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Advantage of Ultrasonic Methods for Studying the Arterial Vascular Wall in Patients with Cardiovascular Diseases

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Abstract:

Currently, there are ultrasound markers of the atherosclerotic process that make it possible to give both a structural and functional assessment of the condition of the vascular wall.

One of the main advantages of ultrasound duplex scanning of vessels is the ability to non-invasively detect small and asymptomatic atherosclerotic changes in the vascular wall with a high degree of accuracy. Identifying individuals with subclinical atherosclerosis at increased risk of cardiovascular events is important in initiating primary preventive measures.

Ultrasound diagnostic methods are the most important diagnostic element in identifying subclinical atherosclerosis, which makes it possible to carry out the necessary drug correction before the onset of clinically manifest forms of CVD and reduce the risk of cardiovascular complications. Standard protocols for duplex scanning of the extracranial section of the brachiocephalic arteries do not provide for the determination of the PS indicator, the prognostic significance of which has already been demonstrated in a number of studies, but requires further study in real clinical practice.

Keywords: dyslipidemia, atherosclerosis, ultrasound examinations, cardiovascular diseases, familial hypercholesterolemia

Ultrasound methods for studying the arterial vascular wall in patients with cardiovascular diseases The ultrasound method for studying the carotid arteries is a non-invasive, accessible, informative, safe, relatively inexpensive (when compared with magnetic resonance computed tomography) method for studying blood vessels, allowing for early preclinical diagnosis of atherosclerosis, assess the severity of atherosclerotic damage to the vascular wall, monitor the atherosclerotic process during dynamic observation, evaluate the effectiveness of therapy, and reduce the risk of coronary atherosclerosis [2,4].

Purpose of the study

Studying the advantages of ultrasound methods for studying the arterial vascular wall in patients with cardiovascular diseases based on studying the results of clinical studies.

Results and analysis

Currently, there are ultrasound markers of the atherosclerotic process that make it possible to give both a structural and functional assessment of the condition of the vascular wall. In real clinical practice, duplex scanning of the extracranial section of the brachiocephalic arteries according to the standard protocol, dopplerography of the arteries of the lower extremities and, less often, determination of the ankle-brachial index (ABI) are most often used. A significant part of the ultrasound parameters that assess the state of the arterial vascular wall have not found widespread use in clinical practice and are either used primarily for scientific purposes or are at the development stage.

According to the clinical recommendations of the All-Russian Scientific Society of Cardiology (VNOK) (2009) and the Russian Society of Cardiology (RKO) (2012), the following algorithm for ultrasound examination of the arterial bed in patients with lipid metabolism disorders is proposed:

✓ Duplex scanning of the extracranial section of the brachiocephalic arteries is recommended for all individuals upon initial detection of dyslipidemia. If atherosclerotic plaques (ASP) are detected, a repeat study is recommended after 0.5 years; if there is no change in the structure and size of the ASP during this period, dynamic observation is indicated once a year.

✓ In persons with lipid metabolism disorders and clinical signs of cerebral circulatory insufficiency, duplex scanning of the brachiocephalic arteries is necessary to exclude atherosclerotic lesions of cerebral vessels [8].

✓ Among patients with low and moderate cardiovascular risk, duplex scanning of the brachociocephalic arteries is recommended for all women over 50 years of age and men over 45 years of age, as well as younger patients if they have hypertension and/or a total cholesterol level of 5.2 mmol/ l or more [7,8].

In diagnostic practice, a standard duplex scan of the extracranial section of the brachiocephalic arteries and, less commonly, the femoral arteries is performed, which allows one to assess qualitative atherosclerotic changes (presence of ASB, their location, shape, mobility, structure, density, surface condition, presence of complications) and quantitative changes (percentage stenosis, blood flow velocity in the area of stenosis). ASP is a focal structure that either protrudes into the arterial lumen by at least 50% of the thickness of the intima-media complex (IMC) of the adjacent sections of the artery, or has a thickness measured as the distance between the “media-adventitia” and “arterinthymic lumen” dividing lines, more than 1.5 mm [1,9].

One of the main advantages of ultrasound duplex scanning of vessels is the ability to non-invasively detect small and asymptomatic atherosclerotic changes in the vascular wall with a high degree of accuracy. Identifying individuals with subclinical atherosclerosis at increased risk of cardiovascular events is important in initiating primary preventive measures.

IMT is currently the most studied indicator of the development of atherosclerotic vascular lesions, as well as their remodeling, measured and monitored during vascular ultrasound. Carotid IMT is an established marker of subclinical arterial disease and is associated with an increased risk of cardiovascular events [3,5], and also serves as an important target for potential therapeutic interventions. [1,6].

The American Society of Echocardiography, in its recommendations (2008) for the study of IMT, outlines the requirements for equipment, personnel, methods of performing the study and evaluating the results of the study. Determination of the average IMT should be performed along the posterior wall of the distal third of the common carotid artery at a distance of 1 cm from the bifurcation. The recommendations also indicate standard indicators based on gender and age. If the IMT value is >75 percentile, then the cardiovascular risk is assessed as high. If the IMT value is from the 25th to 75th percentile, then the cardiovascular risk is moderate. If IMT is <25th percentile, then cardiovascular risk is low [11]. A meta-analysis that included eight studies involving a total of 37,197 people found that a 0.1 mm increase in IMT was associated with an increase in the risk of myocardial infarction from 10% to 15%, and an increase in the risk of stroke from 13 to 18%. [10,12].

