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The Effect of Mitral Stenosis on Maternal and Fetal Outcome in Pregnancy

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Abstract

Objectives: The aim of the study was evaluate maternal and fetal outcomes of mitral stenosis at pregnant women.

Methods: Forty-one pregnant woman with moderate and severe mitral stenosis were enrolled in the study. Predictor variables were the apgar score, new born weight and delivery week. Progression of NYHA functional class, thromboembolism, death, new onset atrial fibrillation was accepted as maternal event. Abortion, fetal or neonatal death, prematurity or low birth weight were accepted as fetal events.

Results: In newborn babies, 10 were followed-up in intensive care. The mothers of these infants had higher LA diameters, their MVA's were smaller and the pulmonary hypertension was higher.It was observed that the LA diameter and warfarin treatment were independent risk factors for the need for intensive care. The NYHA was primarily dependent from the LA diameter, followed by the MVA, mean difference in the pressure and the pulmonary artery pressure (PAP).The independent risk factors of the birth weight and the 1st min. and 5th min. Apgar scores, only the LA diameter was found as significant. Also, the independent risk factors of the gestational age at birth are the NYHA classification and the MVA. Warfarin treatment in the mother has also been observed as a risk factor for IUGR.

Conclusion: These results reveal that especially patients with mitral stenosis should be closelymonitored throughout their pregnancy.

Introduction

Although a rarely observed heart condition, severe forms of rheumatic mitral stenosis (MS) may be life-threatening during pregnancy [1,2]. In developing countries rheumatic heart disease is still predominant and continues to be a major cause of maternal morbidity and mortality [3,4]. MS has already been observed to be related with significantly higher incidences of congestive heart failure, arrhythmia, and initiation or increase of cardiac medications and hospitalizations [5,6]. Previous studies have demonstrated that MS influences the fetal outcome and may lead to higher risks of preterm delivery, intrauterine growth retardation and reduced birth weight [5]. Therefore, it may be wise to advise women with moderate or severe MS planning to get pregnant to undergo corrective treatment for the valvular disease before motherhood. On the other hand, if the stenosis is first diagnosed during the pregnancy, surgical repair and percutantransluminalcommissurotomy of mitral stenosis is suggested in pregnancy when mitral stenosis is severe and medical therapy does not work [7,8]. Considering the risk profiles of the individual treatment modalities, the correct selection of the medication to be applied during pregnancy is of utmost importance both for the mother and the fetus. The aim of the present study is to assess the influence of MS on the maternal and fetal outcome of the pregnancy.

Method

Our study was designed to evaluate the outcome of the pregnancy in patients with rheumatoid MS in a retrospective manner. All the patients were followed-up during pregnancy, labour, and delivery at the Cukurova University Hospital, which is a tertiary-care facility with established ob-gyn and cardiology clinics for high-risk patients. Patients with prosthetic heart valves and performed mitral commissurotomy, patients with other serious valvular lesions and those who have undergone therapeutic abortion due to non-cardiac reasons were excluded from the study. The enrolled patients were classified into four groups according to the New York Heart Association (NYHA) functional classification [9]. During the initial antenatal visit at 8th week, baseline data such as maternal age, parity, NYHA functional class, any cardiac interventions performed prior to the pregnancy, cardiac medications and anticoagulant therapy - if any - were recorded. All the enrolled patients underwent electrocardiographic and echocardiographic examinations. A gynecologist-obstetrician and a cardiologist collaborated to monitor the patients throughout their pregnancies. The patients were evaluated by cardiology and obstetric clinics once in two months in the first two trimesters and in the last trimester once in a month or in case of a new complaint of pregnancy. In all cardiologic consultation, ecocardiographic evaluation was also done during follow-up. In the first trimester heparin was

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used in patients having atrial fibrillation, later warfarin was added to treatment. Monthly INR follow-up was done in patients taking warfarin. The starting dose of Coumadine was arranged as 5 mg and INR level was tried to be kept at 2-3. 2-3 weeks before acquisition birth date, patients on treatment with anticoagulant agents were switched to heparin; and heparin treatment was also suspended at the onset of labour to be resumed 6 hours following the delivery. Cesarean under epidural anesthesia was applied to patients were on walfarin treatment and giving birth before acquisition date.

