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PLANIMETRIC ECG INDICATORS IN CHILDREN WITH PREMATURE VENTRICULAR EXCITATION BY THE TYPE OF CLC SYNDROME, CLC PHENOMENON AND MAHAIM

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Abstract: In the syndrome of premature ventricular excitation (PVE) of the heart, part of the ventricular myocardium or the entire myocardium is activated by impulses conducted through accessory pathways (AP), and patients sooner or later develop tachyarrhythmic attacks, which under certain conditions are transformed into atrial and ventricular fibrillation, posing a threat to the patient's life.

Manifestations of PVE are rare - from 0.15 to 3.1% of the general population, including 9% of the total number of children with cardiac arrhythmias. This disease manifests itself in different forms - from constant clinical and electrophysiological manifestations in the manifest form to the absence of any subjective and objective symptoms in the latent form.

Key words: arrhythmia, accessory pathways, pre-excitation of the ventricles of the heart, planimetry, children.

Introduction. The problem of cardiac arrhythmias and complications associated with them has become especially relevant in pediatrics in recent years [3, 5, 9, 10]. There are a number of heart diseases, such as premature ventricular excitation syndrome (PVS), these cardiac arrhythmias are based on re-entry mechanisms caused by the presence of the AP impulse, the ECG expression of which are varieties of PVS (syndromes and phenomena: WPW, CLC, Mahaima-Levi). There is no reliable data in the literature on the prevalence of arrhythmias caused by AP in children [5, 6, 7]. Unlike adults, in children, rhythm disturbances associated with AP are often asymptomatic and, in 40.0 - 60.0%, are an accidental finding. Active detection and examination of children with arrhythmias due to the presence of AP would be of great theoretical and practical importance, since accumulation of scientific material allows us to determine risk groups for life-threatening arrhythmias, show their characteristic clinical and electrocardiographic criteria, concentrate the efforts of doctors in managing sick children, and determine the focus of preventive programs.

Objective of the study: To study the planimetric parameters of P, the QRS complex and ST–T in standard leads and precordial leads. To study and identify the most significant amplitude–interval parameters of electrocardiography for the manifestation and stabilization of premature ventricular excitation.

Material and methods of the study: 1,733 children aged 7–14 years (827 girls, 906 boys) were examined. They were selected from the general population of schoolchildren (17,330 children) by simple randomization (A–girls, B–boys), which formed the basis of a 10% sample (Dvoyrin V.V., Klimenkov A.A. 1985). The survey program was carried out in two stages. Stage I was conducted according to the following program: standard survey, objective examination of children and standard survey of parents (Rose questionnaire) for detection of attacks of tachyarrhythmia or its equivalents (feeling of heartbeat, pain, sinking,

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interruptions in the heart area, dizziness, "darkening", "goosebumps" before the eyes, etc.); study of blood pressure (three times), pulse counting; anthropometric studies and assessment of puberty of the examined children; Electrocardiography (in 12 standard leads). Planimetric method of quantitative analysis of ECG was conducted according to the recommendation of Stomboltsyan R.G. and R.V., Mikhaelyants (method. recommendations Yerevan, 1981). In this case, planimetric indicators of P, QRS complex and ST-T in standard leads and precordial leads were studied separately (Fig. 1).

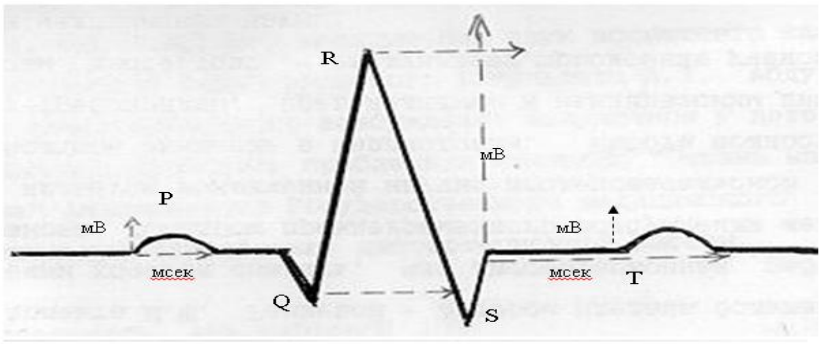

Рисунок.1. Схема планиметрического исследовании ЭКГ площади зубца Р, комплекса QRS и ST – Т.

