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RESEARCH ARTICLE
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BRIDGING THE BRAIN AND BLOOD: THE LINK BETWEEN EEG FINDINGS AND SERUM FERRITIN LEVELS IN PAEDIATRIC FEBRILE SEIZURES.

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Abstract:
Introduction: Febrile seizures and Iron deficiency anaemia are common diseases in developing countries. Iron deficiency is known to cause neurological and behavioural changes, attention and learning deficit. Therefore, this study is performed to find out EEG changes and serum ferritin levels in children with febrile seizures(n=51).
Study design: Cross-sectional study.
Methods: Patients with febrile seizure of age group 6 months to 5 years visiting OPD and admitted under Paediatric Department, KIMSDU Karad were included in this study. EEG was performed using Clarity 16 channel EEG machine under sedation after proper hair wash. Blood samples were collected for estimation of serum ferritin, haemoglobin, MCV, MCH, MCHC levels. Serum ferritin was estimated by using TOSOH AIA 360 machine in department of Biochemistry KIMSDU, Karad. Hb, MCV, MCH, MCHC were estimated using NIHON KOHDEN celtac alpha automated hematology blood analyser in department of Pathology KIMSDU, Karad. EEG and haematological parameters were analysed.
Results: Epileptiform activity in EEG was observed in 31 out of 51 patients (60.8%). Those patients who had Epileptiform activity in EEG had significantly lower Serum Ferritin (p=0.002) and MCV values (p=0.043). No statistically significant difference were observed in Hb, MCH and MCHC in patients with and without epileptiform activity in EEG.
Conclusions: Patients with reduced levels of serum ferritin and MCV showed epileptiform activity in EEG recordings. It is necessary to treat and have regular follow ups in these patients, to find out the persistence of epileptiform activity.

Keywords: Febrile seizures, EEG, Serum Ferritin

Introduction: -

Febrile seizures represent the most prevalent type of seizures in childhood, comprising approximately 2% to 5% of cases in children under 5 years[1]. These seizures typically occur between 6 months and 5 years of age with a body temperature of 38°C (100.4°F) or higher, unrelated to central nervous system infections or metabolic factors, and lacking a history of previous non-febrile seizures[2].
damage, they impose significant emotional, physical, psychological, and mental strain on parents, impacting the family's overall quality of life[3]. The recurrence rate following the initial febrile seizure

episode is approximately 50% in children under 1 year old and 28% in those over 1 year old[4]. Febrile seizures can be categorized as simple or complex, with around 80% being simple seizures lasting less than 6 minutes[5].

In India, approximately 70% of children aged 6 to 60 months experience anaemia, with iron deficiency anaemia (IDA) accounting for over 50% of cases. Interestingly, this coincides with the peak incidence of febrile seizures, occurring between 14 and 18 months of age[6]. A decline in serum ferritin levels, an indicator of iron deficiency, may precede the onset of anaemia. Since iron is crucial for neurotransmitter production, enzyme function, and myelination, its deficiency in children may lower the seizure threshold[7].

As iron deficiency anaemia and febrile seizures are common in children of the same age, it is likely that there is a connection between iron deficiency anaemia and febrile seizures. Therefore, this study aimed to assess the iron profile in children with febrile seizures and explore potential associations between serum ferritin and seizure occurrence.

Methods: Patients with febrile seizure of age group 6 months to 5 years visiting OPD and admitted under Paediatric department, KIMS Karad were included in this study (n=51).

Inclusion criteria: - Known cases of febrile seizures of age group 6 months to 5 years presenting with febrile seizures.

Exclusion criteria: - Children without any history of seizures of age group 6 months to 5 years.
Children with any chronic disease.
Children on any iron supplementation.

EEG was performed using Clarity 16 channel EEG machine. Patients were advised to have a proper hair wash. EEG was recorded under sedation. Blood samples were collected by venipuncture for estimation of serum ferritin, haemoglobin, MCV, MCH, MCHC levels. Haemoglobin, MCV, MCH, MCHC values were analysed by NIHON KOHDEN celtac alpha automated haematology blood-analyser in Department of Pathology. Serum Ferritin was analysed by TOSOH AIA 360 machine in Department of Biochemistry, KIMS Karad. EEG and haematological parameters were analysed.

