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Effects of hypercaloric enteral intervention on malnutrition patients with a history of febrile seizure before the age of six

Hiperkalorik enteral müdahalenin altı yaşından önce ateşli nöbet geçmişi olan malnütrisyon hastalarına etkileri

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Abstract

Aim: Febrile seizure is the most prevalent (~5%) convulsion in children between 3 to 60 months of age and has been related to iron deficiency. Thus, when it is combined with malnutrition, it may increase negative outcomes. In this study, we present the effects of hypercaloric (1.5 kcal/mL) nutritional intervention on undernourished children with a history of febrile convulsions prior to the age of 6.

Methods: A cohort of 44 patients between ages 1-6 years with a history of a febrile seizure was included in the study. Hypercaloric nutritional intervention was applied to all patients. Baseline patient records containing anthropometrical and micronutrient measurements were compared with the 3rd month and the 6th month visits. All patient records were retrospectively obtained from Istanbul Research and Training Hospital, İstanbul, Turkey.

Results: There were significant improvements in the z-scores of weight (P=0.002) and body mass index (P<0.001). Approximately 50% of iron and 25-hydroxyvitamin D3 (25D3) deficient patients were cured and their serum concentrations increased significantly (P<0.001 for both). Treatment did not affect iron concentrations in patients without iron deficiency (P=0.074). Normal concentrations of 25D3, folate, and vitamin B12 improved inside the optimal micronutrient ranges without toxicity.

Conclusion: Overall, hypercaloric nutritional intervention abated iron and 25D3 deficiency and significantly improved the z-scores of BMI and weight in malnourished pediatric patients under the age of 6 with a history of febrile seizures without toxicity.

Keywords: Febrile seizure, Malnutrition, Micronutrients, Body mass index, Enteral nutrition

Öz

Amaç: Ateşli nöbet en yaygın olarak 3 ila 60 aylık çocuklarda görülen (~% 5) ve demir eksikliği ile ilişkilendirilen bir konvülsiyondur. Bu nedenle, yetersiz beslenme ateşli nöbetin olumsuz sonuçlarını artırabilir. Bu çalışmada, 6 yaşından önce ateşli konvülsiyon öyküsü olan yetersiz beslenen çocuklarda hiperkalorik (1,5 kcal/mL) beslenme müdahalesinin etkilerini sunulmaktadır.

Yöntemler: Çalışma kohortu ateşli nöbet öyküsü olan 1-6 yaş arası 44 hastadan oluşmakta olup, tüm hastalara hiperkalorik beslenme müdahalesi uygulanmıştır. Hastaların ilk başvuruları sırasında kaydedilen antropometrik değerler ve mikronütrient ölçümleri, 3. ay ve 6. ay vizitleri ile karşılaştırılmıştır. Tüm hasta kayıtları, İstanbul, Türkiye İstanbul Eğitim ve Araştırma Hastanesi'nden geriye dönük olarak alınmıştır.

Bulgular: Müdahale sonrasında ağırlık (P=0,002) ve vücut kitle indeksi (P<0,001) z-skorlarında anlamlı iyileşmeler görülmüştür. Demir ve 25-hidroksivitamin D3 (25D3) eksikliği olan hastaların yaklaşık% 50'si düzelme gösterirken serum konsantrasyonlarında da önemli ölçüde artış gözlemlenmiştir (her ikisi için de P<0,001). Tedavi, demir eksikliği olmayan hastalarda demir konsantrasyonlarını etkilememiştir (P=0,074). 25D3, folat ve vitamin B12 konsantrasyonları normal olan hastalarda, bu mikronütrientler herhangi bir toksisiteye neden olmaksızın optimal aralıklar içinde kalmıştır.

Sonuçlar: Hiperkalorik beslenme müdahalesi herhangi bir toksisiteye neden olmaksızın ateşli nöbet öyküsü olan 6 yaşın altındaki malnütrisyon teşhisi konulan pediatrik hastalarda demir ve 25D3 eksikliğini azaltmıştır ve vücut kitle indeksi ile ağırlık z-skorlarını anlamlı ölçüde düzeltmiştir.