Apart from obstetric indications, any clear symptoms or signs pointing towards a worsening in the cardiac status were accepted as reason for admittance to the hospital. The decision to deliver the patient and the route of delivery were discussed within the team and determined according to the obstetric indication and cardiac functional capacity. All the patients received prophylactic antibiotherapy as a measure against peripartum infective endocarditis. All neonates were examined by a paediatrician, and a paediatric cardiologist was consulted if necessary. Any changes in the cardiac status of the patient, onset or exacerbation of any cardiac complications, need for new cardiac treatment modalities or modifications in the doses of existing cardiac medications, cardiac interventions required during pregnancy, any obstetrical complications, gestational age at delivery, mode of delivery and postpartum complications were assessed. Perinatal outcomes such as fetal growth restriction (FGR; under the 10th percentile), prematurity (before 37 weeks of gestation), stillbirth (intrauterine death after 20 weeks of gestation) or neonatal death (death within the first 28 days of life), birth weight and birth defects were also investigated.

Apgar test

The APGAR test, which is a practical method for the assessment of the neonate at the 1st and 5th minutes after birth, was carried out by a physician. The score at the first minute indicates how well the infant tolerated the delivery and the score at the 5th minute assesses the adaptation of the neonate to the new environment. Also, a healthcare professional examined the infant's breathing effort, heart rate, muscle tone, reflexes and skin colour.

Echocardiography

The echocardiographies were carried out with the Acuson Sequoia C 256 device (Acuson Corporation, Mountain View, CA, USA) and a 2.5-3.5-MHz transducer. The obtained echocardiographic images were performed according to the criteria of the American Society of Echocardiography [10]. In the parasternal long axis position, the diameters of the aorta, left atrium, and the diastolic and end-systolic diameters of the left ventricle have been measured. The rheumatic involvement of the mitral valve was graded according to the Wilkins scoring system. The mitral, aortic and tricuspid valve insufficiencies were evaluated according to the standard method through Doppler echocardiography. The classification of the MS was based on the calculated mitral valve area (MVA) during the echocardiography. A valve area of ≥1.5 cm^2 was classified as mild, an area between 1.5 and 1.0 cm^2 as moderate and <1.0 cm^2 was classified as severe.

Statistical analysis

Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS), version 11.0, and all values were expressed as mean ± standard deviation. Student's t-test and chi-square test were used to evaluate the comparing data. The correlation analysis was used for relation of clinical, labarotory and echocardiographic findings. A p value of <0.05 was considered significant. The lineer logistic regression analysis was performed for the determination of the independent predictors for birth weight, apgar scores and gestational age at birth.

Results

Forty-one patients were enrolled in the study. The mean age of the patients was 27.6 ± 4.7 (between 20 and 35) years. The demographical and echocardiographic features of the patients are presented in Table 1. Also, 10 patients (24.4%) were observed to have other mild and moderate valvular diseases besides the mitral valve stenosis. During the follow-up of patients having additional valve problem, there was no sign of problem obtained associated with mother and child.

While 10 among our patients had atrial fibrillation (AF) at the beginning of the study, 5 more have developed paroxysmal AF in the course of the study. In these patients sinus rythm was provided by electrical cardioversion. During the follow-up of fetal and mother, there was not any statistically significant difference obtained. During the follow-up, 9 patients were on coumadin treatment and all of these patients were under monitoring due to atrial fibrillation. Thrombosis occurred in 2 patients during the follow-up period (Table 2). These patients were on warfarin treatment and one of them died at the 26th week of gestation. This patient was classified as NYHA class 4 and had moderate tricuspid insufficiency.

The gestational week at delivery was mean; 33.2 ± 3.2 week. Also, the greater part of the neonates had low birth weights (mean 2555.6 ± 617.2 gr) and the 1st min. and 5th min. Apgar scores were 7.2 ± 1.8 and 8.9 ± 1.8, respectively (Table 3).

Twenty patients had caesarean sections (CS). Caesarean deliveries were observed to be more frequently applied in patients who had increases in the LA diameter and maximum mitral valve gradients. Also, the neonates delivered through CS had lower gestational ages and lower Apgar scores compared to those who had normal deliveries (Table 4).

