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Reevaluation of the utility of mean cell hemoglobin (MCH) screening in infants for iron deficiency

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Abstract. *Iron deficiency (ID) at the stage of latent deficiency (LID) or frank anemia (IDA) is still common in pediatric practice. We have assessed the prevalence of LID and IDA in an infant population with an age range of 9-11 months, in Paris. Red cell indices, hemoglobin level, serum iron, transferrin saturation and serum ferritin levels were assayed. There was considerable prevalence of ID as 82% of the children exhibited low levels in one of the above parameters. We found low mean cell hemoglobin (MCH) to be predictive of LID in one third of cases. Since MCH value is routinely available to the physician, it appears that a close examination of this red cell index should allow for the diagnosis of ID in a large number of children at risk, without the need to resort to more elaborate and expensive laboratory tests.*

Teneur moyenne en hémoglobine et dépistage de la carence martiale chez l'enfant

Résumé. *Latente ou avérée, la carence martiale est encore, en pratique pédiatrique, problème courant. Nous en avons étudié l'incidence dans une population de nourrissons âgés de 9 à 11 mois, vus en région parisienne, en nous aidant des paramètres habituels : hémoglobine et indices érythrocytaires, fer sérique, saturation de la transferrine et ferritine sérique. Cette carence est fréquente : chez 82 % des enfants, la valeur de l'un au moins de ces paramètres est inférieure aux normes. Une teneur moyenne en hémoglobine basse peut dépister un tiers des carences en fer. Ce paramètre érythrocytaire facilement disponible lors de tout bilan biologique pourrait permettre de déceler une carence martiale chez de nombreux enfants sans recours à des bilans plus coûteux.*

Key words : *Iron deficiency — Anemia — Erythrocyte mean cell hemoglobin — Ferritin*

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Even in developed countries prevalence of iron deficiency (ID) in children is still a matter of concern [3, 4]. Measurement of paramaters such as transferrin saturation, serum ferritin and free erythrocyte protoporphyrin have been shown to be most accurate in detecting latent iron deficiency (LID) before overt signs of iron deficiency anemia (IDA), as well as in defining target groups at risk for IDA [7, 12]. However, these biological measurements are rarely performed in routine screening for ID in large populations. On the contrary, hemoglobin level and red cell indices are in most countries performed routinely with complete evaluations. We studied the usefulness of these parameters in detecting ID and found, as others have in adult populations [5, 11], the mean cell hemoglobin (MCH) value was useful in screening for ID in infants.

Subjects and methods

The study was conducted in two different children health care centers (Caisse Primaire Centrale d'Assurance Maladie de la Région Parisienne) located in the North and Southwest of Paris. In such centers, covered by national health insurance parents are invited to bring their 10, 24 or 48 month old children for a free medical check-up. All 9-11 month children seen during a 4 month period were entered upon study provided they had never taken supplemental iron, and were not found to be either hetero or homozygote for hemoglobinopathies and/or β thalassemia.

A total of 389 infants were entered in the study of whom 232 (60%) were reevaluated for red cell indices one year later at

approximately 2 years of age. During the visit to the health center, the cultural and socioeconomic background of the family, the course of the pregnancy and the child's diet and growth since birth were established by interview of the parents. The clinical status of the infant was evaluated by routine physical examination. The hemoglobin (Hb) and red blood cell (RBC) indices were measured by electronic counters (Coulter S+ and S+2) which were regularly standardized (Etalonorme, Laboratoire National de la Santé) and showed good stability of RBC indices measurements. Iron total binding capacity, transferrin saturation (TS) and serum iron (SI) were determined by the betaphenantroline technique. Serum ferritin (SF) was measured by radioimmuno assay (Clinical Assay Kit from Abbott) with control standards (10-100 µg/l) obtained from human liver ferritin and human sera assayed before all measurements. Normal ranges were established in 60 infants aged 10 months, and another 76 aged 24 months who had normal values for Hb, MCV, MCH, SI and TS, and 80% in each group were found to have FS value $\geq$12 µg/l.

Statistical studies of the data included chi 2 test and variance analysis.

Diagnostic criteria. Five parameters were studied as diagnostic criteria : infants with hemoglobin values less than 11 g/dl were considered anemic. Diagnosis of LID in non anemic children was based upon reduced values for any of the 4 other parameters: MCV (<74 fl); TS (<16%); SI (<10 µM/l), and SF (<12 µg/l) [2, 7, 10].

Results

Prevalence of iron deficiency

In the group of infants studied, iron deficiency appeared common. Anemia was diagnosed in 87 of 389 examined infants (22%), and LID (defined as decreased value for any of MCV, TS, SI and SF) with normal hemoglobin values was seen in 234 of 389 infants (60%). Only 68 infants (18%) were found to be normal by hemoglobin values as well as MCV, TS, SI and SF values. Thus, in our group of infants with a mean age of 10 months a vast majority appeared to have either anemia or latent iron deficiency (82%). Reevaluation of 232 of 389 infants 12 months later revealed that 9% were anemic, and 14% exhibited low MCV. Twenty-two percent of the children who were initially identified as anemic were still anemic one year later while anemia developed in only 6% of the children who were not anemic at initial screening.

