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STUDY OF ECG CHANGES IN FEMALE ANAEMIC PATIENTS

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Abstract: Introduction: Anemia is a very common disease worldwide with even more prevalence in developing countries like India. Prevalence of anemia among women of reproductive age (% of women ages 15-49) in India was 51.40% as of 2016, compared to 9% prevalence in developed countries. It is also the second most common cause of maternal mortality in India. Anemia leads to hyperdynamic state of heart at rest leading to impaired oxygen supply to myocardium. This ultimately leads to supply-demand myocardial mismatch causing myocardial ischemia or infarction. Long standing hyperdynamic state due to anemia may lead to cardiac dilatation and hypertrophy as well. These changes in heart cause cardiac disturbances. Electrocardiography is used to detect ischemic heart diseases, hypertensive heart diseases and asymptomatic arrhythmias. The abnormalities may be proportional to the severity of anemia or show no correlation to hemoglobin levels. The studies which show the effect of iron deficiency anaemia on ECG changes in females are few in India. Hence in the present study we decided to study the electrocardiographic changes in female anemic population. **Materials and methods**: It is the cross section observation study of 100 female patients of age group between 19-49 years those who were admitted with Hb less than 12 gm/dl. We excluded the patients with pregnancy, diabetes, hypertension, fever, renal disease, liver disease, COPD, cardiac disease and who not giving consent. **Results:** In the present Cross sectional observational study ECG changes in female anemic patents was studied. In the present study, anemia prevalence was higher in age group 20-40. Studies have shown reduced triglyceride levels in patients with anaemia. In the present study, 31 patients out of the 100 had shown cardiomegaly in chest X-ray. In the present study 45% of the patients presented with sinus tachycardia in ECG. Left axis deviation and left ventricular

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hypertrophy are seen 30% of the patients in the present study. Lower the hemoglobin values higher is the frequency of left axis deviation In the present study there were no changes in the P wave and QRS complexes. In the present study, 26% of the patients had ST segment depression and 18% of the patients had inverted T wave in the ECG. **Conclusion:** Anemia is more prevalent in India. Anemia has major effect on heart due to hyperdynamic state. ECG is the basic tool to identify various cardiac diseases. The studies which show the effect of iron deficiency anaemia on ECG changes in females are few in India. Hence in the present study we decided to study the ECG changes in female anemic population.

Key Words: Electrocardiogram, Anemia, Cardiac Arrhythmias, Cardiomegaly

INTRODUCTION

Anaemia is defined as a condition in which the body has a decreased amount of circulating erythrocytes. It can also be defined as a decreased hemoglobin concentration or RBC mass compared with age-matched controls. As with almost all human laboratory assays, normal value is a statistical term used to define a range within which 95% of the population's values fall[1].The WHO defines anaemia as a hemoglobin less than 13gm/dL in adult men and less than 12gm/dL in non-pregnant adult women[2]. Anemia is a very common disease worldwide with even more prevalence in developing countries like India. Prevalence of anemia among women of reproductive age (% of women ages 15-49) in India was 51.40% as of 2016, compared to 9% prevalence in developed countries[3]. It is also the second most common cause of maternal mortality in India[4]. Anemia causes decrease in the amount of oxygen transported by each unit volume of blood, thus tending to produce tissue hypoxia. Most of the clinical features of anaemia are due to the consequences of diminished oxygen carrying capacity of the blood to the tissues and cardiovascular & ventilatory adjustments to compensate the decrease in red cell mass[5]. Anemia leads to hyper dynamic state of heart at rest leading to impaired oxygen supply to myocardium[6]. This ultimately leads to supply-demand myocardial mismatch causing myocardial ischemia or infarction[7]. Heart tries to compensate for this decrease in oxygen transport by various mechanisms like increase in cardiac output (CO) and decrease in circulation time[8]. Long standing hyperdynamic state due to anemia may lead to cardiac dilatation and hypertrophy as well. However, these changes due to hyperdynamic state may be rapidly reversed by partial correction of anemia in almost every instance[9]. These changes in heart cause cardiac

