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Original Research Article

Study and compare the echocardiographic changes in anaemic and non-anaemic pregnant women

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ABSTRACT

Background: AIM: To determine the effect of moderate to severe anaemia on the cardiovascular system of pregnant women. To compare the systolic function and diastolic function among pregnant women with moderate-severe anaemia with that of uncomplicated non-anaemic pregnant women.
Methods: 30-pregnant normotensive women with moderate-severe anaemia were recruited as cases(Group A) and the controls(Group B) were 30 normotensive non-anaemic pregnant women all in 3rd trimester (26-40weeks gestation). After written informed consent, every participant underwent a 2D-transthoracic echocardiography. The parameters measured were 1) LVEDD, 2) LVESD), 3) SWTd, 4) PWTd, 5) EF 6) E/e' and E/A ratio.
Results: Mean Hb of group A participants was 7.47±1.06 g% and that of group B was 11.31±1.21 g%. Mean LVEDD of group A (4.393±0.154 cm) was higher than the group B (3.977±0.177 cm), with p value (0.0010) being statistically significant. The mean of SWTd among the group A was 1.28±0.265 cm and in group B was 1.139±0.538 cm, but their difference was not statistically significant (p value 0.2030). PWTd was significantly increased in group A (1.32±0.589 cm) than the controls (1.07±0.244 cm) with p value:0.0359. EF and Fractional shortening did not have significant difference among the two groups. The mean value of E/e' among group A & B were, 7.42±2.1 & 7.9±2.4 respectively and the difference is not statistically significant (p value 0.4131). The E/A ratio, being an indicator of diastolic function, was higher in the cases (1.622±0.518 & 1.369±0.323 in group A & B respectively) and the difference was statistically significant (p value: 0.0269).
Conclusions: LVEDD, LVESD and PWTd are all significantly increased amongst pregnant women with moderate-severe anaemia compared to pregnant women with Hb≥10g/dl. E/A ratio suggestive of diastolic dysfunction is also increased in pregnant women with anaemia but systolic functions are not affected as indicated by EF and fractional shortening.

Keywords: Anaemia, Echocardiography, E/A ratio, E/e', LVEDD, LVESD, PWTd, Pregnancy, SWTd,

INTRODUCTION

Prevalence of anemia in pregnant women in India has been persistently high (>50%). As defined by WHO, anemia in pregnancy is when Hb concentration falls to <11g/dl with haematocrit of <0.33/l. Pregnancy burdens the heart with major hemodynamic changes leading to major alterations in preload and CO. In echocardiographic study of normal pregnancy, there is an increase in LV end-diastolic volume and an CO. There is an increase in the chamber dimension of LA, RA and RV (extent of dilatation is still minimal). These changes mostly return to normal levels within 3-6 months postpartum.[1] Eccentric symmetrical hypertrophy results due to this rise in LV dimension. Although, there is a slight increase in the LV mass and wall thickness, they tend to stay within range in normal pregnancy.[2] There is a progressive increase in LV sphericity.

In around 40% of women in third trimester, an asymptomatic pericardial effusion tends to develop, especially when the weight gain in pregnancy exceeds>12 kg. Regarding the functional changes, EF shows barely

any changes. There is a steady fall in the levels of GLS.[3] In pulsed-wave doppler echocardiography, E-wave-depicts the LA-LV pressure gradient in early diastole. E-wave is mainly determined by, the pressure gradient in between LA and LV and the LV compliance. A-wave shows the LA-LV pressure gradient in the late diastole. A-wave is determined by the atrial contractility and LV compliance (Figure1).[4]

The deceleration time of early transmitral filling velocity and isovolumic relaxation time also increases. There is a progressive decrease in LV fractional shortening and the E/A ratio, whereas E/e' is load independent and hence remains normal.[5]

Even without pregnancy, various studies have brought forward the evidence that, in cases of severe IDA, there is LV dysfunction and heart failure. There is a decrease in myocardial contractility when haemoglobin is <7 gm%.

Chronic anaemia may lead to increase LV end diastolic pressure and decreased functional reserve. Increase in size of LA is an important predictor of target organ damage.[6] Also, in cases of severe anaemia, CO as well as CI will be significantly raised.

CI is CO from LV per minute/ BSA. LV diastolic volume is increased in anaemic patient which means an increase in preload leads to higher CO.[7] All of these changes can be studied using echocardiography, electrocardiography, cardiac MRI and CXR.