Result:-

Table 1: Distribution of study samples based on EEG findings:-

	Frequency (n)	Percentage (%)
EEG absent	20	39.2%
EEG present	31	60.8%
Total	51	100%

Table No. 2: Comparison of mean biochemical findings based on EEG findings using Mann Whitney 'U' test:-

Test	EEG Normal	EEG Abnormal	Mann Whitney U test	P value Significance
Serum Ferritin (ng/ml)	41.5 (40.5)	16.36 (13.87)	U = 80.0	p =0.002*

Table No. 3: Comparison of mean biochemical findings based on EEG findings using unpaired t test:-

Tests	EEG Normal	EEG Abnormal	Unpaired t test	P value, Significance
Hb(gm/dl)	10.82 (1.5)	10.66 (1.62)	t = 0.347	p =0.730
MCV(fl)	76.98 (9.84)	70.1 (12.44)	t =2.082	p =0.043*
MCH(pg)	26.32 (3.52)	24.58 (6.68)	t =1.070	p =0.290 (NS)
MCHC(gm/dl)	32.42 (1.75)	31.78 (1.75)	t = 1.271	p =0.210 (NS)

Epileptiform activity in EEG was observed in 31 out of 51 patients (60.8%). Those patients who had Epileptiform activity in EEG had significantly lower Serum Ferritin (p=0.002) and MCV values (p=0.043). No statistically significant difference was observed in Hb, MCH and MCHC in patients with and without epileptiform activity in EEG.

Discussion:

This study investigates the association between EEG findings and serum ferritin levels in children with febrile seizures (FS), highlighting significant insights into the role of iron deficiency in febrile seizures. The study found that children with febrile seizures who exhibited epileptiform activity on EEG had significantly lower serum ferritin levels and mean corpuscular volume (MCV) compared to those without epileptiform activity. This finding aligns with previous research by Jang et al. (2019), which also reported decreased serum ferritin levels in children with febrile seizures[13].

The critical role of iron in neurodevelopment is well-documented. Iron is essential for myelination, neurotransmitter synthesis, and overall brain function. A deficiency in iron can impair these processes, potentially lowering the seizure threshold. The observed correlation between low serum ferritin levels and the presence of epileptiform activity in EEG underscores the importance of adequate iron levels for maintaining normal neurological function and potentially preventing febrile seizures.

Contrary to Gencer et al. (2016), who found no significant differences in hemoglobin (Hb), MCV, and red cell distribution width (RDW) in children with febrile seizures, this study demonstrates a significant reduction in serum ferritin and MCV in those with epileptiform activity[14]. The discrepancies between studies could be attributed to differences in study design, population demographics, and criteria for FS classification.

The finding that Hb, mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were not significantly different between the groups suggests that serum

ferritin may be a more sensitive indicator of iron status in the context of febrile seizures. Ferritin, being an acute-phase reactant, could reflect early iron deficiency even before changes in Hb and other red blood cell indices become apparent.

Regular monitoring and management of iron deficiency in children prone to FS are essential. Early detection and treatment of low ferritin levels might help reduce the frequency and severity of seizures. Moreover, this study emphasizes the need for further research to explore the long-term outcomes of children with febrile seizures and low serum ferritin levels, particularly regarding neurodevelopmental and cognitive functions.

Conclusion: -

The study highlights a significant association between low serum ferritin levels and the presence of epileptiform activity in EEG among children with febrile seizures. This finding suggests that iron deficiency may play a crucial role in the pathophysiology of febrile seizures, potentially lowering the seizure threshold through its impact on neurodevelopment and brain function.

Given the high prevalence of iron deficiency anaemia in the paediatric population, particularly in regions like India, routine screening for iron status in children with febrile seizures is warranted. Early intervention with iron supplementation could mitigate the risk of recurrent seizures and improve overall neurological health.

Future research should focus on longitudinal studies to confirm these findings and elucidate the mechanisms linking iron deficiency to febrile seizures. Understanding the precise role of iron in seizure susceptibility could lead to targeted therapeutic strategies, ultimately improving the quality of life for affected children and their families.

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