Original Article

Clinical and Haematological Evaluation of Nutritional Anemias in Pediatric Age Group (1–14 years) in Correlation with Biochemical Studies

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Abstract

Introduction: Anemia is a major health problem worldwide more importantly in India, mostly in rural areas. It is one of the leading causes of morbidity and mortality in pediatric age group. The term 'Nutritional anaemia" encompasses all pathological conditions in which the blood haemoglobin concentration drops to an abnormally low level, due to deficiency in one or several nutrients. Iron deficiency is the most common cause of nutritional anaemia worldwide. Folic acid deficiency and vitamin B_{12} deficiency are less widespread. It is important to know the clinical manifestations andhaematological changes in children with nutritional anaemia to define the correct management approach.

Aims and objectives: 1)To study the causes of nutritional anaemia in children

2) Clinical & haematological evaluation of nutritional anaemia in correlation with biochemical studies in children.

Materials and Methods: A 2 years prospective study was done on 100 children with anemia in the department of pathology, Chalmeda Anand Rao Institute of Medical Sciences for a period of 2years from January 2022 to December 2023.

Key words: Hemoglobin, nutritional anemia, Iron deficiency anemia, megaloblastic anemia

Introduction

Anemia is a major public health problem, mostly affecting young children, pregnant and lactating women.[1,2] It is affecting both developing and developed countries with major consequences for human health as well as social and economic development.[3] According to World Health Organization (WHO), globally, the highest prevalence of Anemia is in preschool children (47.4%). In India, 89 million preschool age children are suffering from Anemia.[4] Predominantly affected children are of under 5years age group.[5,6] Thus, India is the highest contributor to child anemia among the developing countries.[7]

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The most common cause of anemia in developing countries is nutritional.[4] The term 'Nutritional anemia' encompasses all pathological conditions in which the blood hemoglobin concentration is abnormally low, due to a deficiency in one or several nutrients. The main nutrients involved in the synthesis of hemoglobin are iron, folic acid, and vitamin B12.[8] Besides these, other nutrients such as B2 (riboflavin), B6 (pyridoxine), vitamins A, E, D and C also play key role in formation and protection of red blood cell (RBC) by stimulating stem cells as well as by activating a number of antioxidant enzymes. Copper, Cobalt and nickel are essential trace elements with significant impact on the processes of haematopoiesis—stimulation of erythropoietin production and haemoglobin synthesis[9] and all these deficiencies are associated with childhood anemia. Longitudinal studies consistently indicate that anemic children in infancy continue to have poorer cognition, school achievement and more behavior problems into middle childhood.[10]

This study was conducted as effective control of this problem can be achieved by health care providers who should have a comprehensive understanding of the etiologic factors associated with nutritional anemia, clinical presentation and biochemical studies.

Aims and Objectives: 1) To study the causes of nutritional anaemia in children

2) Clinical & haematological evaluation of nutritional anaemia in correlation with biochemical studies in children.

Materials and Methods

The present study was conducted in the department of pathology, Chalmeda Anand Rao Institute of Medical Sciences for a period of 2 years from January 2022 to December 2023 on 100 subjects in the age group of 1 – 14 years with anemia and also those who presented with other complaints but were incidentally found to have anemia. Informed consent was taken from all the parents of patients.

A detailed clinical history of each patient was recorded and a thorough clinical examination was performed. Venous blood was collected with aseptic precautions in EDTA anticoagulant for hematological investigations. Separate blood sample was collected for biochemical investigations. Serum was separated on the same day of blood collection and stored in refrigerator between 2 to 8 degree centigrade. Biochemical study was carried out within three days of blood collection.

The hematological investigations were performed on Sysmex-XN 1000 with standard calibration using fresh whole blood. As a part of CBC, red blood cell indices (MCV, MCH, MCHC), PCV, RDW, white blood cell count and platelet count were obtained.

Peripheral blood smear study was performed on each of these patients. A good peripheral smear was made and the blood film was stained by Leishman's stain.