Anahtar kelimeler: Ateşli nöbet, Yetersiz beslenme, Mikronütrientler, Vücut kitle indeksi, Enteral beslenme

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Introduction

Febrile seizures are often seen in children with a fever higher than 38°C, who are older than 3-6 months but younger than 6 years of age. They most frequently occur between the 12th and 18th months. It is the most prevalent neurologic disorder, affecting 2% to 5% of all children between 3 to 60 months of age. Additionally, due to its high (30% to 40%) risk of reoccurrence before the age of five, febrile seizures are one of the most familiar conditions in pediatrics [1].

The brain loses its excitability over time. Thus, the threshold of the developing brain for generating a seizure in children is relatively low when compared to the adult brain. However, the resistance of the developing brain to excitation stress is higher, which makes early age febrile seizures mostly benign [2]. Secretion of pyrogenic cytokines inside the CNS and temperature-dependent ion channels are related to increased neural excitation during high fever [3,4]. Although the exact mechanism is unknown, iron deficiency may play an indirect role in brain excitation during fever by lowering the seizure threshold in the developing brain. Moreover, fever may exacerbate the effects of an iron deficiency [5].

Iron deficiency is significantly related to febrile seizures in numerous studies as children with iron and ferritin deficiencies (<22 ng/dl and <30 ng/ml respectively) have an approximately three-fold increased tendency to develop a febrile seizure compared to children without iron deficiency. Additionally, iron and ferritin deficiencies have been correlated with increased probability of developing a febrile seizure [6]. It has been found that 42.9 of 737 children who were hospitalized by having seizure had iron deficiency [7]. Iron is a valuable element for achieving homeostasis in multiple organs by regulating various cellular physiological events, such as DNA synthesis, respiration, differentiation, energy balance, and growth [8]. In the brain, iron has important roles in neurotransmitter functionality, metabolism, and myelin formation [5].

Nutritional interventions are the primary treatment widely applied in malnutrition of children as well adults. In children, an early intervention against malnutrition is crucial due to the exaggerated effects of malnutrition on metabolism and development directly proportional to time [9]. In this retrospective study, we performed a comparative analysis between baseline and follow-up measurements of anthropometric scores and micronutrient (Iron, vitamin B12, folate, and 25D3) concentrations in the presence of hypercaloric nutritional intervention on malnourished patients having a history of febrile seizure.

Materials and methods

Sample

This study included 44 pediatric outpatients between the ages of 1-6 years with a history of a febrile seizure with at least 1 incidence. Additionally, same patients were classified as malnourished by a physician due to their weight scores being under 10 weight percentiles at the first presentation to the hospital. Our exclusion criteria consisted of having a chronic disease, an infectious disease, and having been prescribed vitamin or mineral supplements. This is a retrospective single-centered study and all patient records were obtained from Istanbul Research and Training Hospital, İstanbul, Turkey. The authors state that the study protocol was approved by the ethics committee of University of Health Sciences, Istanbul Research and Training Hospital, Istanbul on 2/7/2020 at session number 2180.

Observation

The biochemical and anthropometrical effects of hypercaloric (1.5 kcal/mL) enteral nutrition were investigated on a cohort of 44 malnutrition patients who had a febrile seizure history. Our hypercaloric supplement includes 1.5 kcal mL^{-1} of energy, 9% protein, 40% fat, 37.6% carbohydrates, 2% dietary fiber, 64 mg of sodium, 153 mg of potassium, and 84 mg of calcium. The three-layered comparative analysis was conducted by retrospectively obtaining the patient records of measurements taken at the first presentation to the hospital and at the 3^{rd} and 6^{th} months. To assess the effects of the hypercaloric intervention, weight z-scores, height z-scores, and body mass index (BMI) z-scores as well as laboratory findings covering iron, vitamin B12, folate, and 25D3 were compared. Additionally, a more detailed analysis was made by separately assessing the effects of the hypercaloric intervention on patients with and without micronutrient deficiency. Tolerability, indications, contraindications, and compatibility to the treatment of the hypercaloric enteral intervention will later be discussed in the study.

