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Original Research Article

Clinical and biochemical profile of iron deficiency state in preanemic under 5 children in a tertiary care hospital

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ABSTRACT

Background: Anemia is a global public health problem affecting both developing and developed countries with major consequences for human health as well as social and economic development. The aim was to identify iron deficiency state early before developing anemia and to analyze the clinical finding with iron deficiency state.
Methods: Cross sectional study was done at Vydehi Institute of Medical Sciences and Research Centre, Bangalore, India. 100 children between 6 month to 5 years of age with normal haemoglobin were studied for iron deficiency state. After taking informed consent a detailed history and clinical examination was taken. In those children with normal Hb, investigations like serum ferritin, serum iron and transferrin saturation were done to diagnose the iron deficiency state.
Results: Out of 100 children in the study, mean hemoglobin was 11.8 gm/dl, the mean serum ferritin level was 59.1ng/ml and transferrin saturation was 18.77%. The overall prevalence of iron deficiency in this study based on low serum ferritin was 16% and low transferrin saturation was 51%. 7 children has low DQ out of which 3 were ADHD, 2 had hyperactivity and 2 with learning problem. Among them one child has low ferritin and 5 had low transferrin saturation.
Conclusions: Iron deficiency is an important public health problem. The findings in this study are consistent compared to other studies. Therefore, prompt screening for iron deficiency, even in non-anemic under five children in developing countries should be encouraged. If evaluation of iron status is done only by Hb early signs of iron depletion can go undetected. By monitoring the status of storage iron(ferritin), we can detect iron deficiency state earlier and initiate appropriate treatment to prevent IDA.

Keywords: Ferritin, Hb, ID, IDA, Transferrin saturation

INTRODUCTION

Anemia is a global public health problem affecting both developing and developed countries with major consequences for human health as well as social and economic development. It occurs at all stages of the life cycle, but is more prevalent in pregnant women and young children. Globally, the most significant contributor to the onset of anemia is iron deficiency. It is generally assumed that 50% of the cases of anemia are due to iron deficiency.[1] Anemia is the world's second leading cause of disability and is responsible for about 1 million deaths a year, of which three-quarters occur in Africa and South-east Asia.[2] The World Health Organization recommends cut-off values for IDA in different age, gender and physiological groups. It is one of the micronutrient deficiencies that affects under five years of age population in both the developed and developing nations.[1] Iron deficiency doesn't occur denovo in children. There are several biochemical alterations that happen before the child develops frank anemia in iron deficiency. The condition of child before developing

anemia is called Iron deficiency state. Iron deficiency state progresses from pre-latent stage to latent stage and then to anemia.[3]

In infancy and childhood iron deficiency even before developing anemia (i.e. during the iron deficiency state) can have long lasting detrimental effects on neurodevelopment, learning and behavior which sometimes may be irreversible.[4] Hence it is very important to detect and prevent the above problems in children. Hence, by identifying the children at prelatent stage and latent stage of iron deficiency, we can prevent these children from developing iron deficiency anemia.

METHODS

This is a cross sectional study conducted at Vydehi Institute of Medical Sciences and Research Centre, Bangalore, India between January 2015 to March 2016, where 100 Indian children aged 6 month to 5 years who have normal hemoglobin for the age and sex were enrolled in the study. Children less than 6 months of age or with any evidence of inflammation, or who are already on iron supplements or who received transfusion within 1month or with pre-existing neurological deficits were excluded. In the children who were enrolled, after taking informed consent, a detailed history including development , any learning or behavioural problems and clinical examination were taken in a proforma. In these children with normal Hb, further investigations like serum ferritin, serum iron and transferrin saturation were done to diagnose the iron deficiency state. Hb was analysed by the instrument Beckmann Coulter LH760, method named photometric. Serum Ferritin levels was done by the instruments DxI 600, method named CLIA. Iron estimation was done by Beckmann Coulter DxC860I, method Ferrozine NO deproteinization. Iron binding capacity estimation was done by Beckmann Coulter DxC860I, method Ion Exchange Resin Ferrozine. Transferrin levels was done by IMMAGE 800, method named NEPHELOMETRY and Transferrin Saturation was calculated by using formula - T.S = S. Iron /TIBC*100.

