



## A Study of Cardiac Manifestations in Iron Deficiency Anemia.

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### Abstract

**Background:** Anemia is a significant challenge in global health; iron deficiency (ID) is the most prevalent, preventable, and treatable cause of anemia worldwide. There are numerous studies on heart failure in iron deficiency anemia but there is lack of sufficient data regarding left ventricular mass cavity dilation/EF, wall thickness and volume in iron deficiency anemia. **Objective:** To evaluate the cardiac manifestations of iron deficiency anaemia in male and female. **Methods:** This was a prospective study, conducted on 150 newly diagnosed IDA patients who met the inclusion and exclusion criteria of the study. This study was done in Department of General Medicine, Khaja Banda Nawaz University Faculty of Medical Sciences, Kalaburagi, Karnataka during the period August 2022 – January 2024. **Result:** Average age of the IDA patients found to be  $40.19 \pm 14.45$  years. In this study it has been found that there is female preponderance in IDA when compared to males. Majority IDA patients had ECG abnormalities like sinus tachycardia followed by LVH & left axis. Eccentric hypertrophy was more common in IDA patients when compared to concentric hypertrophy. IVH pressure overload was most seen in 2D echo of IDA patients (89%) followed by LVH volume overload, prolongation of p- wave duration, systolic dysfunction, and diastolic dysfunction. **Conclusion:** The study concludes that there is cardiac abnormalities predominantly LVH along with systolic and diastolic dysfunction.

**Keywords:** Iron Deficiency Anemia, Cardiac Manifestations, Male, Female.



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## INTRODUCTION

Anemia is a significant challenge in global health; it is characterized by lower-than-normal levels of red blood cells and hemoglobin per unit volume of blood and is mainly caused by genetic traits, malnutrition, and loss of trace elements. The main types of anemia identified by studies of the global burden of diseases are iron deficiency anemias (IDA), thalassemia, sickle cell disease, and infection-related anemias. Among the main causes, iron deficiency (ID) is the most prevalent, preventable, and treatable cause of anemia worldwide. IDA is a condition in which iron stores in the body are insufficient to meet the needs of the patient to produce red blood cells, resulting in a lower-than-normal red blood cell count. ID is the most common nutritional deficiency in various regions around the world. Approximately 25% of people worldwide have anemia. Iron deficiency, the most common cause, is responsible for 50% of all anemias. The rate of iron deficiency is higher in developing countries compared to the United States, where the prevalence of iron-deficiency anemia in men under 50 is 1%. In women of childbearing age in the United States, the rate is 10% due to losses from menstruation, while 9% of children ages 12 to 36 months are iron-deficient, and one-third of these children develop anemia. While the rate of iron-deficiency anemia is low in the United States, low-income families are particularly at risk. (1), (2) Moreover, anemia has been confirmed as one of the top 20 risk factors associated with the global burden of disease by the World Health Organization (WHO). (3)

Adequate iron reserves are required for many important processes in the body, including oxygen transport as part of the hemoglobin molecule, enzymatic reactions in the Cytochrome system, and electron transport and energy metabolism in the body. Serum ferritin levels may also be a significant determinant of myocardial ischemia burden during an ischemic attack. ID in the adult general population is defined by the WHO as plasma ferritin  $<15$  mg/L. In chronic heart failure, the criteria for diagnosing ID are not uniform but generally, include an absolute ferritin level  $<100$   $\mu$ g/L and a functional ferritin level 100–300  $\mu$ g/L in combination with a transferrin saturation  $<20\%$ . Using these criteria, a study published in 2010 showed that ID was present in 37% of all patients with heart failure. Recent research has shown that male patients with anemia have a higher incidence of cardiovascular diseases and a worse life expectancy than female patients with anemia,

which was partially due to the younger age of female patients with anemia in this study. Among young people, the prevalence of anemia in women is higher than in men, mainly due to the high prevalence of microcytic anemia in women. In addition, anemia may influence the mortality in patients of both sexes with chronic heart failure, but this effect is reduced in women because of a sex difference in the oxygen affinity of hemoglobin. (4)

Most of the available literature have studied the effects of chronic anemia of any etiology on the cardiac function and have use M mode parameters for the same.(5), (6) There are numerous studies on heart failure in iron deficiency anemia but there is lack of sufficient data regarding left ventricular mass cavity dilation/EF, wall thickness and volume in iron deficiency anemia. Hence, we decided to emphasize on these parameters based on clinical, ECG and Echocardiographic findings in iron deficiency anemia for evaluation of cardiac manifestations.