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disturbances. One of the important and simplest tools for the diagnosis of cardiac disturbances is recording electrocardiogram. Electrocardiography is used to detect ischemic heart diseases, hypertensive heart diseases and asymptomatic arrhythmias. However, to substantiate these, very less ECG studies are done in the past. The incidence of electrocardiographic abnormalities varies significantly in different studies ranging from 10-80%. There are mixed opinions on reports of ECG changes in anemia [10,11]. Early studies described a decrease in QRS amplitude, T wave flattening and minor degrees of AV conduction disturbances[12], but these haven't been found in the more recent studies. Later studies have reported frequent nonspecific ST-T wave changes [13], however it's not certain that these changes are common in anaemics. The abnormalities may be proportional to the severity of anemia [14] or show no correlation to hemoglobin levels[15]. Also, the studies which show the effect of iron deficiency anaemia on ECG changes in females are few in India. Hence in the present study we decided to study the electrocardiographic changes in female anemic population. We decided to correlate ECG changes with severity of anemia with respect to every 3 gm% decrease in hemoglobin level from 12 gm% onwards.

AIM & OBJECTIVES

1. To study prevalence of ECG changes in female anemic patients
2. To study type of ECG changes in female anemic patients
3. To correlate ECG changes with severity of anaemia

MATERIALS AND METHODS

Study Design:

Cross sectional observational study

Study Population:

The study population consisted 100 female patients of age group between 19-49 years those who were admitted with Hb less than 12gm/dl, in SMS Multispeciality Hospital, DR M K Shah Medical College, Chandkheda, Ahmedabad within period of November 2021 to 2022.

INCLUSION CRITERIA

- Female patient with Hb less than 12 gm/dl
- Age between 18 to 49 year

EXCLUSION CRITERIA

- Pregnancy
- Diabetes

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- Hypertension
- Fever
- Renal disease / liver disease
- Alcoholism/smoking
- COPD
- Cardiac disease(ischemic heart diseases, Rheumatic heart disease)
- Patient not giving consent

Methodology:

Informed Consent – Gujarati or Hindi language, Obtained from all the patients fulfilling inclusion criteria and willing to participate in the study. Clinical history taking, examination and Investigations were carried out. Hemoglobin levels were estimated by semi-automated Analyzer which provide idea about severity of anaemia.

All the patients are grouped as following based on their Hb levels:

Group	Hb levels (in gm%)
I	0-<3
II	3-<6
III	6-<9
Iv	9-<12

ECG was taken for all those included in the study using electrocardiograph machine in all the 12 leads and analyzed for the specific changes.

OBSERVATIONS AND RESULTS

Table 1: Age distribution of study population (in years):

Age Group	**Frequency**	**Percentage (%)**
<20	4	4
20-29	51	51
30-39	40	40
>40	5	5

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Table 2: Haemoglobin Distribution in study population:

Haemoglobin	Frequency
0 - <3 gm%	10
3 - <6 gm%	60
6 - <9 gm%	30

Table 3: WBC, PLATELET & ESR distribution in anemic groups:

		WBC	Platelet	ESR
0 to <3 gm%	Mean	6,470.00	1.64	41.60
	Std. Deviation	2,235.41	0.34	12.74
3 to < 6 gm%	Mean	6,880.22	1.63	42.57
	Std. Deviation	2,229.78	0.30	15.26
6 to <9 gm%	Mean	7,107.37	1.59	37.70
	Std. Deviation	2,742.43	0.31	17.15
Total	Mean	6,907.34	1.62	41.01
	Std. Deviation	2,377.46	0.31	15.63

Table 4: Renal Function tests in anemic groups:

Hb Value		Uric Acid	BUN	Creatinine
0 to <3 gm%	Mean	3.27	6.03	0.93
	Std. Deviation	0.37	1.85	0.12
3 to < 6 gm%	Mean	3.15	5.87	0.94