Many studies have analysed the echocardiographic changes in normal and hypertensive pregnancies, but there are limited studies that are available for echocardiographic changes in anaemic women. This study aims to study the haemodynamic changes in women with moderate-severe anaemia, in third trimester where there are major haemodynamic derangements, the knowledge of which should help in guiding the management of these cases.

METHODS

This was an analytical case-control study which was conducted in the Department of Obstetrics and Gynaecology, BNMCC, GMC, Amritsar. Thirty pregnant, normotensive women, attending the indoor or outdoor services from October, 2022 to March, 2024 with moderate-severe anaemia were recruited for this study (Group A) and the control group (Group B) were 30 normotensive non-anaemic pregnant women in 3rd trimester (26-40 weeks of gestation). Patients were included in this study after written informed consent and approval of the study protocol by the institute ethics committee.

Exclusion criteria

Medical history of hypertension, diabetes, connective tissue disorder, structural heart disease or congenital heart disease. Multifetal gestation. Pregnant women haemodynamically unstable or with acute complications like sepsis, heart failure, APH, eclampsia, respiratory distress, etc. Maternal age<20 or >35 years. Women with hypertensive disorders of pregnancy. Anaemia other than IDA.

After taking written informed consent, a detailed history was taken and a complete general and obstetric examination was performed at the time of recruitment. All participants underwent the following baseline investigations: CBC, PBF, RFT, LFT, HPLC, TSH, DIPSI.

Every participant underwent a 2D-transthoracic echocardiography. The parameters that were measured were Left ventricular end diastolic diameter (LVEDD), Left ventricular end systolic dimension (LVESD), Septum wall thickness (SWTd), Posterior LV wall thickness (PWTd), Left ventricular systolic function was studied using ejection fraction and percentage fraction shortening.

Mean E/e'=Early diastolic mitral flow velocity (E), Early diastolic septal velocity (e'), E/A=LA-LV pressure gradient in early diastole, LA-LV pressure gradient in the late diastole

RESULTS

Both the groups were comparable in terms of age, parity, residence, BMI and Gestational Age at the time of echocardiography and the mean Hb of group A participants was 7.47±1.06 g% and that of group B was 11.31±1.21 g%. Nutritional anaemia contributed to 46.66% cases among the cases. Other major contributors to anaemia were H/O HMB (10%), worm infestation (6.7%) and bleeding haemorrhoids (6.7%). Table 2, 3, 4 and 5 shows the comparison of echocardiographic parameters among the two groups.

Mean LVEDD of group A (4.393±0.154 cm) was higher than group B (3.977±0.177 cm), with p value (0.0010) being statistically significant. Also, the mean value of LVESD, was significantly higher in the cases in comparison to the group B (2.903±0.292 cm vs 2.616±0.440 cm) and was statistically significant (p value<0.0001). The LV diameters in group A were significantly larger than those in group B, which implies that anemia may lead to LV enlargement (Table 2).

The mean of SWTd among group A was 1.28±0.265cm and in group B was 1.139±0.538 cm, their difference was not statistically significant (p value-0.2030) (Table 2).

PWTd was significantly increased in group A (1.32±0.589 cm) than group B (1.07±0.244 cm) p value 0.0359 (Table 2). Functional parameters, EF and fractional shortening were within normal limits among the two groups. EF– 63.07% in group A and 62.30% in group B (p value: 0.6962).