To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean and S.D were used for continuous variables. To find the significance in categorical data Chi-Square test was used. The probability value $P < 0.05$ is considered as significant.

RESULTS

The epidemiological data is given in Table 1. Out of 100 children in the study population, 7 were infants, 30 between 1 to 3 years, 63 were above 3 years of age. 26 children were female and 74 were male. History of hyperactivity was noted in 2 children and 2 had poor scholastic performance. History of worm infestation was found in 2 children and one infant was fed with cow milk. Out of 100 children in the study group, 10 had grade I PEM, 4 had Grade II PEM, one had obesity and 85 of them were normal. 52 belonged to lower socioeconomic status(SES), 38 belonged to middle class and 10 belonged to upper class.

Among the children with low serum ferritin levels majority of them belong to low socioeconomic status. 10 belong to lower SES, 5 belong to middle class and one to upper class. As given in the Table 2, the mean hemoglobin of the study group children was 11.8 mg/dl, the mean serum ferritin level of 59.1 ng/ml and transferrin saturation of 18.77% documented in this study.

The overall prevalence of iron deficiency state (ID) in all age groups in this study based on low serum ferritin was 16% (Table 3).

Table 1: Epidemological data.

Parameter	N = 100	%
Age		
<1 year	7	7
1-3 years	30	30
>3 years	63	63
Sex		
F	26	26
M	74	74
History		
Cow milk feeding	1.0	1.0
Hyperactivity	5.0	5.0
Worm infestation	2.0	2.0
Poor scholastic performance	2.0	2.0
Nutrition		
Grade I	10	10
Grade II	4	4
Obesity	1	1
Normal	85	85
SES		
Lower	52	52
Middle	38	38
Upper	10	10

Table 2: Levels of various parameters.

Parameters	Mean	Std.deviation
Hb (g/dl)	11.8690	0.64631
S.Iron (micg/dl)	65.03	32.484
Serum ferritin (ng/ml)	59.1830	156.42866
Transferrin (mg/dl)	268.94	60.874
TIBC (micg/dl)	376.1318	85.19345
Transferrin saturation (%)	18.77	11.426

The mean hemoglobin of the study group children was 11.8 mg/dl, the mean serum ferritin level of 59.1 ng/ml and transferrin saturation of 18.77% documented in this study (Table 2).

Table 3: Ferritin levels among different age groups.

			SF		Total
			Abnormal	Normal	
Age range	< 1 year	Count	2	5	7
		% within SF	12.5%	6.0%	7.0%
	1 - 3 years	Count	7	23	30
		% within SF	43.8%	27.4%	30.0%
	> 3 years	Count	7	56	63
		% within SF	43.8%	66.7%	63.0%
Total		**Count**	**16**	**84**	**100**
		% within SF	**100.0%**	**100.0%**	**100.0%**

Tests of Significance for ferritin levels among different age groups-: p =0.208

Table 4: TS among different age groups.

			TS		Total
			Abnormal	Normal	
Age range	< 1 year	Count	2	5	7
		% within TS	3.9%	10.2%	7.0%
	1 - 3 years	Count	18	12	30
		% within TS	35.3%	24.5%	30.0%
	> 3 years	Count	31	32	63
		% within TS	60.8%	65.3%	63.0%
Total		**Count**	**51**	**49**	**100**
		% within TS	**100.0%**	**100.0%**	**100.0%**

Test of significance for TS levels in different age groups- P = 0.292

The overall prevalence of iron deficiency in all ages in this study based on low serum ferritin was 16% (Table 3).

The overall prevalence of iron deficiency in all age classes in this study based on low transferrin saturation is 51% (Table 4).

