Maternal and fetal outcome in pregnancy with heart disease

Dr. Arpita Jain[1], Dr. Swati Garg[2]

[1]*Senior resident of Obstetric and Gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India*
[2]*MBBS, MS Professor Department of Obstetric and Gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India*
Corresponding Author – Dr. Arpita Jain
Senior resident of Obstetric and Gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India

---

Abstract
Background
Cardiac disease in pregnancy still remains a major problem worldwide, particularly in developing countries like ours. The reported incidence of cardiac disease varies between 0.1 and 4%, and remains a significant cause of maternal death worldwide. The objective of this research was to analyse the incidence of cardiac disease in pregnancy in our hospital and to assess the maternal and foetal outcome.
Material and methods
A retrospective study was carried out in 78 women with cardiac disorders during the period of 18 months in the Department of Obstetrics and Gynaecology of Mahatma Gandhi Medical college and Hospital, Jaipur. Maternal and foetal outcome was analysed, Data were collected and presented as number and percentage.
Results
Prevalence of heart disease was found to be 2.3%. The Rheumatic Heart disease was the principal cause of heart disease followed by Congenital heart disease. Among the women who had Rheumatic heart disease, Mitral Valve stenosis was the most common lesion. Among the women with congenital cardiac disease, ASD was most common lesion followed by VSD.
Although no maternal deaths were recorded during the study period, but a significant number of cardiac and non-cardiac complications were encountered. Most of the patients had vaginal delivery (61.5%) and caesarean section was seen mostly due to obstetric indication. Prematurity was the most common neonatal complication seen in 23.1% of babies.
Conclusions
Cardiac disease in pregnancy is a serious complication. Women with cardiac disease requires a multidisciplinary teamwork to have optimal maternal and foetal outcome. Hence, there is requirement of constant vigilance throughout the antenatal, intrapartum and postpartum period inorder to avoid adverse outcomes.
Keywords Mitral valve stenosis, Pregnancy, Rheumatic heart disease, Congenial heart disease, Cardiomyopathy

---

I. Introduction

Pregnancy with cardiac disease is a high-risk pregnancy, which possess a significant challenge to treating obstetrician and other health care providers.

Approximately around 0.2–2% of all women in pregnancy are complicated by heart defects [1], and 20.5% of maternal mortality is due to cardiac disorders making it a serious complication [2] The Incidence of cardiac disease in pregnancy in India varies from 1 to 4%.[3]

There are two groups of cardiac disease in reproductive aged women: Congenital and acquired heart disease. The acquired heart disease group includes rheumatic heart disease (RHD), cardiomyopathies, and ischemic heart disease. Of which, RHD is the most common type in developing countries, while in developed countries cardiomyopathies and congenital heart disease (CHD) are the main types. [4] In India, prevalence of RHD is 69% of cardiac disorders seen in pregnancy, and most cases present as mixed mitral valve disease.[4]

The burden of maternal heart disease is further expected to increase due to improvements in survival of women with congenital heart disease. There is also the trend to delay motherhood until later life with the associated rise in medical co-morbidities including diabetes, hypertension and obesity[5,6] Perimenopausal woman undergoing IVF represent a separate at-risk group for cardiovascular disease in pregnancy.[6] There has

---

also been an increase in the number of pregnancies in patients with congenital heart disease that was either repaired in childhood or is still being monitored.[7]

The pregnant patient with cardiovascular disease faces significant risks, both to her health and the health of the offspring, including an increased risk for exacerbation of primary disease, acute cardiovascular decompensation, stroke, heart failure, arrythmia, premature delivery, and death.[8] and the baby is at an increased likelihood of stillbirth, preterm birth and acquired congenital disease.[9]

Very few studies have been done to estimate the risk of mortality and morbidity in pregnant females with cardiac disease. Siu et al.[10] developed a scoring (CARPREG) which was widely used to assess risk in pregnancy.