Standardization of weight, height, body mass index scores, and micronutrient reference ranges

Weight, height, and BMI reference values of the population in Turkey were taken from the referred study completed in 2008 [10]. Z-score calculations were obtained via growth references and blood pressure calculation tools indicated in the referred study [11]. Micronutrient reference ranges were as follows: 60-120 ug/dL for iron, 20-100 ng/mL for 25D3, 5-21 ng/mL for folate, and 145-914 pg/mL for vitamin B12.

Ethical Statement

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the ethics committee of University of Health Sciences, Istanbul Research and Training Hospital, Istanbul on 07/02/2020 at session number 2180. The authors state that they have obtained the required informed patient consents regarding the study.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows v20.0 (IBM Corp., Armonk, NY, US). The normality of the data was tested via the Shapiro-Wilk test. Repeated measures of ANOVA followed by Wilks' lambda were utilized as a multivariate test for parametric data. Bonferroni correction with the significance of $P<0.05$ was utilized as a post hoc test during repeated ANOVA tests. Friedman's test was utilized to analyze non-parametric dependent datasets. The level of statistical significance was set at $P<0.05$.

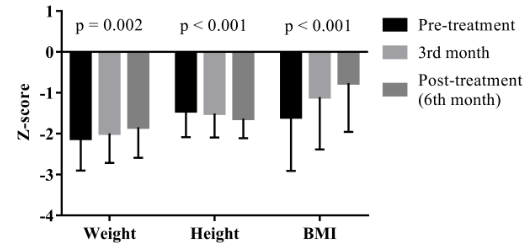
Results

Demographic information of our cohort included in the study is presented in Table 1. Our cohort includes 44 participants between the ages of 1-6 years with the mean age of 3.64 years. It included 14 (31.8%) male and 30 (68.2%) female participants. All patients were intervened with hypercaloric (1.5 kcal/mL) enteral supplement after their first presentation to the hospital.

Detailed information of pre-treatment and post-treatment anthropometrical statuses are given in Table 1. The nutritional intervention yielded significant improvements in weight z-scores and BMI z-scores (*P*=0.002 and *P*<0.001 respectively) (Figure 1). Mean weight z-scores improved from -2.1 (0.79) to -1.91 (0.68) and -1.7 (0.64) at the 3^{rd} and the 6^{th} months of treatment, respectively. Similarly, BMI z-scores improved from -1.53 (1.32) to -1 (1.23) and -0.67 (1.18) at the 3^{rd} and the 6^{th} month of treatment, respectively. On the contrary, height z-scores significantly deteriorated (*P*<0.001) from -1.45 (0.57) to -1.51 (0.53) and -1.6 (0.46) at the 3^{rd} and the 6^{th} month of treatment, respectively (Figure 1).

Detailed information of pre-treatment and post-treatment micronutrient status are presented in Tables 2 and 3. In iron deficient (< 60 ug/dL) patients, there was a significant (*P*<0.001) overall increase (Figure 2a). Mean iron concentrations of iron deficient patients increased from 36.6 (11.67) ug/dL to 46.5 (19.41) ug/dL and 57.3 (26.48) ug/dL at the 3^{rd} and the 6^{th} month of treatment, respectively, thus reducing the number of iron deficient patients from 27 (61.4%) to 22 (50%) and 16 (36.3%). On the contrary, there was no significant difference (*P*=0.074) in iron concentrations of patients without an iron deficiency (60-120 ug/dL). Mean iron concentrations of patients without an iron deficiency were as follows: 83.4 (14.23) ug/dL for baseline, 84.7 (17.93) ug/dL in the 3^{rd} month and 94.1 (38.78) in the 6^{th} month. None of the patients exceeded the 120 ug/dL upper limit for serum iron concentration.

