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Effect of Iron Therapy on the Cognitive & Psychomotor Development in Preschool Children with Iron Deficiency Anemia

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ABSTRACT

BACKGROUND

Iron deficiency anemia is the most common nutritional deficiency in children of developing countries. Anemia is found to retard the cognitive development of children as well as the language development. Studies have shown the short term effects of iron therapy on the development. In this study we were intended to determine the long term effects of iron therapy on the development of child. This study was done to show the long term effects of iron therapy on cognitive function and psychomotor development in preschool anemic children.

MATERIALS & METHODS

A case control study conducted in 75 anemic and 75 normal pre-school children from four Integrated Child Developing centres located near our hospital in Madurai, India over a period of 12 months. They were subjected to developmental evaluation using Binet Kamat Scale of intelligence and were followed up for a period of 12 months. Their cognitive functions and IQ were recorded. Statistical analyses was done using STATA 11.1.

RESULTS

Iron therapy showed significant improvement on cognitive functions such as language, memory, thinking & reasoning in preschool anemic children over long term follow up (p value <0.01). Iron therapy had no significant effects on motor & social functions.

CONCLUSION

Early identification of iron deficiency anemia in pre-school children and initiation of treatment as early as possible will result in good cognition in these children.

KEYWORDS*: Iron deficiency, Anemia, Binet Scale, Cognition, psychomotor development*

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I. Introduction

Anemia is a common public health problem more prevalent in pre-school children of developing countries. Iron deficiency is the most encountered nutritional disorder globally (1). In India, the prevalence of anemia has increased from 74.3% (NFHS-2) to about 78.9% (NFHS-3) (2). Also, in children aged 6-59 months, 7 out of every 10 children in India are anemic – 3 per cent are severely anemic, 40 per cent are moderately anemic, and 26 per cent are mildly anemic (2). Iron deficiency per se means decreased total body iron stores without a reduction in haemoglobin levels. The incidence of iron-deficiency relates to basic aspects of iron metabolism and nutrition. Iron-deficiency anemia (IDA) is diagnosed by low serum iron concentration, low transferrin saturation, and low haemoglobin (Hb) concentration. The American Academy of Paediatrics recommends screening for anemia between the ages of 9 and 12 months, with additional screening between the ages of 1 and 5 years for children at risk (3).

Anemic children have poorer endurance capacity and lack physical fitness thereby causing weakness and loss of interest in play activities. The effect of anemia on neuromuscular development in children is much more serious and needs attention. Iron deficiency anemia is found to retard the cognitive development of children as well as the language development (4-7). In addition, many studies suggest that iron deficiency anemia is associated with lowered scores on tests for mental and motor development in early childhood (8, 9).

What is worrisome is that the neurological changes that occur due to iron deficiency may be long-term or even irreversible.

Binet Kamat Test of Intelligence (BKT) is one of the widely used scale in clinical settings. It is simple to use and cost effective. This scale is applicable from 3 years to 22 years of age. In BKT, each age group consist of six primary questions and three to four alternative questions are given when the particular test is not suitable to the individual. Age at which child passes in all the tests is "Basal age" and age at which child fails in all test is "Terminal age". Speed of response, Perception of form, Memory, Comprehension, Vocabulary, Arithmetic reasoning, Practical judgement, Ideational judgement, Imaging, Sensation and Similarities are the functions assessed by Binet Kamat Scale. This study was conducted to show the long term effects of iron therapy on cognitive function and psychomotor development in preschool anemic children.

II. Materials and Methods

A case control study was conducted in 150 children in the age group of 3 – 5 years (75 Iron deficiency anemic children and 75 healthy children). Children were selected from 4 Integrated Child Development Centres (ICDC) located near our tertiary care hospital, Madurai, India. This study was done over a period of 12 months (May 2012 – April 2013). Institutional Ethical Committee clearance was obtained before starting the study. Informed consent was obtained from parents of the children participating in our study. Demographic details and anthropometric measurements of these children were taken and examined by the paediatrician. Children with acute infections, chronic diseases involving cardiac, respiratory, gastrointestinal and CNS, chronic or congenital anemia, delayed neuromotor development, history of preterm, neonatal asphyxia, convulsion, or hyperbilirubinemia and children receiving iron therapy during the past 12 months, malnutrition were not included in the study.