The overall prevalence of iron deficiencystate(ID) in all age groups in this study based on low transferrin saturation was 51% (Table 4). 7 children had low DQ out of which 3 were ADHD , 2 had hyperactivity and 2 with learning problem. Among them one child has low ferritin and 5 had low transferrin saturation, which was statistically not significant.

DISCUSSION

Iron deficiency has been described as the world's most common nutritional deficiency and the commonest cause of nutritional anemia in infancy and childhood. The deleterious behavioral and cognitive deficits associated with iron- deficiency anemia could be irreversible. A study done by Ekwochi U et al, from December 2009 to June 2010 in Nigeria on 178 children in the age range of 2 months to 59 months, the mean serum ferritin value was found to be 54.9 ng/ml which was almost similar to our study.[5] Most of the children with iron deficiency state belong to lower socioeconomic class in our study, which was also documented in the above study where 45% of study population belong to lower socioeconomic class.[5]

The overall prevalence of ID state in all age groups in our study based on low serum ferritin was 16% and prevalence based on low transferrin saturation was 51%. In the same above study , the prevalence of Iron deficiency based on serum ferritin was 27.5 %.[5] In another study done by Dixon MB et al, which was done in different states of Nigeria in 2001 using serum ferritin model as indicator, 22.3% of children under 5 years of age were iron deficient.[6] In the study done by Haulizume M, Kunii O et al, in South America, ID based on serum ferritin was found to be 32.4% and in the study done by Cogswell ME, Looker AC et al on 848 children aged 3 to 5 years from National Health and nutrition examination Survey 2003-2006 the ID prevalence in them based on ferritin model was 4.5% and in our study it was 7% among that age group.[7,8] In the study done by Dine GA et al grant in Northern Ireland, 311 preschool children were taken up who were above 1 year and screened for iron deficiency and 17% found to be iron deficient.[9] A cross-

sectional secondary data analysis of the National Survey on the Nutritional Situation (ENSIN) done by Robinson et al, conducted in 2010 in Colombia in 3542 children between 12 and 59 months. Serum ferritin levels were determined and found that the mean value of ferritin was 32.1 g/L.[10]

In our study, transferrin saturation was affected in 51% children whereas serum ferritin in 16% children. As ferritin is acute inflammatory marker it is affected in various inflammatory conditions low ferritin levels may not be detected in few cases. Hence, TS can be considered as reliable indicator than serum ferritin.

7 children has low DQ. Among them one child has low ferritin and 5 had low transferrin saturation. There were many proven studies that iron deficiency causes long term neural and behavioral effects in children especially in infancy. Lozoff et al evaluated a group of 191 Costa Rica children whose iron status and treatment were documented in infancy. Psychoeducational assessment was done and found that children who have iron deficiency in infancy continue to have a behavioral and development disadvantage even at 10 years after treatment.[11] McCann and Ames reviewed the evidence of casual relationship between ID/IDA and deficits in cognition and behavioral function.[12] In our study, DQ levels were not significantly low and follow up studies were required to know the long term effects of iron deficiency state on cognition in children later in their life.

Limitation of the study was that sample size of 100 taken in this study is small and the findings may not be true indication of ID in the community. Due to financial constraints we were not able to carry out laboratory studies (e.g., CRP) on the subjects to rule out presence of inflammation other iron indices like zinc protoporphyrin, FEP, bone marrow iron stains, which would have complemented serum ferritin findings were not done due to non-availability resources in our set up.

CONCLUSION

Iron deficiency is an important public health problem in India. This study has documented the prevalence of 51% iron deficiency based on transferrin saturation (latent phase) and 16% based on ferritin levels in preanemic under five children, which were consistent compared to other studies. Therefore, prompt screening for iron deficiency, even in non-anemic under five children presenting in a health facility in developing countries should be encouraged. If evaluation of iron status is done only by testing number of RBC's, Hb and hematocrit, early signs of iron depletion can go undetected and also those tests were not specific to detect iron deficiency state. By monitoring the status of storage iron (ferritin), we can detect iron deficiency state earlier and initiate appropriate treatment to prevent IDA.

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