Among microcytic hypochromic anemias, iron deficiency anemia was diagnosed by serum iron, serum ferritin and TIBC estimation. Serum iron and TIBC were estimated by established method. Serum ferritin was determined by Chemiluminiscent immune assay (CIA). Vitamin B12 and folate assays were done in the patients with peripheral blood picture of macrocytic anemia or dimorphic anemia.

Results

Of the 100 children, females were found to be more anemic compared to male children. Maximum number of patients belong to age group of 1 – 5yrs and least were found in 12- 14yrs. There is no significant association between sex and age Table 1 shows age and gender distribution of cases.

In the present study of 100 children, 18 children had mild anemia, 45 children had moderate anemia, 37 children had severe anemia. Figure 1 shows distribution of cases according to severity of anemia.

Most of the patients presented with complaints of fever (61%), followed by weakness (48%), cough (34%), diarrhea (16%), SOB (12%), H/O pica (9%), vomitings (7%) and knuckle pigmentation (3%). Table 2 shows clinical presentation of cases.

The peripheral smear pattern in this study showed that maximum patients were having microcytic hypochromic anemia (71%), followed by dimorphic anemia (15%), macrocytic anemia (9%) and least patients were having normocytic normochromic anemia (5%)

The most common underlying cause of nutritional anemia in the study sample found to be due to iron deficiency (76%), followed by mixed deficiency (15%), vitaminB12 deficiency (6%) and folic acid deficiency (3%).Table 3 shows spectrum of nutritional anemias.

Biochemical studies of serum iron, ferritin and TIBC were performed in children with microcytic anemia and dimorphic anemia. Serum iron and TIBC were found to be normal in 8 cases of iron deficiency anemia out of 76 children. Mean serum iron and ferritin values were found to be decreasing in children with mild, moderate and severe anemia. Mean TIBC value was found to be increasing with severity of anemia.There is significant association between severity and serum iron studies with a p value <0.05 15 children with dimorphic anemia were having low levels of both serum iron studies and vitamin B12 with normal folic acid levels.

Vitamin B12 and folic acid assays were done in children with macrocytic anemia. Only 3 of them were having folic acid deficiency with a mean of 2.26ng/ml and 6 children have vitamin B12 deficiency. The mean vitamin B12 value was found to be decreasing with severity of anemia Table 4 shows mean values of serum iron, ferritin, TIBC, Vitamin B12 in relation to severity of anemia.

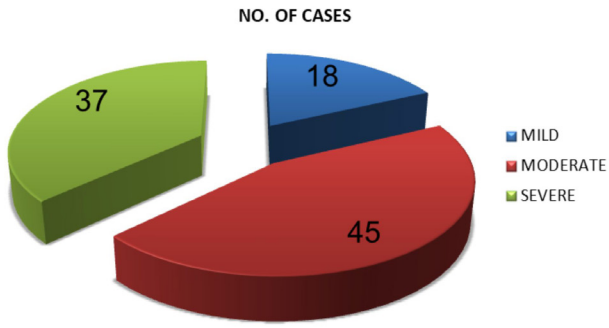

Figure 1: The pie diagram for distribution of cases according to severity of anemia

Table 1: Age and Gender Distribution of Cases

AGE(in years)	MALES (%)	FEMALES (%)	TOTAL	P value
1 – 5	33 (70.21)	29 (54.71)	62	0.259
6 – 11	9 (19.14)	17 (32.07)	26	
12 – 14	5 (10.6)	7 (13.2)	12	
TOTAL	47(100.00)	53 (100.00)	100	

Table 2: Clinical Presentation of Cases

Clinical findings	Total number of study Subjects	Number of patients (%)
Fever	100	61 (61.00)
Weakness	100	48 (48.00)
Cough	100	34 (34.00)
Diarrhoea	100	16 (16.00)
SOB	100	12 (12.00)
H/O pica	100	9 (9.00)
Vomitings	100	7 (7.00)
Knuckle pigmentation	100	3 (3.00)