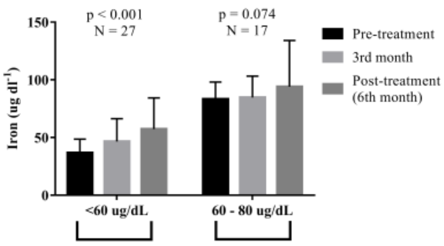
Both 25D3 deficient (<20 ng/mL) and non-25D3 deficient (20-100 ng/mL) patients showed a significant increment (*P*<0.001 and *P*=0.024 respectively) over a duration of 6 months (Figure 2b). Mean 25D3 concentrations of 25D3 deficient patients increased from 14.6 (3.17) ng/mL to 20.3 (5.51) ng/mL and 23.2 (7.51) ng/mL at the 3^{rd} and the 6^{th} months of treatment, respectively. The number of 25D3 deficient patients reduced from 29 (65.9%) to 12 (27.3%) and 10 (22.3%) at the 3^{rd} and the 6^{th} month of treatment, respectively. Mean 25D3 concentrations of patients without 25D3 deficiency were as follows: 26 (6.13) ng/mL at baseline, 26.6 (6.29) ng/mL at the 3^{rd} month and 29.9 (6.85) at the 6^{th} month, and none of the patients exceeded 100 ng/mL upper limit for serum 25D3 concentration.



	Pre-treatment	3rd Month	Post-treatment (6th month)	Post - Pre z-score difference (Improvement / Deterioration
Mean weight z-score (SD)	-2.1 (0.79)	-1.91 (0.68)	-1.7 (0.64)	0.4 (Improvement)
Mean height z-score (SD)	-1.45 (0.57)	-1.51 (0.53)	-1.6 (0.46)	-0.15 (Deterioration)
Mean BMI z-score (SD)	-1.53 (1.32)	-1 (1.23)	-0.67 (1.18)	0.86 (Improvement)

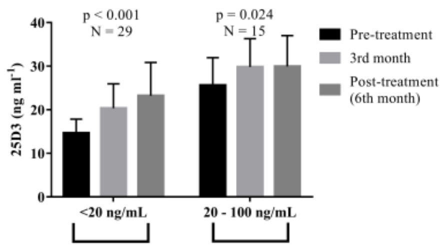
Figure 1: Anthropometrical status of patients at pre-treatment compared with post-treatment. Respective *P*-values were indicated on the graph and mean z-scores of all visits were indicated in the merged table along with the mean difference between pre- and post-treatment.

a) Pre-Post serum iron concentration differences of <60 ul/dL and 60 - 80 ul/dL sub-groups.



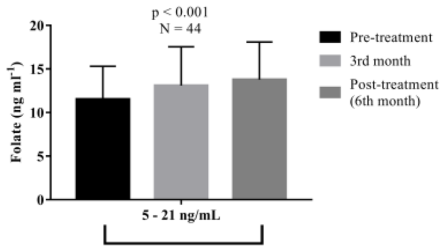
	Pre-treatment	3rd Month	Post-treatment (6th month)	Pre-treatment	3rd Month	Post-treatment (6th month)
Mean iron (ug/dL) (SD)	36.6 (11.67)	46.5 (19.41)	57.3 (26.48)	83.4 (14.23)	84.7 (17.93)	94.1 (38.78)
Iron deficient patient number (%)	27 (61.4%)	22 (50%)	16 (36.3%)	None	None	None

b) Pre-Post serum 25D3 concentration differences of <20 ng/mL and 20 - 100 ng/mL sub-groups.



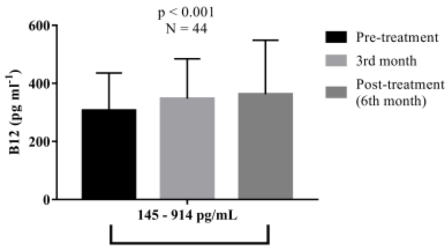
	Pre-treatment	3rd Month	Post-treatment (6th month)	Pre-treatment	3rd Month	Post-treatment (6th month)
Mean 25D3 (ng/mL) (SD)	14.6 (3.17)	20.3 (5.51)	23.2 (7.51)	26 (6.13)	26.6 (6.29)	29.9 (6.85)
25D3 deficient patient number (%)	29 (65.9%)	12 (27.3%)	10 (22.3%)	None	None	None

c) Pre-Post serum folate concentration differences.