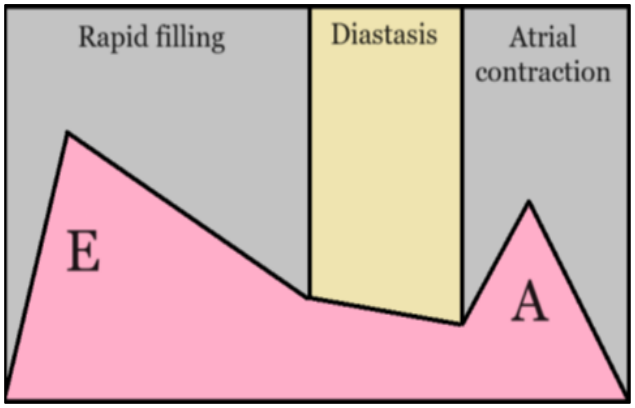
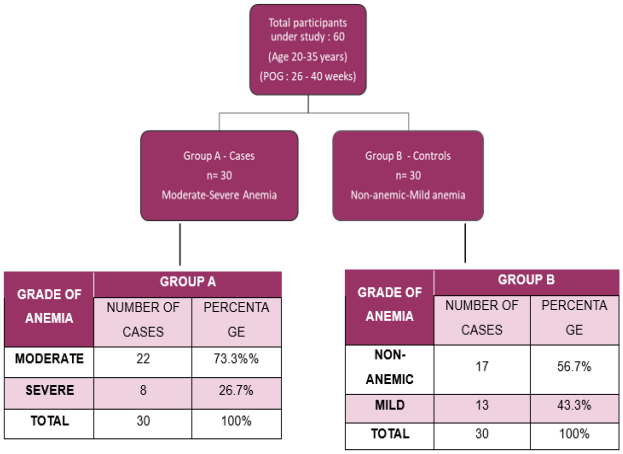


Figure 1: A-wave is determined by the atrial contractility and LV compliance.



GRADE OF ANEMIA	GROUP A	
	NUMBER OF CASES	PERCENTAGE
MODERATE	22	73.3%%
SEVERE	8	26.7%
TOTAL	30	100%

GRADE OF ANEMIA	GROUP B	
	NUMBER OF CASES	PERCENTAGE
NON-ANEMIC	17	56.7%
MILD	13	43.3%
TOTAL	30	100%

Figure 2: Description of study participants.

Fractional shortening was 33.33% in group A and 33.48% in group B (p value 0.9171) (Table 3). "e's" & "e'l", had mean values that were higher in group A (e's-13.81±4.47 cm/s) than group B (13.46±4.03 cm/s) and (e'l-11.44±2.04 cm/s (group A) and 10.72±2.67 cm/s (group B)) the difference was not statistically significant for both the parameters (p value's-0.7512, e'l-p value-0.2453) (Table 4).

Mean of E/e' among group A and B were 7.42±2.1 and 7.9±2.4 respectively and the difference was not statistically significant (p value-0.4131) (Table 4).

E/A ratio, an indicator of diastolic function, was higher in the cases than in the controls. (1.622±0.518 and 1.369±0.323 in group A and B respectively) and the difference was statistically significant (p-value-0.0269). Although there was no diastolic dysfunction, anaemia led on to increased early filling of the ventricles so that the heart is able to compensate for reduced oxygen-carrying capacity of the blood (Table 5).

Increased IVC-diameter being an indicator of RA pressure, was≥2.1 cm in 10% of group A and 6.7% of group B. The mean of IVC-diameter in group A and group B were 1.498 cm and 1.487 cm respectively. The difference between them was not statistically significant (p value 0.6404).

Regurgitant valvular lesions were present in 26.7% of cases and 30% of controls (p value 0.774499), with no statistical significance. Pericardial effusion had an incidence of 10% only among the cases and was not statistically significant (p value 0.0756).

Table 1: Comparison of demographic parameters and haemoglobin levels.

Parameters	Group A	Group B
Mean age	26.33±3.977	26.8±4.003
% of nulliparous patients	33.3%	46.7%
% of multiparous patients	66.7%	53.3%
% belonging to rural area	53.3%	53.3%
Mean GA at recruitment	32 weeks+6 days	33 weeks+4 days
Mean BMI (kg/m^2)	22.12±2.79	22.49±2.77
Hemoglobin(g%) (Mean±SD)	7.47±1.06	11.31±1.21

Table 2: Comparison of echocardiographic parameters of LV dimensions.

Parameters		LVEDD (cm)	LVESD (cm)	SWTd (cm)	PWTd (cm)
Group A	N	30	30	30	30
	Mean	4.393	2.903	1.28	1.32
	Sd	0.431	0.292	0.265	0.589
Group B	N	30	30	30	30
	Mean	3.977	2.616	1.139	1.07
	Sd	0.493	0.440	0.538	0.244
P value		0.0010	<0.0001	0.2030	0.0359

Table 3: Comparison of Ef and % fractional shortening.

parameters		Ef %	% Fractional shortening
Group A	N	30	30
	Mean	63.07	33.33
	Sd	6.96	4.994
Group A	N	30	30
	Mean	62.30	33.48
	Sd	8.19	6.072
P value		0.6962	0.9171

Table 4: Comparison of E/e'.