The area of the initial and final parts of the ventricular complex of the ECG were calculated separately according to the method: the area was conditionally considered positive (+) if the curve comprising it was above the isoline, negative (–) if it was below this line. The initial part of the QRS complex consists of the algebraic sum of the area of the Q, R, S waves, and the final part - ST-T - of the algebraic sum of the areas of the ST-T interval and the T wave. Results and discussion. The planimetric area of the QRS complex in sick children with CLC syndrome (Table 1) is increased in many ECG leads, in sick children with CLC syndrome aged 7-10 years it is increased in six leads (50.0%): AVR, AVL and V1-V4, and in sick children aged 11-14 years in five (41.7%) I, AVR, V1-V3. In CLC syndrome, the decrease in ST–T area by the number of ECG leads was pronounced at the age of 7–10 years (58.3%) and 11–14 years (75%).

Table 1.

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Планиметрические показатели ЭКГ (мв.мс) у больных детей с ПВЖ по типу синдрома CLC (M±m)

Комплексы ЭКГ	ЭКГ отведения											
	I	II	III	AVR	AVL	AVF	V1	V2	V3	V4	V5	V6
7-10 лет												
QRS	3,6	6,78	4,78	-1,91	1,55	8,39*	-2,17	2,22	6,89	12,4	13,8*	10,2*
	0,85	0,2	0,54	0,48	0,18	0,53	0,45	0,29	0,36	0,95	1,33	1,43
ST-T	6,26	6,8	0,61	-3,61	3,1*	3,22	1,06	6,0*	9,67*	7,1	9,55	6,5
	0,35	0,59	0,17	0,53	0,47	0,39	0,59	0,89	1,8	1,56	1,62	1,44
КС	0,56*	0,99	7,83	0,53	0,5	2,61	-2,04	0,4	0,71	1,74	1,45	1,56
	0,08	0,15	0,78	0,09	0,07	0,32	0,3	0,05	0,11	0,22	0,21	0,2
СПО % (QRS)	-40,1	-45,5	-40,6	77,3	12,9	-11,6	75,6	84,0	33,1	113,1	20,2	-15,7
СПО % (ST-T)	21,6	24,4	-83,4	54,8	-17,9	-51,9	80,1	-16,9	0,21	-54,7	-41,0	-47,6
11-14 лет												
QRS	6,25	6,3	3,4	-3,26	1,26	4,75	-0,50	-0,96	4,27	8,4*	7,03	6,93
	0,42	0,61	0,27	0,35	0,38	0,31	0,23	0,3	0,84	1,65	0,73	0,42
ST-T	4,18	7,45*	1,15	-2,6	1,89	3,53	1,6	8,3	9,26	12,2	10,5	7,96
	0,42	0,58	0,23	0,46	0,38	0,41	0,26	0,5	0,58	0,62	0,73	0,5
КС	1,49	0,84	2,95*	1,25*	0,67	1,34	-0,31	-0,12	0,46	0,69	0,67*	0,87*
	0,12	0,07	0,22	0,12	0,06	0,12	0,04	0,01	0,04	0,06	0,05	0,08
СПО % (QRS)	24,5	-53,8	-59,6	70,1	-64,9	-55,6	94,5	91,6	58,5	26,9	-42,4	-38,7
СПО % (ST-T)	-46,2	-16,4	-59,6	70,4	-51,1	-37,9	72,6	-30,3	-34,3	-30,3	-32,7	-33,1
Примечание:	Данные кроме отмеченных (*) (P>0,05) статистически достоверно (P<0,05-0,0011), по по сравнению здоровых в соответствующих возрастах											

These changes were expressed by a decrease in the ST-T area in leads I, II, III, AVF and V4-V6 in sick children aged 7-10 years and in leads I, III, AVL, V3-V6 in children aged 11-14 years.

In sick children with the CLC phenomenon (Table 2), an increase in the QRS area was detected in five ECG leads, more pronounced in the right precordial leads V1-V4. In these leads, the SPR for the QRS area was also increased. At the same time, in contrast to the CLC syndrome, with the CLC phenomenon, a decrease in the ST-T area was observed in the largest number of leads (66.7%) in sick children aged 7-10 years - I, II, III, AVF, V2-V5, than in children aged 11-14 years (33.3%).

Table 2.

