Journal of Research in Medical and Dental Sciences
Volume 5, Issue 5, Page No: 6-12

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Maternal and Fetal Outcome in Pregnant Women with Cardiac Disease

Bhavana Kakaria[1] and Ashish K[2]

[1]Assistant Professor, Department of Obstetrics and Gynecology, SBHGMC Hospital, Dhule, Maharashtra, India
[2]Associate Professor, Department of Medicine, SBHGMC Hospital, Dhule, Maharashtra, India

DOI: 10.24896/jrmds.2017552

ABSTRACT

The objective of the study was to compare and evaluate the pregnancy and fetal outcome of women with cardiac disease, with low risk pregnant women. A retrospective comparative analysis of maternal and fetal outcomes of 34 pregnant women with cardiac disease, with 34 low risk pregnant women who delivered during the same period (June 2015– May 2016) was performed. Low risk women had their hospital identity numbers sealed in an envelope and lots were drawn to pick the numbers to prevent selection bias. Descriptive statistical analysis was used. Women with cardiac disease had a high incidence of cardiac surgical intervention, higher rates of instrumental deliveries (41.16% Vs 8.82%), cesarean deliveries (26.46% Vs 23.52%) and higher morbidity (52.92% Vs 5.88%). Although there was an equal rates of pre-term delivery (5.88% Vs 5.88%), low birth weight (2667.50 +/- 250 Gms Vs 2833.52 +/- 350 Gms), but a higher incidence of APGAR scores < 8 (49.98% Vs 41.16%) was encountered in the subject group. Women with previously detected heart disease and who had late booking during the present pregnancy had more antepartum, intrapartum and post partum complications 50% vs 35.72% and increase transfer of neonate to nursery, though not statistically significant. Women with cardiac procedures done previously had less complications antepartum, intrapartum, and in the postpartum period and less occurrence of intrauterine growth retardation, compared to women who were not operated previously; 01 (12.50%) vs10 (38.46%), p value-<0.05. and 01 (12.50%) vs 08 (30.76%), p value-<0.05 respectively. Multi-specialty approach is required for optimal management and a better outcome in pregnant women with cardiac disease. Pre pregnancy major surgical interventions in the form of balloon mitral valvotomy, closed mitral valvotomy, mitral valve replacement should be performed before pregnancy to prevent maternal complications and to achieve optimum fetal outcome.

Key words: Congenital Heart Disease, Valvular Heart Disease, Maternal Outcome, Neonatal Outcome

HOW TO CITE THIS ARTICLE: Bhavana Kakaria, Ashish K, Maternal and Fetal Outcome in Pregnant Women with Cardiac Disease, J Res Med Dent Sci, 2017, 5 (5):6-12, DOI: 10.24896/jrmds.2017552

Corresponding author: Bhavana Kakaria
e-mail✉bhavanak@gmail.com
Received: 12/07/2017
Accepted: 28/09/2017

INTRODUCTION

Regurgitant valvular lesions are generally well tolerated during pregnancy, as compared to the stenotic lesions, which have a greater potential for de-compensation. Pregnancy outcome in patients with congenital heart disease carries the risk of maternal cardiac de-compensation and the transmission of specific cardiac defects. During pregnancy, screening can be performed with fetal echocardiography or genetic testing in certain women. Due to vast advances in the cardiac care and improvements in reproductive technology, many women with these diagnoses will be planning pregnancy (1).

MATERIAL AND METHODS

A retrospective study of 34 pregnant women with cardiac disease conducted over a period of 5 years (June 2015- May 2016) at SBHGMC Hospital, Dhule, Maharashtra, India. This hospital is a referral center for pregnant cardiac patients, with provisions like 24 hours availability of general physicians, , medical intensive care unit facilities and expert cardiologists and cardio thoracic

surgeons available when required. The control group consisted of 34 pregnant women who did not have cardiac disease, but were delivered in the same hospital during the same period. As a hospital protocol all pregnant women with heart disease were regularly followed up at both antenatal clinic and medical out-patient clinic. Pregnant women with valvular, congenital and cardio-myopathy were included.

Complete present and past obstetric history and any cardiac complications in the present and past were recorded. General physical examination, vital signs and vital functions, obstetric examination were performed and documented. Maternal out come in terms of antenatal events, mode of delivery, maternal complications during and after delivery. Fetal out come- Apgar score, birth weight, reasons for transfer to neonatal intensive care unit were documented in both the subject and control group.