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	Std. Deviation	0.25	1.95	0.12
6 to <9 gm%	Mean	3.09	5.98	0.92
	Std. Deviation	0.20	2.02	0.12
Total	Mean	3.15	5.92	0.93
	Std. Deviation	0.25	1.94	0.12

Table 5: Liver Function Tests in anemic groups:

Hb Value		**Total Bilirubin**	**Direct Bilirubin**	**SGOT**	**SGPT**
0 to <3 gm%	Mean	1.01	0.29	36.90	39.00
	Std. Deviation	0.35	0.22	6.19	6.11
3 to < 6 gm%	Mean	0.90	0.20	38.32	39.23
	Std. Deviation	0.00	0.03	8.21	6.47
6 to <9 gm%	Mean	0.90	0.22	37.50	37.90
	Std. Deviation	0.00	0.11	8.56	6.48
Total	Mean	0.91	0.22	37.93	38.81
	Std. Deviation	0.11	0.10	8.08	6.41

Table 6: Metabolic parameters in anemic groups:

Hb Value		Blood Sugar	Cholesterol	Triglycerides
0 to <3 gm%	Mean	104.10	123.20	93.30
	Std. Deviation	9.55	15.60	9.04

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3 to < 6 gm%	Mean	106.08	128.53	92.00
	Std. Deviation	9.10	14.85	9.23
6 to <9 gm%	Mean	105.50	126.37	95.13
	Std. Deviation	9.04	14.73	3.46
Total	Mean	105.71	127.35	93.07
	Std. Deviation	9.05	14.83	7.98

Table 7: Study population showing Cardiomegaly & their distribution in anemic groups:

		Chest X Ray				Total
		Cardiomegaly	Mean CTR	Normal	Mean CTR	
Hb Value	0 to <3 gm%	10	0.58	0	-	10
	3 to < 6 gm%	18	0.54	42	0.48	60
	6 to <9 gm%	3	0.52	27	0.46	30
Total		31		69		100

Table 8: Prevalence of ECG changes:

		ECG Changes		Total	P value
		Present	Absent		
Hb Value	0 to <3 gm%	10	0	10	0.000005
	3 to < 6 gm%	46	14	60	
	6 to <9 gm%	9	21	30	
Total		65	35	100	

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Table 9: Sinus Tachycardia:

		Sinus Tachycardia		Total	P value
		Sinus Tachycardia	Normal		
Hb Value	0 to <3 gm%	10	0	10	0.000005
	3 to < 6 gm%	32	28	60	
	6 to <9 gm%	3	27	30	
Total		45	55	100	

Table 10: Axis Deviation:

		Axis		Total	P value
		Left Axis Deviation	Normal		
Hb Value	0 to <3 gm%	9	1	10	0.000033
	3 to < 6 gm%	20	40	60	
	6 to <9 gm%	1	29	30	
Total		30	70	100	

Table 11: Left Ventricular Hypertrophy:

		Left Ventricular Hypertrophy		Total	P value
		Present	Absent		
Hb Value	0 to <3 gm%	9	1	10	0.000033
	3 to < 6 gm%	20	40	60	
	6 to <9 gm%	1	29	30	
Total		30	70	100	

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P wave and QRS Complex were found to be normal in all the patients

Table 12: ST Segment:

		ST_Segment		Total	P value
		Depression	Normal		
Hb Value	0 to <3 gm%	7	3	10	0.00004
	3 to < 6 gm%	19	41	60	
	6 to <9 gm%	0	30	30	
Total		26	74	100	

Table 13: T wave:

		T_Wave		Total	P value
		T wave Inversion	Normal		
Hb Value	0 to <3 gm%	3	7	10	0.01
	3 to < 6 gm%	15	45	60	
	6 to <9 gm%	0	30	30	
Total		18	82	100	

DISCUSSION

The study was conducted exclusively in female population as the prevalence rate of anaemia is higher in women. In the present study 90% of the patients were between the age group of 20 to 40 years of age. The mean age of study population was found to be 29.44 years. Women in the childbearing years are particularly susceptible to iron-deficiency anemia because of the blood loss from menstruation and the increased blood supply demands during pregnancy. There is no