## **MATERIALS AND METHODS**

This prospective cross-sectional study has been done over a period of 18 months from August 2022 to January 2024 on 100 patients attending KBN Teaching and General Hospital as both outpatients and inpatients. : The study was conducted after obtaining permission from the Institutional Ethics Committee (IEC). All the data collected was kept strictly confidential and used for the purpose of this study as described below. Written Informed Consent (in English/Kannada) was taken from the subjects and/or their attendants before the recruitment of the subjects in the study.

### **Inclusion Criteria:**

- Patients with iron deficiency anaemia of age above 15 years.
- Patients with iron deficiency anaemia of both sexes.

### **Exclusion criteria:**

- Other types of anaemia
- Hypertensive heart disease.
- Ischemic heart disease.
- Congenital heart disease
- Alcohol induced cardiomyopathy

**Study Procedure:** A Prospective cross-sectional type of observational study consisting of 150 cases of IDA convening to the inclusion criteria were enrolled in the study after being explained to about the proceedings of the study and after taking the consent. On initial assessment symptoms with examination findings were noted as per the case record form. They were investigated on the parameters mentioned below:

1. Complete Blood Count
2. Peripheral smear study
3. Iron profile
4. ECG
5. 2D Echocardiography

### **Sample size calculation:**

n = sample size for study group

In the reference study: WHO report [7]

Prevalence of iron deficiency anemia = 29.9%

P = 29.8 Q = 70.1

L = Permissible error was 25% of P was 7.47

Power of study was 80.0

Sample size (n) =  $Z2\alpha PQ/L2$

$$= (1.96)^2 \times 29.9 \times 70.1 / (7.47)^2$$

$$n = 3.8416 \times 2095.99 / 55$$

$$n = 7800.65/55.5 = 146.33$$

Round figure Sample size n = 150 cases

**SAMPLING PROCEDURE:** Study subjects will be selected after applying inclusion, exclusion criteria. Information will be collected through prepared proforma from each case by simple random sampling technique.

Statistical data analysis: Statistical data will be analyzed by IBM SPSS 20.0 version software. Collected data will be spread on excel sheet and prepared master chart. Through the master chart tables, graphs and diagrams will be prepared. For quantitative data analysis t-test and ANOVA tests will be applied. For qualitative data analysis chi-square test is applied, for statistical significance. If P-value was less than 0.05 considered as significant.

## RESULTS

The results of the data have been explained after applying the appropriate statistical tests as mentioned in the methodology section.

This study is conducted to evaluate the cardiac manifestations in patients diagnosed with Iron deficiency anaemia attending KBN Teaching and General Hospital. The average age of study participants found to be  $40.19 \pm 14.45$  (Mean  $\pm$  SD) years. Majority of the patients were belonged to 30-44 years (49 patients, 32.7%) of age group followed by 45-59 years (43 patients, 28.7%) of age group.

Out of 150 IDA patients, most of them were females (90 patients, 60%) as anemia more common in females when compared to males (60 patients, 40%). The average Hemoglobin levels of IDA patients found to be  $5.54 \pm 0.62$  gm% (Mean  $\pm$  SD). The average Serum Iron levels of IDA patients found to be  $28.6 \pm 5.82$   $\mu$ g/dl (Mean  $\pm$  SD). The average Serum ferritin levels of IDA patients found to be  $7.03 \pm 1.11$  ng/dl (Mean  $\pm$  SD). All IDA patients had microcytic hypochromic picture on peripheral smear. The average LV mass of IDA patients found to be  $108.59 \pm 21.29$  gm/m<sup>2</sup> (Mean  $\pm$  SD).

In this study it has been evaluated the ECG findings in IDA patients namely normal ECG findings, sinus tachycardia, LVH & Left axis of the heart. Only 6% of IDA patients (9 patients) had normal ECG findings. 70.7% of IDA patients sinus tachycardia (106 patients), majority IDA patients had this finding when compared to LVH (51 patients, 34%) & left axis (42 patients, 28%).

### Echocardiographic Changes in IDA

In this study Left ventricle (LV) wall thickness, hypertrophy, left ventricle ejection fraction (LVEF), systolic & diastolic dysfunction, IVH pressure overload & LVH volume overload has been assessed using 2D echocardiography. 22 % of IDA patients (33 patients) had LV wall thickness  $>0.42$  which restricts pumping ability of heart.

**Table 1. LV wall thickness in IDA patients**

| LV wall thickness | Number of Patients | Percentage (%) |
|-------------------|--------------------|----------------|
| <b>&lt;0.42</b>   | 70                 | 46.7           |
| <b>&gt;0.42</b>   | 33                 | 22.0           |
| <b>0.42</b>       | 47                 | 31.3           |
| <b>Total</b>      | <b>150</b>         | <b>100.0</b>   |

20 % of IDA patients (30 patients) had concentric hypertrophy which restricts pumping ability of heart.