	Pre-treatment	3rd Month	Post-treatment (6th month)
Mean folate (ng/mL) (SD)	11.5 (3.82)	13 (8.05)	13.7 (4.38)
Folate deficient patient number (%)	None	None	None

d) Pre-Post serum vitamin B12 concentration differences.



	Pre-treatment	3rd Month	Post-treatment (6th month)
Mean 25D3 (pg/mL) (SD)	313.4 (130.31)	356.6 (137.23)	368.5 (172.81)
Vitamin B12 deficient patient number (%)	None	None	None

Figure 2: Micronutrient status of patients with insufficient and normal concentrations at pre-treatment compared with post-treatment. Respective *P*-values were indicated on the graph and mean z-scores of all visits were indicated in the merged table along with the number of patients with deficiencies at the related visit.

There were not any folate nor vitamin B12 deficient patients at baseline as well as at the post-treatment measurement. However, there was a significant increment (*P*<0.001 for folate and *P*<0.001 for vitamin b12) in both micronutrient concentrations without exceeding their upper limits (>21 ng/mL for folate and >914 pg/mL for vitamin B12) (Figure 2c and 2d respectively). Mean folate concentrations increased from 11.5 (3.82) ng/mL to 13 (8.05) ng/mL and 13.7 (4.38) ng/mL at the 3rd and the 6th months of treatment, respectively, while Vitamin B12 concentrations increased from 313.4 (130.31) pg/mL to 356.6 (137.23) pg/mL and 368.5 (172.81) pg/mL.

In addition, the hypercaloric enteral supplementation was well-tolerated among the majority of our patients (72.9%, n=35). Six patients (12.5%) had distension, 3 patients vomited (6.3%), and 4 patients (8.3%) had not tolerated the nutritional intervention at the 6th month after the initial intervention.

Table 1: Pre-treatment and post-treatment mean anthropometrical z-scores of the patients, mean differences and significances

		Total	Males	Females
Pre-treatment	Mean weight z-score (SD)	-2.1 (0.79)	-2.01 (1.08)	-2.08 (0.60)
	Mean height z-score (SD)	-1.45 (0.57)	-1.43 (0.54)	-1.45 (0.48)
	Mean BMI z-score (SD)	-1.53 (1.32)	-1.19 (0.98)	-1.69 (1.42)
Post-treatment (6th month)	Mean weight z-score (SD)	-1.7 (0.64)	-1.7 (0.71)	-1.8 (0.61)
	Mean height z-score (SD)	-1.6 (0.46)	-1.56 (0.51)	-1.61 (0.44)
	Mean BMI z-score (SD)	-0.67 (1.18)	-0.3 (0.74)	-0.85 (1.30)
Mean difference (post - pre)	Weight z-score	0.4	0.31	0.28
	Height z-score	-0.15	-0.13	-0.16
	BMI z-score	0.86	0.89	0.84
P-values	Weight z-score	0.002 Improvement		
	Height z-score	<0.001 Deterioration		
	BMI z-score	<0.001 Improvement		

BMI: Body mass index, SD: Standard deviation

Table 2: Pre-treatment mean serum micronutrient status of the patients and respective demographic distributions

