ASPECTS OF THE BENIGN EXTRASYSTOLIC ARRHYTHMIA IN THE CHILD AND TEENAGER WITH TETANY

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Abstract: The tetany in children represents a state of pathological hyperexcitability of the central and peripheral nervous system. The aim of this study is to present aspects of the benign extrasystolic arrhythmia in the children and teenagers with tetany, starting from the assumption that electrolyte imbalances of calcium and magnesium ions might be the cause of these dysrhythmias. The patients with hypocalcemic and hypomagnesemic tetany had the greatest share, followed by the patients with normocalcemic and normomagnesemic tetany, with no statistically significant difference between the atrial, respectively ventricular extrasystoles in any of the forms of tetany. The percentage of the occurrence of extrasystoles in the patients with latent tetany was higher than in the patients with manifest tetany, with a significant statistical difference between the types of extrasystoles, in both types of tetany.

INTRODUCTION

The tetany in children represents a state of pathological hyperexcitability of the central and peripheral nervous system (Kurdziel K et al., 2016). It is well known that Na+, K+, OH ions increase the neuronal excitability while the Ca++, Mg++, H^- ions decrease it. From the point of view of the etiopathogenic mechanism, there can be hypocalcemic tetany: due to hypoparathyroidism or to the lack of D vitamin, hypomagnesemic and psychogenic tetany: the normocalcemic tetany in the big child and the teenager. Clinically, there are two main types of tetany: manifest and latent tetany. Irrespective of the primary cause of tetany, the symptomatology is heterogeneous, represented by motor manifestations of the peripheral nervous system: the carpopedal spasm, the contraction of the facial muscles, laryngospasm, cardiac manifestations: precordial pricking pain and palpitations, sensitive manifestations: paresthesias or psychical manifestations: asthenia, anxiety and even depression. The patient with latent tetany does not present spontaneous clinical manifestations, thus, a specific motor answer can be reached through the excitation of nerves by the action of tapping over (Matasaru, 2007) (Ito et al., 2007). The Chvostek sign is a clinical clue indicative of the latent tetany in children and teenagers which should become the practice for each general practitioner (Hasan et al., 2014). The aim of this study is to present aspects of the benign extrasystolic arrhythmia in the children and teenagers with manifest or latent tetany, starting from the assumption that electrolyte imbalances of calcium and magnesium ions might be the cause of these dysrhythmias appearing on a healthy cord.

MATERIALS AND METHODS

The batch included 41 children aged 12-18 years, diagnosed with tetany at the medical check-up and in the case of whom extrasystoles were identified on the standard electrocardiogram. The examined batch included a number of 41 children aged 12-18 years, diagnosed with tetany at the general examination and in whom extrasystoles were detected on the standard electrocardiogram. All the children presented the Chvostek sign at the objective examination, 12 children having symptoms, with clinical light, heterogeneous manifestations. The forms of tetany in the examined children were the following ones: 25 cases of hypocalcemic tetany associated with light hypomagnesemia (61%), 15 cases of normocalcemic tetany (36.60%) and 1 case of hypocalcemia (2.40%). According to the ectopic focus, 27 children presented atrial extrasystoles - AE (65.85%) and 14 children presented ventricular extrasystoles - VE (34.15%).
The assessment of each patient was based on the past medical history, the clinical examination and paraclinical investigations (the measurement of the total and ionized calcium, magnesium levels, electrocardiogram investigation). The children suffering from a cardiac condition have not been taken into account for the analysis. The patients were followed up for a period of 18 months.
The statistical analysis was carried out by applying the Chi-square test, a non-parametric test used for statistical hypotheses, in the case of two or more samples taken randomly from a population and for which the frequencies are differently distributed between them.

RESULTS AND DISCUSSIONS

Atrial extrasystoles: there were 27 patients identified, representing 65.85% of the total number. The distribution of cases by sex highlights a higher frequency in the female patients, 17 cases (62.96%) compared to the male patients, 10 cases (37.04%).