The American Society of Echocardiography recommends that IMT be measured not only in patients with intermediate cardiovascular risk (according to the Framingham scale), but also in all persons with a family history of early development of cardiovascular disease in first-degree relatives; examination is also recommended for persons aged less than 60 years of age with one but aggravating risk factor (for example, hereditary hyperlipidemia), who have no other indications for drug therapy for atherosclerosis, in addition, it is recommended for women under 60 years of age with two or more CVD risk factors [2,14].

A study of 1969 patients showed that, in routine clinical practice, measuring carotid IMT in addition to identifying existing risk factors significantly improves the predictability of cardiovascular events in a large group of patients who fall into the intermediate-risk category and who are not currently involved. in carrying out active preventive measures [13].

IMT measurement is used not only to identify atherosclerotic lesions, but also to assess the effectiveness of pathogenetic treatment. Ultrasound studies ACAPS, KAPS, MARS, ARBITER, ASAP, REGRESS, METEOR have convincingly shown that effective lipid-lowering therapy can stop the increase in IMT, and even lead to a decrease in this parameter [13,14].

The presence of ASP in the carotid arteries enhances the prognostic significance of carotid IMT [2] and is itself a predictor of coronary artery disease, even to a greater extent than carotid IMT. [1,8] In recent years, more and more people are turning to the ultrasound indicator, referred to in the English literature as the “plaque score” (PS). At the present time, the term does not have a generally accepted Russian analogue. In a number of works it is referred to as the total height of carotid plaques [11].

PS is the sum of the maximum thickness of all ASPs of both carotid arteries [3,7] or the ratio of the sum of the maximum thickness of all plaques of both carotid arteries to the number of plaques [9]. To calculate this index, the carotid artery is conventionally divided into 4 segments, each 1.5 cm long: 1 segment - 1.5 cm above the bifurcation, 2nd segment - bifurcation, 3 and 4 segments - sections of the artery below the bifurcation. The maximum plaque thickness is measured for each of the specified segments [13].

In patients with pre-existing ASP, PS is likely to be a more sensitive marker of atherosclerosis than common carotid IMT [9]. According to Sakaguchi M. et al. in 186 patients with coronary artery stenosis of more than 50%, the PS score was 3 times higher than in the group of patients without significant coronary artery stenosis (84 people), and amounted to 14.1 ± 9.5 and 4.6 ± 5, 9 respectively. The study also demonstrated that PS and mean IMT of the bifurcation and internal carotid artery are stronger predictors of coronary atherosclerosis than mean IMT of the common carotid artery, while the sensitivity and specificity of PS and mean IMT of the bifurcation and internal carotid artery were statistically comparable, which is evidence that PS is as significant a predictor of coronary atherosclerosis as the mean IMT of the bifurcation and internal carotid artery used in large studies such as the CHS and ARIC [6,9]. PS characterizes the condition of not only the posterior wall of the distal third of the common carotid artery, but also the condition of the anterior wall of this area and the anterior and posterior walls of 3 more segments, including the bifurcation and internal carotid artery, where ASB develop more often and earlier compared to the common carotid artery [1,2]. PS, in contrast to the average IMT of the common carotid artery, is a reflection not of local changes, but of the overall severity and prevalence of the atherosclerotic process in the carotid region, but only in the presence of ASP.

Morito N. et al. evaluated PS data in 116 patients who underwent coronary angiography. The study showed that the total height of carotid plaques exceeding 1.9 mm is a prognostic value indicating the presence of coronary atherosclerosis [13,20]. The sensitivity of the method was 79.7%, and the specificity was 63.4%.

ABI is the ratio of ankle pressure to shoulder pressure, which was first determined using ultrasound. In 2000, Papamichael C.M. et al. et al. demonstrated that an ABI value of less than 0.9 is an independent factor predicting the development of serious cardiovascular complications [6,9]. In 2006, reports appeared on the results of a prospective study lasting 13 years, which included 1325 patients, suggesting ABI as a significant prognostic factor for the risk of MI and cardiovascular death. It was found that a decrease in ABI by 0.1 risk is accompanied by an increase in the risk of MI by 22%, and the risk of cardiovascular death by 35% [5,19,21]. ABI is an indicator that allows you to identify the presence of hemodynamically significant pathology of the arteries of the lower extremities already at the preclinical stage, assess the state of blood circulation, including dynamics, and with a high degree of probability suggest the presence of atherosclerotic changes in the carotid and coronary systems [3,15].

A number of other ultrasound techniques for studying the arterial bed, such as determining the number of plaques, the area and volume of an atherosclerotic plaque [12,14], quantitative study of plaque heterogeneity in two-dimensional mode [10,16], study of arterial stiffness and reflected waves [9,17], have not been widely used in real clinical practice due to technical difficulties in performing studies and insufficient data on their prognostic significance. Techniques such as the study of heterogeneity of the intima-media complex [7,22] and quantitative study of plaque heterogeneity in three-dimensional mode are currently under development.

Conclusion. Thus, ultrasound diagnostic methods are the most important diagnostic element in identifying subclinical atherosclerosis, which makes it possible to carry out the necessary drug correction before the onset of clinically manifest forms of CVD and reduce the risk of cardiovascular complications. Standard protocols for duplex scanning of the extracranial section of the brachiocephalic arteries do not provide for the determination of the PS indicator, the prognostic significance of which has already been demonstrated in a number of studies, but requires further study in real clinical practice.

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