Blood samples were collected from all children and complete haematological evaluation was done. Complete blood count, RBC indices, serum iron and serum ferritin were done. Following this, anemic children were dewormed with albendazole and started on iron ascorbate. Healthy children were given placebo. Blood investigations were repeated at 3 months, 6 months and 12 months. Children were subjected to developmental evaluation using Binet Kamat Scale of Intelligence at 0, 3, 6 and 12 months in both the groups. Their Cognitive function and IQ was recorded and noted as Base line values. Cognitive Function analysed with Binet Kamat scale of Intelligence were language, memory, thinking, reasoning, motor and social functions. The IQ was calculated as (mental age/chronological age) x 100. IQ grading was done as shown in table 1.

IQ GRADING	MENTAL IQ
Profound	<20
Severe	20-36
Moderate	37-52
Mild	53-67
Borderline	68-89
Average	90-110
Above average	110-120
Superior	120-130
Very superior	>130

Table 1: Grading of Mental Intelligent Quotient

The statistical analysis was performed by STATA 11.1 (Stata corp, college station TX USA). The continuous variables of age, Hb, height and weight was described as mean and standard deviation. The categorical variables of gender, cognitive functions were described as frequency and percentage. To find the significance of cognitive function improvement from baseline to 3 months, 6months and 12 month, Mcnemar test was used. Paired t-test was used for Hb values to find the significant difference. $P<0.05$ was considered as statistically significant.

III. RESULTS

We included a total of 150 children (75 anemic and 75 healthy). The distribution of male and female sex ratio was similar between cases and controls group. The mean age, mean height and mean weight of children with and without anemia are given in table 2. The most common presenting symptom in children with anemia was easy fatiguability and poor physical activity which was seen in 60%.

	CASES	CONTROLS
Male	43 (57.3%)	42 (56%)
Female	32 (42.7%)	33 (44%)
Mean Age in years (Mean ± SD)	4.04 ± 0.51	3.91 ± 0.36
Mean Height in cms (Mean ± SD)	100.93 ± 2.78	100.28 ± 1.73
Mean Weight in kg (Mean ± SD)	13.92 ±1.27	13.67 ± 0.72

Table 2: Demographic details of Children

There were significant differences in baseline haemoglobin, serum iron, serum ferritin levels between cases and control groups (p value <0.01). The values were on the higher side in control group (table 3). Development assessment using Binet scale of intelligence showed significant abnormalities during initial assessment in language, memory, thinking, reasoning, motor and social functions between cases and control groups (p<0.01) (table 4). There was a significant difference in intelligent quotient (IQ) between the two groups.

	CASES	CONTROLS
Hemoglobin in g/dl (Mean ± SD)	8.7 ± 0.41	12.8 ± 0.96
Hematocrit in % (Mean ± SD)	27.2 ± 1.9	37.1 ± 2.01
Mean Corpuscular Volume in fL (Mean ± SD)	62.25 ± 4.61	78.38 ± 4.21
Mean Corpuscular Hemoglobin in pg (Mean ± SD)	22.52 ± 3.11	28.12 ± 2.12
Red cell distribution width in % (Mean ± SD)	16.81 ± 1.64	14.18 ± 0.33
Serum Iron in µg/dl (Mean ± SD)	31.73 ± 18.84	65.70 ± 11.10
Serum ferritin in µg/dl (Mean ± SD)	11.41 ± 5.62	35.74 ± 9.11

Table 3: Baseline values of RBC indices, serum iron and serum ferritin

Anemic children were started on treatment with iron and were followed up at 3 months, 6 months and 12 months. Hemoglobin levels improved significantly after iron treatment in anemic children at all intervals compared to baseline. Cognitive functions such as language, memory, thinking and reasoning showed significant improvement in anemic children following treatment with iron in all intervals compared to baseline (table 4). Motor and social functions showed no significant improvement even after initiation of iron therapy at the end of 12 months follow up. Intelligent quotient improved significantly after iron therapy in anemic children when compared to baseline values.

	Baseline	3 months	6 months	12 months	p value
Hb (g/dl) Cases Controls	8.7 ± 0.41 12.8 ± 0.96	11.10 ± 0.35 12.82 ± 0.69	12.61 ± 0.59 12.97 ± 0.65	13.11±0.78 13.25 ± 0.48	**<0.001**
Language Cases – Pass Fail Controls – Pass Fail	48 (65%) 27 (35%) 67 (89%) 8 (11%)	64 (85%) 11 (15%) 70 (93%) 5 (7%)	65 (87%) 10 (13%) 67 (89%) 8 (11%)	67 (89%) 8 (11%) 67 (89%) 8 (11%)	**<0.01** 1.000
Memory Cases – Pass Fail Controls – Pass Fail	2 (3%) 73 (97%) 39 (52%) 36 (48%)	47 (63%) 28 (37%) 54 (72%) 21 (28%)	46 (61%) 29 (39%) 57 (76%) 18 (24%)	51 (68%) 24 (32%) 49 (65%) 26 (35%)	**<0.001** 0.08