In newborn babies, 10 were followed-up in intensive care. The gestational weeks, birth weights and the 1st min. and 5th min. Apgar scores of these infants were lower. Also, the mothers of these infants

	n (%)
Age	27.6 ± 4.7
Multiparite	20 (48.8)
Concomitant valvular disease	10 (24.4)
Caesarean	10 (24.4)
AF NYHA II III IV	10 (24.4) 12(29.2) 26(63.4) 3(7.4)
New onset AF	5 (12.2)
Death of mother	1 (2.4)
Thrombosis	2 (4.9)
Warfarin	9 (22)
NICU	10 (24.4)
LV EF	62.5 ± 3.9
LA diameter	53.2 ± 4.2
MVA	1.1 ± 0.2
PAP	52.5 ± 8.8
Max grd.	18.6 ± 4.9
Mean grd.	10.3 ± 3.0

CS:Caesarean, AF: Atrial Fibrilation, LV EF: Left ventricle ejection fraction, LA: Left Atrium, NICU: Neonatal Intesive Care Unit MVA: Mitral Valve Area, PAP:PulmonerArter Pressure

Table 1: The demographical and echocardiographic features of the patients.

	Exitus	SVO
Age	27	26
Multigravida NYHA (at the delivery)	(+) IV	(+) III
Concomitant valvular disease	(+)	no
Caesarean Sections	(+)	(+)
Atrial Fibrilation	(+)	(+)
Warfarin INR	(+) 2.24	(+) 2.45
LV EF(%)	61.0	63.0
Left Atrium diameter (mm)	56	58
Mitral Valve Area	0.9	1.0
Pulmonary Artery Pressure NICU	56 (+)	53 (+)

LV EF: Left ventricle ejection fraction

Table 2: The clinical and echocardiographic characteristics of the two patients with thrombosis.

	n (%)
1st min. Apgar score	7.2 ± 1.8
5th min. Apgar score	8.9 ± 1.8
Birth weight	2555.6 ± 617.2
Gestational week at delivery	33.2 ± 3.2

Table 3: The delivery status of newborns.

	Spontaneous 31	Caesarean 10	p
Age	27.2 ± 4.7	28.1 ± 4.7	0.562
Concomitant valvular disease	7 (25.8)	2 (20.0)	0.484
Atrial Fibrilation	3 (9.7)	7 (70.0)	> 0.01
New onset AF	4 (12.9)	1 (10.0)	0.343
Warfarin	2 (6.5)	7 (70.0)	1.000
NICU	5 (16.1)	5 (50.0)	> 0.01
EF	63.1 ± 3.7	61.8 ± 4.0	0.289
LA diameter	51.6 ± 3.5	54.8 ± 4.3	0.013
MVA	1.2 ± 0.2	1.1 ± 0.2	0.070
PAP	50.8 ± 8.1	54.4 ± 9.2	0.188
Max grd.	17.0 ± 4.5	20.4 ± 4.7	0.023
Min grd.	9.6 ± 3.0	11.0 ± 2.8	0.127
1st min. Apgar score	7.8 ± 1.1	6.6 ± 2.2	0.033
5th min. Apgar score	9.5 ± 0.6	8.3 ± 2.3	0.026
Birth weight	2726.2 ± 494.4	2376.5 ± 692.0	0.072
Gestational week at delivery	34.2 ± 2.6	32.1 ± 3.5	0.034

Table 4: Comparing of spontaneous deliveries with caesarean sections.

had higher LA diameters, their MVA's were smaller and the pulmonary hypertension was higher. Besides, the greater part of these mothers had AF and they were on warfarin treatment (Table 5). When the infants admitted to intensive care were assessed using the logistic regression analysis, it was observed that the LA diameter and warfarin treatment were independent risk factors for the need for intensive care (p=0.004, r=-0.632, p=0.011, r=-0.621, respectively).