Table 3: Spectrum of Nutritional Anemias

Type of Nutritional anemia	No. of. cases (%)
Iron deficiency anemia	76 (76%)
Megaloblastic anemia (vitamin B12 deficiency)	6 (6%)
Megaloblastic anemia (folic acid deficiency)	3 (3%)
Mixed deficiency(iron and vitamin B12)	15 (15%)
Total	100 (100.00)

Table 4: Mean values of serum iron, ferritin, TIBC, Vitamin B12 in relation to severity of anemia

SEVERITY	S. iron	TIBC	S.ferritin	Vit.B12
Mild	44.06	407.24	12.52	NA
Moderate	24.76	429.85	11.37	96.5
Severe	18.92	482.76	5.60	91.75

Discussion

Anemia is considered the most prevalent nutritional deficiency globally, affecting about a quarter of the world population, especially children.

Nutritional anemia is a big problem in India with major consequences not only on the morbidity and mortality in children but also affects their growth and intellectual development. The present study is a prospective study done over a period of 2 years.

I00 children of age group 1 – 14 yrs were studied and divided into 3 groups,1- 5yrs, 6 – 11yrs, 12 – 14yrs of age. Maximum number of patients belong to age group of 1 – 5 years and least were found in age group of 12 – 14years.Female children were more affected compared to males. Our study was close to studies of Nasera Bhatti et al [11,] Venkatesh G et al [12,] Reddy BA et al [13.]

In the present study, maximum patients on eliciting the clinical presentation were found to be having fever, followed by weakness. In contrast, maximum patients in the study carried out by Ramana Sastry[14], presented by weakness (81.8%), followed by fever (40.9%). Pallor can be a helpful diagnostic clue.

Peripheral smear examination showed microcytic hypochromic anemia(figure 2) in 71% children, dimorphic anemia blood picture(figure3) in 15%, macrocytic anemia blood picture(figure4) in 9%. Least number of patients was having normocytic normochromic anemia (5%).

The present study was in similarity with the study done by Ramana sastry[14] who found microcytic hypochromic anemia(81.8%) as more common in children followed by dimorphic anemia (9.09%) and normocytic normochromic anemia (9.09%).

The similar study was also shown by Venkatesh G et al[12] which showed that maximum children were having microcytic hypochromic anemia (54.4%), followed by dimorphic anemia(33.6%), and macrocytic anemia blood picture (9%).

In contrast, another study conducted by Deeksha Kapoor et al[15] found maximum number of children had dimorphic anemia blood picture (37.1%) followed by microcytic hypochromic anemia blood picture (33.9%)

The most common cause of anemia in this study is iron deficiency followed by mixed deficiency, vitamin B12 and folic acid deficiency.

Similar study conducted by Ramana sastry[14] found maximum cases of irn deficiency anemia (72.7%) followed by megaloblastic anemia(18.1%).

The studies of Nasera Bhatti et al[11] and Venkatesh G et al [12] were in accordance with our study. Globally, 50% of all anemias can be attributed to iron deficiency. It is the most common type seen in children below 2 years of age. Late weaning was the most important predictor of iron deficiency anemia in these children.

In this study of 100 children with nutritional anemia, the final diagnosis was made mainly by biochemical studies.

76 children were having pure iron deficiency anemia with mean values of serum iron, TIBC, serum ferritin as 27.15 µg/dl, 442.2 µg/dl, and 9.71ng/ml respectively. Similar observations have been in the study of Abdus Sattar Khan et al[16] with mean values 46 µg/dl, 453.5µg/dl and 8.5 ng/ml respectively.

Serum ferritin was the only reliable and sensitive haematological parameter for diagnosis of iron deficiency anaemia. It was more precise and sensitive as compared to serum iron, TIBC for detection of iron stores.

15 children with dimorphic anemia were having mixed deficiency with decreased serum ferritin and vitamin B12 levels 6 children were having vitamin B12 deficiency with mean vitamin B12 value of 93.33pg/ml and 3 were having folic acid deficiency with a mean value of 2.26ng/ml.