Parameters		E/e's	E/e'l	E/e' Mean
Group A	N	30	30	30
	Mean	6.95	7.49	7.42
	Sd	2.4	2.4	2.1
Group B	N	30	30	30
	Mean	7.11	8.7	7.9
	Sd	2.5	2.9	2.4
P value		0.8013	0.0836	0.4131

Table 5: E/A.

Echo parameters		E (cm/s)	A (cm/s)	E/A
Group A	N	30	30	30
	Mean	88.53	56.97	1.622
	Sd	25.94	15.27	0.518
Group B	N	30	30	30
	Mean	88.61	68.31	1.369
	Sd	23.15	24.35	0.323
P value		0.99	0.0348	0.0269

DISCUSSION

LVEDD is an important parameter for evaluating the chamber size and associated diastolic-dysfunction. Mean LVEDD was higher among cases (4.393±0.431 cm) as compared to controls (3.977±0.493 cm) in our study and the difference was statistically significant (p-value-0.0010). Whereas, in studies on healthy pregnant women the mean LVEDD in third trimester was Mesa (4.3±0.4 cm), Adeyeye (5±0.28 cm) and Iloeje (5.33±0.71 cm).[8-10] In our study, mean LVESD was 2.903±0.292 cm in group A and 2.616±0.440 cm in group B which was statistically (p value <0.0001). LVESD is a potential marker of LV systolic dysfunction which has more significance in those with heart failure.

Other structural parameters evaluated in our study include, SWTd and PWTd. SWTd and PWTd have been found to be elevated in patients with LVH in studies done on hypertensive pregnant women. SWTd had a mean of 1.28±0.265 cm and 1.139±0.538 cm amongst our group A and B respectively, mean values in other studies like that of Fok (1.1±0.3 cm), Mesa (0.9±0.1 cm) and Adeyeye (0.99±0.11 cm), nearly similar to our controls.[8,9,11]Studies like that of Fok, Adeyeye, Mesa and Iloeje shows a mean PWTd of 1.2±0.2 cm, 0.99±0.11 cm, 0.9±0.1 cm and 1.07±0.15 cm respectively, whereas in our study the mean PWTd was 1.32±0.589 cm and 1.07±0.244 cm in group A and B, which was a significant difference (p value 0.0359).[8-11] Contractility, preload, afterload and HR influences the LV shortening, which depends on the cardiac load. Since there are high chances of volume overload in anemic patients, these functional parameters could aid in evaluation.[12] EF, not with much significant difference among the groups shows a mean of 63.07±6.96% and 62.30±8.19% among group A and B respectively. The mean value among the controls is almost similar to the EF obtained in the study by Fok (58.2±11.2%) and Mesa (60±3%), whereas in other studies the EF had particularly higher mean value, i.e., Adeyeye (75.17±3.30%) and Sonali (74.17±5.7%).[8,9,11,13]

E/A is a very important marker of LV-diastolic dysfunction. The E/A ratio had an average of 1.622±0.518 and 1.369±0.323 in group A and B respectively, which was similar to that obtained by Mesa (1.3±0.2) while 1.13±0.07 Adeyeye and 1.4±0.2 Fok, studies had higher values than our controls.[8,9,11] Importantly, E/A value was significantly

higher among our cases compared to the controls, as reduced oxygen-carrying capacity of blood is compensated by heart.

CONCLUSION

Anemia in pregnancy continues to be highly prevalent in our country and is associated with higher risks of complications for both mother and the fetus. LVIDs (end-systolic and end-diastolic) and PWTd are all signifcantly increased amongst pregnant women with moderate-severe anemia compared to pregnant women with Hb≥10g/dl. E/A ratio suggestive of diastolic-function is also increased in pregnant women with anemia but systolic functions are not affected as indicated by EF and fractional shortening.

Other parameters of diastolic dysfunction like E/e' and TR are also not affected. These findings suggest that cardiac function amongst pregnant women with anemia have to compensate more for the decreased oxygen carrying-capacity of blood and any additional stress can lead to rapid decompensation, thus threatening maternal life. There is paucity of studies using this non-invasive technology in studying the cardiovascular hemodynamics in high risk pregnancy group with anemia and more such studies in Indian population can help in getting critical information to manage and monitor these patients.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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