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Cerebral dysfunction in patients with acute myocardial infarction

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Abstract

Background. *The article discusses the features of one of the complications of acute myocardial infarction − cerebral dysfunction, which negatively affects the quality of life of patients, worsens the disease prognosis, increases the hospital length of stay and the risk of death. The presence of cerebral disorders in patients with acute myocardial infarction causes difficulties in the choice of therapeutic tactics, including the decision on myocardial revascularization. The identification of predictive factors for cerebral deficiency in acute myocardial infarction and the development of an algorithm for the management of such patients is an urgent task of today medicine.*

Aim. *To study the features of cerebral dysfunction in patients with myocardial infarction according to contemporary Russian and foreign literature sources. To create an algorithm for the diagnosis and treatment of cerebral dysfunction in patients with acute myocardial infarction.*

Material and methods. *Patients with acute myocardial infarction who developed cerebral dysfunction in the acute period of the disease were examined.*

Conclusion. *Timely diagnosis, antiplatelet therapy, emergency reperfusion therapy in the acute period of myocardial infarction, as well as preventive measures reduce the development of cerebral complications, improve the results of treatment of patients with myocardial infarction, reduce the number of inpatient treatment days, as well as improve the long term prognosis.*

Keywords: acute myocardial infarction, cerebral dysfunction, stroke, delirium, cognitive impairment

Conflict of interests Authors declare no conflict of interest

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AF, atrial fibrillation
AMI, acute myocardial infarction
CVA, cerebrovascular accident
ECG, electrocardiogram
LV, left ventricle

Introduction

Cardiovascular diseases rank first in prevalence and are the main causes of mortality in Russia and the world [1]. Acute myocardial infarction (AMI) is one of the clinical forms of coronary heart disease, which is characterized by the development of necrosis at a myocardium site related to its impaired blood supply. Despite the progress achieved in recent years in the cardiovascular pathology treatment and its mortality reduction, the AMI complicated course remains an urgent problem [2, 3].

One of these conditions is the cerebral dysfunction, which is identified in approximately 10% of AMI patients. In scientific literature, cerebral disorders associated with brain abnormalities against the background of cardiac pathology have been described as a “cardiocerebral syndrome” [3]. The cause of cerebral dysfunction in patients with AMI may be an acute cerebrovascular accident (CVA), delirium, and cognitive impairments.

Aim. To study the typical features of cerebral dysfunction in patients with acute myocardial infarction by reviewing current Russian and foreign literary sources.

Acute cerebrovascular accident in acute myocardial infarction

One of the most serious complications of AMI is stroke. The length of the stroke increased risk period after AMI remains a subject of debate. According to some data, stroke is most likely to develop up to 4 weeks after AMI, but the increased risk of this complication persists for up to 3 months or longer [4]. According to J. Luo et al. (2018), ischemic stroke occurs in 0.9% of cases within 1 month and in 3.7% of cases within a year after AMI, while the risk of death within a year in the presence of stroke increases by 15% [5].

The basis of acute vascular diseases of the heart and brain includes common pathophysiological mechanisms: multifocal atherosclerosis with damage to the coronary and cerebral arteries, as well as the inflammation with the development of endothelial dysfunction [2]. Acute CVA and AMI have common risk factors, such as arterial hypertension, dyslipidemia, smoking, diabetes mellitus, and age. In recent years, a genetic predisposition to the development of atherosclerosis has been proven, and the role of immune mechanisms is discussed [4].

The most significant risk factors for the combined development of AMI and stroke of the ischemic type are male gender, age over 70 years, a previous history of stroke, the presence of post-infarction cardiosclerosis and the 1st day of Q-myocardial infarction of the left ventricle (LV) anterior wall [6].

In case of AMI, especially that of the LV anterior wall, the irritation of the cardiac muscle receptors occurs due to hypoxia, which leads to the intracardial reflex activation [7]. Due to arterial hypotension, the perfusion of the heart and brain decreases, and hypoxia deteriorates.

The pathogenetic basis for the development of stroke in AMI is paroxysmal disturbances of central hemodynamics against the decreased myocardial contractility (hypokinesia/akinesia or LV aneurysm), disturbances of cardiac rhythm and conduction, especially high-grade ventricular extrasystoles (according to B. Lown–M. Wolf classification) atrial fibrillation (AF) and paroxysmal tachycardia [2].