Планиметрические показатели ЭКГ (мв.мс) у больных детей с ПВЖ по типу феномена CLC (M±m)

Комплексы ЭКГ	ЭКГ отведения											
	I	II	III	AVR	AVL	AVF	V1	V2	V3	V4	V5	V6
7-10 лет												
QRS	4,66*	9,05	5,8	-3,75	-0,61	7,25	-2,0	-3,05	4,0	6,0*	9,5*	8,7
	0,89	1,04	0,69	0,74	0,19	0,64	0,74	0,45	10,4	0,59	1,59	1,24
ST-T	4,72	6,3	1,14	-3,88	6,5	1,88	0,32	0,95	1,2	5,01	8,25	9,65*
	0,54	1,14	0,39	0,65	1,29	0,44	0,27	0,39	1,14	1,29	6,3	1,19
КС	0,98*	1,44*	5,02	0,92*	-0,12	3,83	6,25	3,2	0,77	1,19	1,15	0,91*
	0,12	0,19	0,16	0,12	0,02	0,39	0,52	0,36	0,09	0,16	0,15	0,09
СПО % (QRS)	-20,2	-27,3	-27,9	55,4	65,7	-23,6	77,6	78,1	61,2	3,1	17,2	27,3
СПО % (ST-T)	-40,9	-30,6	-69,0	-51,4	72,0	-71,9	93,9	-86,9	-45,9	-68,1	-49,1	-22,2
11-14 лет												
QRS	2,93	8,64	5,42	-7,1	2,1	7,21	2,71	4,14	10,4	12,4	9,92*	9,71*
	0,71	1,61	1,21	1,31	0,35	1,13	0,49	0,97	1,38	1,02	1,79	1,55
ST-T	9,21*	8,42*	5,37*	-1,5	2,5*	6,24	1,42	7,78	8,21	10,9	9,71	10,7*
	1,85	1,79	0,6	0,67	0,83	1,07	1,01	1,31	1,43	1,67	0,95	2,2
КС	0,32	1,03	1,61	4,73	0,84*	1,14	1,91	0,53	1,27	1,14	1,02*	0,91*
	0,06	0,23	0,28	0,78	0,25	0,24	0,32	0,09	0,24	0,19	0,19	0,15
СПО % (QRS)	-41,6	-36,4	-35,6	34,9	-49,0	-32,6	70,3	63,7	0,9	51,5	18,7	14,1
СПО % (ST-T)	18,67	-5,49	18,2	82,9	-35,4	+9,7	75,7	-34,6	-41,8	-37,7	-37,7	-10,1
Примечание:	Данные, кроме отмеченных (*) (P>0,05) статистически достоверны (P<0,05-0,001) по сравнению со здоровыми в соответствующих возрастах											

We have shown that the relationships of the QRS areas (r=0.560, r=0.574, r=0.509) and ST–T (r=0.606, r=0.591, r=0.597) closely correlate with the ECG intervals P–Q and QRS in leads V6. When studying the planimetric indices of QRS and ST–T in sick children with the Mahaim phenomenon (Table 3), we found smaller changes, i.e. an increase in the

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INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

QRS area was rarely detected in 25% and 33.3% of cases by the number of ECG leads at the age of 7–10 and 11–14 years. They were expressed only in leads V4–V6 at the age of 11–14 years. It should be noted that if in other groups of sick children with PVZ (WPW, CLC syndromes and phenomena) the number of leads by low values of the QRS area is not exceeded in 33.3% of cases, then with the Mahaim phenomenon, a low QRS area was found more often at the age of 11–14 years (66.7%).

Table 3.

Планиметрические показатели ЭКГ (мв.мс) у больных детей с ПВЖ по типу феномена Махайма (M±m)