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clear association with the white blood cell count and anaemia. WBC levels have shown an increase in patients with ischaemia and inflammation. Since, anaemia leads to hypoxic conditions and ischaemia, there can be an increase in the White Blood Cell counts in patients. A study by Singh et al has shown increase in the Total Leucocyte count in patients with anaemia[16]. However, in a study in children in Africa, no correlation was seen with the WBC levels and the markers for iron deficiency anaemia[17]. Another study by Lim et al showed that there is leucopenia in patients with anaemia[18]. In the present study WBC counts remained in the normal range across all groups. Platelet levels tend to rise in iron deficient anaemia. Studies by Kadikoylu et al in women with iron deficiency anaemia, showed increased platelet counts[19]. Evstatiev et al postulated that the increased platelet counts seen in anaemia could be to maintain the coagulation in case of chronic bleeding in patients with anaemia[20]. In the present study however, no increase in platelet counts were observed. The Uric acid values were in the normal range. The BUN and Creatinine levels were also in the normal range. Anemia commonly occurs in people with chronic kidney disease (CKD). Anemia tends to worsen as CKD progresses .The total bilirubin values and the direct bilirubin values were in the normal range. The SGOT and SGPT enzyme levels were also in the normal range. A study by Tiwari et al, in pregnant Indian women with anaemia on oral iron supplementation found that there is an increase in the serum bilirubin Alanine Aminotransferase and Aspartate Aminotransferase enzymes. Folic acid deficiency and B12 deficiency can aggravate the anaemia due to chronic liver disease. Special anaemia types such as hemolytic anaemia increases the unconjugated bilirubin levels. The absence of increased bilirubin levels in the present study points to the fact that patients who were included in the study were suffering from non-hemolytic anaemia. Anaemia can lead to distortions in the diagnosis of diabetes mellitus. A study by Christy et al has shown that in patients with iron deficiency anaemia the HbA1C levels remain elevated[21]. In the present study, the random blood sugar levels remained normal in patients across all subgroups. The mean cholesterol level in patients in the present study was 127 mg/dl. This was like the results obtained in the study by Chowta et al, the mean cholesterol level was 122 mg/dl[22]. Similarly, Ozdemir et al showed reduced levels of total cholesterol in patients with anaemia compared with control[23]. The postulated mechanism is the increased cholesterol requirement due to the high erythropoiesis in the marrow due to anaemia. The triglyceride levels in the study was 93 mg/dl. Similar to the reduced levels of cholesterol levels in patients with anaemia, studies have shown

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reduced triglyceride levels in patients with anaemia. However, in a study by Verma et al, the levels were triglycerides were raised in patients with anaemia and subsided with the treatment of the condition[24]. Anaemia is one of the causes for cardiomegaly along with coronary artery disease, hypertensive heart disease, valvular heart disease and cardiomyopathy. Though anaemia is associated with heart failure, anaemia leading to heart failure is uncommon in patients without a pre-existing structural risk factors and occurs when the Hb levels drop below 5 gm/dl. In the present study, 31 patients out of the 100 had shown cardiomegaly in chest X-ray. Out of the 31, 10 patients had Hb level less than 3%, suggesting severe impairment in the oxygen carrying capacity of the blood. This is similar to the findings of Varat et al, who in 1972 observed cardiomegaly in two thirds of the patients with severe anaemia. They also observed the reversal of changes within few weeks of treatment. Studies have shown coagulation abnormalities in patients with low serum iron with increased incidences of deep vein thrombosis and pulmonary embolism. Patients with hypertension and anaemia were associated with increased diastolic pressure, nocturnal non dipping pattern compared to non-anaemic patients. Low haematocrit in patients with anaemia may lead to cerebral ischaemia, moreover, the turbulent flow in anaemia may preclude thromboembolic events. Anaemia in patients with a stroke event might reduce the blood supply to the ischaemic penumbra. One more important cardiac complication seen in patients with anaemia is cardiac arrythmias. Anaemia has shown to be associated with various arrythmias, supraventricular tachycardia, ventricular arrythmias and prolonged QTc interval.