It is known that the stroke incidence is significantly higher in patients with AF. This form of cardiac arrhythmia, when present, creates favorable conditions for the formation of blood clots in the left atrial appendage or in the atrium itself and increases the risk of developing cardioembolic ischemic stroke [8]. Heart rhythm disturbances occur due to electrical instability of the left atrium myocardium caused by its hypoxia and stretching during AMI [9]. In AF, an atrial systole is absent, which results in the disruption of laminar blood flow and increases the likelihood of thrombi formation [10].

In the presence of CVA, the developed AMI often occurs in a painless or arrhythmic form, which makes a timely diagnosis of the disease difficult [11]. In acute CVA, 70% of patients show changes in the ST segment on the electrocardiogram (ECG), which complicates a timely diagnosis [7]. In patients with acute CVA of ischemic type, T-wave

inversion (34.48%), ST-segment depression (32.75%) and QT interval prolongation (29.31%) are observed on the ECG. In patients with hemorrhagic stroke, the ECG shows T-wave inversion (33.33%), arrhythmias (33.33%) and ST-segment depression (23.8%). Typical "cerebral" T waves are symmetrical, at least 5 mm deep, recorded in 4 adjacent leads [12].

ECG changes depend on the cerebral event location, suggesting changes in the central regulation of cardiac activity as a mechanism for the development of these changes. According to the study by O.E. Dubenko et al. [13], the ECG shows a prolongation of the QT interval more often in patients with hemorrhagic type CVA type in the left brain hemisphere than in patients with damage to the right hemisphere. There were no statistically significant differences in the ST segment changes between individuals with different types of acute CVA. It was revealed that the QT interval prolongation and T-wave inversion were statistically significantly more often observed in patients with hemorrhagic stroke with the development of medial and mixed hematoma ($p < 0.05$).

In both AMI and acute CVA, there is an increase in the blood levels of cardiac troponins, in particular, troponin I. In patients with ischemic acute CVA, the increase in troponin I is associated with increased blood levels of circulating epinephrine [14]. In this case, the activation of the sympathoadrenal system may be an important link in the pathogenesis of myocardial damage. According to a meta-analysis of studies published in PubMed and Embase, increased cardiac troponin levels are an independent predictor of increased all-cause mortality in patients with ischemic acute CVA [15].

The treatment tactics for stroke in AMI should include administering the nitrates, beta-blockers, antiplatelet and anticoagulant therapy [16].

Delirium in acute myocardial infarction

The main psychopathological complications of AMI are delirium, anxiety, depression, and cognitive impairments [17].

Delirium is an acute, reversible psychopathological syndrome with a nonspecific etiology, which is characterized by a combined disorder of attention and cognitive functions, and disturbances in psychomotor activity, as well as a disorder of the sleep-wake cycle [18]. In patients with AMI under the age of 80 years, the incidence of delirium makes 2–15% and increases to 50% in those over 85 years of age [19].

To date, the mechanism of delirium development has not been precisely determined. Apparently, the nature of this condition is polyetiological, since most patients have a combination of several risk factors. Elderly and senile age, severe comorbidity, previous dementia, alcohol abuse, arterial hypertension, hypoxic conditions (in particular, anemia), and high psycho-emotional stress predispose to the delirium development [20]. Meanwhile, according to M. Jackel et al. (2021), location, prevalence, and type of AMI (with or without ST-segment elevation) have no impact on the delirium development [21]. Meantime, risk factors for its development correlate with an increase in hospital mortality in elderly patients with ST-T segment elevation AMI who have undergone percutaneous coronary interventions [22].

It is known that delirium worsens the prognosis of cardiac patients, prolongs hospital length of stay and increases the risk of death. The study by A. Abdullah et al. (2018) showed that mortality among patients with AMI who developed delirium was 10.5% versus 2.6% in patients without delirium ($p<0.001$, statistically significant) [23].