Only in the case of 2 patients could we detect extrasystoles on the medical examination. The non-standardized stress tests were carried out for all the children, the absence of symptoms being noticed in all the cases. Based on the associated symptoms, the atrial extrasystoles were diagnosed by electrocardiography in 23 asymptomatic (85.2%) and 4 symptomatic (14.8%) patients.

Regarding the plasmatic level of calcium and magnesium, 1 patient (3.7%) was hypocalcemic, 16 patients (59.3%) had hypocalcemia associated with hypomagnesemia and 10 (37%) had normal levels of calcium and magnesium.

The asymptomatic patients presented: hypocalcemia - 1, hypocalcemia and light hypomagnesemia - 16, normocalcemia and normomagnesemia - 6; all 4 symptomatic patients were normocalcemic and normomagnesemic.

After examining the morphological aspect, all the atrial extrasystoles registered were monomorphous and isolated (sporadic), repetitive atrial extrasystoles not being registered (couples or atrial run). In none of the cases, the presence of arrhythmia had any hemodynamic consequence. As the atrial extrasystoles were monomorphous, isolated and appeared on a normal-sized heart, no antiarrhythmic teatment was administered, taking into account their benign character. Since they had no particular clinical significance, the prognostic is excellent. All the patients were treated with magnesium over a period of 3 months and the patients with hypocalcemia were administered calcium, 10 days a months, for 3 consecutive months, with a view to correcting the magnesium and calcium deficiencies.

Ventricular extrasystoles: there were 14 patients identified, respectively 34.15% of the total number. The distribution of cases by sex highlights a relatively equal distribution, 8 girls (57.14%) and 6 boys (42.86%).

At the medical examination, we suspected the presence of extrasystolic arrhythmia in 3 patients, the standard electrocardiogram subsequently confirming it. In one of the children, the extrasystolic arrhythmia was associated with respiratory arrhythmia. This situation was caused by the significant variations of the sinus rhythm, over 30 beats per minute, as a consequence of the variations of the vagal tone determined by respiration: the cardiac rhythm increases at the end of inspiration, the vagal tone being decreased and the cardiac rhythm decreases at the end of expiration, the vagal tone being increased. The non-standard stress test led to the disappearance of arrhythmia in all the cases, this one representing an important prognostic factor (Beaufort-Krol GC et al., 2008). Ventricular extraystoles were detected on the electrocardiogram of 6 asymptomatic (42.9%) and 8 symptomatic children (57.1%).

After testing the plasmatic level of calcium and magnesium, 9 children had hypocalcemia associated with light hypomagnesemia (64.3%) and 5 had normal levels of calcium and magnesium (35.7%).

Out of the asymptomatic patients, 3 had hypocalcemia and hypomagnesemia, 3 had normal levels of calcium and magnesium; out of the symptomatic children, 6 were hypocalcemic and hypomagnesemic and 2 had normal levels of calcium and magnesium.

In none of the cases, the presence of arrhythmia had any hemodynamic consequence. In the cases we encountered, there were not any ventricular extrasystoles that should lead to the R/T phenomenon, situation in which the ventricular extrasystole overlaps the descending part of the T wave of the previous QRS complex. In all the cases, the ventricular extrasystoles were isolated (sporadic), rare, monomorphous and non-systematic. No antiarrhythmic treatment was administered since they were well tolerated by children.
In the patients with hypomagnesemia and hypocalcemia, the treatment with magnesium was assigned for a period of 3-6 months, followed by the treatment with calcium, the magnesium and calcium levels being tested by biochemical tests while in the patients with normal values of calcium and magnesium, only treatment with magnesium was administered. The clinical and electrocardiographical evolution was favourable in all the cases, the patients being re-evaluated every 3 and 6 months since the extrasystoles were diagnosed.
Although the 24-hour Holter ambulatory monitoring has a significant role in the quantitative and qualitative analysis of extrasystolic arrhythmia (Ciudin R et al., 2003), its performance was conditional on the child's and the family's compliance, on costs, being performed only in 3 cases. Extrasystolic dysrhythmia was identified in 15 (36.6%) (10 with AE, 5 with VE) of the patients having normocalcemic tetany and in 25 (61%) (16 with AE, 9 with VE) of the patients with hypocalcemic and hypomagnesemic tetany, only one patient (2.4%) with hypocalcemia presenting atrial extrasystoles (Figure 1). The percentage in the patients with hypocalcemic and hypomagnesemic tetany was 1.6 higher than in the patients with normocalcemic and normomagnesemic tetany.

