

II. Clinical problems

COMPARATIVE MORPHOLOGICAL AND ELECTROCARDIOGRAPHICAL (VECTOR ANALYSIS) INVESTIGATION OF MYOCARDIUM IN INFANTS AGED UP TO 3 YEARS WITH SEPTIC STATES

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Modern concepts concerning diagnosis and treatment of cardiovascular diseases require an exact evaluation of the myocardial functional state parallelly with determination of the anatomical substrate of the illness. Electrocardiographical examination is of primary importance because of a series of advantages (accessible, non-invasive, reiterable) although expert evaluation of the common electrocardiogram cannot always estimate quantitatively the myocardial lesion on hand. In this sense, term introduction of «vector analysis» of conventional electrocardiographical recording is warrantable and enables the quantitative determination of myocardial lesions (4) but its comparison with the morphological myocardium investigation — also the evaluation of its practical importance.

The aim of the present study is to juxtapose the capacities of electrocardiographical vector analysis to the results from the examination of myocardial morphology in deceased infants with septic diseases.

Material and methods

Our study covered a total of 80 deceased infants aged up to 3 years in the First Pediatric Clinic of the Higher Institute of Medicine in Varna during the period 1977—1981. The necropsic investigation performed in the Department of Pathological Anatomy confirmed the clinical diagnosis «sepsis» in these cases. Histological preparations were stained with HE, Azan after Cruchay, PAS, toluidine blue at pH 4 and 6, for fuxinophilic necroses after Lie, with PTAH for striated myofibrils and fibrin, and Sudan III for fats. In some autopsies the whole heart was investigated with a view to the ascertaining of morphological lesion topography.

Electrocardiograms of deceased infants done while still living by using of monochannel or threechannel apparatus, «Hellige» type, underwent a vector analysis by means of area calculation in mVsec of chamber complex «QRS» and «T» wave in 1st and 3rd standard leads and by projecting digital data obtained on three-axial Baxley's coordinate system (fig. 1). Vectors of the chamber complex and «T» wave as well as of the chamber gradient \vec{g} were geometrically determined on it. The following parameters were calculated: $|\vec{g}|$ — quantity of chamber gradient vector; $|\vec{g}|/|\vec{QRS}|$ — ratio of the quantity of chamber gradient vector to quantity of chamber complex vector; $\angle \vec{g}$ — angle of chamber gradient vector; $\angle \vec{QRS}/\vec{g}$ — angle between chamber complex vector and chamber gradient vector; $\angle \vec{g}/\vec{AT}$ — angle between chamber gradient vector and «T» wave

vector. Literature data (8) were used concerning normal values of the aforementioned parameters.

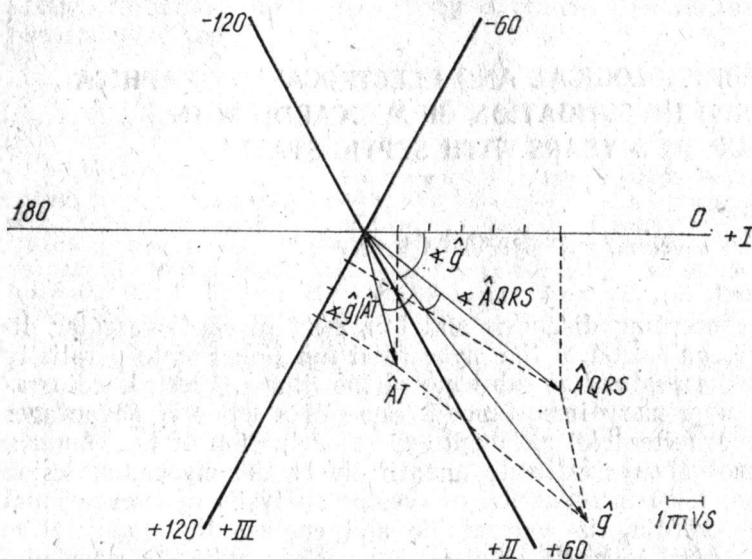


Fig. 1. Baxley's coordinate system

Results and discussion

Myocardial lesions of different character were light-microscopically established in most cases (87.50 per cent) (table 1). It could be seen that myocardial inflammatory alterations were found out in almost the half of the cases. It was notable that interstitial myocardites with most commonly focal character were the most frequent findings (in 22.50 per cent of the cases). Inflammatory infiltrates consisted mainly of mononuclear cells (lymphocytes, histiocytes, plasmocytes) and single leukocytes and were located perivascularly or amidst myofibrils (fig. 2). Purulent myocarditis and abscesses was established in 4 cases (5 per cent) with septicopyemia. Chronic interstitial myocarditis with advanced perivascular sclerosis was found out in other 2 infants with relapsing bronchopneumoniae. There was also a secondary endocardial fibrosis reaching in depth up to 500 μ m probably due to an endomyocarditis in 2 cases. In a 6-months old infant a fibrous plaque in the coronary artery was also observed. In any myocarditis cases there were scattered fuxinophilic myocardial necroses most severely expressed in purulent ones.

