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ASSESSMENT OF CARDIAC FUNCTIONS IN PATIENTS WITH ANEMIA USING ECG AND ECHOCARDIOGRAPHY

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ABSTRACT

Background: Anemia is a significant medical problem involving multiple organ systems in addition to its economic and social implications. Appropriate treatment of anemia at the right time can prevent complications. **Aims and Objectives:** This study was designed to assess the cardiac function using ECG and echocardiographic parameters in anemic patients with hemoglobin less than 9gm/dl. **Materials and Methods:** A cross-sectional study was conducted in the department of Physiology and Cardiology, in a tertiary care hospital. 80 patients in the age group 18-60 years from various clinical departments whose Hb level were found to be < 9 gm/ dl were included in the study. All cases underwent 12 lead ECG and 2D echocardiography studies and statistical analysis was performed. **Results:** A total of 80 patients with anaemia (Hb<9 gm/dl) were enrolled in the study. 60% cases had moderate anemia, indicated as hemoglobin between 7- 9 gm/dl and 40% had severe anemia indicated as hemoglobin below 7.0 gm/dl. There were ST depression in 14 cases(17.5%), T wave inversion in 19 cases(23.75%), T wave flattening in 34 cases (42.5%) in the ECG. Majority of cases of severe anemia were associated with ECG changes. There were statistically significant association with severity of anemia and abnormality in ECHO parameters like LAD, LVIDd, PWT, Mean peak E velocity and A velocity. **Conclusion:** Our study helps in making necessary plan to diagnose cardiovascular complications of anemia with the help of ECG and ECHO that helps in treatment planning.

KEYWORDS: Anemia; Hemoglobin; Left ventricular hypertrophy.

INTRODUCTION

Anemia is a wide spread public health problem all over the world, more so in a developing country like India. It affects various organs including the heart. It is one of the common causes of hyper dynamic state of heart at rest.[1] The worldwide prevalence of anemia was estimated by the WHO Global Database on Anemia to be 25 % with the prevalence being as high as 43% in the developing countries.[2]

Anemia reduces oxygen delivery to tissues and causes a compensatory cardiovascular response. Chronic anemia is usually accompanied by increased cardiac mass and left ventricular eccentric hypertrophy.[3] Cardiac symptoms such as dyspnea, palpitation and sometimes substernal pain may develop during the course of anemia. Based on the severity and time period of prevalence, it can lead to congestive cardiac failure even in the absence of cardiac comorbidity.[4]

Red blood cells are critical to our body's well-being. They carry hemoglobin, a complex protein that contains iron molecules. The main function of these molecules is to carry adequate oxygen from the lungs to the rest of our body. Anemia decreases the oxygen-carrying capacity of the blood, reducing the amount of oxygen delivered to tissues and resulting in tissue hypoxia. Most clinical symptoms of anemia are due to this impaired oxygen transport and the resulting compensatory cardiovascular and respiratory adjustments made to counteract the

reduced red blood cell mass.[5,6] Anemia is reported to be one of the nonspecific causes for ST segment depression and T wave inversion (in the absence of coronary artery disease). When sinus tachycardia coexists, ECG can perfectly mimic an acute coronary emergency.[4] Anemia is often a byproduct of other diseases that disrupt the body's ability to produce healthy red blood cells. The cardiovascular system is the most commonly affected one in chronic anemia. Anemia increases cardiac output, leading to left ventricular hypertrophy. Increased left ventricular performance results due to increased preload (Frank-Starling mechanism) and increased inotropic state associated with sympathetic activity. [7] Chronic anemia leads to progressive cardiac enlargement and left ventricular hypertrophy due to volume overload which can be reflected on echocardiography.[6,8]

Anemia depending on severity, duration and presence or absence of underlying heart disease can lead to congestive cardiac failure. Therefore appropriate treatment of anemia at the right time can prevent complications. Many cardiac abnormalities can be detected by ECG interpretation.

There is a great diversity of opinion in literature on the electrocardiographic changes in anemia and scarcity of published data on the correlation between hemoglobin concentration and left ventricular functions as reflected in echocardiography. The aim of the current study was to explore any significant ECG and echocardiographic abnormalities in patients with anemia.