The correlation analysis revealed that the NYHA was primarily dependent from the LA diameter (p<0.001, r=0.720), followed by the MVA, mean difference in the pressure and the pulmonary artery pressure (PAP) (Table 6). In the linear regression test performed in order to determine the independent risk factors of the birth weight and the 1st min. and 5th min. Apgar scores, only the LA diameter was found as significant (Table 7). Also, the evaluation based on the same linear regression analysis pointed out the independent risk factors of the gestational age at birth are the NYHA classification (p=0.002, r=0.325) and the MVA (p=0.023, r=-0.452).

Discussion

The main symptom of our study was to show the finding of extremely high fetal and maternal risk in pregnants having moderate and extensive mitral stenosis. In mitral stenosis pregnancies in order to obtain the best result in maternal and fetus, the patients must be followed closely and their treatments must be optimalized.

The optimum treatment modality in pregnant patients with MS should target a reduction in the heart rate and the LA pressure. The medications of choice are beta blockers. The LA pressure can be controlled by limiting the salt intake and the careful use of diuretics. It must be noted that the increased incidence of cardiac arrhythmias during pregnancy [11,12] may be associated with the changes brought about by the gestational hormones and a greater sensitivity to catecholamines [13]. All the patients who were taken to our study, were taking beta blocker and during controls diuretic was carefully started to symptomatic patients. While 10 of our patients had chronic AF from the beginning, 5 more patients developed AF during the follow-up. The patients who were evaluated as paroxysmal atrial fibrillation, were used electrical cardioversion and sinus rhythm was provided.

	Healthy 31	NICU 10	p
Age	28.0 ± 4.4	26.4 ± 5.5	0.415
Multigravida	16 /12 /3	5 / 4 / 1	0.996
Concomitant valvular disease	8 (25.8)	2 (20)	1.000
Caesarean Sections	7 (22.5)	3 (0.3)	0.159
Atrial Fibrilation	5 (16.1)	5 (50.0)	0.045
New onset AF	4 (12.9)	1 (10.0)	1.000
Death of mother	0 (0.0)	1 (10.0)	0.244
Thrombosis	0 (0.0)	2 (20.0)	0.055
Warfarin	4 (12.9)	5 (50.0)	0.025
LV EF	62.0 ± 4.2	64.0 ± 2.2	0.056
LA diameter	51.9 ± 3.4	57.1 ± 4.0	0.003
MVA	1.2 ± 0.2	1.0 ± 0.2	0.032
PAP	51.0 ± 8.7	57.2 ± 7.6	0.045
Max gradient	17.8 ± 4.7	21.1 ± 4.6	0.070
Mean gradient	10.0 ± 3.0	11.2 ± 2.8	0.255
1st min. Apgar score	7.7 ± 1.3	5.5 ± 2.2	0.011
5th min. Apgar score	9.4 ± 0.9	7.3 ± 2.8	0.038
Birth weight	2747.1 ± 476.9	1962.0 ± 946.1	0.004
Gestational week at delivery	34.3 ± 2.5	29.6 ± 2.7	< 0.001

Table 5: Comparing of healthy babies with followed-up in intensive care unit.

	P	r
Left atrial diameter	<0.001	0.720
Mitral valve area	0.002	0.475
Mean difference in the pressure	0.002	0.475
Pulmonary artery pressure	0.01	0.400

AF: Atrial Fibrilation, LV EF: Left ventricle ejection fraction, LA: Left Atrium, NICU: Neonatal Intensive Care Unit

Table 6: The echocardiographic parameters correlated with NYHA.

	p	r
Left atrial diameter was found the independent risk factor of the birth weight	<0.001	0.632
Left atrial diameter was found the independent risk factor of the 1st min. Apgar scores	<0.001	0.621
Left atrial diameter was found the independent risk factor of the 5th min. Apgar scores	<0.001	-0.583

Table 7: Lineer regression analysis with birth weight, 1st min. and 5th min. The p and r values for LA diameter that is the only independent risk factor for Apgar scores.

