospitals near Beijing. AS was established before pregnancy in 16 (61.5%) and after pregnancy in 10 (38.5%) patients. Baseline maternal characteristics are presented in Table 1. The

Table 2. Maternal and fetal outcomes.

	All AS	Moderate AS	Severe/very severe AS	*p* value	Asymptomatic patients	Symptomatic patients	*p* value
Maternal mortality, n (%)	1 (3.8)	0 (0)	1 (7.1)	1.000	0 (0)	1 (16.7)	0.231
Maternal cardiac hospital admission, n (%)	8 (30.8)	1 (8.3)	7 (50)	0.036	4 (20)	4 (80)	0.051
Cardiac complication, n (%)							
Heat failure	14 (53.8)	4 (33.3)	10 (76.9)	0.113	8 (40)	6 (100)	0.017
Arrhythmias	6 (23.1)	1 (8.3)	5 (35.7)	0.170	4 (20)	2 (33.3)	0.596
Sinus Tachycardia	3 (11.5)	1 (8.3)	2 (14.3)		2 (10)	1 (16.7)	
PSVT	1 (3.8)	0 (0)	1 (7.1)		1 (5)	1 (16.7)	
PVT	2 (7.7)	0 (0)	2 (14.3)		1 (5)	0 (0)	
Cerebrovascular complication, n (%)	4 (15.4)	0 (0)	4 (28.6)	0.100	2 (10)	2 (33.3)	0.218
NYHA class, n (%)				0.081			0.028
I	11 (42.3)	10 (83.3)	1 (7.1)		11 (55)	0 (0)	
II	8 (30.8)	1 (8.3)	7 (50.0)		6 (30)	2 (33.3)	
III	6 (23.1)	1 (8.3)	5 (35.7)		3 (15)	3 (50)	
IV	1 (3.8)	0 (0)	1 (7.1)		0 (0)	1 (16.7)	
Worsening NYHA class, n (%)	12 (46.2)	2 (16.7)	10 (71.4)	0.008	8 (40)	4 (66.7)	0.365
Obstetric complications, n (%)	9 (34.6)	4 (33.3)	5 (35.7)	1.000	5 (25)	4 (66.7)	0.138
Pre-eclampsia	2 (7.7)	1 (8.3)	1 (7.1)		1 (5)	1 (16.7)	
GDM	1 (3.8)	0 (0)	1 (7.1)		1 (5)	0 (0)	
Fetal distress	1 (3.8)	0 (0)	1 (7.1)		0 (0)	1 (16.7)	
Anemia	3 (11.5)	1 (8.3)	2 (14.3)		1 (5)	2 (33.3)	
Placenta previa	1 (3.8)	1 (8.3)	0 (0)		1 (5)	0 (0)	
PPH	1 (3.8)	1 (8.3)	0 (0)		1 (5)	0 (0)	
Fetal outcome							
Neonatal asphyxia, n (%)	0 (0)	0 (0)	0 (0)	_	0 (0)	0 (0)	_
Pregnancy duration, weeks	37 (35–38)	37 (37–38)	37 (35–37.5)	0.152	37 (37–38)	35 (32.8–37)	0.011
Pre-term birth, n (%)	10 (38.5)	1 (8.3)	9 (69.4)	0.004	5 (25)	5 (83.3)	0.018
Mean birth weight, g	2784.6 ± 623.6	3014.2 ± 621.9	2572.7 ± 567.4	0.076	2937.1 ± 591.2	2301.7 ± 490.2	0.026
Low birth weight, n (%)	8 (30.8)	1 (8.3)	7 (53.8)	0.030	3 (15)	5 (83.3)	0.004
Therapeutic abortion, n (%)	1 (3.8)	0 (0)	1 (7.1)	1.000	1 (5)	0 (0)	1.000

PVT, Premature ventricular beats; PSVT, Paroxysmal supraventricular tachycardia.