Acute ischemic myocardial changes without myocarditis presented the second main group (31.25 per cent) of the cases. The ischemic changes were manifested morphologically by undulating myofibrils and fuxinophilic necroses (fig. 3 and fig. 4). Fuxinophilic necroses were established in the atrio-ventricular node in one case from this group. Severe fatty myocardial degeneration was observed in 11 (13.75 per cent) cases.

In most myocardia irrespective of the character of the lesion there were microcirculatory disorders consisting in paralysis of the microcirculatory bed ma-

Character of the lesion	Total number n	%	\bar{x}	$\hat{\sigma}/\text{QRS}$	$\hat{\sigma}$	$\hat{\sigma}/\text{QRS}$	$\hat{\sigma}$	$\hat{\sigma}/\text{QRS}/\bar{x}$	$\hat{\sigma}/\Delta T$
Myocarditis	34	42.50	n \bar{x} 34 18 ± 12.7	34 2 ± 0.9	34 57 ± 28.8	34 34 ± 30.1	34 28 ± 23.9		
Acute ischemic changes	25	31.25	n \bar{x} 25 12.3 ± 7.3	25 1.5 ± 0.8	25 64 ± 28.2	25 33 ± 31.8	25 44 ± 27.9		
Fatty degeneration	11	13.75	n \bar{x} 11 28.6 ± 25.9	11 2.5 ± 1.2	11 45 ± 18.7	11 48 ± 13.6	11 14 ± 12		
No morphological changes	10	12.50	n \bar{x} 10 36.7 ± 11	10 2.3 ± 1.1	10 46 ± 29.2	10 36 ± 29.8	10 21 ± 19.4		
		80	100						

Normal values (after Burch and De Pasquale) 28-95 mvs 1.3-3 24-79° 0-47° 0-40°

nifested with an expressed dilatation of capillaries and venules, stasis, sludging. Fibrin and thrombocyte microthrombi could be observed in single cases. Spasm

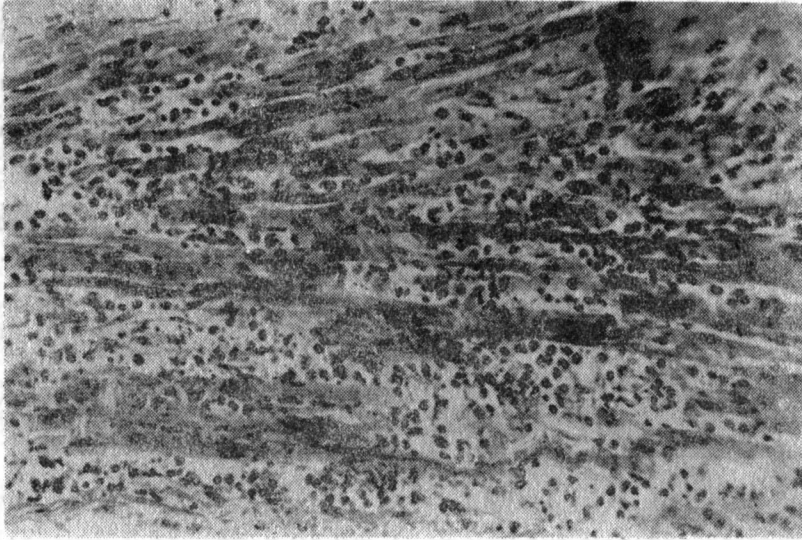


Fig. 2. Interstitial myocarditis. Stain H. E., Magn. 10x16

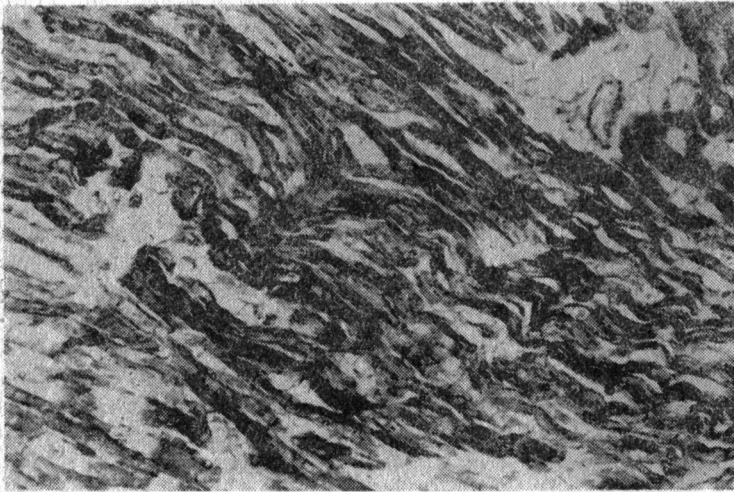


Fig. 3. Undulating myofibrils with contracture alterations and fuxinophilic necroses. Stain with Azan after Cruchay; Magn. 10x16