Figure – CARPREG Risk Predictors

CARPREG risk predictors	Score
Prior cardiac event (heart failure, transient ischaemic attack, stroke before pregnancy or arrhythmia)	1
Baseline NYHA functional class >II or cyanosis	1
Left heart obstruction (mitral valve area <2 cm², aortic valve area <1.5 cm² or peak left ventricular outflow tract gradient >30 mm Hg by echocardiography)	1
Reduced systemic ventricular systolic function (ejection fraction <40%)	1

Total score	Maternal cardiovascular risk
0	5%
1	27%
≥1	75%

NYHA = New York Heart Association
Adapted from: 1) Circulation 2001;104:515–521; 2) Eur Heart J 2011;32:3147–3197

This score was seemed adequate for congenital heart diseases, valvular heart disease, myocardial diseases, and arrhythmias, but was not useful for prosthetic heart valves, aortopathies, and pulmonary artery hypertension (PAH). Hence, Silversides et al.[11] presented a more comprehensive risk score, CARPREG II.

Figure 2 – CARPREG II Risk Predictors

Predictor	Points
Prior cardiac events or arrhythmias	3
Baseline NYHA 3–4 or cyanosis	3
Mechanical valve	3
Systemic ventricular dysfunction LVEF<55 %	2
High-risk valve disease or left ventricular outflow tract obstruction (aortic valve area <1.5 cm², subaortic gradient >30, or moderate to severe mitral regurgitation, mitral stenosis < 2.0 cm²)	2
Pulmonary hypertension, RVSP >49 mmHg	2
High-risk aortopathy	2
Coronary artery disease	2
No prior cardiac intervention	1
Late pregnancy assessment	1

Primary cardiac event risk: score = 1, 5 % risk, score = 2, 10 % risk, score = 3, 15 % risk, score = 4, 22 % risk and 41 % risk if score greater than 4. NYHA = New York Heart Association Functional Classification; LVEF = left ventricular ejection fraction; RVSP = right ventricular systolic pressure. Source: Silversides et al., 2018, with permission from Elsevier.[14]

The cardiovascular system undergoes structural and hemodynamic adaptations in pregnancy to sustain a high-volume load. Hence, an understanding of these physiologic changes is essential for health care providers.

Table 1 – Cardiovascular changes in normal pregnancy[*]

	First Trimester	Second Trimester	Third Trimester	Stage 1 Labor	Stage 2 Labor	Early Postpartum	3–6 months Postpartum
Cardiac output	↑5–10%	↑↑35–45%		↑30%	↑↑50%	↑↑↑60–80% immediately, then rapidly decreases within the first hour	Return to prepregnancy values
Heart rate	↑3–5%	↑10–15%	↑15–20%	During uterine contractions: ↑40–50%		↓5–10% within 24 hours; continues to decrease throughout the first 6 weeks	Return to prepregnancy values
Blood pressure	↓10%	↓5%	↑5%	During uterine contractions: ↑SBP 15–25% ↑DBP 10–15%		↓SBP 5–10% within 48 hours; may increase again between days 3–6 due to fluid shifts	Return to prepregnancy values
Plasma volume	↑	↑↑40–50%		↑	↑↑	↑↑↑500 mL due to autotransfusion	Return to prepregnancy values

[*]ACOG Practice Bulletin No. 212: Pregnancy and Heart Disease

The most common clinical features of cardiac lesions like breathlessness, pedal oedema, murmurs which mimic normal physiological changes in pregnancy posing a diagnostic difficulty and this leads to delay in diagnosis and subsequent care. [12] It was considered that if cardiovascular disease were to be considered in the differential diagnosis by treating health care providers, than a quarter or more of maternal deaths could be prevented [12, 13, 14]

Therefore, by understanding the physiologic cardiovascular changes in pregnancy (table 1) and the specific challenges of different cardiac disease processes, physicians can tailor the patient's care to optimize monitoring of her pregnancy and prepare for the anticipated time and mode of delivery.

Managing pregnant patients with complex cardiac disease mandates participation from a multidisciplinary team including an obstetrician, cardiologist, cardiovascular surgeon, maternal-fetal medicine specialist, and neonatologist early in the pregnancy so that best course of management can be discussed and planned to reach the optimal pregnancy outcome.

There are very few studies available in India that focus particularly on heart disease in pregnancy. We, therefore retrospectively examined the frequency of pregnancy-related complications in Indian women with heart disease to provide contemporary information on the impact of a wide range of cardiovascular diseases on maternal and fetal mortality and morbidity and to identify the clinical pattern and outcomes of these patients in order to improve prevention, diagnosis, management and their outcomes as an ultimate goal

II. Material And Methods

This is a retrospective hospital based, time bound study done in the Department of Obstetrics and Gynaecology of Mahatma Gandhi Medical college and Hospital, Jaipur from January 2018 to July 2019 in order to evaluate the prevalence of heart disease in pregnancy and its maternal and foetal outcome.