41 % of IDA patients (62 patients) had eccentric hypertrophy which restricts pumping ability of heart. Average LVEF in IDA patients found to be  $50.94 \pm 12.60$  % (Mean  $\pm$  SD).

53.3 % of IDA patients (80 patients) had systolic dysfunction. 44 % of IDA patients (66 patients) had diastolic dysfunction

**Table 2. Systolic dysfunction in IDA patients**

| Systolic dysfunction | Number of Patients | Percentage (%) |
|----------------------|--------------------|----------------|
| <b>PRESENT</b>       | 80                 | 53.3           |
| <b>ABSENT</b>        | 70                 | 46.7           |
| <b>Total</b>         | <b>150</b>         | <b>100.0</b>   |

62.7 % of IDA patients (94 patients) had Prolonged P-wave duration. 89 % of IDA patients (134 patients) had IVH Pressure Overload. 69 % of IDA patients (103 patients) had LVH Volume Overload.

### Sex Correlation with echocardiographic changes in IDA patients

In this study it has been revealed that there is higher number of male IDA patients (19 patients) had concentric hypertrophy when compared to females. This association is significant with the p value 0.004.

**Table 3: Gender Distribution of Concentric Hypertrophy in IDA patients**

| Concentric Hypertrophy | Sex       |           |            | P- value       |
|------------------------|-----------|-----------|------------|----------------|
|                        | Female    | Male      | Total      |                |
| <b>ABSENT</b>          | 79        | 41        | <b>120</b> | <b>0.004 *</b> |
| <b>PRESENT</b>         | 11        | 19        | <b>30</b>  |                |
| <b>Total</b>           | <b>90</b> | <b>60</b> | <b>150</b> |                |

\*: Significant association using chi square correlation

In this study it has been revealed that there is higher number of female IDA patients (56 patients) had eccentric hypertrophy when compared to males. This association is extremely significant with the p value <0.0001.

In this study it has been revealed that there is higher number of female IDA patients (56 patients) had systolic dysfunction when compared to males. This association is significant with the p value 0.045. In this study it has been revealed that there is higher number of female IDA patients (56 patients) had diastolic dysfunction when compared to males. This association is not significant with the p value 0.06.

**Table 4: Gender Distribution of Systolic Dysfunction in IDA patients**

| Systolic Dysfunction | Sex    |      | Total | P- value |
|----------------------|--------|------|-------|----------|
|                      | Female | Male |       |          |
| ABSENT               | 42     | 38   | 80    | 0.045 *  |
| PRESENT              | 48     | 22   | 70    |          |
| Total                | 90     | 60   | 150   |          |

\*: Significant association using chi square correlation

In this study it has been revealed that there is higher number of female IDA patients (38 patients) had prolongation of P-wave duration when compared to males. This association is not significant with the p value 0.129.

**Table 5: Gender Distribution of Prolongation of P-wave duration in IDA patients**

| Prolongation of P-wave duration | Sex    |      | Total | P- value |
|---------------------------------|--------|------|-------|----------|
|                                 | Female | Male |       |          |
| ABSENT                          | 52     | 42   | 94    | 0.129    |
| PRESENT                         | 38     | 18   | 56    |          |
| Total                           | 90     | 60   | 150   |          |

In this study it has been revealed that there is higher number of males IDA patients (8 patients) had IVH pressure overload when compared to females. This association is not significant with the p value 0.388.

In this study it has been revealed that there is higher number of females IDA patients (36 patients) had LVH volume overload when compared to males. This association is significant with the p value 0.005.

**Table 6: Gender Distribution of LVH Volume Overload in IDA patients**

| LVH Volume Overload | Sex    |      | Total | P- value |
|---------------------|--------|------|-------|----------|
|                     | Female | Male |       |          |
| ABSENT              | 54     | 49   | 103   | 0.005    |
| PRESENT             | 36     | 11   | 47    |          |
| Total               | 90     | 60   | 150   |          |