MATERIALS AND METHODS

This cross-sectional study was conducted in the department of Physiology and Cardiology, in a tertiary care hospital, Kochi for a period of six months after obtaining approval from Institutional ethics committee. Patients in the age group 18-60 years from various clinical departments in the hospital whose hemoglobin value found to be less than 9gm/dl irrespective of etiology were included in the study. Total number of subjects recruited for study were 80. A written informed consent was obtained from all the participants.

Inclusion criteria

Patients in the age group 18-60 yrs
Hemoglobin content less than 9 gm/ dl
Normal serum potassium level

Exclusion criteria

Structural heart disease (Valvular heart diseases, Ischemic heart disease, Cardiomyopathy etc)
Renal disorders
Hypokalemia
Use of Digitalis or similar medication
Pregnancy

Methods of Study

Hemoglobin level of the study population was estimated by automated analyzer which provided idea about severity of anemia. Resting 12 lead electrocardiography was performed in all subjects using Cardio line Ar-600 model electrocardiography machine at a paper speed of 25 mm/s and standardized at 0.1 mv/mm.

Patients with potentially confounding factors affecting ECG interpretation were excluded by clinical examination and serum electrolyte levels. Transthoracic echocardiography was performed for all subjects using a commercially available imaging ultrasound system.

Study Variables

ECG parameters such as ST segment depression, T wave inversion and flattening, PR interval, QT interval, QTc, QRS duration and Heart rate were studied. The ST depression was judged to be present if the J point was depressed by 1 mm or more and was followed by a horizontal or downward sloping ST segment for at least 0.08 second in one or more of the 12 leads except aVR.[9]

T wave inversion was confirmed whenever there was negative T wave with amplitude > 1mm in limb leads or > 2mm in precordial leads in at least one of the leads except aVR, V1 and lead III. Flattened T waves were said to occur when the amplitude is less than 1mm in the limb leads and less than 2mm in the precordial leads.[9]

Echo cardio graphic parameters included were AD (Aortic diameter), LAD (Left atrial diameter), EF% (Ejection fraction, LVIDs (Left ventricular internal diameter in systole), LVIDd (Left ventricular internal diameter in diastole), IVST(Interventricular septum thickness), PWT (Posterior wall thickness), E velocity (Mitral early diastolic velocity) and A velocity (Mitral late diastolic velocity).

Statistical analysis

All data were entered in Microsoft excel and analyzed using IBM SPSS 20 version software. Continuous variables are expressed as mean and standard deviations and discrete variables as percentages. For categorical variables, the Chi-square test was used, and for continuous variables, the Student t-test was used where a P value <0.05 was considered statistically significant.

RESULTS

In our study, a total of 80 patients with Hb less than 9 gm/dl were enrolled in which females were 49 with a mean age of 38.43 ± 10.42 and males were 31 with a mean age of 37.6 ± 11.2. Out of the total 80 patients, 48 (60%) cases had moderate anemia, indicated as hemoglobin between 7- 9 gm/dl and 32(40%) had severe anemia indicated as hemoglobin below 7.0 gm/dl. (Figure 1)

ECG abnormalities noted in the study group were –ST depression in 14 cases(17.5%), T wave inversion in 19 cases(23.75%), T wave flattening in 34 cases (42.5%). (Figure 2)