Thinking Cases – Pass Fail Controls – Pass Fail	21 (28%) 54 (72%) 48 (64%) 27 (36%)	62 (83%) 13 (17%) 60 (80%) 15 (20%)	67 (89%) 8 (11%) 64 (85%) 11 (15%)	65 (87%) 10 (13%) 75(100%) 0	**<0.001** **<0.001**
Reasoning Cases – Pass Fail Controls – Pass Fail	34 (45%) 41 (55%) 42 (56%) 33 (44%)	55 (73%) 20 (27%) 51 (68%) 24 (32%)	53 (71%) 22 (29%) 47 (63%) 28 (37%)	50 (67%) 25 (33%) 44 (59%) 31 (41%)	**0.005** 0.855
Motor Cases – Pass Fail Controls – Pass Fail	62 (83%) 13 (17%) 40 (53%) 35 (47%)	64 (85%) 11 (15%) 51 (68%) 24 (32%)	68 (91%) 7 (9%) 57 (76%) 18 (24%)	64 (85%) 11 (15%) 75 (100%) 0	0.669 <0.001
Social Cases – Pass Fail Controls – Pass Fail	39 (52%) 36 (48%) 32 (43%) 43 (57%)	54 (72%) 21 (28%) 48 (64%) 27 (36%)	46 (61%) 29 (39%) 45 (60%) 30 (40%)	42 (56%) 33 (44%) 35(44%) 40 (56%)	0.631 0.736
IQ Evaluation Cases– Borderline Average Control-Borderline Average	70 (93%) 5 (7%) 3 (4%) 72 (96%)	1 (1%) 74 (99%) 5 (7%) 70 (93%)	2 (3%) 73 (97%) 1 (1%) 74 (99%)	2 (3%) 73 (97%) 1 (1%) 74 (99%)	**<0.001** 0.500

Table 4: Development Assessment using Binet Scale – Comparison

IV. DISCUSSION

This was a prospective case control study done in 150 children (75 anemic and 75 health) from four integrated child developing centres. This study was conducted to show the long term effects of iron therapy on cognitive function and psychomotor development in preschool anemic children. We observed that iron therapy showed significant improvement on cognitive functions such as language, memory, thinking & reasoning in preschool anemic children over long term follow up (p value <0.01). Iron therapy had no significant effects on motor & social functions.

Literature have shown that iron deficiency anemia during infancy is associated with impaired psychomotor development. Various studies have stressed the significance of protecting the growing brain from the ill-effects of iron deficiency (10, 11). Children suffering from chronic iron deficiency have had lower scores on developmental scales for mental and motor functioning. These children are at increased risk for having learning difficulties and socioemotional disturbances (12, 13).

Our study reported that there were significant abnormalities during initial assessment in language, memory, thinking, reasoning, motor and social functions in anemic children compared to healthy children by Binet scale of intelligence. This was consistent with other studies done by E Pala et al (14) who showed 67.3% of children with iron deficiency anemia had abnormal developmental assessment. They also found delay in personal/social, fine motorand language development skills. Similar findings were observed in studies done by Seshadri S et al (15), Bruner AB et al (16).

In our study, the anemic children were treated with iron and followed up at 3 months, 6 months and 12 months. They were subjected to Binet scale of intelligence during these intervals. The children who were treated with iron showed significant improvement in language, memory, thinking, reasoning and intelligence quotient

(IQ) when compared to children treated with placebo. The findings were similar to study conducted by Martin Falkingham et al who had conducted RCT on whether iron supplementation improved cognitive domains: concentration, intelligence, memory, psychomotor skills and scholastic achievement in children. They concluded that iron supplementation improved attention, concentration and IQ. There was no significant improvement in motor and social functions at the end of 12 months follow up. This finding was in correlation with a study done by Tal Shafir et al (17) who conducted study on the Effects of iron deficiency in infancy on patterns of motor development over time. Their study shows that lower motor scores in children did not improve over time despite iron therapy that corrected IDA. Similarly, another study done by Lena hulthe et al showed that nutritional iron replacement readily corrects haematological iron status in iron deficient children but behavioural problems persist for several months or years.

Although we have followed up children for a long period, we do have certain limitations. The main limitation is the sample size and we have not included children with iron deficiency with normal haemoglobin values. Further studies are required to demonstrate a definite role of iron deficiency in psychomotor impairment.

V. CONCLUSION

Early identification of iron deficiency anemia in pre-school children and initiation of treatment as early as possible will result in good cognition in these children.

Conflict of Interest: NIL
Funding: NIL

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