Statistical Methods

Descriptive statistical analysis has been used in the present study. Chi-Square test/Fisher Exact test have been used to find the significance of characteristics of interest between subject and control groups.

+ Suggestive significance 0.05<P<0.10.
** moderately significant 0.01< P £0.05. ** Strongly significant P £ 0.01*

Statistical software: SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data [2, 3].

RESULTS

The subject group consisted of 34 pregnant women with cardiac disease and the control group consisted of pregnant women with no cardiac disease. The characteristics of women in both the groups are shown in Table 1. The results matched between the two groups with regard to the age, parity, ethnicity (religion). There was a significant number of booked women in the control group and significant number of un-booked women in the subject group on comparison (26/34 Vs 17/34; 76.44% Vs 49.98%; *p value* 0.024) and (11/34 Vs 2/34; 32.34% Vs 5.88%; *p value* 0.006) table 1 respectively. Most women had their first antenatal visit in the second trimester of pregnancy in both the groups (12/34 Vs 16/34; 47.04% Vs 35.28%; *p value 0.324).*

Most women had combined valvular involvement 27/34 cases (79.41%), mitral regurgitation alone was seen in 2/34 cases (5.88%), congenital heart disease was found in 3/34 cases (8.82%), multi-valvular lesion leading to dilated cardio-myopathy was found in 1/34 case (2.94%). Total number of women with valvular disease was 31/34(91.17%) and congenital heart disease was 3/34 (8.8%). Table-2

Table 2A: In the subject group there was significant increase in the overall operative interventions compared to the control group. (8/34 Vs 2/34; 23.52% Vs 5.88%; *p value-0.040*). Antenatal complications specific to cardio-vascular problems were significantly higher in the subject group (8/34 Vs 0/34; 23.52% Vs 0%; *p value 0.002*). Congestive cardiac failure was seen in 2/34 (5.88%), sinus tachycardia 3/34 (8.82%), dilated cardio-myopathy 1/34 (2.94%) and 2 women required emergency surgical intervention in the subject group 2/34 (5.88%). No such complications were recorded in the control group.

Table 2B: Medical problems other than cardio-vascular problems (10/34 Vs 2/34; 29.4% Vs 5.88%; p *value*< 0.01) was significantly more in the subject group. There were no maternal deaths in both the groups. Higher number of women with moderate anemia was recorded in subject group (5/34 Vs 1/34; 14.7% Vs 2.94%; *p value* <0.197). All required postnatal transfusion.

Therefore, there was an overall higher incidence of cardiovascular related and other medical complications in the subject group compared to the control group (18/34 Vs 2/34; 52.92% Vs 5.88%; *p value <0.01*) Table 2A and 2B.

Table 3: There was a higher occurrence of gestational hypertension (4/34 Vs 1/34; 11.76% Vs 2.94%; *p value 1.000*), fetal growth restriction (9/34 Vs 5/34: 26.46% Vs 14.7%; p value 0.230) and +lower mean birth weight in the subject group (2667.5+/-250 gms Vs 2833.5+/-300 gms) as compared to the control group. Apgar score <8 (17/34 Vs 14/34; 49.98% Vs 41.16%, p value 0.465) was almost equal in both the groups. However, the subject group had significantly higher number of neonates transferred to the neonatal intensive care unit (16/34 Vs 6/34, 47.04% Vs17.64%; p value <0.042) and they

Table 1: Characteristics of women

S.no	Characteristics of women	Subject-group	Control group	*"p" value*	Significance
	No. of women	34	34	-	-
1.	Marriage; Mean years	21.62 years (14- 42 years)	20.68 years (16-30 years)	-	-
2.	Mean Parity	primipara	primipara	-	-
3.		Religion N (%)			
	Hindu	27 (79.385 %)	31 (91.1%)	0.171	NS
	Muslim	07 (20.58 %)	03 (8.82%)	0.171	NS
4.		Obstretic history N(%)			
	Abortion(previous)	07 (20.5%)	03 (8.82%)	0.171	NS
	Still- birth(previous)	00	02 (5.88%)	0.493	NS
	Pre-term delivery(previous)	00 (00%)	00 (00%)		
5.		Present preference N (%)			
	Booked	17(49.98%)	26(76.44%)	0.024*	Sig
	Registered	06(17.64%)	06(17.64%)	1.000	NS
	Un-booked	11(32.34%)	02 (5.88%)	0.006**	Sig
6.		First visit			
	Ist trimester	02(5.88%)	10(9.4%)	0.011**	Sig
	IInd trimester	12(36.28%)	16(47.04%)	0.324	NS
	IIIrd trimester	10(29.4%)	06(17.64%)	0.253	NS
	Emergency U.B	10(29.4%)	02(5.88%)	0.011*	Sig