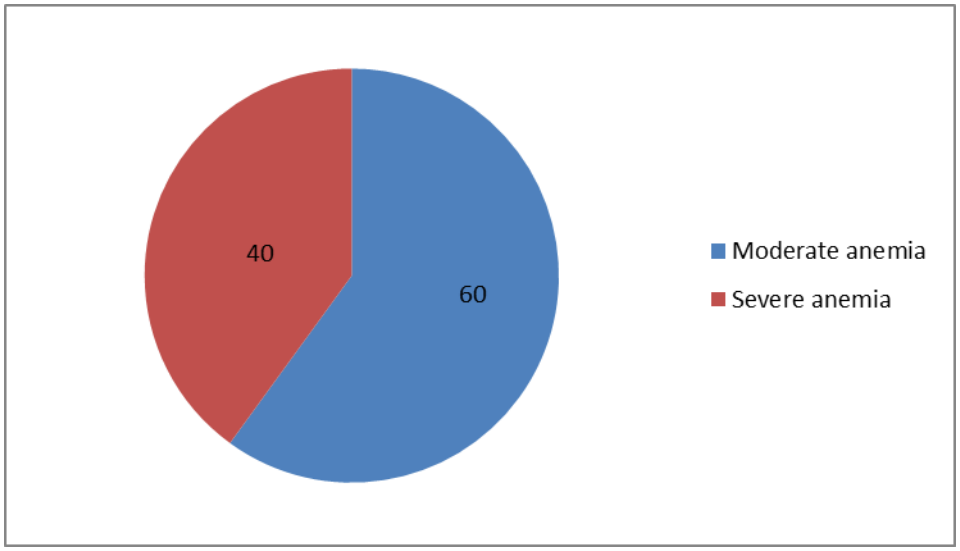

Figure 1: Percentage distribution of different grades of anemia.

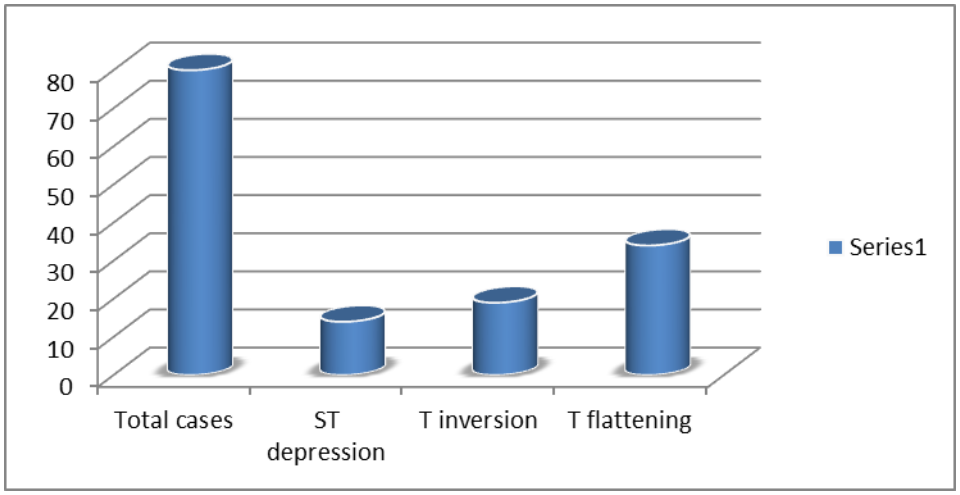

Figure 2: Number of cases associated with ECG abnormalities.

Majority of cases of severe anemia were associated with ECG changes (Table 1).

There was statistically significant association with severity of anemia with abnormality in ECHO parameters like LAD, LVIDd, PWT, Mean peak E velocity and A velocity (Table 2).

Table 1: Comparison of ECG parameters between moderate and severe anemic patients.

Variables	Moderate anemia n = 42	Severe anemia n = 38	P value
ST segment - depression	3 (6.25%)	11 (34.38%)	0.012
T wave inversion	5 (10.4%)	14 (43.75%)	0.047
T wave flattening	14 (29.1%)	20 (62.5%)	0.007
PR interval sec	0.156 ± 0.021	0.157 ± 0.023	0.729
QT interval sec	0.395 ± 0.036	0.404 ± 0.026	0.087
QTc	0.399 ± 0.02	0.400 ± 0.03	0.84
QRS duration sec	0.091 ± 0.013	0.092 ± 0.009	0.482
Heart rate bpm	82 ± 10	91 ±9	0.007

Table 2: Echocardiographic parameters between moderate and severe anemic patients.

Variables	Moderate anemia n= 48	Severe anemia n= 32	P value
AD mm	27 ±3.2	28 ±4.1	0.462
LAD mm	36.2 ±1.5	39.4 ±2.1	0.014
EF %	61± 02	63 ±03	0.366
LVIDs mm	30.1 ± 3.8	31.2 ± 4.7	0.18
LVIDd mm	46.2 ±5.1	52.1± 5.4	0.042
IVST mm	8 ±1.2	7.2 ±0.8	0.14
PWT mm	7.4 ±1.1	8.5 ± 0.9	0.008
Mean peak E velocity (m/s)	0.8 ± 0.21	1.1 ± 0.20	0.038
Mean peak A velocity(m/s)	0.3 ± 0.025	0.38 ± 0.02	0.002

A-Aortic diameter, LAD -Left atrial diameter, EF - Ejection fraction, LVIDs-Left ventricular internal diameter in systole, LVIDd -Left ventricular internal diameter in diastole, IVST-Interventricular septum thickness, PWT - Posterior wall thickness.