A retrospective analysis of all patients admitted with cardiac disease over a 18 month period was performed. We included all the pregnant women or puerperia with congenital or acquired cardiac lesions who delivered during this time period in order to evaluate the prevalence and to study the maternal and fetal outcome of heart disease in pregnancy.

Information was retrieved from previous medical records and files obtained from medical record department with due permission which included demographic details, diagnosis, surgery performed pre-pregnancy and during pregnancy, and data on maternal and foetal outcomes.

Maternal characteristics like age, SES, parity, gestational age and the type of cardiac lesion were noted. Maternal outcome was analysed by using the following criteria: deterioration in NYHA functional class, cardiac and non-cardiac complications, cardiac interventions during pregnancy and mode of delivery. Neonatal outcome was analysed by using the following criteria: gestation of delivery, birth weight, stillbirth, congenital abnormalities, NICU admissions.

The data were collected in a structured format coded and entered into Microsoft Excel spread sheet and analysed using appropriate tests.

III. Result And Observation
Table 1 –Prevalence of heart disease in pregnancy

Total Number of deliveries in 18 months	3349
Number of cases	78
Prevalence of heart disease in pregnancy	2.3%

A total of 78 women where pregnancy was complicated by heart disease were included in the study. Prevalence of heart disease amongst all pregnancies found in the hospital was 2.3%

Table 2 – Maternal Characteristics

CHARACTERISTICS	Number of patients	Percentage
1)AGE		
18-20	5	6.4
21-25	33	42.3
26-30	30	38.5
31-35	10	12.8
2)SOCIOECONOMIC STATUS		
Upper	8	10.1
Upper Middle	14	24.0
Lower Middle	27	34.7
Lower	29	31.2
3)Parity		
Primiparity	42	53.8
Gravida$_2$	22	28.2
Gravida$_3$ or more	14	18
2) Gestational Age		
28-32	11	14.1
33-36	18	23.1
37-40	41	52.6
>40	8	10.2

The age of patients was ranged from 18-35 years with maximum number of patients in 20-30 years age group (80.8%) and most of the patients belonged to lower middle and lower socioeconomic status (65.9%)
In this study, most of the patients were Primiparity (53.8%) and majority were term gestation (62.8%)

Table 4 –Type of cardiac disease

CARDIAC LESION	Number of patients	Percentage
1)Congenital Heart Disease	9	11.5
ASD	5	55.5
VSD	2	22.3
TOF	1	11.1
Ebstein anomaly	1	11.1
2)Rheumatic Heart Disease	35	44.9
MS only	10	28.6
MR only	7	20
MS+MR	5	14.3
AR	2	5.7
AS	1	2.9
TR	2	5.7
Multiple Valve lesion	8	22.8
3)Peripartum Cardiomyopathy	5	6.4
Previous pregnancy	2	40
Current pregnancy	3	60
4)Miscellaneous		
Globular Hypokinesia	1	1.3
5)Surgical Correction	28	35.9
ASD closure	1	3.6
VSD closure	2	7.1
MVR	12	42.8
PTMC	3	10.7

DVR	8	28.6
Balloon Valvoplasty	2	7.2

The Rheumatic Heart disease was the principal cause of heart disease amongst all pregnancies seen in 44.9% followed by Congenital heart disease present in 11.5% patients and peripartum cardiomyopathy in 6.4%

Among the women who had Rheumatic heart disease, Mitral Valve stenosis being the most common lesion and seen in 28.6% of patients with RHD while MR was seen in 20%. Multiple cardiac lesions were present in 8 (22.8%) women.

Among the women with congenital cardiac disease, ASD was most common lesion constituting 5 (55.5%) followed by VSD (22.3%).

The surgical correction was done in 28 patients (35.9%), of which 3 patients underwent surgery during pregnancy due to worsening of the disease and rest 25 prior to pregnancy, none of the patient had residual disease after surgery

Table 4 – Functional class of the disease

NYHA class	Number of patients	Percentage
CLASS I	40	51.3%
CLASS II	29	37.2%
CLASS III	8	10.3%
CLASS IV	1	1.2%

Most of the patients had NYHA class I (51.30%) followed by NYHA class II (37.2%). In study population it was seen that the outcome worsened as the class of the disease increased, complications were more in NYHA class III and IV.