N- values given as (%).UB- unbooked. Booked- minimum of 5 visits. Un-booked –no visits. Registered- 1 or 2 visits

Table 2: Types of Valvular lesion

S. No.	Lesion	Number
1	MR only	02
2	MS+MR	07
3	MS+MR+AR	02
4	MS+MR+AR+TR	03
5	MS+MR+AR+TR+PAH	06
6	MVP+TVP+MR+TR	01
7	MR+AR	01
8	MR+TR	01
9	MS+AS+TR	01
10	MVP+MR	01
11	MVP only	01
12	DCM	01
13	Post surgery- MS+TR+MR*	03
14	MVP+TR	01
15	Congenital heart disease	
	1. ASD	01
	2. ASD+MR+TR	01
	3. VSD	01
	Total	34

** Prosthetic valve on anticoagulants. Congenital heart disease- 3/34 women; 8.823%, Multi-valvular lesion- 27/34 women; 79.41%, Only mitral regurgitation- 2/34 women; 5.88%, Only mitral valve prolapse- 1/34 woman; 2.94%, Multi-valvular lesion leading to dilated cardio-myopathy- 1/34 woman; 2.94%. Total number of valvular heart disease- 31 women. (91.18%) Total number of congenital heart disease –03 women. (8.82%)*

Table-2B: Medical complications Antenatally other than cardio-vascular problems

Medical complications	Subject group(n=34)	Control group(n=34)	*"p" value*	Significance.
1.Fever+ UTI+URI*	1(2.94%)	1(2.94%)	1.000	NS
2.Pyelonephritis AT 21 weeks *	1(2.94%)	0	1.000	NS
3.Hemiparesis at 6 weeks (right) *	1(2.94%)	0	1.000	NS
4.Pulmonary Kochs detected at 24 weeks *	1(2.94%)	0	1.000	NS
5.Anemia *(moderate)	5(14.7%)	1(2.94%)	0.197	NS
6.Basal ganglia infarct(asymptomatic) *	1(2.94%)	0	1.000	NS
Total	10(29.4%)	2(5.88%)	0.011*	Sig

** presented in the present pregnancy.*

UTI- urinary tract infection. URI- upper respiratory tract infection. Therefore, there was an overall higher incidence of cardiovascular and other medical complications in the study group compared to the control group 18/34 Vs 2/34; 52.92% Vs 5.88% ; p value<0.01) Table 4 A and 4B.

Table 2A: Antenatal events in two groups

I	Events	Subject group (n=34)	Control group(n=34)	*"p"- value*	Significance
1.	Operative interventions ***				
	PTMC	03	00	0.239	NS
	CMV	01	00	1.000	NS
	BMV	01	00	1.000	NS
2.	VSD(repair)	01	00	1.000	NS
3.	MVR	01	00	1.000	NS
4.	ASD(repair)	01	00	1.000	NS
5.	Previous lower segment cesarean section.	00	01	1.000	NS
6.	Ovarian cyst aspiration	00	01	1.000	NS
7.	Total operated cases	08 (23.52%)	02 (5.88%)	0.040*	Sig
8.	Not operated	26 (76.44%)	32 (94.08%)	0.040*	Sig
II	Antenatal complication @	-	-	-	-
1.	No complications	25(73.5%)	34(100%)	0.002**	Sig
2.	Complications	08(23.52%)	00	0.002**	Sig
3.	CCF	02(5.88%)	00	0.493	NS
4.	Sinus tachycardia	03(8.82%)	00	0.114	NS
5.	DCM not in failure	01(2.94%)	00	1.000	NS
6.Emergency intervention during89pregnancy					
	PTMC	01(2.94%)	00	1.000	NS
	CMV	01(2.94%)	00	1.000	NS
7.	Maternal mortality	00	00	-	-

**** includes patients who had intervention in the present pregnancy (PTMC-1; CMV-1); previous pregnancy (BMV-1, PTMC-1); interval period or during childhood (ASD repair-1, VSD repair-1, MVR-1, PTMC-1).*
@-- only complications related to cardio- vascular problems in the antenatal period.
PTMC- Per-cutaeneous trans mitral commissurotomy.
CMV- Closed mitral valve commissurotomy.
BMV-ballon mitral valvotomy. MVR- mitral valve replacement. VSD- ventricular septal defect.
ASD-atrial septal defect. CCF- congestive cardiac failure. DCM- dilated cardimyopathy.