mean age at pregnancy was 31.4 ± 4.8 years. Eleven (42.3%) patients had a successful previous pregnancy. Ten women already had one child, and one woman had two children. Before pregnancy, 6 (23.1%) patients were symptomatic for AS, whereas 20 (76.9%) were classified as NYHA functional class I and 6 (23.1%) as NYHA functional class II. Bicuspid aortic valve (BAV) was the most prevalent etiology for AS (17, 65.4%) in the present cohort. The other etiologies included stenosis after aortic valvuloplasty (3, 11.5%), calcified tissue prosthetic valve (1, 3.8%), rheumatic valvular disease (2, 7.7%), congenital superior septum of aortic valve (1, 3.8%) and congenital inferior septum of aortic valve (2, 7.7%). The ascending aortic diameter was more than 35 mm in 4 (15.4%) patients, of which 1 (3.8%) was over 50 mm. One (3.8%) patient with moderate AS was complicated with mild mitral valve stenosis. Except the mean aortic gradient and peak velocity, no significant difference was found in baseline cardiac parameters between the patients with moderate AS and severe/very severe AS, such as AS locations, previous heart failure symptoms, and heart function. All patients had normal left ventricular systolic function. When the patients were stratified according to previous heart failure symptoms, symptomatic patients with AS were more likely classified as NYHA functional class II. Overall, the previous cardiac procedures performed in the current study cohort included 3 (11.5%) aortic valvuloplasty, 1 (3.8%) endoluminal stent graft implantation for descending aorta, and 1 (3.8%) aortic valve replacement with bioprosthesis. None of them was given anticoagulation therapy. Two patients in severe/very server group took diuretics before pregnancy.

3.2 Cardiac outcomes

During pregnancy, cardiovascular events were common in this cohort. Heart failure was complicated in 14 (53.8%) pregnancies and arrhythmia was complicated in 6

(23.1%) pregnancies. Totally, 8 (30.8%) patients were admitted due to cardiac disorders during pregnancy. Compared with moderate AS, the patients with severe or very severe AS had higher chance to experience worsen heart functional class (71.4% vs. 16.7%, $p = 0.008$) and were more likely to hospitalize for cardiac conditions during pregnancy (50% vs. 8.3%, $p = 0.036$, Table 2). The higher rates of heart failure (100%) and NYHA class III–IV (66.7%) were seen in the systematic patients. Cardiac surgical interventions were more frequent in the patients with severe/very severe AS than in those with moderate AS (50% vs. 0, $p = 0.006$) during the pregnancy and follow-up periods. Half of the patients with severe/very severe AS underwent surgical interventions, including 1 (7.1%) percutaneous balloon aortic valvuloplasty in 17th gestational week, 3 (21.4%) aortic valve replacement at the same time of pregnancy termination, and 3 (21.4%) aortic valve replacement during the follow-up period. Of the 26 patients, 25 were followed-up after delivery. Media duration of follow-up was 6 (4–11.8) months. There was one sudden cardiac death in severe/very severe AS group, occurring 1 week after delivery.

3.3 Obstetric and fetal outcome

In the current cohort, 9 (34.7%) pregnancies developed obstetric complications, including 2 (7.7%) PE, 3 (11.5%) pregnancy anemia, 1 (3.8%) GDM, 1 (3.8%) placenta previa, 1 (3.8%) fetal distress, and 1 (3.8%) postpartum hemorrhage. No significant difference in the rate of obstetric complications was revealed between patients with moderate AS and sever/very sever AS. Caesarean section was performed in all patients, of which 19 (73.1%) were for maternal cardiac indication and 7 (26.9%) for obstetric indication. The rates of caesarean section were 85.7% in the patients with severe/very severe AS and 53.8% in the patients with moderate AS, respectively. All patients with moderate AS received regional anesthesia, including 8 spinal anesthesia, 1 epidural-spinal anesthesia, and 3 epidural anesthesia. Eleven patients (78.6%) with severe/very severe AS received regional anesthesia, including 3 spinal anesthesia, 1 combined epidural-spinal anesthesia, and 7 epidural anesthesia, and 3 (21.4%) received general anesthesia.

Information on fetal outcome is shown in Table 2. There was no neonatal asphyxia or neonatal death in the cohort. Therapeutic abortion was reported in 1 (3.8%) patient with very severe AS. There was statistically significant difference in the incidence of premature deliveries (8.3% in moderate AS vs. 69.4% in severe/very severe AS, $p = 0.004$) and low birth weight (moderate AS 8.3% vs. severe/very severe AS 53.8%, $p = 0.030$) between the patients with moderate AS and severe/very severe AS. When symptomatic patients were compared with asymptomatic patients, significant differences were revealed in pregnancy duration (35 weeks vs. 37 weeks, $p = 0.011$), incidence of preterm delivery (83.3% vs. 25%, $p = 0.018$), mean birth weight (2301.7 ± 490.2 g vs. 2937.1 ± 591.2 g, $p = 0.026$), and incidence of low birth weight (83.3% vs. 15%, $p = 0.018$).

Table 3. Clinical characteristics of patients from Beijing and other cities.

