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# ECHOCARDIOGRAPHIC FINDINGS AND ISCHEMIC STROKE

Natalya DADAMYANTS

Republican Scientific Center of Emergency Medicine, Tashkent, Uzbekistan

## ABSTRACT

In order to study cardiac pathology in different subtypes of ischemic stroke we examined 165 stroke patients. The 1st group included 90 (54.5%) patients with hemodynamic stroke, the 2nd one - 75 (45.5%) patients with cardioembolic stroke. Control group consisted of 45 individuals without cerebrovascular diseases. Cardiac pathologies with the prevalence of various types of ischemic heart disease were observed in all groups. The parameters of left ventricular stroke volume and ejection fraction were lower in patients with hemodynamic stroke than in other groups, but were within normal limits. Potential sources of cardiogenic embolism were found in all groups: in the 1st group at 74.4%, in the 2nd one at 100%. Thus, most patients with ischemic stroke have different heart defects related to the subtypes of ischemic stroke.

## UDC CODE & KEYWORDS

■ UDC: 612.1 ■ Echocardiography ■ Cardiac Pathology ■ Ischemic Stroke.

## INTRODUCTION

Recent studies demonstrate a close relationship between cardiac and cerebral pathologies caused by the most prevalent cardiovascular diseases, in particular hypertonic disease and atherosclerosis [14,15]. Today, cardiac pathology which leads to cardiocerebral embolism and as a consequence to cardioembolic ischemic stroke, as well as ischemic stroke at the presence of cerebrovascular insufficiency, is well studied. Additionally, the development of clinical neurological symptoms associated with cerebral vascular insufficiency was found to usually occur on a background of long-term disability of cerebral blood flow, in particular due to cardiac reasons such as valve abnormality and myocardial infarction [9,11,12].

According to several authors [2], various heart pathologies were found in 77% of patients who had suffered ischemic cerebrovascular disturbances. In this case, cardiac structural changes are often the main source of embolism in young patients [5]. Brain lacunar infarctions, according to the literature, in 50% of cases can be associated with potential cardiac embolegenic source [1]. Atrial fibrillation (AF) is a cause of ischemic cerebrovascular episodes of ischemic character about in 20% cases. Patients with AF associated with rheumatic heart defect have risk of ischemic stroke 17 times higher than patients with normal sinus rhythm [7]. In this regard, we can basically assume that the parameters of central hemodynamics may have the huge importance in determining a subtype of ischemic stroke (IS).

**The purpose of research** was to study echocardiographic parameters in patients with ischemic strokes.

### Materials and methods

We examined 165 patients with IS, 87 males (52.7%) and 78 females (47.3%) at the age from 16 to 87 years (mean 52.7±7.5 years old). All patients underwent computed tomography (CT) scan of the brain on spiral CT “Aura” (Philips, Germany), duplex scanning of the head magisterial arteries (EUB-6000, Hitachi, Japan), echocardiography (Sonoline Omnia, Siemens, Germany). In 77 cases we performed Transcranial Doppler (MT 1010, Mindray, China). Also we evaluated the state of local contractility of the left ventricle (LV); disturbances like akinesia or hypokinesia by segments were regarded as dyskinesia. The following echocardiographic parameters were analyzed: LV stroke volume (SV), ejection fraction (EF), and cardiac output (CO). A quantitative assessment of global LV contractility was assessed by the Simpson method. The value of EF below 50% was considered as impairment of the global LV contractility.

Based on the analysis of debut of disease, medical history, course of stroke, and compared clinical data with results of CT scan, echocardiography and duplex scanning, we identified the leading pathogenetic mechanism of IS development, according to that the patients were divided into 2 main groups. The 1st group included 90 (54.5%) patients with hemodynamic stroke (HDS), the 2nd one - 75 (45.5%) patients with cardioembolic stroke (CES). Control group consisted of 45 individuals (29 men and 16 women) aged from 30 to 68 years (mean 47.8±8.5 years old) without clinical, neuroimaging, ECG, and echocardiographic signs of cardiovascular disease.

Cardiac pathology was divided into 3 groups: infectious and inflammatory diseases of heart (rheumatic heart defects, bacterial endocarditis, and dilated cardiomyopathy), ischemic heart disease (acute myocardial infarction, postinfarction cardiosclerosis, cardiac arrhythmias, and angina pectoris).

The data obtained were processed statistically using the software package Microsoft Excel 98. To check the hypothesis of differences between groups t-test was used. Statistically significant differences were considered at $p<0.05$.