Nine patients were on warfarin treatment and all of these patients were already being monitored due to chronic AF. Warfarin is an anticoagulant that passes placenta and has teratogenetic effect. During pregnancy warfarin usage causes spontenousabortus, premature or dead birth, fetal bleeding and cerebral hemorrhages. If warfarin is used in the first trimester, it causes embryopathy, nasal hypoplasis and in any other trimester of pregnancy it causes central nervous system malformations [14,15]. However, with current datas and strict INR control throughout pregnancy, it was mentioned that warfarin usage is the most secure method for the mother [14]. In a study, a group of patients used anticoagulant during pregnancy was compared to the other group who used anticoagulant after heparin in the first trimester, and the risk of embryopathy between two groups were found the same so it was indicated that the embryopathy due to warfarin usage was exaggerated and anticoagulant usage throughout pregnancy was offered [16]. In our study 9 patients were using walfarin as anticogulant. A strict INR control was provided in those patients and the INR level progressed between 2.0-3.5. There was not any embryopathy due to warfarin usage reported in our study but warfarin was found as an independent risk factor in intrauterine growth retardation. That was thought to be related with the finding of arrhythmia that causes IUGR in those patients. Despite of warfarin usage, one of the patients experienced transient ischemic attack and in the other one there was a development of trombus on left atrium. The patient having trompus on the left atrium was lost in the postpartum period, 6 days after a successful CS delivery performed in conjunction with a mitral valve replacement and thrombectomy

The link between the conditions leading to this patient's death and her pregnancy is unclear. In pregnant women with MS, the increased blood volume and heart rate bring about an increase in the mitral valve gradient. This condition further leads to an increase in the LA pressure and thus to pulmonary congestion [17,18]. The leading cause of death in pregnant women with MS has been reported as acute pulmonary edema [19]. Especially the fast increase in the venous return before and after the delivery is an important cause for cardiac decompensation. Mortality has been reported as 0.4% in NYHA class I-II patients and as 6.8% in class III-IV patients [2]. Among the patients enrolled in our study during labor and delivery, 12 were NYHA class II, 26 were NYHA class III and 3 patients were NYHA class IV. In our study the independent risk factors of the gestational week at delivery were found that the NYHA classification and the mitral valve area. The patient was died classified as NYHA class 4 at delivery. Apart from that, both our data and additional data from other reports [20,21] point out that mortality rates in pregnant women with MS can be reduced by a timely diagnosis and meticulous follow-up.

In pregnant patients with MS, before, during and after the birth when the venous return is increased due to the relief of the uterocaval obstruction, the pulmonary edema may become more severe. Therefore, patients must be hemodynamically monitored during the peripartum period (12-24 hours). Vaginal delivery is a well-tolerated preferred method in mitral stenosis pregnants [22]. Vaginal delivery should be individualized by taking birth time, induction method, anesthesia technique and necessity of monitorization into consideration. The patients having vaginal deliver are suggested epidural anesthesia in order to prevent catecholamine induced tachycardia [23]. Also, hemodiamic control is easy with epidural anesthesia since anestesia is provided slowly [24]. When vaginal delivery is compared to ceserean delivery, there is less bleeding and infection risk however the risk of venous thrombosis and thromboembolism is higher. Although if there is not a complete consensus on the situations which vaginal delivery contraindicated, at the beginning of birth the cardiopulmonary reserve of mother should be evaluated carefully and ceserean delivery should be considered [25-29]. During the beginning of delivery in some situations such as acute decompensed cardiac insufficiency and oral usage of anticoagulant, ceserean delivery is preferred. In our study, 10 patients having acute cardiac insufficiency and were unstable as hemodynamic, were applied ceserean. Among these patients 7 of them were using warfarin. In conclusion, when CS and normal deliveries were compared, it was observed that CS was more frequently performed in patients with increased LA diameter and maximum gradient values. In addition, CS delivery patients were terminated at an earlier gestational period and have low apgar score.