In the present study 65% of the patients presented with ECG changes. In a study Dhamangaonkar et al, out of 94 patients 29 presented with tachycardia[25]. ECG abnormalities more common in patients with severe anaemia. In the present study 45% of the patients presented with sinus tachycardia in ECG. Similar results were seen in a study by GV Sashikala et al[24]. In a study Dhamangaonkar et al, out of 94 patients 25 presented with tachycardia[25]. . Left axis deviation and left ventricular hypertrophy is seen 30% of the patients in the present study, lower the haemoglobin values higher is the frequency of left axis deviation. Decreased oxygen carrying capacity of the blood in anaemia leads to increased cardiac output it is achieved by increase in heart rate and increased cardiac muscle mass. Left ventricular hypertrophy is one of the important reasons for left axis deviation in the ECG. Left ventricular hypertrophy was seen in 25 to 30% of the patients in the study GV Sashikala et al[2]. Contrary to the present study, no left ventricular hypertrophic changes were reported in the study done by Dhamangaonkar et al[25]. In

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the present study there were no changes in the P wave and QRS complexes. They were normal similar to the results in the study by GV Shashikala and Dhamangaonkar[25,26]. ST segment denotes the time between QRS complex and the repolarising T wave. ST wave elevation and depression points to important changes in the heart. ST elevation is seen in Acute myocardial infarction, pulmonary embolism, pericarditis. ST segment depression may be due to myocardial ischaemia, posterior wall MI and hypokalemia. In the present study, 26% of the patients had ST segment depression. ST segment depression correction by treatment of iron deficiency anaemia was observed by Mehta et al in 1983. Mehta et al treated the patients with iron deficiency anaemia and with ST segment depression at baseline with iv iron dextran and found out that ST segment depression corrected with the treatment of anaemia. ST segment depression was observed with patients with anaemia, similar to the present study by GV Shashikala et al (24%) and Dhamangaonkar et al (30%)[25,26]. ST segment depression in anaemia should not be confused with ST segment depression with inferior wall myocardial infarction in clinical practice. T wave is the repolarising wave, inversion of T wave may suggest myocardial ischaemia, ventricular strain, bundle branch blocks and hypertrophic cardiomyopathy. In the present study, 18% of the patients had inverted T wave in the ECG. Results were similar in other studY by GV Shashikala et al[26]. In the present study more changes in the ECG were seen in patients with relatively lower haemoglobin levels. It may be due to the heart going for decompensation at Haemoglobin levels less than 7 gm/dl.

LIMITATION OF STUDY

The study has certain limitations. Etiology of anaemia was not assessed, the duration of the disease, peripheral smear picture and response to treatment were not assessed. An echocardiogram would have correlated the ECG findings into functional abnormalities. We further recommend the study to be done in a larger number of patients and to correlate with types of anaemia ECG changes and to study the effects of treatment.

CONCLUSION

In the present Cross sectional observational study ECG changes in female anemic patents was studied. In the present study, anemia prevalence was higher in age group 20-40. The mean age of study population was found to be 29.44 years. All the participants in this study had hemoglobin levels less than 9gm/dl. Studies have shown reduced triglyceride levels in patients with anaemia. In the present study, 31 patients out of the 100 had shown cardiomegaly in chest X ray. In the

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present study 65% of the patients presented with ECG changes. In the present study 45% of the patients presented with sinus tachycardia in ECG. Left axis deviation is seen 30% of the patients in the present study, lower the hemoglobin values higher is the frequency of left axis deviation. Left ventricular hypertrophy is seen 30% of the patients in the present study. In the present study there were no changes in the P wave and QRS complexes. In the present study, 26% of the patients had ST segment depression. In the present study, 18% of the patients had inverted T wave in the ECG. In the present study more changes in the ECG was seen in patients with relatively lower hemoglobin levels.

Conflict of Interest: there is no conflict of interest among the authors

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