of small intramural muscular arteries with palisade arrangement of endothelial cell nuclei was also found out. However, in 10 cases no light microscopic alterations could be detected.

Vector analysis parameters of electrocardiograms of deceased infants (processed after the variation method in the same groups as during the morphological investigation of the myocardium) were demonstrated on table 1.

It could be seen that $\langle g \rangle$ values were under the normal ones in the groups of myocardites and of the acute ischemic myocardial changes. The difference between the arithmetical means of the ventricle gradient in these two groups com-

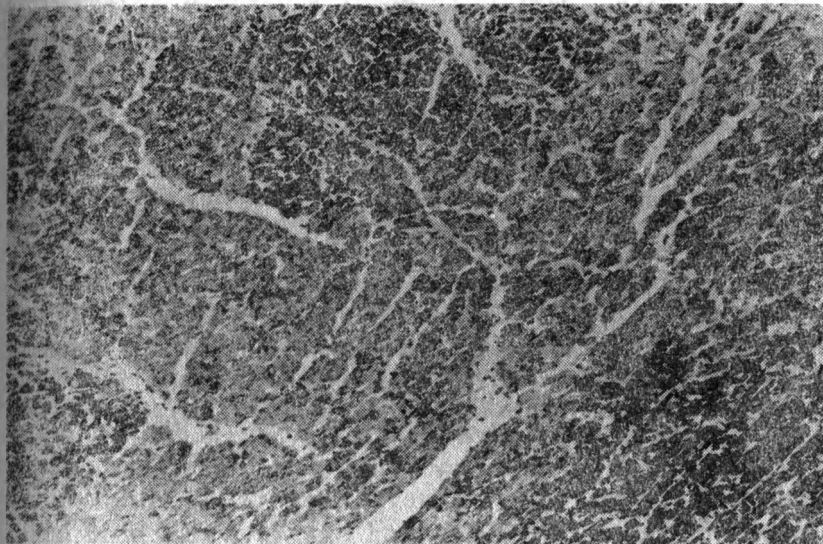


Fig. 4. Numerous confluent fuxinophilic necroses (darkly stained zones). Stain after Lie, Magn. 10×6.3

pared with $\langle g \rangle$ normal values was statistically reliable ($p < 0.001$). $\langle g/\hat{A}QRS \rangle$ ratio varied in normal ranges (between 1.3 and 3.0) in all groups. The rest parameters of the vector analysis of electrocardiograms were also within the borders of the norm.

It was, therefore, established that myocardial lesions occurred rather frequently in septicemia cases. According to A. K. Ageev (cited by 2) there were various myocarditis forms in 40—58.5 per cent of septicemia cases. The rare development of a purulent myocarditis should be related to the prevalence of septicemia over septicopyemia in the course of sepsis in infancy. The character of inflammatory alterations, most commonly of an interstitial myocarditis with prevalence of proliferative changes but sometimes with a chronic course was also inherent to infants' myocarditis (3).

Ischemic myocardial lesions could be pathogenetically determined by microcirculatory and probable electrolyte disturbances. However, despite certain electrolyte disorders mainly concerning potassium levels ($\bar{x}=4.91$, $\sigma=\pm 1.28$ for myocarditis group and $\bar{x}=4.48$, $\sigma=\pm 0.57$ for the acute ischemic changes one) as well as total serum protein levels ($\bar{x}=5.61$, $\sigma=\pm 1.1$ for the first group and $\bar{x}=6.39$, $\sigma=\pm 1.06$ for the second) no statistically significant difference could be established ($p > 0.01$).