Besides investigating the relationship between MS and maternal mortality, the present study also focussed on the relationship between MS, pregnant and the fetal outcome [14,15]. Among the patients in our study, gestation was associated with higher rates of IUGR, preterm deliveries, and lower birth weight; particularly among the patients with moderate or severe MS. The higher incidence of the intrauterine growth retardation among our patients with valvular heart disease may be explained by the hemodynamic compromise brought about by the valvular stenosis and the consequent decrease in uterine blood flow. Since maternal arrhythmias have also been demonstrated to cause fetal distress [30], they may be an additional factor leading to a compromise in the uterine blood flow and even to fetal outcomes. Although the effect of cardiovascular treatments on the fetus could not be evaluated, medications such as beta-adrenergic blockers, digitalis derivatives or diuretics have been associated with impaired uterine blood flow and increased incidence of IUGR/prematurity [31-33]. In our study, the LA diameter was found as an independent risk factor for the birth weight and the 1st and 5th minute Apgar scores. Ten of the neonates (24.4%) had to be monitored in the neonatal intensive care, and a significant relationship was observed between the need for neonatal intensive care and factors such as the presence of AF, thrombosis, LA diameter, ejection fraction, MVA and pulmonary arterial pressure. it was observed that the LA diameter was independent risk factors for IUGR. The higher incidence of IUGR found in our study underlines the importance of antepartum fetal surveillance and periodic ultrasonographic examinations in order to monitor the fetal growth in patients with moderate or severe mitral valve stenosis. Also, in our study, it was observed that the LA diameter and warfarin treatment were independent risk factors for IUGR.

It is hard to manage pregnancy period of pregnants having mitral stenosis. Maternal and neonatal event rates, however, dramatically increase in high risk patients. In these patients the clinical risk should be identified and treatment should be individualized according to patient.

Repair of valvular stenosis in such patients should be performed prior to pregnancy, if possible. The summary of all these parameters suggests the conclusion that especially patients with risk factors should be closely monitored throughout their pregnancy. **Limitations**

In our study the results of mitral stenosis on pregnanat and fetus were evaluated. Although monthly ultrasonographies and when necessary fetal non-stress tests were applied during their follow-up, this subject was not additionally given a place in our article. Also this study was limited by patients having chronic atrial fibrillation, paroxysmal atrial fibrillation and the ones provided sinus rhythm. However, for this group of patients there needed other studies in which arrhythmias are separately evaluated or may be Holtermonitorization is used. Because the absence of warfarin effect and necessary number of patients, this

subject was not explained in details in the aim of our study. Also, since the postpartum follow-ups were not the main subject of this study, they were not evaluated particularly.