	Beijing (n = 16)	Other cities (n = 10)	*p*
Severe/very severe, n (%)	6 (37.5)	8 (80.0)	0.051
Symptomatic patients, n (%)	1 (6.3)	5 (50.0)	0.018
Hospital admission, n (%)	2 (12.5)	6 (60.0)	0.026
Preterm birth, n (%)	4 (25.0)	6 (66.7)	0.053
Miscarriages, n (%)	0 (0)	1 (10.0)	0.385
Low birth weight, n (%)	3 (18.8)	5 (55.6)	0.087
Weight of newborn, n (%)	2889.1 ± 615.6	2598.9 ± 629.0	0.273

3.4 Differences between patients of Beijing and other cities

In this cohort, sixteen patients underwent prenatal examination from Beijing (group A), and 10 were transferred from other cities near Beijing (group B). The two groups were not different in the proportion of severe AS (severe and very severe AS 37.5% in group A vs. 80.0% in group B; $p = 0.051$). Compared with patients in group A, women in group B had more symptomatic at baseline (group B 50.0% vs. group A 6.2%; $p = 0.018$) and had more hospital admissions during pregnancy for cardiac reasons (group B 60.0% vs.group A 12.5%; $p = 0.026$). The rates of fetal complications, such as pre-term birth (group A 25.0% vs. group B 66.7%, $p = 0.053$), therapeutic abortion (group A 0 vs. group B 10.0%, $p = 0.385$) and low-birth weight (grpoup A 18.8% vs. group B 55.6%, $p = 0.087$) were similar between the groups (Table 3).

4. Discussion

In current study, the incidence of pregnancy with AS is not explored. According to Registry of Pregnancy and Cardiac Disease, AS comprises 0.03% pregnancy with structural heart diseases and 23% of those with valve lesion [13]. Similar to the previous studies, the bicuspid aortic valve is the leading cause of aortic stenosis in the present study [11,14], comprising 65.4% of pregnancy with AS.

4.1 Cardiac outcomes

Because the risk of mother and fetus is low in women with mild AS [6], the present study focused on women with moderate and severe AS and found that most pregnancies were uncomplicated in pregnant women with AS, even in some with severe AS. The maternal mortality was reported to be rare [11,14]. Similarly, the rate of mother death in this cohort is low, and only one mother died during postpartum period. However, this study showed that pregnancies may be associated with a relatively high maternal morbidity in patients with severe AS. Patients with

severe AS, especially those who are symptomatic before pregnancy, are more likely to suffer cardiac complications during pregnancy and require surgical interventions during follow-up. Heart failure is the leading cardiac complication during pregnancy in patients with moderate and severe AS [7,11]. However, we did not see increased incidence of cardiac complications in the patients with severe/very severe AS. But it was noted that patients with severe/very severe AS have a higher rate of deterioration in the NYHA status during pregnancy. Heart failure and arrhythmia were still common in those patients, which are 76.9% and 35.7% in this cohort, respectively. The high rate of HF may partly be attributed to small sample size which might overrepresent the adverse outcome. And patients with severe/very severe AS are more likely to hospitalize during pregnancy. Symptomatic patients before pregnancy were found to have higher risk of heart failure during pregnancy in our study. The deterioration of heart function may be owed to the marked hemodynamic changes and progression of AS occurring during gestation [3,7].

Some borderline differences were identified between patients from Beijing and from other cities, including more symptomatic patients and higher rate of maternal hospitalizations in the latter group. These differences are likely because most patients transferred from other cities to Beijing (where Anzhen hospital is located) had serious AS.

Patients with severe AS are shown to be more likely to have a cardiac surgery during pregnancy and the follow-up period than patients with mild and moderate AS [3,7,11,14]. Percutaneous aortic valvuloplasty can be considered for patients with symptoms refractory to medical therapy, while surgical intervention should only be considered in women with severe AS and refractory NYHA class III/IV symptoms or hemodynamic instability [15]. Percutaneous balloon valvuloplasty was performed on one patient in present study in the second trimester, and 3 patients received aortic valve aortic replacement with cardiopulmonary by pass (CPB), following a caesarean delivery. Ionizing radiation sholud be avoided to reduce adverse effect on fetus [6,15]. Haemodilution, changes in coagulation, and hypotension during CPB may have a deleterious effect during pregnancy [16,17]. However, the recent clinical data show that CPB are relatively well tolerated by the mothers [18].

4.2 Obstetric and fetal outcomes

It was reported that the incidence of PE in China is 4.2% [19], similar to that observed in the present study. Adverse fetal outcomes, such as small for gestational age (SGA), preterm deliveries, and lower birth weight have been reported frequently in patients with AS [3,7,11,14]. The present study showed that the rate of preterm birth in pregnant women with moderate and severe/very severe AS is much higher than that reported 7.8% in China [20]. Compared to patients with moderate AS, shorter pregnancy in symptomatic patients before pregnancy are more frequent and the mean birth weight in these patients are lower in addition to high preterm deliveries and low birth weight. However, fetal outcomes are not statistically different between the patients from Beijing and other cities. Deteriorations of heart function appear to be the leading cause resulting in preterm deliveries. Previously, maternal complications, such as arrhythmias, and use of cardiovascular drugs, such as diuretics, digitalis, and β adrenergic blocking agents have been associated with the impairment of uterine blood flow, and thus with SGA [3,11].