### Results of research and discussion

Patients with HDS more often had ventricular extrasystolia, transient AV-block of II-III degree with pauses for no less than 2 seconds, and prolongation of the Q-T interval on the ECG (Table 1).

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Table 1: ECG changes in patients with ischemic stroke and control group

| Form of pathology | 1st group | 2nd group | Control group |
|---|---|---|---|
| | (n=90) | (n=75) | |
| **Ventricular rare extrasystolia** | 47 (52.2) | 24 (32) | 20 (44.4) |
| **Ventricular frequent extrasystolia** | 5 (5.55) | 10 (13.3) | 0 |
| **Supraventricular extrasystoles** | 44 (48.8) | 23 (30.6) | 13 (28.8) |
| **Paroxysmal tachycardia** | 10 (11.1) | 7 (9.3) | 0 |
| **Paroxysmal form of AF** | 25 (27.7) | 30 (40) | 0 |
| **Permanent form of AF** | 29 (32.2) | 27 (360 | 0 |
| **AV-block of II-III degree** | 2 (2.22) | 1 (1.3) | |
| **Prolongation of the Q-T interval** | 10 (11.1) | 6 (8) | |

Source: Author

AF significantly more common appeared in patients of the 2nd group ($p<0.05$). Probably, the presence of paroxysmal and permanent forms of AF should be considered as the disturbances closely associated with CES, because conditions for blood clots in the heart cavities develop only in this type of arrhythmia due to chaotic low-amplitude atrial contraction. However, there is a pathogenetic relationship between these dysrhythmias with HDS due to a sufficiently large presentation of AF in the 1st group. Paroxysmal AF leads to a disruption of central hemodynamics, reducing LV SV by an average of 43% [8]. This, in its turn, can lead to a decrease in cerebral blood flow. On this basis, we can assume that in some cases, paroxysmal AF is an underlying cause of cerebral hemodynamic lesion at obligatory consideration of the clinical course of AF paroxysm. Equally low incidence of AV-block of II-III degree in both groups does not allow correlate this type of pathology with CES and HDS.

The results of research have found cardiac pathology in all subtypes of IS in 84 (73%) of 115 patients. Ischemic heart disease occurred in 58 (69%) patients, whereas infectious and inflammatory diseases, as well as congenital abnormalities were determined in 19 (22.6%) and in 7 (8.4%) patients, respectively.

Patients with HDS had cardiac pathology in 85.5% of cases (n=77) (Table 2). Table 2 shows the clear prevalence of various types of ischemic heart disease identified in 74.4% of observations ($p<0.001$ compared with the 2nd group). Infectious and inflammatory diseases were presented rarely – in 11.1% of patients ($p<0.0001$ compared with the 2nd group). Patients with CES had heart diseases in all cases. The spectrum of illnesses revealed varied by groups. 68% of patients in the 2nd group had various forms of ischemic heart disease ($p<0.05$), 32% - infectious and inflammatory diseases, 2.7% - aneurysm of the thoracic aorta, 4% -myxoma, i.e. a comprehensive representation of cardiac pathologies with a certain predominance of ischemic heart disease is noted.

Table 2. Types of cardiac pathology in patients with ischemic stroke

| Type of cardiac pathology | 1st group (n= 90) | | 2nd group (n=75) | |
|---|---|---|---|---|
| | Abs. | % | Abs. | % |
| **Ischemic heart disease** | 67 | 74,4 | 51 | 68 |
| **Infectious and inflammatory diseases** | 10 | 11,1 | 24 | 32 |
| **Potential sources of embolism** | 67 | 74,4 | 75 | 100 |

Source: Author

Potential sources of cardiogenic cerebral embolism appeared in all groups, but their frequency was different. For example, if patients of the 2nd group had them in all cases, so in the 1st group they were detected only in 63.3% of observations ($p<0.001$). Postinfarction cardiosclerosis was diagnosed in 32 (35.5%) patients of the 1st group and 15 (20%) patients of the 2nd one ($p<0.01$), whereas rheumatic heart defects occurred in 22 (24.4%) and 31 (41.3%) patients ($p<0.05$), respectively. Mitral stenosis was a more common sign for the 2nd group. Aortic defect was diagnosed rarely. We also paid attention to the combination of mitral stenosis and AF in 41% of cases. The most number of these patients had CES.