References

1. Mueller SD, Willerson JT (1995) Pregnancy and the heart. In: Willerson JT, Cohn JN, editors. Cardiovascular Medicine. New York: Churchill Livingstone, 1551– 1606.
2. Bhatla N, Lal S, Behera G, Kriplani A, Mittal S, et al. (2003) Cardiac disease in pregnancy. Int J Gynaecol Obstet 82: 153-159.
3. Sawhney H, Aggarwal N, Suri V, Vasishta K, Sharma Y, et al. (2003) Maternal and perinatal outcome in rheumatic heart disease. Int J Gynaecol Obstet 80: 9-14.
4. Nqayana T, Moodley J, Naidoo DP (2008) Cardiac disease in pregnancy. Cardiovasc J Afr 19: 145-151.
5. Hameed A, Karaalp IS, Tummala PP, Wani OR, Canetti M, et al. (2001) The effect of valvular heart disease on maternal and fetal outcome of pregnancy. J Am Coll Cardiol 37: 893-899.
6. Desai DK, Adanlawo M, Naidoo DP, Moodley J, Kleinschmidt I (2000) Mitral stenosis in pregnancy: a four-year experience at King Edward VIII Hospital, Durban, South Africa. BJOG 107: 953-958.
7. Abdi S, Salehi N, Ghodsi B, Basiri HA, Momtahen M, et al. (2012) Immediate results of percutaneous trans-luminal mitral commissurotomy in pregnant women with severe mitral stenosis. Clin Med Insights Cardiol 6: 35-39.
8. Traill TA (2012) Valvular heart disease and pregnancy. Cardiol Clin 30: 369-381.
9. The Criteria Committee of the New York Heart Association (1979) Nomenclature and criteria for diagnosis of diseases of the heart and great vessels, 8th edn. New York Heart Association.
10. Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, et al. (2006) ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease) Developed in Collaboration With the Society of Cardiovascular Anesthesiologists Endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. J Am Coll Cardiol 48: 598–675.
11. Elkayam U, Gleicher N (1998) Hemodynamics and cardiac function during normal pregnancy and the puerperium. In: Elkayam U, Gleicher N, editors. Cardiac Problems in Pregnancy. 3rd ed. New York: Wiley- Liss 3–19.
12. Brodsky M, Doria R, Allen B, Sato D, Thomas G, et al. (1992) New-onset ventricular tachycardia during pregnancy. Am Heart J 123: 933-941.
13. Shotan A, Ostrzega E, Mehra A, Johnson JV, Elkayam U (1997) Incidence of arrhythmias in normal pregnancy and relation to palpitations, dizziness, and syncope. Am J Cardiol 79: 1061-1064.
14. Zagrosek V, Blomstrom Lundqvist C, Borghi C, Cifkova R, Ferreira R, et al. (2011) ESC Guidelines on the management of cardiovascular diseases during pregnancy. The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology (ESC). Eur Heart J 32: 3147–3197.
15. Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, et al. (2008) "2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1998 guidelines for the management of patients with valvular heart disease). Endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons". J Am Coll Cardiol 52: e1–142.
16. Al-Lawati AA, Venkitraman M, Al-Delaime T, Valliathu J (2002) Pregnancy and mechanical heart valves replacement; dilemma of anticoagulation. Eur J Cardiothorac Surg 22: 223-227.
17. Burwell CS, Metcalfe J (1968) Heart disease and pregnany. Physilogy and management. Little Brown, Boston. p: 127.
18. Szekely P, Turner R, Snaith L (1973) Pregnancy and the changing pattern of rheumatic heart disease. Br Heart J 35: 1293-1303.
19. Braunwald E (1997) Valvular heart disease. In: Braunwald E, editor. Heart Disease. 5th ed. Philadelphia: Saunders :1007–1076.
20. Lao TT, Sermer M, MaGee L, Farine D, Colman JM (1993) Congenital aortic stenosis and pregnancy--a reappraisal. Am J Obstet Gynecol 169: 540-545.
21. Widerhorn J, Widerhorn AL, Rahimtoola SH, Elkayam U (1992) WPW syndrome during pregnancy: increased incidence of supraventricular arrhythmias. Am Heart J 123: 796-798.
22. Clark SL, Phelan JP, Greenspoon J, Aldahl D, Horenstein J (1985) Labor and delivery in the presence of mitral stenosis: central hemodynamic observations. Am J Obstet Gynecol 152: 984-988.
23. Kuczkowski KM, van Zundert A (2007) Anesthesia for pregnant women with valvular heart disease: the state-of-the-art. J Anesth 21: 252-257.
24. Allen NM, Page RL (1993) Procainamide administration during pregnancy. Clin Pharm 12: 58-60.
25. Vahanian A, Baumgartner H, Bax J, Butchart E, Dion R (2007) Guidelines on the management of valvular heart disease: the Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology. Eur Heart J 28: 230–268.
26. Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, et al. (2008) 2008 Focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease): endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. Circulation 118: e523-661.
27. Bonanno C, Gaddipati S (2008) Mechanisms of hemostasis at cesarean delivery. Clin Perinatol 35: 531-547, xi.
28. Elkayam U, Ostrzega E, Shotan A, Mehra A (1995) Cardiovascular problems in pregnant women with the Marfan syndrome. Ann Intern Med 123: 117-122.
29. Hiratzka LF, Bakris GL, Beckman JA, Bersin RM, Carr VF, et al. (2010) 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with Thoracic Aortic Disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. Circulation 121: e266-369.
30. Barron WM, Mujais SK, Zinaman M, Bravo EL, Lindheimer MD (1986) Plasma catecholamine responses to physiologic stimuli in normal human pregnancy. Am J Obstet Gynecol 154: 80-84.
31. Shoemaker ES, Gant NF, Madden JD, MacDonald PC (1973) The effect of thiazide diuretics on placental function. Tex Med 69: 109-115.
32. Suonio S, Saarikoski S, Tahvanainen K, Pääkkönen A, Olkkonen H (1986) Acute effects of dihydralazine mesylate, furosemide, and metoprolol on maternal hemodynamics in pregnancy-induced hypertension. Am J Obstet Gynecol 155: 122-125.
33. Weaver JB, Pearson JF (1973) Influence of digitalis on time of onset and duration of labour in women with cardiac disease. Br Med J 3: 519-520.