According to the study by J.S. Pollock et al., which included 107 patients who stayed in the cardiac Intensive Care Unit for acute coronary syndrome, in 100% of cases, with an increase in body temperature,

delirium was observed, which lasted on average from 1 to 4 days [24]. Delirium develops in 1 of 3 patients with acute heart failure. Typically, these patients with delirium and acute heart failure have higher blood levels of B-type natriuretic peptide than patients without delirium [25].

Some cardiac medications (procainamide, metoprolol, lidocaine, amiodarone, digoxin) used to treat cardiac arrhythmias occurring as AMI complications can provoke the development of delirium [26].

We should note that traditional drugs used to treat delirium are often contraindicated for AMI patients as they can provoke the development of life-threatening arrhythmias [21]. A promising trend in the delirium treatment of a cardiac patient in the Intensive Care Unit is the use of dexmedetomidine, an α2-adrenergic receptor agonist [27]. This drug showed its efficacy in preventing delirium in a study in patients after cardiac surgery [28].

Impaired cognitive functions in acute myocardial infarction

Cognitive functions are the most complex functions of the brain, through which the process of rational cognition of the world and interaction with it occurs. It should be noted that in AMI, executive cognitive functions associated with the patient's planning of goal-directed actions and making relevant decisions are most affected [5].

According to NCDR (the National Cardiovascular Data Registry), among 43,812 patients over the age of 65 years with ST-segment elevation AMI, a mild cognitive impairment was detected in 3.9%, and moderate or severe cognitive impairment in 2.0%. Among 90,904 patients with non-ST segment elevation AMI, 5.7% had mild cognitive deficits, and 2.6% had moderate or severe cognitive deficits [21]. Moreover, in the AMI recovery period, the incidence of moderate cognitive deficit increases to 10−13.3%. According to A. Salzwedel et al. (2017), more

than 1/3 of the patients at the stage of cardiac rehabilitation have cognitive impairments [12].

To date, the risk factors for cognitive impairment after AMI have not been fully elucidated. It is assumed that AMI, leading to a decrease in the pumping function of the heart, together with concomitant atherosclerosis of cerebral vessels, contributes to the development of cerebral hypoperfusion, deterioration of the cerebral cortex cell metabolism, which all ultimately lead to the development of cognitive deficit [21]. The pain syndrome in AMI contributes to the development of marked psycho-emotional disorders that often precede the development of cognitive impairments and represent the first symptom of chronic cerebral ischemia [27]. In addition to the fact that cognitive impairments significantly reduce the quality of life in patients, they may be associated with longer hospital stay, increased in-hospital mortality, and the development of new impairments of cognitive functions [15].

Anxiety and depression are very common conditions in patients with cardiovascular diseases [29]. The presence of depression in patients with AMI significantly worsens the course of the disease and prognosis [30].

The study by P. Serpytis showed that after AMI, depression developed in 71.4% of female patients and in 60.4% of male patients; HADS-D scores were statistically significantly higher in women than in men ($p=0.004$). It was also found that men suffering from depression were, on average, younger than those who were not diagnosed with depression [29].

Treatment of depression in patients after AMI, including psychotherapy and physical exercises, showed high but short-term efficacy [31]. Successful treatment of depression has improved the long-term prognosis of patients with cardiovascular diseases.

The patient's cognitive status influences the choice of treatment tactics in patients with AMI. For example, the study by D.A. Levine et al., has shown that patients with cognitive impairment undergo cardiac catheterization and myocardial revascularization less often than patients with a preserved cognitive function [32]. This circumstance may worsen the results of rehabilitation of patients after AMI.

However, to date, no generally accepted algorithm for the diagnosis and treatment of patients with cognitive impairment in the acute period of myocardial infarction has been developed. Treatment in this case is targeted at the main pathogenetic links in the chain of the developing cognitive disorders (hypoperfusion, hypoxia) [33].

Conclusion

Cerebral dysfunction in patients with acute myocardial infarction has a negative impact on the quality of life of patients and the prognosis of the disease, increases the hospital length of stay and the risk of death. In addition, the presence of cerebral disorders in patients with acute myocardial infarction often complicates the choice of adequate therapeutic tactics. In this regard, an actual trend of timely medicine is the study of predictive factors for the development of cerebral deficits in acute myocardial infarction, and the development of algorithms for managing these patients.

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