Serum micronutrient concentrations	Concentration range sub-groups	Mean age (SD) Males Females Total	Number of patients (%) Males Females Total	Mean serum concentration (SD) Males Females Total
Iron	< 60 ug/dL	3.3 (1.47) 3.4 (1.35) 3.4 (1.39)	8 (57.1%) 19 (63.3%) 27 (61.4%)	59.64 (14.57) 37.2 (10.14) 36.6 (11.67)
	60-120 ug/dL	3.6 (1.49) 3.5 (1.01) 3.5 (1.21)	6 (42.9%) 11 (36.6%) 17 (38.6%)	92.3 (7.06) 78.5 (14.76) 83.4 (14.23)
	> 120 ug/dL	None	None	None
25D3	< 20 ng/mL	3.7 (1.56) 4.2 (1.42) 4 (1.48)	9 (64.3%) 20 (45.5%) 29 (65.9%)	14.5 (3.08) 14.7 (3.20) 14.6 (3.17)
	20-100 ng/mL	3.5 (1.73) 3.2 (1.18) 3.3 (1.4)	5 (35.7%) 10 (22.3%) 15 (34.1%)	22.8 (2.78) 27 (6.83) 26 (6.13)
	> 100 ng/mL	None	None	None
Folate	< 5 ng/mL	None	None	None
	5-21 ng/mL	3.6 (1.62) 3.9 (1.44) 3.8 (1.51)	14 (100%) 30 (100%) 44 (100%)	12.3 (3.92) 11 (3.71) 11.5 (3.82)
	> 21 ng/mL	None	None	None
Vitamin B12	< 145 pg/mL	None	None	None
	145-914 pg/mL	3.6 (1.62) 3.9 (1.44) 3.8 (1.51)	14 (100%) 30 (100%) 44 (100%)	268.9 (84.46) 334.2 (142.19) 313.4 (130.31)
	> 914 pg/mL	None	None	None

25D3: 25-Hyrdoxyvitamin D3, SD: Standard deviation

Table 3: Post-treatment mean micronutrient status of the patients and respective demographic distributions

Serum micronutrient concentrations	Concentration range sub-groups	Mean age (SD) Males Females Total	Number of patients (%) Males Females Total	Mean serum concentration* (SD) Males Females Total
Iron	< 60 ug/dL	3.6 (1.88) 4.2 (1.54) 4 (1.70)	6 (42.9%) 10 (33.3%) 16 (36.3%)	52.8 (31.8) 59.3 (23.62) 57.3 (26.48)
	60-120 ug/dL	3.6 (1.41) 3.7 (1.35) 3.7 (1.37)	8 (57.1%) 20 (66.7%) 28 (63.6%)	108.8 (51.64) 86 (26.18) 90.9 (31.26)
	> 120 ug/dL	None	None	None
25D3	< 20 ng/mL	5 (0.82) 4.9 (1.36) 4.9 (1.22)	3 (21.4%) 7 (23.3%) 10 (22.3%)	26.2 (9.34) 21.9 (6.04) 23.2 (7.51)
	20-100 ng/mL	3.2 (1.59) 3.6 (1.32) 3.5 (1.42)	11 (78.6%) 23 (76.7%) 34 (77.3%)	31 (8.60) 29.4 (5.70) 28.3 (6.87)
	> 100 ng/mL	None	None	None
Folate	< 5 ng/mL	None	None	None
	5-21 ng/mL	3.6 (1.62) 3.9 (1.44) 3.8 (1.51)	14 (100%) 30 (100%) 44 (100%)	14.9 (4.02) 13.1 (4.43) 13.7 (4.38)
	> 21 ng/mL	None	None	None
Vitamin B12	< 145 pg/mL	None	None	None
	145-914 pg/mL	3.6 (1.62) 3.9 (1.44) 3.8 (1.51)	14 (100%) 30 (100%) 44 (100%)	370.6 (203.38) 367.5 (156.50) 368.5 (172.81)
	> 914 pg/mL	None	None	None

* Mean micronutrient concentrations were based on patients who belong to the related concentration range sub-groups during pre-treatment to demonstrate the mean difference. 25D3: 25-Hyrdoxyvitamin D3, SD: Standard deviation

Discussion

Febrile seizures are one of the most prevalent neurological disorder complications mostly encountered in children under the age of 6 caused by a fever above 38°C. In addition to its high reoccurrence rate (30% to 40%), it has a high prevalence rate, affecting 2% to 5% of children under the age of 5 years [1].