Table 3: Obstetric complications and fetal outcome

S.No	Complications	Subject group	Control group	*"p" value*	Significance
1.	Hypertension in Pregnancy				
	HELPP*	01 (2.94%)	00	1.000	NS
	Mild PIH	04 (11.76%)	01 (2.94%)	0.356	NS
2.	Gestational Diabetes Mellitus	01 (2.94%)	01 (2.94%)	1.000	NS
3.	GDM+PIH**	00(00%)	01(2.94%)	1.000	NS
4.	FGR***	09(26.46%)	05(14.7%)	0.230	NS
5.	Pre-term delivery	02(5.88%)	02(5.88%)	1.000	NS
6.	Gestational age-	36.32 wks+/- 1 wk	38.67 wks+/- 1 wk	-	-
	Mean/ S.D(weeks)	(254.26 days)	(270.73 days)		
7.	Congenital anomalies	00	00	-	-
8.	Birth weight,mean/S.D(Gms)	2667.50 Gms+/-250Gms	2833.52 Gms+/-350Gms	-	-
9.	Low birth weight (< 2500 Gms ->1200 Gms)	09(26.46%)	05(14.7%)	0.230	NS
10.	Apgar score[<8 at 1 min/ 5 min	17(49.98%)	14(41.16%)	0.465	NS
11.	Transfer to NICU	16(47.04%)	06(17.64%)	0.042*	Sig
	1. TTNB****(0-12 hours)	09	04	0.123	NS
	2. TTNB+ Phototherapy##	04	02	0.673	NS
	3. TTNB+Pneumonitis(4-5day)	01	00	1.000	NS
	4.Preterm + FGR(7days)	01	00	1.000	NS
	5.Term FGR (5-7days)	01	00	1.000	NS
	Total	16	06	0.010	Sig
12.	Still Birth	00	00	-	-

*HELLP: haemolysis, elevated liver enzymes and low platelets.**GDM+PIH: gestatinal diabetes mellitus + pregnancy induced hypertension.*
****FGR: fetal growth restriction.*
*****TTNB: transient tachyapnea of new born.*
transient tachypnoea of new born and were shifted back for phototherapy.

Table 4: Mode of Delivery

S.No.	Mode of Delivery	Subject(n=34)	Control(n=34)	*"p"-value*	Significance
1	Vaginal	11 (32.34%)	23(67.62%)	0.097	Sug.Sig
2	Cesarean	09 (26.46%)	08(23.52%)	0.779	NS
3	Instrumentation	14 (41.16%)	03(8.82%)	0.002**	Sig
		Forceps-13	Forceps-1	<0.001**	Sig
		Vaccum-01	Vaccum-2	1.000	Sig
	Total	34	34	-	-

Table 5: Events in the Post-natal period

S.No.	Events	Study group	Control group	*"p" value*	Significance
1	Post-partum haemorrhage (atonic)	01	01	1.000	NS
2	wound gaping	01	00	1.000	NS
3	Blood transfusion	05	01	0.197	NS
4	Pneumonia	02	00	1.000	NS
5	Atrial fibrillation	01	00	1.000	NS
6	Pulmonary edema	01	00	1.000	NS
7	Total	11(32.34%)	02(5.88%)	0.006**	Sig

Table 6: Relationship of maternal & fetal outcome in presently & previously detected cardiac disease

Maternal and Fetal Outcome	Present pregnancy -early booking (13-17 wks) 14/	Previously detected and late booking, (32 weeks) 8/ 15	"p" value	Significance
Maternal outcome* Complications. Antepartum, Intrpartum and Postpartum	5/ 14 35.72 %	4/ 8 50 %	0.100	NS
Fetal outcome Transfer to nursery	6/ 14 42.85 %	4/ 8 50 %	1.000	NS

(- No maternal complications were seen in 12/14 Vs 4/8; 64.28% Vs 50 %.)*

Table 7: Relationship of maternal and fetal outcome in operated and un-operated women

Maternal and Fetal Outcome	Operated women (8/34- 23.52%)	Un -operated women(26/34-76.48%)	"p" value	Significance
Maternal outcome Complications. Antepartum, intrpartum and postpartum.	01 (12.50%)	10 (38.46%)	<0.05	Sig
Fetal outcome				
IUGR	01 (12.50%)	08 (30.76%)	<0.05	Sig
Transfer to nursery.	04 (50.00%)	12 (46.15%)		

Totally eight women were operated out of which two were operated in the present pregnancy and six of them were operated previously. 26 of the women in the study group were not operated.

required a more prolonged stay compared to the control group. There were no significant differences in the incidence of preterm deliveries, gestational diabetes, gestational diabetes with gestational hypertension and congenital anomalies between the two groups.