Комплексы ЭКГ	ЭКГ отведения											
	I	II	III	AVR	AVL	AVF	V1	V2	V3	V4	V5	V6
7-10 лет												
QRS	5,5*	10,5*	8,83*	-6,25*	-3,87	4,25	-3,5	-18,0*	-13,6	16,2	14,1*	12,6*
	±1,26	±1,54	1,54	1,40	0,54	1,08	0,26	2,29	1,12	1,11	1,59	1,78
ST-T	9,62*	9,5*	1,88	-6,5*	1,24	2,13	-3,63*	10,8	18,0	32,0	29,6	37,5
	±1,64	1,54	0,26	1,08	0,28	0,4	1,4	1,48	1,99	1,1	8,6	1,46
КС	0,57*	1,11*	4,69	0,96*	-3,12	1,99*	0,96	-1,67*	0,76*	0,50*	0,47*	0,34
	±0,12	±0,34	±1,18	±0,28	±0,86	±0,44	±0,33	±0,54	±0,24	±0,18	0,15	0,12
СПО % (QRS)	-5,82	-15,6	9,69	25,8	117,4	-55,2	60,8	29,4	32,0	178,4	22,8	4,13
СПО % (ST-T)	20,6	5,1	-48,9	18,6	-67,2	-68,2	31,8	45,2	86,5	103,8	82,7	202,4
11-14 лет												
QRS	3,55	6,28	1,2	-4,42	0,12	3,33	-2,78	-3,28	-2,07	12,9	14,5*	14,8
	0,59	0,53	0,59	0,93	0,23	0,33	0,5	0,82	0,79	1,32	1,99	1,52
ST-T	9,5*	12,5	3,78*	3,35	2,37	6,07*	-3,71*	9,00	16,7*	26,1	23,2	19,7
	1,92	1,66	1,19	0,19	0,13	1,12	1,19	1,99	1,25	2,31	1,25	1,98
КС	0,35	0,5	0,32	-10,7*	0,16	0,54	0,75	-0,36	-0,12	0,49*	0,63*	0,75*
	0,09	0,09	0,08	0,54	0,02	0,09	0,15	0,08	0,03	0,12	0,10	0,11
СПО % (QRS)	-33,3	-53,8	-85,7	59,4	-97,1	-68,9	69,5	71,2	79,9	57,7	18,8	30,9
СПО % (ST-T)	22,3	40,3	32,6	96,1	-38,8	6,68	36,6	19,6	18,4	49,1	48,7	65,5
Примечание:	Данные, кроме отмеченных (*) (P>0,05) статистически достоверно (P<0,05-0,001), по сравнению со здоровыми в соответствующих возрастах											

A distinctive feature of the Mahaim phenomenon was also a more frequent increase in the ST–T area in both age groups (41.7% each) than in children in other groups with PVS (from 16.7 to 25%). The ST–T complex is significantly increased in leads V3–V6 due to giant T waves and reversion of the ST–T interval. As a result, the SPR increased to 103.8% (V4) and 202.4% (V6). In sick children with Mahaim phenomena, the area of the QRS complex positively correlates more with the P–Q interval in lead V6 (r=0.466) than with the ST–T area. The QRS of the de– and repolarization phase (Fig. 2) in sick children with CLC syndrome aged 7–10 years is increased in leads V2–V5 compared to their healthy peers. With age (11–14 years), this indicator decreased in leads V1–V4 or was unchanged. In the CLC phenomenon at the age of 7–10 years, as well as in the CS syndrome, it is increased in leads V1–V5), and at the age of 11–14 years, only in leads V2–V3. CS in the Mahaim phenomenon in children aged 7–10 years did not differ significantly from that of healthy children in leads V1–V5, and in V6 it was reduced. In sick children with the Mahaim phenomenon at the age of 11–14 years, a significant decrease in CS was detected in leads V1–V2. It should be noted that in the syndrome, the CLC phenomenon and the Mahaim phenomenon, the direction of the CS is the same as in healthy children, only the conduction of the impulse through the accessory pathways or the AV node is accelerated, and therefore an initial high activation of one of the ventricles is detected in leads V1–V2 (the syndrome and the CLC phenomenon at the age of 7–10 years) or a slowdown in the conduction of the impulse along the other (the syndrome and the CLC phenomenon at the age of 11–14 years,

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the Mahaim phenomenon). These conditions create mechanisms of asynchronous de– and repolarization and can be the cause of Microre–entry, longitudinal dissociation and summation of excitation impulses at the level of Purkinje cells and contractile myocardium [6, 8].