Table 5 – Maternal Complication

COMPLICATION	Number of patients	Percentage
1)CARDIAC	15	19.2
CCF	5	33.4
Pulmonary Edema	4	26.6
PAH	3	20
AF	3	20
2)OBSTETRIC	32	41
Anemia	6	18.8
Thrombocytopenia	2	6.2
PIH	8	25
`Pre Eclampsia	3	9.4
Abruptio	4	12.5
PPH	5	15.6
Wound Infection	4	12.5
3) ICU admissions	12	15.4
4) Maternal mortality	0	

There were no maternal deaths during our study period, however a significant number of cardiac and non-cardiac complications were encountered. Cardiac complications occurred in 15 (19.2%) patients and were mainly related to rhythm disturbances and heart failure. The most common cardiac complication was CCF seen in 5 patients.

Obstetric complications were noticed in 20 patients most common being anemia and 12 patients (15.4%) required ICU care.

Table 6 – Mode of delivery

Mode of delivery	Number of patients	Percentage
1)VAGINAL	**48**	**61.5**
Spontaneous	31	64.6
Induced	17	35.4
Instrumental	10	20.8
2) Caesarean section	**30**	**38.5**
Elective	21	70
Emergency	9	30

Most of the patients had vaginal delivery (61.5%) and caesarean section was seen in 38.5% patients. The labour was of spontaneous onset in 31 and induced in 17 cases. The indication for induction was mostly post-dated pregnancy and severe pre-eclampsia. In 10 patients instrumental delivery was done to cut short the second stage of labor. The various indications for LSCS were foetal distress, cephalopelvic disproportion malpresentations etc.

Table 7 – Neonatal Outcome

Neonatal Outcome	Number of patients	Percentage
IUGR	8	10.3
Preterm	18	23.1
Still Birth	1	1.3
Neonatal mortality	1	1.3
IUD	3	3.8
Birth Asphyxia	2	2.5
Low Apgar	8	10.2
Meconium Aspiratipon	8	10.2
NICU admission	16	15.4

None of the alive babies had congenital heart disease.
Prematurity was the most common neonatal complication seen in 23.1% of babies, Growth retardation was seen in 10.3% of babies and the other neonatal complications are shown in Table 7.
A total of 16 babies required NICU care and the various indications are shown in Table 7. There were 3 IUD deliveries and 2 perinatal deaths, of which one was fresh stillborn and one was neonatal death (3 days after birth) due to asphyxia.

IV.   Discussion

This study was conducted in the Department of Obstetrics and Gynaecology, MGMCH, Jaipur in total of 78 women. In the present study we determined the prevalence of heart disease in pregnancy, type of cardiac lesion and assessed the maternal and fetal outcomes in pregnant women with heart disease.

Multiple studies have estimated that 0.3% to 3.5% of all pregnancies are complicated by cardiac disease. In the present study, the prevalence of 2.3% was found which was same as that of the study conducted by Puri S et al.[15]

Pujitha KS[16] found incidence as 0.21% in their study. Low incidence was mostly because it was a referral center and high incidence in our study is due to the fact that our hospital is a tertiary care centre.

In the current study, majority of the patients were in the age group of 20-30 years (80%) and most of them were either primigravidae or primipara (53.8%). This was comparable to Salam S et al.[17] where 74.5% were below 30 years and 60% were primipara
Most of them belonged to low socioeconomic status (65.9%).

The predominant lesion was rheumatic heart disease (44.9%) followed by congenital heart disease (11.5%) and peripartum cardiomyopathy (6.4%).

We observed that RHD was much more common than CHD, as was consistent with previous studies[17-20]. This can be explained by lack of preventive treatment and inadequate use of secondary antibiotic prophylaxis against streptococcal infections in developing countries like ours. This is in contrast to developed countries in which congenital heart lesions are the dominant anatomical lesions.[21,22]

In the current study RHD (44.9%) was the principal cardiac lesion and mitral stenosis was the most common cardiac lesion (28.6%). These results were similar with studies of Salam et al Vidyadharet al, Devabhaktula et al, Mazhar SB et al and N Bhatla et al.[17,23-26]

Out of 78 pregnant women in the present study group 35.9% underwent surgical intervention for cardiac disease. The results were comparable with studies conducted by Pujitha KS et al[16] and Bhatla et al[23]. Most common procedure was Mitral valve replacement (42.8%) followed by double valve replacement (28.6%)

3 patients underwent cardiac surgery Balloon Valvoplasty during pregnancy due to severe MS. In general, cardiac surgery is avoided during pregnancy due to associated significant risk to the foetal mortality and morbidity because of the possible teratogenic effects of the drugs used during anaesthesia, which interferes in uteroplacental blood flow and causes embolic events to the uteroplacental circulation.

