

Electrocardiographic changes in persons of South region of Bihar suffering from Iron deficiency Anaemia

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Abstract

Anaemia, a very common blood disorder causes a great burden of morbidity and even mortality in severe cases. Iron deficiency anaemia has been the most common type of anaemia, typically in the settings of developing countries like India. Iron deficiency anaemia adversely affects the hemodynamics of cardiovascular system, manifested by different clinical signs and symptoms like tiredness, pale skin, palpitations, anxiety, headaches and dizziness, shortness of breath etc. The homeostatic compensatory mechanisms come into action when the iron deficiency anaemia lasts longer and the structure and function of the heart gets modulated accordingly. These changes can be detected by electrocardiography.

The present cross sectional study was done to observe the electrocardiographic changes in patients of south Bihar region suffering from iron deficiency anaemia. 150 subjects, coming to the Medicine OPD of Anugrah Narayan Magadh Medical College, Gaya (Bihar), were included in this study that fulfilled the inclusion criteria laid down by us. Standard 12 lead Electrocardiography of these subjects was done at the Physiology Department of Anugrah Narayan Magadh Medical College, Gaya and their blood samples were sent for the relevant investigations for iron deficiency anaemia. ECG parameters and data obtained from blood investigations were analysed.

We found that the prevalence of iron deficiency anaemia was more in females as compared to males in our study subjects (males = 65, females = 85, n = 150) and it was also seen that severe iron deficiency anaemia was more common in females (males = 8, females = 12, n = 20). Severity of anaemia is linearly related to the adverse Electrocardiographic changes, this hypothesis was proved to be correct as manifested by the results of our study. LVH, ST-T changes, QT intervals, R-R intervals are some of the ECG parameters studied which were adversely changed in subjects with severe iron deficiency anaemia and significant correlation was observed (p value ≤ 0.05).

From our study, it was concluded that anaemia itself has many deleterious effects upon the heart function as depicted by different ECG findings. It can turn into a potential risk of heart diseases if left untreated. It is advised that anaemia must be treated promptly and on emergency basis in order to mitigate the adverse cardiac functions.

Keywords: Iron deficiency anaemia, Electrocardiography, Hemodynamics.

Date of Submission: 26-10-2020

Date of Acceptance: 05-11-2020

I. Introduction

Anaemia is a chronic but very common blood disorder which has great morbidity, and in some cases, can lead to death, if not treated early. As generally used in clinical medicine, the term "anaemia", refers to reduction below normal in the concentration of hemoglobin or red blood cells in the blood. But, mean normal value and the lower limits of the "normal" range depend upon the age (childhood or adult life) and gender¹.

The World Health Organization (WHO) has defined anaemia in adults as a hemoglobin of <13 g/dL in males (a hematocrit [Hct] of about 39) and <12 g/dL in females (Hct about 36)². Also

WHO has graded anaemia depending upon its severity (WHO 2011)³:

| Grading of anaemia | Female > 15 years of age | | Male > 15 years of age |
|--------------------|--------------------------|----------|------------------------|
| | Non-pregnant | Pregnant | |
| Cut-off value | 12 | 11 | 13 |
| Mild | 11-11.9 | 10-10.9 | 11-12.9 |
| Moderate | 8-10.9 | 7-9.9 | 8-10.9 |
| Severe | < 8 | < 7 | < 8 |

However, "Anaemia" is simply an objective sign of the presence of disease. The correct diagnostic terminology for a patient with anaemia requires the inclusion of its pathogenesis¹.

Anemia is a multi-factorial disorder, but iron deficiency is the most common causative factor and Iron-deficiency anaemia is the most common type of anaemia worldwide¹. Almost one fourth of the World's population, are anaemic with a higher prevalence in low socioeconomic groups, and iron deficiency accounts for about half of the World's anaemia burden⁴. Approx. 50% of anaemia in women worldwide is due to iron deficiency³.