DISCUSSION

Prevalence of electro cardiographic abnormalities in anemia have been reported to vary considerably in different studies. The data in our study confirm certain findings from previous ECG studies. But some other findings are at variance with what has been published previously.

We conducted a cross sectional study in of 80 anemic patients with haemoglobin < 9 gm/dl.

According to the criteria of grading anemia, those with Hb level between 9 and 12 gm/ dl were considered under mild anemia.[9] As mild anemia was not expected to have cascading effects on the cardiovascular system, we included cases with hemoglobin of less than 9 gm/dl in the study. In our study, we correlated haemoglobin levels with ECG changes pertaining to ST segment, Twave, PR and QT interval, QRS duration and volume overload changes by 2D Echocardiography.

In the current study, ECG changes seen were ST segment depression (17.5%), T wave flattening(42.5%) and inversion(23.75%). Also, our data demonstrates a strong association (p< 0.05) between anemia severity and the aforementioned ECG changes.

Many studies of anemia have reported changes in ECG like ST segment depression, flat or inverted T waves, but without corresponding changes in QRS complex.[10-12]

A study done by Pandya N, et al divided the cases into mild, moderate and severe anemia. It was found that 8 out of 75 cases (11%) in their study had T wave inversion.[13] The prevalence of T wave inversion in their study was less, probably due to the fact that the proportion of mild anemia cases were more in their study. Another study conducted by Khatri M, et al in 300 anemia patients showed 26 % patients to have T wave inversion and 3% with T wave flattening.[14] The mean heart rate in the severe anemia group of is high (p< 0.05) compared to the moderate anemia cases in our study. This is in accordance with a study by Renuka BG et al, where they observed presence of sinus tachycardia in different grades of anaemia.[12]

Echocardiographic parameters

In the present study, LVIDd in patients with severe anemia was found to be 52.1± 5.4 mm as compared to 46.2 ±5.1 mm in moderate anemial group (p<0.05). Our findings were consistent to the studies done by Cho et al and Takahashi M et al.[15,16] These findings reflect the changes in end diastolic volume in severe anemia and may be attributed to the Frank starling mechanism in the hyperdynamic condition of anemic patients.

In our study, there was a significant increase in terms of left atrium size(P<0.05) for severe anemic patient group (39.4 ±2.1mm) than moderate group (36.2 ±1.5mm).

The PWT is significantly increased in patients with severe anemia (P<0.05) indicating left ventricular hypertrophy. This was consistent with Hussein et al who had examined the relation between anemia and LVH.[17] Anemia increases the heart's work load by increasing preload and sympathetic activity which can lead to chamber enlargement over time.

In this study, the ejection fraction among the severe anemia group was 63 ±03 % and among the moderate anemia group was 61± 02%. Our finding was consistent with a previous study by Sarin et al.[18] Ejection fraction was found to be raised nonsignificantly (P=0.366) may be due to increased preload, better myocardial contractility, and decreased afterload.

The Mean peak E velocity and Mean peak A velocity in severe anemia patients are statistically higher than the moderate anemia patients in our study. These findings were comparable with a similar study by Cho et al.[15]

Hemodynamic adaptations of anemia permit adequate cardiovascular compensation. The combination of increased heart rate and stroke volume increases cardiac output, which, in turn, improves oxygen delivery whereas in severe anemia, diastolic and systolic LV chamber sizes increase to accommodate this greater output.

CONCLUSION

It is evident from our study that anemia leads to significant ECG abnormalities in the form of ST segment depression and T wave changes. Left ventricular dysfunction is also frequently observed in patients with severe anemia. This study helps in making necessary plan to diagnose cardiovascular complications of anemia with the help of ECG and ECHO that helps in treatment planning.

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