## DISCUSSION

Iron deficiency is the most common nutritional deficiency in developed and developing regions of the world. Approximately 10% of adult men and 90% of adult women in India have iron deficiency, and it is the most common cause of anemia in this country. The prevalence of iron deficiency is greater among infants, pregnant women, and the poor. (5) The average age of study participants found to be  $40.19 \pm 14.45$  (Mean  $\pm$  SD) years. Similarly, Mohammed et al study also showed  $42 \pm 11$  years. (8) Majority of the patients were belonged to 30-44 years (49 patients, 32.7%) of age group followed by 45-59 years (43 patients, 28.7%) of age group. Out of 150 IDA patients, most of them were females (60%) as anemia more common in females when compared to males (40%). Brady et al, in his study showed that although IDA is most common in toddlers and women of reproductive age, it is found in 1 to 2% of men and 2% of women over the age of 50 years. (6) Iron deficiency may be caused by prolonged intake of diets low in iron, increased iron requirement (pregnancy and lactation), loss of blood, or gastrointestinal malabsorption of iron. In adults over the age of 50 years, gastrointestinal blood loss is an important cause of iron deficiency. (9)

The average Hemoglobin levels of IDA patients found to be  $5.54 \pm 0.62$  gm% in this study but Mohammed et al study showed Mean hemoglobin levels as  $10.9 \pm 1$ . (8) The average Serum Iron levels of IDA patients found to be  $28.6 \pm 5.82$   $\mu$ g/dl in this study which is higher when compared to Simsek et al study in which it was  $19.5 \pm 5.1$   $\mu$ g/dl. (7) The average Serum ferritin levels of IDA patients found to be  $7.03 \pm 1.11$  ng/dl in this study which is higher when compared to Simsek et al study in which it was  $4.54 \pm 3.51$  ng/dl. (8) All IDA patients had microcytic hypochromic picture on peripheral smear. In this study the average LV mass of IDA patients found to be  $108.59 \pm 21.29$  gm/m<sup>2</sup> which is more compared to Mohammed et al study in which it was only  $96 \pm 24$  gm/m<sup>2</sup>. (8) Higher LV mass may be because we had more severe anemic patients.

In this study it has been evaluated the ECG findings in IDA patients namely normal ECG findings, sinus tachycardia, LVH & Left axis of the heart. Only 6% of IDA patients (9 patients) had normal ECG findings. 70.7% of IDA patients sinus tachycardia (106 patients), majority IDA patients had this finding when compared to LVH (51 patients, 34%) & left axis (42 patients, 28%).

In this study Left ventricle (LV) wall thickness, hypertrophy, left ventricle ejection fraction (LVEF), systolic & diastolic dysfunction, IVH pressure overload & LVH volume overload has been assessed using 2D echocardiography. 22 % of IDA patients (33 patients) had LV wall thickness >0.42 which restricts pumping ability of heart.

20 % of IDA patients (30 patients) had concentric hypertrophy which restricts pumping ability of heart. 41 % of IDA patients (62 patients) had eccentric hypertrophy which restricts pumping ability of heart. 53.3 % of IDA patients (80 patients) had systolic dysfunction. 44 % of IDA patients (66 patients) had diastolic dysfunction in this study which is very high when compared to Mohammed et al study showed only 8%. (66) 62.7 % of IDA patients (94 patients) had Prolonged P-wave duration. 89 % of IDA patients (134 patients) had IVH Pressure Overload. 69 % of IDA patients (103 patients) had LVH Volume Overload.

In this study it has been revealed that there is higher number of male IDA patients (19 patients) had concentric hypertrophy when compared to females. This association is significant with the p value 0.004. In this study it has been revealed that there is higher number of female IDA patients (56 patients) had eccentric hypertrophy when compared to males. This association is extremely significant with the p value <0.0001. In this study it has been revealed that there is higher number of female IDA patients (56 patients) had systolic dysfunction when compared to males. This association is significant with the p value 0.045. In this study it has been revealed that there is higher number of female IDA patients (56 patients) had diastolic dysfunction when compared to males. This association is not significant with the p value 0.06. In this study it has been revealed that there is higher number of female IDA patients (38 patients) had prolongation of P-wave duration when compared to males. This association is not significant with the p value 0.129. In this study it has been revealed that there is higher number of males IDA patients (8 patients) had IVH pressure overload when compared to females. This association is not significant with the p value 0.388. In this study it has been revealed that there is higher number of females IDA patients (36 patients) had LVH volume overload when compared to males. This association is significant with the p value 0.005.

## CONCLUSION

Average age of the IDA patients found to be  $40.19 \pm 14.45$  years. In this study it has been found that there is female preponderance in IDA when compared to males. Majority IDA patients had ECG abnormalities like sinus tachycardia followed by LVH & left axis. Eccentric hypertrophy was more common in IDA patients when compared to concentric hypertrophy. IVH pressure overload was most seen in 2D echo of IDA patients (89%) followed by LVH volume overload, prolongation of p- wave duration, systolic dysfunction, and diastolic dysfunction.

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