Iron deficiency anaemia

It results from an imbalance between available body iron for haemoglobin production and the minimal amount needed to sustain normal haemoglobin production during erythropoiesis . Because of the combined effectiveness of dietary absorption and retention of iron under normal circumstances, this mismatch is most often due to blood loss, with the gastrointestinal (GI) tract being the most common site in men and non-menstruating women⁴ (The most common cause of iron deficiency world-wide is blood loss from the gastrointestinal tract resulting from hookworm infestation⁵). Genitourinary tract blood loss resulting in iron deficiency is most common in menstruating women⁶.

Whatever be the cause, iron deficiency can result in unpleasant symptoms that can deleteriously affect the health, concentration and work productivity, because it ultimately results into low Hb which greatly decreases the oxygen delivery to the body tissue, leading to creating extra load over the heart, to supply adequate amount of blood (& thus O₂) to various organs of the body. So, it ultimately leads to structural & functional changes in the heart (thereby causing ECG changes) in later stage. Also, through homeostatic mechanism, blood is shifted to more important organs of the body leading to varied type of clinical presentations conferred by the organs with poor blood supply⁷.

Signs and Symptoms of Iron deficiency anaemia

Depending upon the severity of the anaemia, some people have obvious symptoms, while others experience none at all. Common signs and symptoms of iron deficiency anaemia include tiredness, pale skin, noticeable heartbeats, anxiety, headaches and dizziness, feeling short of breath, dry and damaged hair and skin, sore or swollen tongue and mouth, restless legs and brittle or spoon-shaped nails. Luckily, most forms of iron deficiency can be treated fairly easily, usually through an iron-rich diet or iron supplements.

Lab diagnosis of Iron deficiency anaemia

Iron deficiency anemia is diagnosed as Microcytic, Hypochromic anaemia with low ferritin level. According to Davidson's medicine, "Plasma ferritin is a measure of iron stores in tissues and is the best single test to confirm iron deficiency"⁸.

Prevalence of Iron deficiency anaemia in India

According to The Global Prevalence of Anaemia given by WHO in 2011, percentage of non-pregnant women of age 15 to 49 years, in India with blood Hb. conc < 12 gm/dl was 48% while that of blood Hb. conc < 8 gm/dl was 2.5%⁹.

The recently published information from IIPS and MoHFW (2017), based on NFHS-4 2015-16 suggest that, despite the rigorous efforts of government to reduce the prevalence of anaemia in terms of free distribution of Iron Folic Acid (IFA) tablets, the prevalence of anaemia (50.3%) in India remains one of the highest in the world, while percentage of non-pregnant women of age 15-49 years with blood Hb. Conc. < 12 gm/dl was 60.4% and that of man in same age group 32.3%¹⁰.

In one cross-sectional study conducted in Indira Gandhi Institute of Medical Sciences, Patna, Bihar, out of 200 girls, prevalence of anaemia in adolescent girls was 50% (43.3% Mild, 3.3% Moderate and 3.3% Severe¹¹.

Prevalence of Iron deficiency anaemia in Gaya

South region of Bihar is an agricultural belt, so most of the inhabitants are of low socio-economic status and having poor health care. Since the Gaya district factsheet of NFHS-4 2015-16 states that 25.7% of Men of age 15-49 years and 61.8 % female of same age group were anaemic¹², it is pertinent to assess it to make the lives of inhabitants of this region more socially productive.

Aim & Objective

Several works have done on correlation of Hb. level with cardiac changes in different region of India, very few work have been done relating anemia to ECG changes in Bihar, especially in this region. Therefore present

study was undertaken to evaluate the association of Hb level with changes in the heart of anemic persons assessed by ECG changes.

II. Material & Method

A descriptive study was conducted during the period from 1st July 2019 to 31th March 2020. People in the age of 25 to 35 years of age were randomly selected from the persons visiting in Out Patient Department of Medicine, at Anugrah Narayan Magadh Medical College, Gaya (Bihar) which is located in South region of Bihar for non-specific symptoms (such as weakness, fatigue, and/or tiredness) with whitish lower palpebral conjunctiva. 250 people were selected for brief examination and for fulfilling the inclusion & exclusion criteria.