The eye of the left atrium having over 80% of intracardiac thrombi is known to be the main source of emboli in AF. The brain is the main “target” of the thrombi. Calcification of the aortic valve structures and aorta is a source of calcified emboli [10]. In our study, there has been a tendency to more frequent IS occurrence in patients with mitral stenosis and calcification of the mitral valve than in patients with mitral insufficiency. This fact may be explained by the rare combination of isolated mitral regurgitation with intraatrial thrombus development. Rough mitral regurgitation over time results in dilation of the left atrium associated with dilation of its ear. However, due to the fact that the reverse blood flow creates a constant blood flow in the heart cavity, the opportunities for blood clotting are decreased.

Thus, the majority of patients with IS have different variants of cardiac pathology, testifying to the interrelation of brain and heart vascular lesions.

According to echocardiographic findings, LV EF in the 1st group was 65.3%, i.e. significantly lower than in the 2nd ($p<0.05$) and control groups (Table 3). A similar dependence was noted when comparing LV SV in two groups (76.2 ml/min and 85.9 ml/min, respectively, $p<0.01$). In control group LV SV was 83.5 ml/min, CO - 5.92 L/min, i.e. significantly higher than similar parameters in patients of the 1st group and comparable with the 2nd group. Thrombi in the heart cavities were often determined in patients with CES. The disturbances of local and total contractility in control group were absent.

HDS develops in conditions of “hemodynamic crisis” as a result of transient disorders of systemic hemodynamics. These changes are rarely the object of interest of doctors, since their verification requires the monitoring of basic functional

parameters of the cardiovascular system [13]. The interpretation of echocardiographic disorders in HDS is quite difficult due to the large variety of pathophysiological mechanisms that lead to cerebral vascular insufficiency [4]. In recent years, decrease in CO and LV EF developing with AF and congestive heart failure are considered to be the most stable echocardiographic markers for HDS [12]. In our study, we also report about lower values of CO and LV EF in patients of the 1st group, compared with the 2nd and control groups, although the values of the above parameters did not extend beyond the lower limit of norm. Perhaps, this can be explained by a significantly higher proportion of postinfarction cardiosclerosis in patients of the 1st group (35%) than in the 2nd one (20%). Taking into account the fact that the absolute values of volume parameters in patients with HDS did not extend beyond the lower limit of norm, apparently, adoption of the values of CO and LV EF as highly informative criteria for defining HDS is not possible. Apparently, short-term transient cardiac hemodynamic disturbances which are inaccessible to verification at single echocardiographic examination are relevant for HDS.

Table 3. The data of echocardiographic investigation

| Echocardiographic parameter | Group of patients | | Control (n=45) |
|---|---|---|---|
| | 1 (n=90) | 2 (n=75) | |
| **Left ventricular stroke volume, ml** | 76,2 | 85.9* | 83,5 |
| **Cardiac output, L/min** | 5.1# | 6.1** | 5,92 |
| **Ejection fraction, %** | 65.3# | 67.1** | 72,2 |
| **Zones of dyskinesia (the number of patients, %)** | 21 (23.3) | 29 (38.6) | 0 |
| **Reduction of the total LV contractility (the number of patients, %)** | 17 (18.9) | 21 (28) | 0 |
| **Thrombi in the heart cavities (the number of patients, %)** | 8 (8.88) | 30 (40)## | 0 |

Notes: * - differences p<0.001 to the 1st group;

** - differences p<0.01 to the 1st group;

# - differences p<0.05 to control;

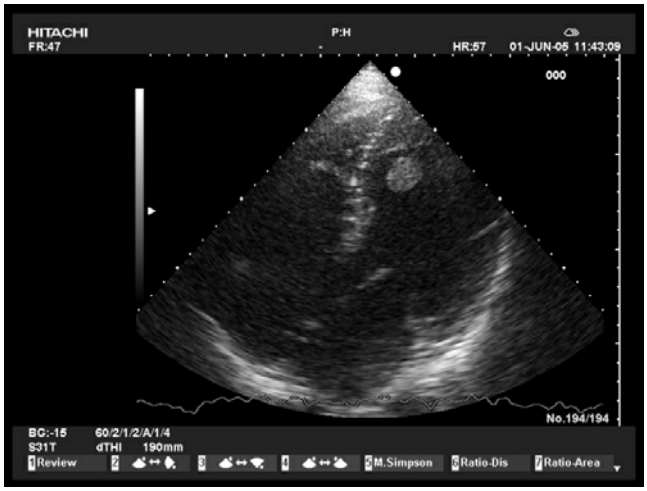
## - differences p<0.0001 to the 1st group

