RETROSPECTIVE STUDY ON THE ASSOCIATION OF IRON DEFICIENCY ANEMIA WITH ABNORMAL NEUROMOTOR DEVELOPMENT

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Abstract: *Iron deficiency is the most common deficiency in macronutrients worldwide. Nutritional anemia is associated with altered psychomotor development, coordination, learning ability, spatial memory, selective attention and an increased incidence of psychiatric pathology. We performed a retrospective study on 783 patients admitted with a diagnosis of psychomotor development disorder in Sibiu Pediatric Hospital until 2016 for which we observed the corpuscular indices (MCV, MCH and MCHC) and blood iron levels. The objective was to determine if iron deficiency anemia is associated with psychomotor development delay. Our results confirm the association between nutritional anemia and the delay in psychomotor acquisitions and we recommend the integration of monitoring the nutritional status in the evaluation protocol of patients with a development disorder. Correcting deficiencies, especially of iron deficiency anemia could limit or improve neurocognitive impairment. Patients with severe disorders of psychomotor development may be exposed to iron deficiency anemia due to eating difficulties or food peculiarities.*

INTRODUCTION

Iron deficiency anemia is a public health problem if we talk about the 2 million persons who suffer from anemia worldwide and that it affects half the children with ages between 6 months to 5 years in developing countries.(1) Iron deficiency is the most common deficiency in macronutrients worldwide. During development there are three critical moments for the installation of iron deficiency, namely: the neonatal period, infancy and adolescence. In each of these moments, iron deficiency is associated with reduced cerebral performance. Reduction of brain performance is due both to iron deficiency and iron deficiency anemia.

The mechanisms are complex, iron deficiency causing morphological, physiological, biochemical changes and altered neuronal metabolism by interfering with the synthesis of neurotransmitters. The results of these actions are complex, so psychomotor development, coordination, learning ability, spatial memory and selective attention are affected. Language disorders and psychiatric manifestations (manifestations of autism and ADHD) are also associated with iron deficiency.(1-11)

PURPOSE

The objective was to determine if iron deficiency anemia is associated with psychomotor development delay.

MATERIALS AND METHODS

We conducted a retrospective study which included 783 patients admitted in Sibiu Pediatric Hospital until 2016 with a diagnosis of psychomotor development disorder, and with cognitive and/or motor purchases delay. We enrolled only the ones with a development quotient (a ratio between the chronological age and the age development) and IQ (intelligence quotient) below 70 and with the hemoglobin level lower than the age specific minimum. We excluded the patients who only presented dyslalia type language disorders. The parameters of interest were serum iron and erythrocyte indices: hemogoblin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and (mean corpuscular hemoglobin concentration (MCHC) values varying by age and gender.(12)

The data came from the Hospital data base and were statistically processed in the Research and Telemedicine Centre for Neurological Diseases in Children.

The statistical interpretation was conducted using SPSS version 20 and Microsoft Excel 2013. Quantitative data were expressed as frequency and percentage using standard deviations or averages. Blood iron levels and corpuscular indices distribution was analysed based using histograms. . For each parameter used in assessing anemia (iron, corpuscular indices) we used values distribution curves. For correlations between age, various corpuscular indices and blood iron levels we applied Pearson correlations quotient.(13,14)

RESULTS

After searching the Hospitals digital library the software generated 783 cases with identified corpuscular indices and only 567 for blood iron levels.

To study the type of anemia associated disorders psychomotor development we used distribution curves for each parameter analysed to define anemia (corpuscular indices).

Thus, in figure no. 1 we represented the Gaussian distribution curve, obtained from the patients diagnosed with impaired psychomotor development MCV values. In the study group we found that the average value of MCV for the study group was 77.42 fl (SD 8.4).

After analysing the MCH and MCHC values for 783 respectively 784 patients we obtained the Gaussian distribution curve that highlights an average value for MCH of 26.82 (SD 4.8) and for MCHC of 34.08 (SD 2.44) (figures no. 1 and 2).