Various micronutrient deficiencies (MNDs) can be observed in patients with malnutrition and protein-energy malnutrition (PEM). The peak prevalence of MNDs has been observed in children under the age of five and iron is one of the most common MNDs encountered during early childhood worldwide [12]. Iron deficiency anemia is encountered in 78% of 1120 children between 6 months of age to 18 years [13], and is related with febrile seizures [5,7]. Iron deficiency caused by malnutrition may render the patient susceptible to developing a febrile seizure [13]. Additionally, vitamin D deficiency has also been found in 15% of 265 children, which requires supplementation [14]. Importance of vitamin B12 on BMI values of newborns and future risk of malnutrition has been also underlined [15]. In this study, we tried to cover both micronutrients that have been underlined as the most prevalent MNDs.

BMI is a widely accepted measurement of malnutrition according to the World Health Organization (WHO) [16]. Thus, it was considered the most important anthropometrical variable in this study to evaluate malnutrition. Weight z-scores and BMI z-scores of our patients had significantly improved over 6 months. However, although height z-scores deteriorated, none of the patients' decreased below a -2-height z-score, which is considered the threshold for being stunted by the WHO. Monitoring the same cohort for a longer duration in the presence of a nutritional intervention may or may not replace deterioration with an improvement in the case of height z-scores because of its slowness to catch-up due to the impaired bone development that may even cause irreversible damage on the longitudinal bone growth [17].

Improving iron concentrations in malnourished children via proper nutritional intervention has been considered important in terms of preventing further febrile seizures from recurring or occurring in the first place, by increasing the upper limit of the seizure threshold [6,18]. Present findings showed significant improvements in all four micronutrients (iron, vitamin B12, folate, and 25D3), except iron concentrations of patients without iron deficiency, due to hypercaloric enteral nutritional intervention over 6 months. More specifically, there was no significant difference between pre- and post-treatment measurements of iron concentrations in patients without its deficiency. Based on this finding, we can say that hypercaloric enteral supplementation prevents unnecessary increment of iron concentration. On the contrary, mean iron concentrations of iron deficient patients significantly increased from pre-treatment to post-treatment of hypercaloric supplementation, reducing the number of iron deficient patients significantly. In the case of patients without 25D3 deficiency there was a slight difference between pre- and post-treatment values and all were within non-toxic range. Similar to iron concentration improvement, 25D3 concentrations were also significantly increased in patients with 25D3 deficiency when comparing pre-treatment with post-treatment, significantly reducing the number of 25D3 deficient patients. These results indicate the two-tailed improvement of hypercaloric intervention on iron and 25D3 deficiencies in undernourished children with a history of a febrile seizure. Hypercaloric intervention was well tolerated in our patients, as most our cohort did not show any signs of intolerability.

There were no folate and vitamin B12 deficient patients at the pre-treatment or at the post-treatment measurements. Significant increase of these micronutrients did not show any toxic results as the optimal range was preserved. In fact, both folate and vitamin B12 mean values were approximated to middle values inside their optimal range, which may be considered an improvement. Middle values inside the optimum range of these micronutrients are as follows: 13 ng/mL for folate and 529.5 pg/mL for vitamin B12.

None of the patients in our cohort encountered another febrile seizure for 6 months. It is expected that the reoccurrence rate of febrile seizure may diminish via hypercaloric treatment due to normalized iron concentrations. However, much longer monitoring with a larger cohort is required to state it for certain.

Limitations

Longer monitoring and a larger cohort is required for more certain results in the case of height z-scores due to its slowness to change and the status of the rate of febrile seizure reoccurrence after normalized serum iron concentrations.

Conclusion

Hypercaloric enteral nutritional intervention significantly improved weight z-scores and BMI z-scores of our cohort, and reduced the number of iron and 25D3 deficient patients by increasing serum concentrations while preserving, or even improving, the non-deficient values of micronutrients. Lastly, our nutritional intervention was well tolerated among many of our patients without any signs of side effects. According to our results, hypercaloric intervention is a feasible nutritional intervention that can be used to treat malnutrition in children with a history of febrile seizure due to its highly beneficial outcome and high tolerability.

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