Inclusion criteria

Patients satisfying the following criteria were included in our study

1. Young people and non-pregnant, non-nursing females with normal menstruation,
2. Patients having clinical sign of anaemia as pallor (whitish lower palpebral conjunctiva)
3. Non-smokers
4. Hb. conc. 4.5-12 gm/dl

Exclusion criteria

Patients with following conditions were excluded from our study

1. Recent history of major blood loss
2. Pre-existing heart disease like valvular heart disease, hypertensive heart disease, Congenital heart disease
3. Hypothyroidism and Thyrotoxicosis
4. Scurvy
5. Liver disease
6. Inflammatory disease
7. Systemic disorders which are likely to affect cardio-respiratory dynamics like renal failure, cor-pulmonale, and other respiratory diseases
8. Pregnancy
9. Skeletal & neuromuscular diseases
10. Haematological disorder other than anaemia
11. Unwilling Patient

Selected subjects were asked to visit Physiology Department, Anugrah Narayan Magadh Medical College, Gaya (Bihar) of next morning at 9:00 A.M. with empty stomach. After taking written consent, Subjects were examined as follows:

- a. 12 lead Electrocardiogram was taken using Cardiart 6208 view ECG Machine of BPL in lying down position with standard settings of 1 mV voltage showing 10 mm deflection and paper speed of 25mm/sec.
- b. Blood sample was taken for the estimation of Total RBC Count, PCV and Serum Ferritin level. RBC count and Peripheral Blood Smear Examination were done manually by using conventional methods; PCV by centrifuge and MCV & MCHC were calculated indirectly by using RBC count, Hb level, PCV value. Serum Ferritin level was tested by chemiluminescence immunoassay method.

Normal Range

The following electrocardiographic parameters were monitored:

- PR interval
- R amplitude
- R-R difference
- ST segment depression
- T wave changes and
- QT interval

Goldberger ECG data were accepted for their normal value ¹³.

Deviation (elevation or depression) of the ST-segment from the baseline is the most common ECG presentation for diagnosis of coronary artery disease (ischemia usually defined by significant ST-depression as horizontal ST-segment depression of at least 0.1 mV measured 0.06 second).

WHO data were accepted for blood indices while Serum ferritin concentrations of 10 mcg/L or less were accepted as characteristics of iron-deficiency anemia as stated in William Haematology 13th Edition².

A total of 160 subjects with low Ferritin level and Hb concentration 4.4 -12 gm./dl of whole blood were selected for study, the rest were directed to follow the Medicine OPD advice.

All the subjects were given antihelminthic therapy (Albendazole 400 mg tab at bed time for 3 consecutive nights) and oral iron therapy (Ferrous sulphate 200 mg 3 times daily one hour before meal advised by Medicine OPD) and were instructed to visit Physiology Dept. at one month interval for three consecutive months. On every visit, all the above investigations were repeated and the results were noted.

III. Result

A total of 150 subjects completed the entire study programme; so their results were tabulated for analysis. Among the subjects there were 65 males and 85 females. Since significant ECG changes linearly correlated to the severity of anemia, severely anemic subjects were sub-divided into Hb. with 5-8 g/dl and Hb with < 5 gm/dl.

Table: 1
Grading of patients on Severity of Anaemia

| Hb Level | Mild | Moderate | Severe | |
|----------|------------|----------------|---------------|-----------------|
| | < 11 gm/dl | 8 – 10.9 gm/dl | 5 – 7.9 gm/dl | 4.9 - 4.4 gm/dl |
| Male | 18 | 17 | 22 | 8 |
| Female | 22 | 23 | 28 | 12 |