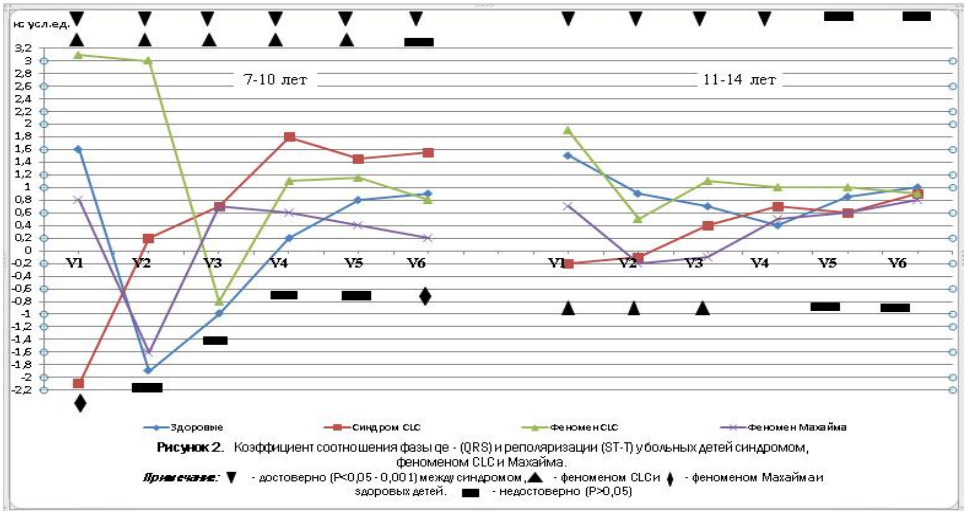

Рисунок 2. Коэффициент соотношения фазы де - (QRS) и реполяризации (ST-T) у больных детей синдромом, феноменом CLC и Махайма.

Примечание: ▼ - достоверно (P<0,05 - 0,001) между синдромом, ▲ - феноменом CLC и ♦ - феноменом Махайма и здоровых детей. ▬ - недостоверно (P>0,05)

As an objective method characterizing the relationship between the processes of ventricular de- and repolarization, we studied the integral values of the QRS and ST–T complex, their vectors (Ĥ) axis (Â), as well as the divergence angle (ÂQRS–ÂST–T) in the frontal and horizontal plane. The results of such an analysis of the ECG of children with PVS are given in Tables 4 and 5.

Таблица 4.

Интегральные величины QRS и ST-T у здоровых и больных детей с проявлениями ПВЖ в возрасте 7-10 лет (M±m)

№	Интегральные величины	Здоровые n=50	Синдром WPW n=4	Феномен WPW n=7	Синдром CLC n=9	Феномен CLC n=11	Феномен Махайма n=4
1	H QRS *	2,00±0,08	0,80±0,24	1,50±0,24	1,32±0,19	1,45±0,18	1,92±0,59
2	H ST-T	1,82±0,07	1,81±0,59*	1,85±0,35*	1,34±0,18	1,10±0,12	2,14±0,65*
3	H G	3,37±0,11	2,26±0,71*	3,36±0,52*	1,74±0,22	1,93±0,23	3,6±0,98*
4	A QRS ф.	76,2±1,76	58,4±9,04*	56,5±5,46	68,4±4,38*	72,7±3,82*	76,3±1,26*
5	A ST-T ф.	32,4±1,39	38,6±6,82	56,5±5,51	14,5±1,21	26,3±1,86	20,2±4,37
6	A G ф.	58,3±1,02	44,6±10,2*	28,3±1,90	53,4±4,33*	48,3±3,21	48,6±6,63*
7	(AQRS ф.-AST-T ф.)	43,8±1,12	19,8±4,09	12,8±1,87	53,9±6,76*	46,6±3,45*	56,1±12,9*
8	A QRS г.	11,4±0,16	-6,4±0,89	-8,5±0,95	3,6±0,19	7,9±0,52	11,5±1,63*
9	A ST-T г.	-32,4±1,08	-26,2±7,52*	-38,3±1,86	-50,3±5,73	-38,5±4,00*	-44,6±10,7*

Примечание:
1.*-векторы QRS и ST-T представлены в виде единицы Ашмана (1ед.=4 мв.мс)
2. AQRSф, AST-Tф, AG ф во фронтальной плоскости направлены влево, вниз, а в горизонтальной - вперед (+), назад (-)
3. *-статистически не достоверны по сравнению со здоровыми (P>0,05), соответствующего возраста.
**-статистически не достоверно по сравнению со здоровыми в возрасте 7-10 лет

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INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

Таблица 5.

Интегральные велиичины QRS и ST-T у здоровых и больных детей с проявлениями ПВЖ в возрасте 11-14 лет (M±m)