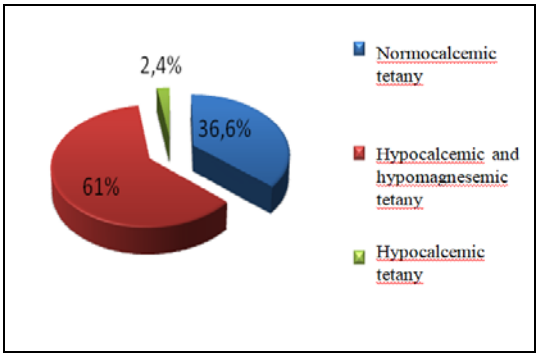

Figure 1. The distribution of pacients based on calcium and magnesium level

For the patients having normal values of Ca and Mg, the identified percentage (37%) of atrial extrasystoles was slightly higher than the percentage of ventricular extrtasystoles (35.7%). In the patients with low values of Ca and Mg, the percentage of atrial extrasystoles identified was 3.7% while the venticular extrasystoles have not been detected (0%) (Figure 2). After aplying the Chi-square test, the statistical significance was not obtained.

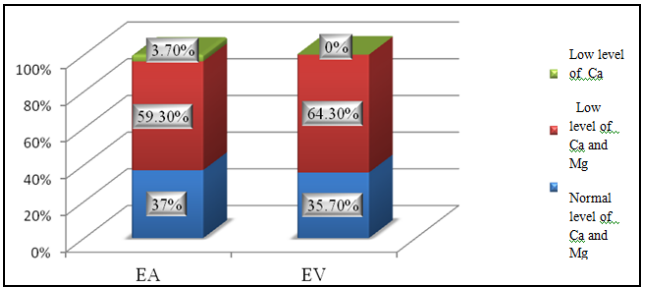

Figure 2. EA/EV at pacients with normal values of Ca and Mg, low Ca si Mg and low Ca

The test calculation: The Chi-square value for alpha=5% (probability - 95%) and 3-1 the degree of freedom is 5.99. The value obtained for Chi square (0) is lower than the carrying value, therefore the percentages are not statistically different.
As concerns the type of tetany, arrhythmia was detected in 12 symptomatic patients with manifest tetany (29.3%) and in 29 asymptomatic patients with latent tetany (70.7%) (Figure 3). The percentage in the patients with latent tetany was 2.4 higher than in the patients with manifest tetany.

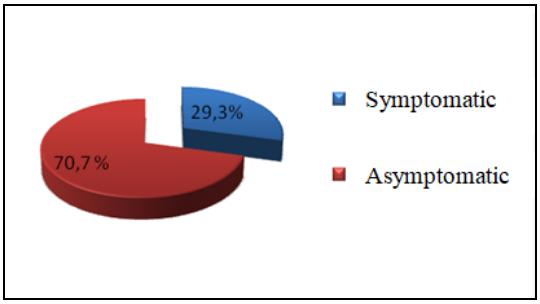

Figure 3. The distribution of symptomatic (manifest tetany)/asymptomatic (latent tetany) patients

In the symptomatic patients with manifest tetany, the percentage of ventricular extrasystoles (57.1%) detected was approximately 4 times higher than that of atrial extrasystoles (14.8%). In the asymptomatic patients with latent tetany, the percentage of detected atrial extrasystoles (85.2%) was almost double compared to that of ventricular extrasystoles (42.9%) (Table 1, Figure 4). After applying the Chi-square test, we obtained an important statistical significance between the ratios.