Utility of MCH value in diagnosis of iron deficiency

The distribution of MCH in the two different age groups is shown in Fig. 1. The mean MCH for 68 infants with normal iron status at initial screening was 25.7±1.2 pg (Table 1). In contrast the mean MCH for 87 anemic children was decreased at 23.0±2.0 pg. The MCH value for infants with latent iron deficiency was intermediate at 24.9±1.6 pg. Moreover the mean MCH values for infants who exhibited reduced values for 3 or 4 of laboratory parameters were lower than that of infants with reduced values for only 1 or 2 parameters (24.0±1.8 VS 25.2±1.5 pg). Thus the MCH value appears to accurate by reflect the iron status in these infants and is able to discriminate between groups of normal infants and those with anemia or latent iron deficiency as diagnosed by the most established criteria. By chi square test we calculated the MCH values that discriminate iron deficient from normal patients by choosing a threshold for each of the biological parameters (Hb, MCV, SI, TS and SF). In the 10 month-old group, anemic and non anemic children could be discriminated by a MCH value of 22 pg. Parameters other than Hb were assessed and showed the following : (1) SF values exhibited a large scatter that did not allow for a discriminating threshold of MCH. The MCH mean value in 10 month old infants with SF values of from 12

Table 1. Mean MCH values (pg) in the 10 month-old group of 389 children according to the iron status (LID: latent iron deficiency)

Normal (n:68)		25.7 ± 1.2	
LID (n:234)	1 or 2 criteria (n: 178)	25.2 ± 1.5	24.9 ± 1.6
	3 or 4 criteria (n:56)	24.0 ± 1.8	
Anemic (n:87)		23.0 ± 2.0	

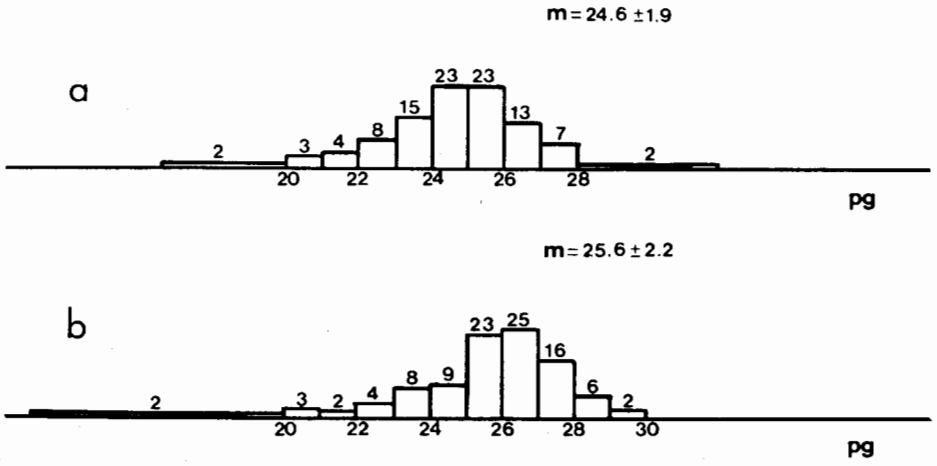

Fig. 1 a, b. Distribution of MCH values in the two different age groups. **a** 9-11 months; **b** 23-25 months

to 20 µg/l was 24.6±1.6 pg (19.9-27.9). However the scatter disappeared with age and, 1 year later, the discriminatory threshold was 23 pg. (2) In contrast the threshold of 25 pg could discriminate among the 232 LID children wich normal of low values for either MCV, SI or TS. (3) When a threshold of 24 pg was tested, it detected 27% of the children with 1 to 4 criteria of LID. (4) Finally when none of the RBC indices, but only SI, TS and SF, were taken into account for defining LID, MCH appeared to be a more accurate parameter than MCV for the diagnosis of LID, showing low values for 17% of the cases (VS 10% for MCV) when 1 or 2 parameters were present, and in 26% (VS 15%) for 3 parameters.

MCH values below 22 pg are indicative of IDA, and values ranging from 22 to 25 pg are indicative of LID.

Discussion

Our finding of a high prevalence of iron deficiency anemia and latent iron deficiency in a large urban population of infants confirms other recent studies which have also shown iron deficiency to be common amongst pregnant women and infants in France, especially in the immigrant population [4, 13]. It should be emphasized that over half of the urban population we evaluated were not of French or Caucasian origin. The socioeconomic background as well as the nutritional habits of the group we have studied may in part account for the high incidence of iron deficiency. The persistence of iron deficiency in the same infants one year after initial evaluation is however disquieting as the results of the tests had been mailed to the parents and their physicians. This in part, may result from the fact that most physicians are unaware of the non hematologic consequences of iron deficiency such as immune suppression [1] or impaired behavioral development [9] and, as such, do not treat iron deficiency before the onset of overt anemia. An important aspect of the present study is our finding that MCH may serve as an effective tool for early diagnosis of iron deficiency. Although it has previously been shown that low MCH is closely related to ID, and that MCH values begin to increase early after initiation of iron treatment [8, 11], the usefulness of this red cell index has not been adequately appreciated in children. While SF values have been shown to be an inaccurate reflection of iron stores in infants [6], our present study shows that MCH is a better indicator of LID than SF level in 9-11 month-old infants. The normal range bound in our study had a considerably lower minimal value when compared to previous works: Dallman et al [2] in 12-24 month non ID children found the 50th percentile to be 27.4 pg and the 5th percentile 22 pg, while in our non ID group those values were respectively 25.8 and 23.2 pg. Saarinen et al [10] for 12 month-old children found the normal mean value to be 26.8±0.2 pg (versus 25.7±1.2 in our normal iron status group). It should be stressed, however, that the former authors excluded a large number of their population sample to definitely rule out ID and the latter studied MCH distribution after iron treatment.

The large limit of the MCH threshold has to be accurately established, as MCH appears to be a sensitive index for detecting an appreciable proportion of LID based only upon automated hematology counts.

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