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Figure no. 1. MCV distribution curve for the entire study group (children with psychomotor development disorders)

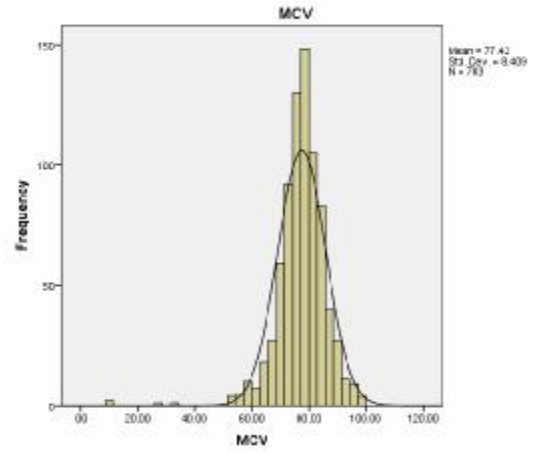


Figure no. 2. Distribution of MCH curve for the entire study group (children with psychomotor development disorders)

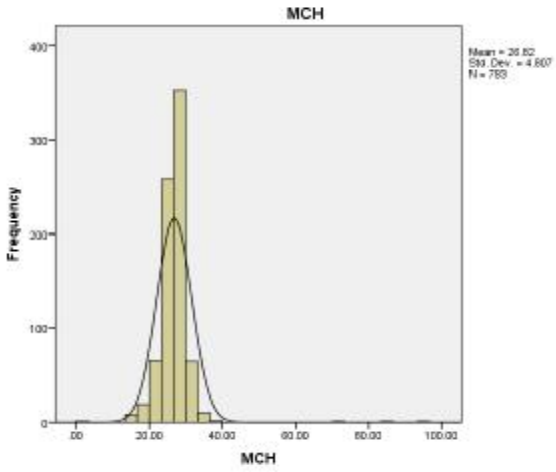
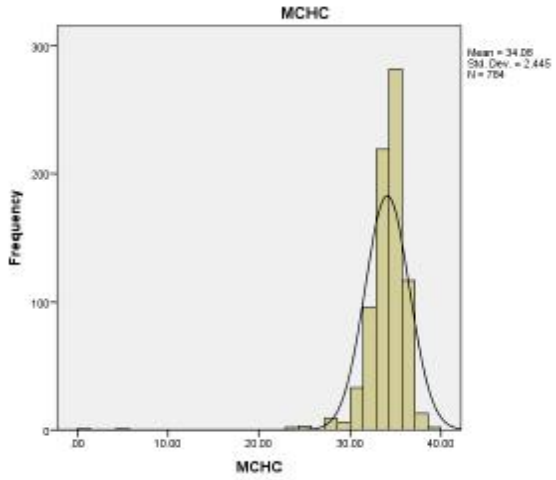
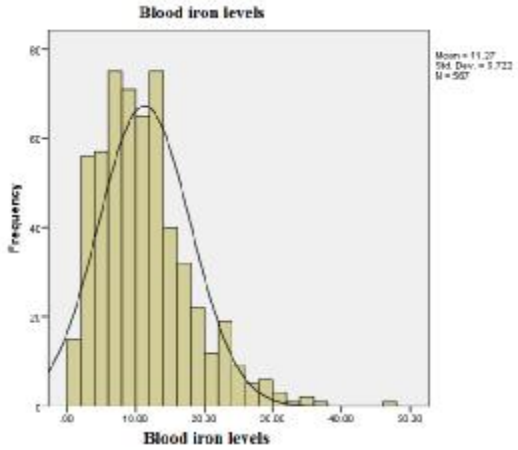


Figure no. 3. MCHC distribution curve for the entire study group (children with psychomotor development disorders)



Blood iron levels ranged between 1 - 47.2 µmols/l with an average of 11.26 µmols/l (SD 6.72) (figure no. 4).

Figure no. 4. Blood iron levels distribution curve for the entire study group (children with psychomotor development disorders)



As shown in table no. 1, using Pearson correlations for: age, MCV, MCH, MCHC we found that age correlates significantly with erythrocyte indices (MCV, MCH) and blood iron levels. Literature data is confirmed regarding patients with neurological conditions (delay in psychomotor acquisitions) age groups that exhibited predilection for iron deficiency anemia.