Table1. EA/EV – symptomatic/asymptomatic patients

Rhythmic disorders * SimptomatologieCrosstabulation					
			Symptomatology		
			AS	S	Total
Rhythmic disorders	EA	Cases	23	4	27
		% ↔	85.2%	14.8%	100.0 %
		% ↕			
	EV	Cases	6	8	14
		% ↔	42.9%	57.1%	100.0 %
		% ↕			
Total		Cases	29	12	41
		% ↔	70.7%	29.3%	100.0 %

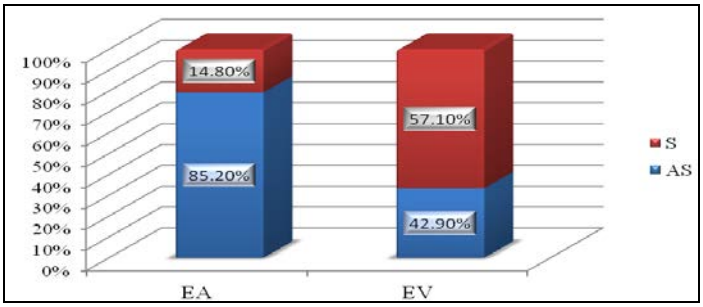

Figure 4 - EA/EV - symptomatic/asymptomatic patients

Theoretical frequencies

Theoretical frequencies	AS	S	Total
EA	19,09	7,91	27
EV	9,90	4,10	14
Total	28,99	12,01	41

The Ch-square value is calculated basen on the following formula: $\chi_c^2 = \sum_i \sum_j \frac{(O_{ij} - T_{ij})^2}{T_{ij}}$,

where O_{ij} represents the frequencies noticed and T_{ij} the theoretical frequencies. For the "heart rhythm disorder" variable that has two variants, AE and VE, we will use the index: i with the values: 1 și 2. In the case of the "Symptomatology" variable with two variants: AS and S, we will use the j index having the values 1 and 2. The theoretical Chi-square value for alpha=5% (95% probability) and 1 ((2-1)(2-1)), the degree of freedom is 3.84. Consequently, the value obtained for Chi square (7.97) is greater than the carrying value, thus the ratios differ, as confirmed by the statistically high percentage.

The analysis of the data of this study shows that the patients with hypocalcemic and hypomagnesemic tetany had the greatest share, followed by the patients with normocalcemic and normomagnesemic tetany, only one case with hypocalcemia having isolated atrial extrasystole. It is worth mentioning the fact that the hypocalcemia and hypomagnesemia of the patients examined were not serious.

It is well known that hypocalcemia is a common manifestation of hypomagnesemia. Up to a third of the patients with hypomagnesemia can have hypocalcemia. There is a positive correlation between the plasmatic levels of magnesium and those of calcium, even a slightly low level of magnesium can lead to a significant decrease of the calcium level. Only the treatment with magnesium can restore to normal the serum concentration of calcium (Gärtner, 2003; Swaminathan, 2003).

Magnesium is the second most common intracellular cation, having the role of important metabolic co-factor for over 300 enzymatic reactions in the whole human body. Among its different roles, magnesium modulates the entry and the release of calcium from the sarcoplasmic reticulum and regulates the ATP pomps in the myocite and the neuron, thus controlling the cardiac and neurone excitability. Consequently, the deficiency in this essential mineral can lead to cardiovascular disorders (Gröber et al., 2015; Mawri et al., 2017).