Majority of the patients (88.5%) belong to NYHA class I and class II. The percentage of patients with NYHA class III and IV was 11.5% and had a poor outcome. These observations were comparable with the study done by Pujitha KS et al[16] and Indira et al.[27] This is mostly because the patients symptoms are relieved due to surgical correction and multidisciplinary team approach with the cardiology department

There was a high rate of complications related to cardiac disease in this study (19.2%), the most common being congestive cardiac failures which was consistent with Joshi's study, which reported that heart failure was considered as a common complication among 42 women with cardiac disease[19].

While studying the mode of delivery most patients delivered vaginally out of which 10 patients had instrumental vaginal delivery to cut short the second stage of labor.

In this study, 48 (61.5%) women had vaginal delivery as compared to 65.3%(Manohar Rangaswamyet al) 35.6% (salam S et al.) Cesarean Section (36.7%) was done only for obstetrical indications. Manohar Rangaswamy et al reported 34.6% Salam S et al. reported in 36.7% [17,28]

In the present study we had 20 NICU admissions, due to birth asphyxia, MSAF, IUGR and preterm. We had found two perinatal mortality, due to prematurity and respiratory distress syndrome. Results were comparable with Pujitha KS and Prameela et al.[16,29]

V.   Conclusion

Cardiac disease is a major risk condition, which has adverse effect on pregnancy and its outcome. This study revealed that RHD as the main clinical pattern among pregnant patients and this is agreed with the current available and updated evidence that documented RHD as the most common Heart Disease in pregnancy, which complicated 50–90% of Heart Disease in pregnancy and associated with the higher rate of mortality even with the advent of antibiotics against streptococcus.

Our data supports the fact that the prognosis of pregnant women with heart disease has improved, leading frequently to successful outcome. Proper evaluation of maternal prognosis prior to conception and adequate clinical follow up during pregnancy are both fundamental measures for obtaining a satisfactory outcome in these patients We therefore stress the need to monitor cardiac patient for early detection and management of heart failure throughout the course of pregnancy, labor and puerperium.

References

[1]. Barbosa, P.J.B.; Lopes, A.A.; Feitosa, G.S.; Almeida, R.V.d.; Silva, R.M.d.; Brito, J.C.; Duarte, M.L.; Almeida, A.J.G. Prognostic factors of rheumatic mitral stenosis during pregnancy and puerperium. Arq. Bras. Cardiol. 2000, 75, 220–224. [CrossRef] [PubMed]

[2]. Sawhney, H.; Aggarwal, N.; Suri, V.; Vasishta, K.; Sharma, Y.; Grover, A. Maternal and perinatal outcome in rheumatic heart disease. Int. J. Gynecol. Obstet. 2003, 80, 9–14.

[3]. Bansode BR. Pregnancy and heart disease. Assoc Physicians Ind. 2010;773-6.

[4]. Konar H, Chaudhuri S. Pregnancy complicated by maternal heart disease: A review of 281 women. J Obstet Gynaecol India 2012;62:301-6.

[5]. Klein LL, Galan HL. Cardiac disease in pregnancy. Obstet Gynecol Clin N Am 2004; 31: 429–459.

[6]. Van Mook WNKA, Peeters L. Severe cardiac disease in pregnancy, part II: impact of congenital and acquired cardiac disease during pregnancy. Curr Opin Crit Care 2005; 11(5): 435–448.

[7]. Anandaraja S, Kothari SS, Bahl VK. Management of valvular heart disease during pregnancy. Ind Heart J 2005; 57(2): 101–108.

[8]. Saving Mothers. A report of the National Committee on Confidential Enquiries into maternal deaths in South Africa (1999–2001) DOH. Pretoria: 162–174

[9]. 9 Roos-Hesselink JW, Ruys TP, Stein JI, et al. Outcome of pregnancy in patients with structural or ischaemic heart disease: results of a registry of the European Society of Cardiology. Eur Heart J 2013;34:657–65.