4.3 Mode of delivery

Labor and delivery are a crucial time for women with AS experiencing additional hemodynamic stress during peripartum period. Even asymptomatic, AS women are subjected to hemodynamic stress at the delivery and in the immediate postpartum period. Therefore, they would become symptomatic. It is important to seek a balance between vaginal delivery and caesarean delivery for AS patients. According to 2018 ESC guideline, vaginal delivery is recommended for asymptomatic patients with mild and moderate AS. On the other hand, cesarean section is reserved mainly for symptomatic patients with severe AS or patients with obstetric indications [6]. Patients with moderate and severe AS often have high rate of cesarean section [11,12]. In the present study, 73.1% patients took caesarean delivery due to maternal cardiac reasons. The rate is higher than the overall rate of 42% reported in the ROPAC registry [21] and in previous AS studies [4,11]. The difference may be associated with relatively small sample size, high portion of patients with severe/very severe AS, and very high proportion of patients with heart failure in our cohort.

4.4 Anesthetic management

It is still controversial on the choice of anesthesia in patients with AS. In recent AS studies, regional anesthesia, rather than general anesthesia, is widely performed during caesarean delivery [3,11,14,22]. The choice of anesthesia in our study is similar to that in these studies. Because AS, especially severe AS, is associated with relatively fixed cardiac output, the keys to successful anesthetic management are to maintain hemodynamic stability and to avoid tachycardia, myocardial depression, and decreased left ventricular afterload. Both tachycardia and decreased left ventricular afterload could lead to failure of the left ventricle to adapt stroke volume, thereby resulting in hypotension, a high-risk situation for both the mothers and fetus. In addition, sinus rhythm must be maintained, since adequate left ventricular filling is dependent upon atrial contractility.

4.5 Assessment of risk of pregnancy with AS

Similar to the previous studies, the maternal mortality associated with moderate and severe AS is low, but the maternal morbidity and fetal adverse outcomes are common. Severe AS, especially symptomatic AS, is more likely as-

sociated with these adverse events. The severity of AS is considered an important predictor for adverse events during pregnancy [11]. Therefore, appropriate assessment and counseling are necessary to avoid pregnancy complications, and to allow for elective procedures to be performed before pregnancy, especially in symptomatic women with severe AS. The bicuspid aortic valve is the most cause of AS in pregnant women, which may contribute to the problem of ascending aortopathy. Assessment of aortic dimension should be part of routine care for patients with known BAV before pregnancy. In our study, aortic dimensions were evaluated and aortic diameter over 50 mm was found in 1 (3.8%) patient with BAV. Patients with BAV in which aortic dimension is over 50 mm is recommended to undergo cardio surgery [6].

4.6 Limitation

There are limitations in our study. This study collected a limited number of cases from a single center for pregnancy and cardiac disease. Patients comorbided with mild cardiac diseases were not excluded, and these comorbidities may progress with advancing pregnancy and may become a factor influencing pregnant outcome. In addition, not all of the patients had a pre-pregnancy echocardiographic assessment. It is likely that transaortic gradients would increase with increasing cardiac output. Therefore, the classification of AS severity before pregnancy might be different in some patients with borderline measurements and first presentation during advanced pregnancy.

5. Conclusions

In our cohort, the maternal mortality rate is low and the morbidity related to severe AS is high. Both pre-term birth and low birth weight are more frequently observed in the patients with severe AS. Therefore, women with AS should be examined and counseled by multi-disciplinary teams and recommended for cardiac surgery as appropriate before pregnancy.

Abbreviations

AS, aortic stenosis; BAV, bicuspid aortic valve; CPB, cardiopulmonary bypass; ESC, European Society of Cardiology; GDM, gestational diabetes mellitus; IQR, interquartile range; NYHA, New York Heart Association; PE, preeclampsia; SD, standard deviation; SGA, Small for gestational age.

Author contributions

DY, ZB and JZ designed the study. DY, HZhang, ZB, HZhao and YL collected the data and performed analysis. DY, YL and JZ drafted the manuscript. All authors read and approved the final manuscript

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Anzhen Hospital (approval number 2021108x) and written consent was obtained from every patient.

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Conflict of interest

The authors declare no conflict of interest.

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