№	Интегральные велиичины	Здоровые n=30	Синдром WPW n=5	Феномен WPW n=10	Синдром CLC n=15	Феномен CLC n=9	Феномен Махайма n=8
1	H QRS *	1,80±0,06	2,80±0,69*	1,70±0,19*	1,26±0,12	1,37±0,09	0,86±0,16
2	H ST-T	1,86±0,08**	1,53±0,33*	2,2±0,26*	1,17±0,02	1,92±0,23*	1,71±0,25*
3	H G	3,54±0,14**	3,92±0,88*	5,23±0,67	2,14±0,21	2,25±0,30	3,70±0,47*
4	A QRS ф.	78,4±1,16**	84,3±12,1*	42,3±2,74	46,7±2,36	78,4±5,45*	26,4±1,67
5	A ST-T ф.	30,6±0,40**	46,3±5,63	+42,3±2,85	18,5±0,89	28,2±0,73*	+26,3±1,80
6	A G ф.	56,4±1,14**	72,3±7,83	12,6±0,70	32,8±1,56	58,3±4,84*	1,65±1,12
7	(AQRS ф.-AST-T ф.)	47,8±0,80	38,0±3,99	68,6±3,98	28,2±1,89	50,2±3,05*	36,5±2,17
8	A QRS г.	+2,0±0,19**	17,9±1,85	-24,1±1,36	-19,7±0,84	12,3±0,75*	-40,0±2,85
9	A ST-T г.	-35,8±0,80	-20,1±2,64	-24,1±1,34	-47,9±2,76	-38,2±2,16*	-40,1±3,14*

Примечание:
1.*-векторы QRS и ST-T представлены в виде единицы Ашмана (1ед.=4 мв.мс)
2. AQRS, AST-T, AG во фронтальной плоскости направлены влево, вниз, а в горизонтальной - вперед (+), назад (-)
3. *-статистически не достоверно по сравнению со здоровыми (P>0,05) соответствующего возраста
**-статистически не достоверно по сравнению со здоровыми в возрасте 7-10 лет

Как видно из данных таблицы 4 и 5, у больных детей с ПВЖ по типу WPW, CLC and Mahaim, the integral values of the HQRS vector are reduced, and the HST–T vector is reduced by CLC compared to healthy children of the same age. The absence of changes in the ventricular gradient vector HG in many sick children with PVG indicates that the ST–T changes are due to primary changes in the QRS complex, i.e. due to impaired impulse conduction along additional conduction pathways. The unusual impulse conduction leads to a multidirectional change in the ÂQRS and ST–T angles in the horizontal plane, which is expressed in the WPW syndrome and phenomenon and CLC, as the Mahaim phenomenon. Thus, the main parameters of the ventricular complex of the ECG (QRS and ST–T) of sick children by amplitude-interval values, planimetric parameters of the ECG of sick children with PVG are characterized by a violation of the synchronicity of the phases of de– and repolarization of the ventricles by the area of the QRS and ST–T complex, ECG, the expression of which are "peaks" and "dips". In sick children with PVG aged 7–10 years, an increase in repolarization shifts is observed without a change in the ventricular gradient, which leads to electrical instability of the ventricular myocardium. With age (by 11–14 years), such electrical instability leads to changes in the ventricular myocardium (hypertrophy, hyperfunction), and from that the ventricular gradient in most cases of PVG is changed. Conclusion

1. The main structure of the PVS is the syndrome (29.3%), the CLC phenomenon (24.4%) and the WPW phenomenon (20.7%), than the Mahaim phenomenon (14.6%) and the WPW syndrome (11.0%).

2. In assessing the severity of atrial damage in children with PVS, in addition to the amplitude-architectonic characteristics of the P wave, an important place is occupied by additional indicators of atrial electrical activity: the triangle coefficient (mm / sec), the strength of the ratio of the area of the right and left atrium in lead V1 (SSPLP, mm / sec), the time of internal deviation of the right and left atrium (TIRD, TILD, sec), the rate of rise of P (mm / 0.01 sec) angle , , as well as planimetric indicators of P, (mV • ms) the angle of divergence of the vector ÂP and ÂQRS, in the frontal and horizontal planes.

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3. Sick children with PVG have features in the indices of electrical activity and stability of the heart: in the CLC type, the period of electrical stability of the heart (T–P). In sick children with PVG, the "ventricular excitation phase" (Q–T1), the period of early repolarization (ST–T), the vulnerability index (RR•QT/RR) are significantly shortened, and the prematurity index (RR/QT) is increased.

4. Sick children with PVG reliably often have ECG signs indicating the predominance of the right ventricle (low indices R1, V5, V6, deep S, V5, V6), immaturity of the left ventricular myocardium - low QRS, ST–T, (mV, m sec) their vectors HQRS, HST–T, HG (Ashman units), angles ÂP–ÂQRS and ÂQRS–ÂST–T. In this case, the value of the vector and angle of the ventricular gradient (ÂG, ĤG), ECG syndromes of ventricular repolarization [(Tv1 – Tv6)] and de- and repolarization of the right ventricle [(Rv1) – (Tv1)] have important diagnostic information.

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