Table 4: There was a significantly higher incidence of instrumental delivery in the subject group (14/34 Vs 3/34; 41.16% Vs 8.82%; *p value* <0.002) compared with the control group. The cesarean section rates were almost the same in both the groups (9/34 Vs 8/34; 26.46% Vs 23.52%; p value- 0.779).

Table 5: (Post-partum events). There was a significant increase in the post-partum events in the subject group (11/34 Vs 2/34; 32.34% Vs 5.88%; *p value* <0.006) as compared to the control group. One patient in each group had atonic post partum hemorrhage, which responded to uterotonics, and they did not require any blood transfusion, all the 5 cardiac disease women(5/34 Vs 1/34; 14.7% Vs 2.94%; *p value 0.197*.) required at-least two units each of blood transfusion. One woman in the subject group required high dose antibiotics to treat pneumonia (1/34 Vs 0/34; 2.94% Vs 0%), three women required transfer to coronary care unit to treat atrial fibrillation and

pulmonary edema and severe pneumonia in the subject group, who were initially NYHA class I (3/34 Vs0/34; 8.82% Vs 0% p *value1.000*). One woman in the subject group needed resuturing of wound on seventh post-operative day. No women in the control group required major medical or surgical intervention. Women who were operated previously had a better maternal outcome „in terms of lesser antenatal, intranatal and postnatal complications (1/8 Vs 10/26; Vs 12.5% Vs 38.46%; *p value* <0.05). Fetal outcome was also better in the operated group in terms of lesser intrauterine growth retardation (1/8 Vs 8/26; 12.5% Vs 30.76%; *p value* <0.05) compared to the un-operated group. Transfer of the new born to the nursery was almost the same in both the groups.

Table-6, women with previously detected heart disease and who had late booking during the present pregnancy had more antepartum, intrapartum and post partum complications 50% vs 35.72% and increase transfer of neonate to nursery, though not satistically significant.

Table-7: women with cardiac procedures done previously had less complications antepartum, intrapartum, and in the postpartum period and less occurrence of intrauterine growth retardation, compared to women who were not operated previously; 01 (12.50%) vs10 (38.46%), p value-<0.05 and 01 (12.50%)vs 08 (30.76%), p value-<0.05 respectively.

DISCUSSION

Valvular diseases appear to be more common than the congenital heart disease. Mitral stenosis is the most dangerous lesion and surgical commissurotomy and balloon mitral valvotomy have been performed for severe mitral stenosis in the second trimester of pregnancy, with remarkable symptomatic relief and good maternal and fetal outcome [4, 9]. In the present study multi-valvular lesions (79.41%) were more common compared to the congenital lesions (8.82%). Mitral stenosis with mitral regurgitation was more common (25.93%). Franklin *et al*., [10] reported, due to the increased survival of children born with congenital heart disease (CHD) over the past 30 years, the population of adults with congenital heart disease in the U.S. now exceeds 1 million. Thus, there are now more adults with CHD than children with CHD. Many of these adult survivors of pediatric heart disease are of childbearing age and are considering pregnancy.

Antenatal complications involving the cardiovascular and medical problems were significantly higher in the subject group (18/34 Vs 2/34; 52.92% Vs 5.88%; *p value <0.01*).Congestive cardiac failure was seen in 2/34 (5.88%), sinus tachycardia 3/34 (8.82%), dilated cardio-myopathy 1/34 (2.94%) and 2 women required emergency surgical intervention in the subject group 2/34 (5.88%).

No such complications were recorded in the control group. There were no maternal deaths in either of the groups. Our results were similar to those of other studies Hameed *et al* [5] reported a 38% of congestive cardiac failure, Desai et al, [7] Traill TA [9]observed 38% congestive cardiac failure in their study of mitral stenosis during pregnancy. The increased incidence of congestive cardiac failure is due to the marked hemodynamic changes that occur in pregnancy, the commonest contributing factor in developing countries being nutritional anemia as reported in the present study.

