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## Original Article

# Iron deficiency anemia in children with cyanotic congenital heart disease and effect on cyanotic spells

Maj Sweta Mukherjee<sup>a,\*</sup>, Maj Gen Mukti Sharma<sup>b</sup>, Col Amit Devgan<sup>c</sup>, Brig S.K. Jatana, (Retd)<sup>d</sup>

<sup>a</sup> Graded Specialist (Paediatrics), Command Hospital (Eastern Command), Kolkata, India

<sup>b</sup> MG Med, HQ Western Command, India

<sup>c</sup> Associate Professor (Paediatrics), Armed Forces Medical College, Pune 40, India

<sup>d</sup> Professor (Pediatrics), Melaka Manipal Medical College, Malaysia

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## ABSTRACT

**Background:** Iron deficiency anemia (IDA) in cyanotic congenital heart disease (CCHD) and its association with cyanotic spells has been documented in literature. However, Indian data especially in the pediatric age group is scarce. This study was conducted to find out the prevalence of IDA in this population.

**Methods:** An observational study was conducted in a tertiary care hospital. Children with CCHD in the age group of birth–12 years were included in the study. Hematological parameters of these patients were determined and compared. An assessment of the incidence of cyanotic spells in the iron-deficient and iron non-deficient children was also done. Data analysis was done using Fischer's exact test.

**Results:** The prevalence of IDA was 47.06% in the study population. The study also showed that hemoglobin and hematocrit levels were paradoxically higher in the iron-deficient group as compared to the non-deficient, though the iron studies revealed the iron deficiency. The incidence of cyanotic spells was higher in the iron-deficient group. The mean corpuscular volume (MCV), red cell distribution width (RDW), serum ferritin, serum iron, total iron binding capacity (TIBC), and transferrin saturation (TS) values were the parameters, which were found to be statistically significant to differentiate the study groups.

**Conclusion:** The prevalence of IDA in children with CCHD was found to be high. Iron-deficient group had an increased frequency of cyanotic spells as compared to the non-deficient group, which was statistically significant.

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\* Corresponding author.

E-mail address: [sonai24@yahoo.com](mailto:sonai24@yahoo.com) (S. Mukherjee).

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## Introduction

Cyanotic congenital heart disease (CCHD) is congenital heart defect with right to left shunting of desaturated blood. This results in decreased oxygen saturation in the systemic circulation which acts as a trigger for increase in erythropoietin production and secondary erythropoiesis in an effort to maintain tissue oxygenation.<sup>1</sup> The resultant polycythemia and hyperviscosity manifests clinically as thromboembolic events in the children with CCHD.<sup>1,2</sup> Iron deficiency anemia (IDA) is commonly encountered in children of CCHD. IDA aggravates hyperviscosity symptoms due to the presence of microcytic erythrocytes not amenable to deformation in the microcirculation. Thus, presence of IDA in these children further increases their chances of morbidity in the form of cerebrovascular events and cyanotic spells.<sup>3</sup> Polycythemia causes hemoglobin and hematocrit to rise and the otherwise normal values for age are unable to reflect the iron-deficient status of these children.

This study is an attempt to look at the prevalence of iron deficiency in Indian children with CCHD and to find out the prevalence of cyanotic spells in the subsets of iron-deficient and iron non-deficient children with CCHD.

## Material and methods

The study was an observational study conducted in pediatric OPD of a tertiary care center in Western India over 18 months. Informed consent from parents and institutional ethical committee clearance was obtained.

### Inclusion criteria

All children with CCHD were diagnosed on 2D-Echocardiography.

### Exclusion criteria

The children were excluded if they had undergone definitive surgery, received iron supplements in the previous three months, had systemic involvement to explain the cause of anemia e.g. chronic kidney disease, hemolytic anaemia. A total of 51 children were included in study.

The demographic profile, clinical data including frequency of cyanotic spells and the results from 2-D Echocardiography were chronicled. Thereafter, these children underwent complete blood count including red blood cell indices and reticulocyte count and serum iron studies including serum ferritin, total iron binding capacity (TIBC) and transferrin saturation. Based on Serum Ferritin levels the children were divided into iron deficient and non-deficient group. IDA was diagnosed by a serum ferritin concentration of less than 12 ng/mL in children less than 5 years and 15 ng/mL in children more than 5 years and 30 ng/mL in children with infection.<sup>4-7</sup>

### Sample collection and estimation methods

Two ml of blood was collected in an EDTA vacutainer for CBC, red cell indices and PBS and the sample was tested within four

hours of collection. The CBC and red cell indices were done on Beckman Coulter five point differential automated hematology analyzer. The values for Hemoglobin (Hb), Mean Corpuscular Volume (MCV), and Total Iron-Binding Capacity (TIBC) are directly derived and rest were calculated. 3 ml of blood was taken in sterile vacutainer for serum iron studies and the serum separated at room temperature. The sample was preserved at  $-10^{\circ}\text{C}$  till it was run. Serum ferritin was done by ELISA by the Bio Rad ELISA reader model 680. Serum Iron was done by Bathophenanthroline method and the transferrin saturation (TS) was calculated.

## Statistics

The data was recorded in a predecided format. This was fed into an excel sheet by the authors and verified by a co-author. The data was analysed using SPSS. The Fischer's exact test was used to find the various associations among the cases and a  $p$ -value of  $\leq 0.05$  was considered statistically significant.

## Results

Fifty one children participated in the study with mean age of 4 years (Range 3 months–9 yrs). These included thirty four male (66.67%). The demographic details have been highlighted in the table (Table 1). Thirty eight of fifty one children had tetralogy of Fallot.

Twenty four of fifty one children (47.06%) were iron deficient, 95% CI [34.05, 60.48] and 52.94% were non-deficient, 95% CI [39.52, 65.95]. Seven out of fifty-one children (13.72%) had a history of cyanotic spells, 95% CI [6.81, 25.72]. There was a significant association between iron deficiency and cyanotic spells ( $p = 0.042$ ) (Table 2). The iron deficient group had a higher prevalence (12%) of cyanotic spells, 95% CI [12.00, 44.90] as compared to the non-deficient group (3.7%), 95% CI [0.66, 18.28].

The hematological parameters of the iron-deficient and non-deficient groups were compared. The Hb and hematocrit were higher in the iron-deficient group as compared to the non-iron deficient group. The mean serum ferritin was 7.63 ng/mL (SD 3.4) in the iron-deficient group as compared to 33.53 ng/mL (SD 10.51) in non-iron deficient group. The serum iron and TS were lower and the TIBC higher in the iron-deficient group. The group with cyanotic spells and the group with no cyanotic spells were compared. Among the various haematological parameters MCV, RDW, Serum Ferritin, TIBC, TS and Serum Iron were detected to be significantly associated with the incidence of cyanotic spells. The mean serum ferritin in

**Table 1 – Age-wise distribution of the study population.**

Age	No of cases	Percent
Birth–6 months	16	31.37
6 months–1 year	15	29.41
1 year–6 years	18	35.29
6 years–12 years	2	3.92

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