Also we determined statistically significant associations between MCV and MCH; MCHC and blood iron levels; HEM and CHEM and blood iron levels; and CHEM and blood iron levels, which points towards an etiology of deficiency (iron deficiency) anemia. These findings together with the blood iron deficiency's Gaussian curve shifting to the left tends to an etiology of nutritional (iron deficiency) anemia. But analyzing the distribution curves of erythrocyte indices, we found evidence of isolated cases or hyperchromy, macrocytosis which supports the presence of other types of anemia as well (megaloblastic, thalassemia etc).

Table no. 1. Correlations between age and anemia evaluation parameters (corpuscular indices, blood iron levels)

Correlations

		Age	MCV	MCH	MCHC	Blood iron lvl
Age	Pearson Correlation	1	.319**	.148**	.014	.165**
	Sig. (2-tailed)		.000	.000	.689	.000
	N	830	783	783	784	567
MCV	Pearson Correlation	.319**	1	.179**	.226**	.190**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	783	783	783	783	553
MCH	Pearson Correlation	.148**	.179**	1	.177**	.421**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	783	783	783	783	553
MCHC	Pearson Correlation	.014	.226**	.177**	1	.122**
	Sig. (2-tailed)	.689	.000	.000		.001
	N	784	783	783	784	554
Blood iron level	Pearson Correlation	.165**	.190**	.421**	.122**	1
	Sig. (2-tailed)	.000	.000	.000	.004	
	N	567	553	553	554	567

**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSIONS

The data obtained after our study supports the

association of nutritional anemia with cognitive and mental development disorders. Although our study does not provide details on the extent of brain damage (severity of psychomotor delay) the presence of nutritional deficiencies and various degrees of malnutrition in children with impaired psychomotor development is known. This is due to neurological disorders, in particular the coordination of swallowing, chewing, eating habits especially in patients with mental retardation. Meanwhile, the iron involvement in securing homeostasis, neurotransmission and neuromodulation, energy metabolism and glial myelination is known.(2) Through its action on the dopamine receptors it alters the seizure threshold even interfering with the pathogenic mechanisms of epilepsy or febrile convulsions.(15,16) Our results support the literature involving iron and persisting iron deficiency involved in neuropsychiatric alterations including impaired learning processes, lack of attention, behaviour problems. Also, iron deficiency is associated with depressed immune function (1) and thus with a context of recurrent infection. This might be an explanation for the case of a small number of patients capping transient psychomotor acquisitions.

Correcting iron deficiency should be promoted particularly inside vulnerable groups.

However, a prospective study must be conducted with other parameters that could cause delay in psychomotor procurement (genetic, socio-cultural, chronic diseases) and including the evaluation nutritional status and maternal iron intake, antenatal or postnatal, for predominantly natural fed infants. Studies on groups of preterm children with or without iron deficiency demonstrate the involvement of iron in optimal neurocognitive development. In addition, infants with a maternal history of antepartum anemia associated difficulty in differentiating the maternal voice from foreign voices, which supports the impact of iron on brain structures coordinating the recognition memory function (hippocampus).(3)

In our study we also found cases of macrocytosis that needs further investigation regarding cobalamin deficiency. It is known that severe vitamin B12 deficiency associates with elevated serum methylmalonic acid and homocysteine hiperglicinuric levels and could evolve with hypotonia, growth restriction, metabolic acidosis and other neurological symptoms.(17)

A more extensive evaluation is therefore necessary in the case of patients with severe anemia development and biological deficiencies (iron, folic acid, B12 vitamin).

CONCLUSIONS

Our results confirm the association of anemia deficiency with the delay in psychomotor acquisitions and recommend the monitoring of nutritional status in patients with developmental disorders. Correcting deficiencies, especially of iron deficiency anemia could limit or improve neurocognitive impairment. Patients with severe disorders of psychomotor development may be exposed to iron deficiency anemia due to eating difficulties or peculiarities.

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