Table: 2
ECG findings

| Anaemia Grading | Mild | | Moderate | | Severe | | | |
|-----------------------|---------|---------|----------|--------|--------|--------|-------|--------|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Hb. Level (g/dl) | 11 – 13 | 11 – 12 | 8 - 10.9 | | < 8 | < 8 | < 5 | < 5 |
| PR interval | N | N | N | N | ↑ 1 | ↑ 2 | N | ↑ 2 |
| R amplitude | ↓ 2 | ↓ 2 | ↓ 2 | ↓ 2 | ↓ 2 | ↓ 2 | LVH 5 | LVH 4 |
| | | | | | | | ↓ 3 | ↓ 8 |
| R-R duration | nil | ↓ 2 | nil | ↓ 10 | ↓ 11 | ↓ 16 | 7 | 12 |
| ST segment depression | 1 | 2 | nil | 1 | 8 | 12 | 4 | 10 |
| T wave changes | nil | nil | 3 | 5 | 6 | 11 | 4 | 8 |
| QT interval | nil | nil | ↑ 2 | ↑ 1 | ↑ 4 | ↑ 5 | ↑ 3 | ↑ 4 |

↓ = Decrease; ↑ = Increase; N = Normal; LVH = Left Ventricular Hypertrophy

Table: 3
Overall ECG changes in subjects of different Hb Level (gm/dl)

| Hb Conc. | N | LV H | ST depression | T wave changes | R Amplitude low | Tachycardia | P-R interval | Q-T interval |
|-----------------|----|------|--------------------|----------------|-----------------|--------------------|--------------|---------------|
| Up to 11 gm/dl | 40 | 0 | 1 | 0 | 4 | 2 | 0 | 0 |
| 10.9 – 8 gm/dl | 40 | 0 | 1 | 8 | 4 | 10 | 0 | 2 |
| 7.9 – 5 gm/dl | 50 | 0 | 20 | 17 | 4 | 27 | 3 | 2 |
| 4.9 - 4.4 gm/dl | 20 | 9 | 14 | 12 | 11 | 19 | 2 | 3 |
| p-Value | | | < 0.0001 | 0.1923 | 0.094 | < 0.0001 | 1 | 0.8669 |

N = Number of total subjects

IV. Discussion

Anaemia is the global health problem and it itself can worsen cardiac function, both because it causes cardiac stress through tachycardia and increased stroke volume, and because it can cause reduced renal blood flow and fluid retention, adding further stress to the heart²⁴. Such a problem is especially more concerned in low socioeconomic group, as the results denote.

In our study, 80 cases were mild to moderately anaemic while 70 cases were severely anaemic. In mild cases, only 4 subjects (2 males & 2 females) were having low voltage R-wave (2 were also having tachycardia). Similarly in 4 moderately anaemic cases, it was down which was mainly asthenic muscle mass. Low voltage R was also found in severely anaemic persons especially in females.

In our study, tachycardia was occasional in mildly anaemic persons similar to the findings of study done by Mohit et.al.²⁰. This tachycardia gradually became more prominent in severely anaemic subjects and almost all cases except one having high heart rate especially in Hb less than 5 gm/dl. It is similar to the findings of Jain et. al.¹⁹ and Mohit et.al.²⁰. The explanation to these findings is to maintain the needed cardiac output, heart rate was increased to supply adequate blood to all the organs.

P-R interval was increased in severely anaemic subjects and same was the effect upon QT interval. This may be explained by possible structural change in cardiac muscle such as fibrosis.

Left Ventricular Hypertrophy (LVH) was seen in our study only in subjects where Hb was less than 5 gm/dl. It could be explained that anaemia was chronic and sustained for prolonged period in these subjects, because such subjects were more than 30 years of age.

ST changes, especially depression were seen in our study more frequently in very low Hb conc. contrary to the findings of Jain et.al. but almost tallying with the findings of Mohit et.al. In the subjects of Gujarat State, as noted by Neha et. al.²², only 25% cases were having ST depression. In our study, ST depression was more in female cases and similarly T wave changes was more prominent in female cases (similar to Jain et. al. but contrary to Mohit et. al. and Neha et. al.).

ST-T changes in females of sustained low Hb conc. could be explained on the basis of history, where females bore the brunt of illiteracy, large families and cultural taboos (like customs of eating last).

V. Conclusion

From our study, it was concluded that anaemia itself has many deleterious effects upon the heart function as depicted by different ECG findings. It can turn into a potential risk of heart diseases if left untreated. Therefore, it is advised that anaemia must be treated promptly and at emergent level in order to mitigate the adverse cardiac functions.

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