There was a higher occurrence (though not statistically significant) of gestational hypertension (11.76% Vs 2.94%;), fetal growth restriction(26.46% Vs 14.70%), low birth weight babies (26.46% Vs 14.7%; p value 0.230), lower mean birth weight (2667.5 +/-250 Gms Vs 2833.5+/-300.Gms), lower mean gestation duration (36.32 +/-1week Vs 38.67 +/-1 week) and almost same number of neonates with Apgar score <8 (49.98% Vs 41.16%,) in the subject group compared to the control group. Significant number of neonates required admission and a more prolonged stay in the neonatal intensive care unit (47.04% Vs 17.64%; p value 0.042) in the subject group. There were no still births in both groups.

There was a significantly higher incidence of instrumental delivery in the subject group (41.16% Vs 8.82%; p value 0.002) compared with the control group. There was a significant increase in the post-partum events in the subject group (32.34% Vs 5.88%; p value 0.006) in terms of blood transfusion, transfer to coronary care unit due to atrial fibrillation, pulmonary edema, medical intensive care for severe pneumonia and restoring for wound dehiscence compared to the control group. Similarly, higher maternal complications have been observed in many other studies [1, 5,

9]. Women who were operated previously had a better maternal outcome, in terms of lesser antenatal, intra-natal and postnatal complications (12.5% Vs 38.46%; *p value* <0.005). Fetal outcome was also better in the operated group in terms of lesser intrauterine growth retardation (12.5% Vs 30.76%; *p value* <0.05) compared to the un-operated group. Transfer to the nursery was almost the same in both the groups. Therefore, mitral valve repair and replacement should be performed before pregnancy for a better maternal and fetal outcome, as noted by other authors [7-9].

Resorting to the multispecialty approach in the management of women with cardiac disease during pregnancy and labor resulted in no maternal mortality. Therefore, our data indicate that early diagnosis, counseling, vigilant follow-up both antenatal and post-natally, effective surgical and medical interventions whenever required, availability of and access to the super-speciality care can make maternal mortality rare in women with cardiac disease, a similar observation was also made by other authors[1, 5, 8, 9].

CONCLUSION

Rheumatic heart disease contributes to a major share of cardiac disease in pregnancy with significant maternal and perinatal morbidity in developing countries. Congenital cardiac disease when dealt at earlier age in life has lesser morbidity and mortality. However, the gravely dangerous lesions do not make it to the reproductive age. There is need for early detection, effective counselling, and vigilant follow up, with careful fetal surveillance and follow up of these women in the post-natal period. Ideally, major surgical interventions in the form of balloon mitral valvotomy, closed mitral valvotomy, mitral valve replacement should be performed before pregnancy to prevent maternal complications. However, the availability and access to immediate medical, surgical obstetric and nursing care i.e., a multi-specialty approach remains the cornerstone for an optimal maternal and fetal outcome in these women.

REFERENCES

1. Malhotra M, Sharma JB, Tripathii R, Arora P, Arora R. Maternal and fetal outcome in valvular heart disease. International Journal of Gynecology & Obstetrics. 2004; 84(1):11-16.
2. Bernard Rosner (2000), Fundamentals of Biostatististics, 5th ed. Duxbury.
3. Reddy MV. Statistics for Mental Health Care Research, NIMHANS publication, India, 2002.
4. Gupta A, Lokhandwala YY, Satoskar PR, Salvi VS. Balloon mitral valvotomy in pregnancy: maternal and fetal outcomes. Journal of the American College of Surgeons. 1998; 187(4):409-15.
5. Hameed A, Karaalp IS, Tummala PP, Wani OR, Canetti M, Akhter MW, Goodwin M, Zapadinsky N, Elkayam U. The effect of valvular heart disease on maternal and fetal outcome of pregnancy. Journal of the American College of Cardiology. 2001; 37(3):893-9.
6. Desai DK, Adanlawo M, Naidoo DP, Moodley J, Kleinschmidt I. Mitral stenosis in pregnancy: a four-year experience at King Edward VIII Hospital, Durban, South Africa. BJOG: An International Journal of Obstetrics & Gynaecology. 2000; 107(8):953-8.
7. Oakley CM. Valvular disease in pregnancy. Current Opinion in Cardiology. 1996; 11(2):155-9.
8. Nelson-Piercy C, Chakravarti S. Cardiac disease and pregnancy. Anaesthesia & Intensive Care Medicine. 2007; 8(8):312-6.
9. Traill TA. Valvular heart disease and pregnancy. Cardiology Clinics. 2012; 30(3):369-81.
10. Franklin WJ, Gandhi M. Congenital heart disease in pregnancy. Cardiology Clinics. 2012; 30(3): 383-394.