Source: Author

Thus, echocardiography has detected cardiac pathology in 73% of patients with heterogeneous subtypes of IS. At the same time, there were diagnosed different nosological variants of heart diseases that accordant to the published data [2,11]. Zones of akinesia and hypokinesia were found in 28% of the total number of heart diseases in stroke patients with a significant predominance in those with HDS. Despite the local LV dyskinesia is a manifestation of postinfarction cardiosclerosis and usually does not lead to alteration of heart pumping function, transient instability of coronary blood flow can be develop. Previous studies demonstrated that painless myocardial ischemia may be accompanied by a large overall reduction in blood pressure and LV contractility disturbance [6]. A sudden decrease in LV EF may lead to a reduction of regional cerebral blood flow in the basin of stenotic vessels and disruption of cerebrovascular reserve, and as a consequence to the development of focal cerebral ischemia. Thus, we believe that the local LV dyskinesia can be considered as a fairly significant sign for the possibility of HDS development.

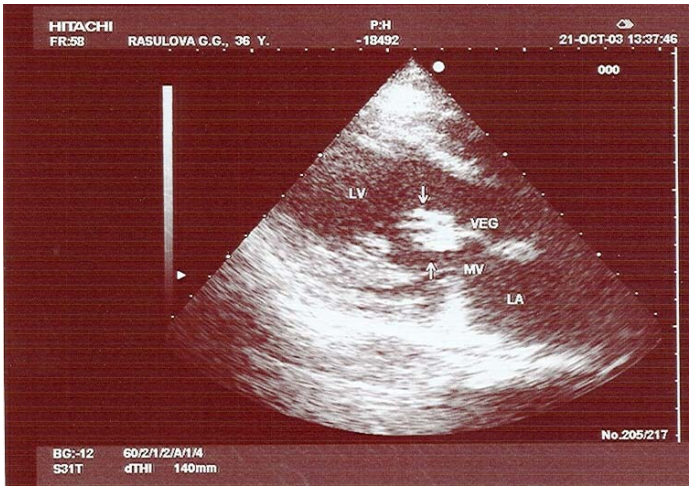
All patients of the 2nd group had cardiac pathology. It was interesting that blood clots were observed in the heart cavities, predominantly in the LV (Figure 1) in 16 (45.7%) of investigated in this group. 12 of them had thrombosis of the internal carotid artery upon duplex scanning, and extensive cortico-subcortical or hemispheric brain infarction on CT. Severe course of stroke with the development of rough neurological deficit was noted in all cases. Infectious and inflammatory diseases appeared more rarely (12%) and were represented mainly by bacterial endocarditis (Figure 2).

Figure 1. Thrombus in the apex of the left ventricle.




Source: Author

Figure 2. Vegetations (Veg) in the leafs of the mitral valve (are showed by pointers). LV - left ventricle, MV - mitral valve, LA - lung artery.




Source: Author

41 (45.5%) patients in the 1st group had lacunar foci of cerebral ischemia due to pathology of small cerebral arteries, in particular arteriolosclerosis in arterial hypertension. Probably, the presence of ischemic heart disease in this case reflects a certain parallelism between hypertensive and atherosclerotic changes in the vascular bed. The disease usually had a more favorable course and limited by a minimal neurological deficit.

Thus, cardiac pathology in more or less degrees is characteristic for all subtypes of IS. Underestimation of both cardiac pathology in patients with IS and potentially dangerous link between cardiac and cerebral disturbances may cause recurrent IS. Cardiac embolism may be the most formidable mechanism of recurrent stroke. Its incidence, according to several authors, amounts up to 30-35% of all IS cases [5,7,12].

A comprehensive examination has identified cardiac changes - potentially sources of cardiac embolism - in all groups, regardless of the pathogenetic mechanism of stroke: in 67 (74.4%) patients of the 1st group and in all (100%) patients of the 2nd one. This suggests that the presence of cardiac pathology in patients with different subtypes of IS not only reflects the participation of heart in total damage of the cardiovascular system, but also indicates a risk of possible cerebral complications.

**Conclusions**

1. The majority of patients with ischemic stroke have various cardiac pathologies, mainly different forms of ischemic heart disease.
2. Cardioembolic subtype of ischemic stroke often leads to the development of extensive cortico-subcortical and hemispheric cerebral infarctions, and is characterized by the most severe course of disease.
3. The combination of mitral heart defect with atrial fibrillation generally leads to the development of cardioembolic stroke.
4. The parameters of left ventricular stroke volume and ejection fraction in patients with hemodynamic stroke are low than in cardioembolic subtype, but they do not exceed the lower limit of norm.
5. The local left ventricular dyskinesia is a stable echocardiographic marker for hemodynamic subtype of ischemic stroke developing as a result of unstable systemic hemodynamics, leading to cardiocerebral insufficiency.

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