[10]. Siu SC, Sermer M, Colman JM, Alvarez AN, Mercier LA, Morton BC, et al. Prospective multicenter study of pregnancy outcomes in women with heart disease. Circulation 2001;104:515-21.

[11]. Silversides CK, Grewal J, Mason J, Sermer M, Kiess M, Rychel V, et al. Pregnancy outcomes in women with Heart disease: The CARPREG II study. J Am Coll Cardiol 2018;71:2419-30.

[12]. Hameed AB, Lawton ES, McCain CL, Morton CH, Mitchell C, Main EK, et al. Pregnancy-related cardiovascular deaths in California: beyond peripartum cardiomyopathy. Am J Obstet Gynecol 2015;213:379.e1–10. (Level III)

[13]. Gunderson EP, Croen LA, Chiang V, Yoshida CK, Walton D, Go AS. Epidemiology of peripartum cardiomyopathy: incidence, predictors, and outcomes. Obstet Gynecol 2011;118:583–91. (Level II-2)

[14]. Kuklina E, Callaghan W. Chronic heart disease and severe obstetric morbidity among hospitalisations for pregnancy in the USA: 1995-2006. BJOG 2011;118:345–52. (Level II-3)

[15]. Puri S, Bharti A, Puri S, Mohan B, Bindal V, Verma S. Maternal heart disease and pregnancy outcomes. JK Sci. 2013;15(1):7-10.

[16]. Pujitha KS, Sheela SR, Jyothi NS. A study of maternal and fetal outcome in cardiac disease in pregnancy at tertiary care center. Int J Reprod Contracept Obstet Gynecol 2017;6:5095-8.

[17]. Salam S, Mushtaq S, Mohi-ud-Din, Gul I, Ali A. Maternal and fetal outcome in pregnancy with heart disease in tertiary care hospital in India. Int J Reprod Contracept Obstet Gynecol 2017;6:3947-51.

[18]. Pillutla, P.; Nguyen, T.; Markovic, D.; Canobbio, M.; Koos, B.J.; Aboulhosn, J.A. Cardiovascular and neonatal outcomes in pregnant women with high-risk congenital heart disease. Am. J. Cardiol. 2016, 117, 1672–1677.

[19]. Joshi, G.; Joshi, S.; Jha, S.; Singh, Y.; Joshi, A. Maternal heart disease and pregnancy outcome: Findings from a retrospective cohort in a tertiary care government hospital in Haldwani, Nainital. Niger. J. Cardiol. 2015, 12, 120–123.

[20]. Abbasi, S.; Siddiqua, S.F.; Rijvi, S.; Akhtar, S.; Haque, B.; Jesmin, S. Study of Maternal and Fetal Outcome in Pregnancy with Heart Disease. Anwer Khan Mod. Med Coll. J. 2017, 8, 112–116.

[21]. Van Mook WNKA, Peeters L. Severe cardiac disease in pregnancy, part II: impact of congenital and acquired cardiac disease during pregnancy. *Curr Opin Crit Care* 2005; **11**(5): 435–448.

[22]. Thorne SA. Pregnancy in heart disease. *Heart* 2004; **90**: 450–456.

[23]. Bhatla N, Lal S, Behera G, Kriplani A, Mittal S, Agarwal N et al. Cardiac disease in pregnancy. Int J Gynecol Obstet. 2003;82(2):153-9.

[24]. Bangal VB, Singh RK, Shinde KK. Clinical study of heart disease complicating pregnancy. IOSR. 2012;2(4):25-8.

[25]. Mazhar SB. Fetomaternal outcome in pregnancy with cardiac disease. JCPSP. 2005;15(8):476-80.
[26]. Pratibha D, Kiranmai D, Rani VU, Vani NG. Pregnancy outcome in chronic rheumatic heart disease. J Obstet Gynecol India. 2009;59(1):41-6.
[27]. Indira I, Sunitha K, Jyothi. Study of pregnancy outcome in maternal heart disease. IOSR J Dental Med Sci. 2015;14(7):6-10.
[28]. Rangaswamy M, Pradeep MR. Pregnancy with cardiac disease: a retrospective five year study in a teaching hospital. Int J Reprod Contracept Obstet Gynecol 2016;5:1589-92.
[29]. Prameela. Clinical study of cardiac disease complicating pregnancy. Int Med J. 2015;115-7.