The use of magnesium as an antiarrhythmic agent in ventricular and supraventricular arrhythmias is a more and more discussed and controversial subject in recent years. Experimental studies have proved the importance of magnesium in maintaining the electrical stability of myocardial cells. That is why its use in the treatment of arrhythmias seems to be reliable (Zehender, 1996). Clinical trials show that the incidences of extrasystoles as well as patients' symptoms are reduced during oral magnesium therapy (Stühlinger et al., 2000).

The favourable evolution of our cases after the treatment with magnesium highlights the fact that the lack of this ion would explain the heart rhythm disorders that occur without any cause in teenagers, on a normally-sized heart. The magnesium deficiency, quite often detected in patients within this age range, due to a poor food intake, is usually latent, but can have an influence on the electrical activity of the heart, as evidenced by the electrocardiography. Determining the magnesium value is not useful many times since the magnesium deficiency is intracellular and plasma is only a transit sector. This would explain the appearance of extraystoles also in the patients with normocalcemic and normomagnesemic tetany. Therefore, in any patient who has an extrasystolic arrhythmia, magnesium therapy appears to be beneficial (Pignide et al.,1985).

Generally, tetany is caused by imbalances of the calcium and magnesium ions, although it is debated, in recent years, that it is caused by several electrolytic imbalances: hypokalemia, alkalosis or the electrolytic imbalances after hyperventilation (Gryglas et al., 2015). Magnesium ion coordinates a multitude of events in the heart cell, so its role is very complex. As mentioned above, there is evidence in the literature that the magnesium deficiency may be the cause of ventricular and supraventricular arrhythmias. At the same time, there is a discussion of the coexistence of a significant depletion of potassium, rejecting the idea that isolated hypomagnesemia may be the cause of arrhythmia. However, there is enough evidence to indicate that hypomagnesemia will significantly exacerbate the proarrhythmic effect of hypocalcaemia (Millane et al., 1992).

On the other hand, in the normocalcemic and normomagnesemic tetany – the psychogenic form, the psychical stress can be the main triggering factor although it coexists with the magnesium deficiency. It is well known that the psychogenic form is more frequently encountered in

teenagers and young women (Toruńska, 2003), females being prevalent in the analysed group (65.85%).
In our analysis, we did not obtain a correlation between the type of extrasystoles and the value of calcium and magnesium levels, the percentage of patients with atrial extrasystoles being comparable to that of patients with ventricular extrasystoles, both in the children with hypocalcemic and hypomagnesemic tetany and in the children with normocalcemic and normomagnesemic tetany.
Concerning the occurrence of extrasystoles based on the clinical manifestations of the patient, the latent tetany prevailed, which shows that identifying the Chvosteck sign must be taken into consideration. The Chvostek sign is very significant in children and teenagers, losing its value in adults, being most of the time negative. A study conducted in 2003 concluded that up to 25% of the healthy adults and up to 29% of those with hypocalcemia may have the positive Chvostek sign (Méneret et al., 2003). The detection of the Chvostek sign in all our cases represented a starting point in the measurement of calcium and magnesium levels in the children with latent tetany.
From the point of view of the type of extrasystoles, the atrial extrasystoles were prevalent in the asymptomatic patients with latent tetany while the ventricular extrasystoles were prevalent in the symptomatic patients with manifest tetany.

CONCLUSIONS

The percentage of patients with hypocalcemic and hypomagnesemic tetany exhibited extrasystoles at a rate of 1.6 times higher than that the patients with normocalcemic and normomagnesemic tetany, with no statistically significant difference between the atrial, respectively ventricular extrasystoles in any of the forms of tetany.
The percentage of the occurrence of extrasystoles in the patients with latent tetany was 2.4 higher than in the patients with manifest tetany. There is a significant statistical difference between the types of extrasystoles, both in the case of latent tetany and in the manifest tetany.
Since all the extrasystoles were isolated, monomorphous and non-systematic, we administered treatment with magnesium, followed or not by treatment with calcium, according to the type of tetany.
In a patient with tetany, the treatment with magnesium should not depend on its plasmatic value, most of the times it is an ionic deficiency at the intracellular level.

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