The study conducted by Mustafa Taskesen et al[17] on 134 children showed that the mean value of vitamin B12 was 69.4pg/ml and that of serum folate was 2.3ng/ml.

These observations are in accordance with present study.

In patients with megaloblastic anemia (figure 5), bone marrow aspiration shows megaloblastic changes in the erythroid and myeloid cell lines, asynchronous nuclear-cytoplasmic maturation, and giant metamyelocytes.In our study, 2 patients underwent bone marrow aspiration and in all of these cases megaloblastic changes and hyperplasia in the erythroid line were observed.

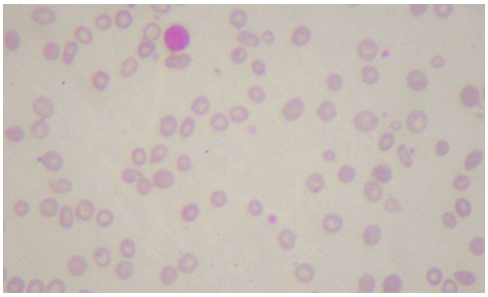

Figure 2: Microcytic hypochromic blood picture leishman stain (100x)

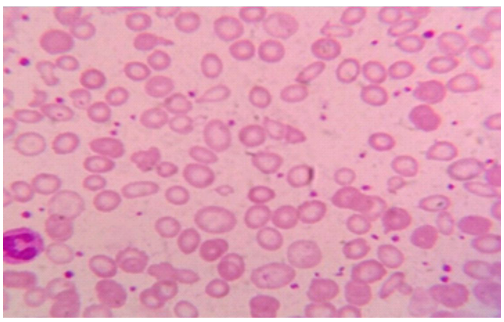

Figure 3: Dimorphic blood picture leishman stain (100x)

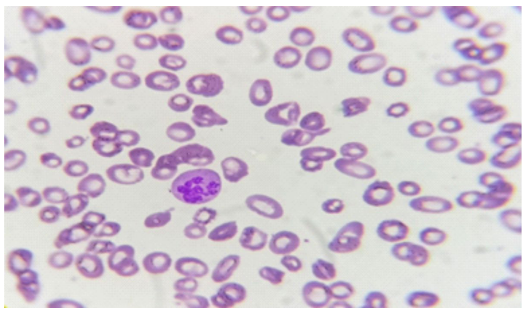

Figure 4: Macrocytic blood picture leishman stain (100x)

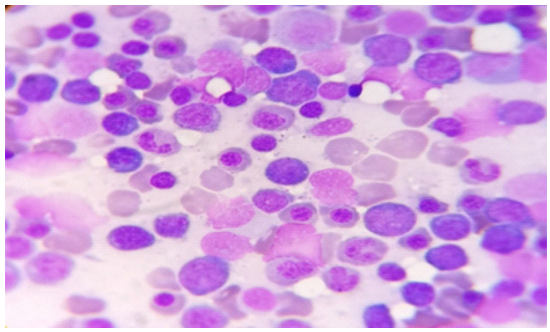

Figure 5: Bonemarrow picture of megaloblastic anemia leishman stain (40x)

Conclusion

Despite the modern diagnostic advances, pediatric anemia still remain under-reported and inadequately investigated, especially when mild, thereby necessitating evaluation of even mild anemias in this population. Estimation of serum Iron, Ferritin, TIBC levels, Vitamin B12 and Folic acid are very important in diagnosing the cause of nutritional anemia and also in differential diagnosis. Confirming the type of nutritional anemia is critical to direct the investigation for profiling the etiology since it is well known that the treatment of anemia goes a long way in improving the overall outcome and quality of life.

Ethical Clearance: This study was reviewed and approved by Institute Ethics committee, CAIMS, Karimnagar (Ref.No: IEC/CAIMS/2022/012 and Dated 03/01/2022)

Conflict of Interest: Nil

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