Myocardial changes were a component of the great problem of sepsis and thus of particular importance first of all for the diagnosis of atypical clinical forms of sepsis in early infancy. Besides, the correct ascertaining of myocardial state helped to evaluate the severity of the disease because in a lot of cases

myocardial damage could be the immediate reason for death. Electrocardiographic changes in case of myocardial lesion in early infancy did not vary considerably (tachycardia, changes of the ventricle complex and of «T» wave, and considerably more seldomly — disorders of rhythm and conductivity). They were not characteristic of the various kinds of myocarditis and were hardly estimated quantitatively. However, the latter could be corrected to a certain extent by using of the vector analysis of the electrocardiogram. Ventricle gradient $\langle \hat{g} \rangle$ presented a summarized vector in the frontal plane from the differences in excitation potentials of the ventricular musculature. It was described already by Wilson. Its normal ranges for adults were elaborated in detail by Ashman and co-workers, and those for childhood — by Burch and De Pasquale. The latter varied in rather wide ranges which could be due to numerous factors influencing upon ventricle gradient estimation — muscle mass, position of the body, heart frequency, some medicaments such as digitalis preparations, etc. For all that, contractile capacity of myocardium had the greatest and most essential significance. That was why the investigators assumed that by means of $\langle \hat{g} \rangle$ one could distinguish primary from secondary myocardial alterations. Burch and De Pasquale reported a series of examples illustrating the fact that hypertrophy of ventricular myocardium due to congenital heart anomalies or to acquired valvular defects did not induce $\langle \hat{g} \rangle$ and $\langle \hat{g}/\hat{AQRS} \rangle$ changes while inflammatory myocardial alterations were related with reduced ventricle gradient levels. However, this was not valid for the rest parameters, namely for $\langle \hat{\angle} \hat{g} \rangle$, $\langle \hat{\angle} \hat{AQRS} \hat{g} \rangle$ and $\langle \hat{\angle} \hat{g} \hat{AT} \rangle$. They were influenced by ventricular hypertrophy and induced changes in the direction of the vectors and by this way — in the angles measured in case of congenital or acquired heart defects related with an augmented musculature of certain heart cavities. Our results confirmed the aforementioned conclusions — statistically reliable difference of $\langle \hat{g} \rangle$ values was ascertained in groups with most essential morphological alterations (myocarditis and acute ischemic myocardial lesions) while the rest parameters of vector analysis of the electrocardiogram did not show any abnormal values reported by the authors cited.

We can draw the following conclusions:

1. There are severe inflammatory and ischemic changes in the myocardium of infants deceased of septic diseases which can be related to thanatogenesis.
2. Our results show that myocardial undulation described 1974 by Bouchardy and Maino (7) as an early ischemic sign can be successfully used with the morphological examination of infantile myocardium, too.
3. Vector analysis of electrocardiogram in deceased infants reveals statistically significant low values of the ventricle gradient in both groups — with myocarditis and ischemic myocardial changes.
4. The reduced ventricle gradient values can be applied as a diagnostic criterion for myocardial damage in septicemia in early infancy. However, on the basis of them only no conclusions can be made concerning the inflammatory or non-inflammatory character of myocardial changes, indeed.

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СОПОСТАВИТЕЛЬНОЕ МОРФОЛОГИЧЕСКОЕ И ЭЛЕКТРОКАРДИОГРАФИЧЕСКОЕ (ВЕКТОРНЫЙ АНАЛИЗ) ИССЛЕДОВАНИЕ МИОКАРДА ПРИ СЕПТИЧЕСКИХ СОСТОЯНИЯХ У ДЕТЕЙ В ВОЗРАСТЕ ДО ТРЕХ ЛЕТ

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РЕЗЮМЕ

У 80 детей в возрасте до трех лет, умерших в результате септических состояний, проведено сопоставительное электрокардиографическое (векторный анализ) и морфологическое исследование миокарда. На основании установленных морфологических увреждений исследованные случаи были распределены в три группы: миокардиты (диффузный или очаговый интерстициальный, паренхиматозный, гнойный и хронический интерстициальный) — 42,5 %, с наличием жировой дистрофии миокарда — 13,75 %, с острыми изменениями ишемического характера (волнообразность миофибр и наличие фуксинофильных некроз) — 31,25 % и без существенных морфологических изменений — 12,5 %. Электрокардиографическое исследование на основе векторного анализа включает вычисления \bar{g} , $\bar{g}/\bar{A}QRS$, $\angle \bar{g}$, $\angle \bar{A}QRS / \bar{g}$, $\angle \bar{g}/\bar{A}T$.

Наиболее значительные статистически значимые изменения устанавливаются на камерном градиенте \bar{g} в группе с острыми изменениями ишемического характера в миокарде ($\bar{x}=12,3 \pm 7,3$) и в группе с миокардитами ($\bar{x}=18 \pm 12,7$).

Настоящее исследование выявляет возможности количественной оценки изменений электрокардиограммы при изменениях ишемического и воспалительного характера в миокарде и их диагностическое значение при сравнении с морфологическими находками изменений миокарда.