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Modern Approaches To The Diagnosis And Treatment Of Combined Occlusive Lesions Of The Brachiocephalic Arteries And The Terminal Aortic Segment

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Abstract: Vascular diseases, particularly occlusive lesions of major arteries, remain among the leading causes of disability and mortality. A special clinical challenge is posed by combined lesions of the brachiocephalic arteries and the terminal segment of the aorta, which reflect the multifocal nature of atherosclerosis and are associated with a high risk of stroke, critical limb ischemia, and multiple organ failure. This article reviews current concepts of the pathogenesis of such conditions, their epidemiological significance, and diagnostic opportunities, including duplex ultrasonography, multislice computed tomography, and magnetic resonance angiography. Particular attention is given to a comparative analysis of surgical, endovascular, and hybrid treatment modalities, as well as to the choice of optimal patient management strategies. A promising direction is the personalized approach, which incorporates comprehensive diagnostic and therapeutic algorithms aimed at reducing the risks of stroke, amputation, and improving long-term outcomes.

Keywords: Occlusive lesions, brachiocephalic arteries, terminal aorta, multifocal atherosclerosis, diagnosis, treatment, carotid endarterectomy, stenting, endovascular technologies, hybrid interventions.

Introduction: Vascular diseases remain one of the most pressing challenges in modern medicine, as they determine high morbidity, disability, and mortality rates in the general population [1]. Among these, occlusive lesions of major arteries, including the brachiocephalic vessels and the terminal aortic segment, hold a special place [2]. These lesions are not only widespread but also tend to occur in combination, reflecting the multifocal nature of the atherosclerotic process [17]. The clinical significance of this pathology is determined by the high risk of stroke, chronic lower limb ischemia, critical cerebral ischemia, and multiple organ failure [9,15]. Therefore, optimizing diagnostic strategies and treatment choices for such patients is of paramount importance [19].

Epidemiological data show that stenoses of the brachiocephalic arteries are found in one-third of patients with coronary artery disease and in more than half of patients with peripheral atherosclerosis [1,2]. Stenoses and occlusions of the carotid arteries increase the risk of ischemic stroke several-fold, especially in cases of hemodynamically significant narrowing and unstable atherosclerotic plaques [3,5,15]. At the same time, occlusive lesions of the terminal aorta and iliac bifurcation, known as Leriche's syndrome, manifest as intermittent claudication, rest pain, trophic disturbances, and erectile dysfunction [18]. The combined involvement of these regions is associated

with severe disease course, significantly reduced quality of life, and the need for a complex therapeutic approach [16,18].

The pathogenetic basis of such disorders is systemic atherosclerosis, which develops against the background of chronic endothelial dysfunction, vascular wall inflammation, hypercoagulation, and lipid metabolism disturbances [17]. Traditional risk factors—smoking, hypertension, diabetes mellitus, obesity, and hereditary predisposition—act most aggressively in patients with multifocal lesions, accounting for their rapid progression and frequent complications [1,17]. In recent years, increasing attention has been paid to immunoinflammatory mechanisms and the role of cytokines, which contribute to plaque instability and systemic vascular inflammation [17,20].

Diagnosis of combined occlusive lesions is based on the integration of clinical findings and modern imaging techniques. Duplex ultrasonography remains the first-line method for evaluating brachiocephalic artery involvement, as it provides information on the degree of stenosis, plaque morphology, and hemodynamic changes [1,2]. For the assessment of the aortoiliac segment, Doppler ultrasound and multislice computed tomography angiography are widely used, offering visualization of lesion extent and collateral circulation [12,13]. Magnetic resonance angiography is employed as a noninvasive method to assess vascular anatomy and detect hemodynamically significant stenoses without ionizing radiation [1,12]. Despite technological advances, digital subtraction angiography remains the “gold standard” for surgical planning [4,18]. Functional imaging modalities such as perfusion CT and MRI of the brain are gaining importance for evaluating the clinical significance of lesions and ischemic risk [12].

Surgical treatment of combined occlusive lesions requires an individualized approach. Carotid endarterectomy has become the most widespread procedure over the past decades, proving effective in stroke prevention in high-risk patients [3,5,15]. In cases of occlusion of the terminal aorta and iliac bifurcation, aorto-femoral bypass remains the standard of care, providing good long-term patency [18]. However, open surgical procedures are associated with significant invasiveness, high complication rates, and prolonged rehabilitation, limiting their use in elderly patients or those with severe comorbidities [18,19].

Against this background, endovascular techniques have gained wide acceptance. Carotid artery stenting has demonstrated outcomes comparable to endarterectomy, particularly in high-risk patients and those with restenosis after prior surgery [2,9,15]. Endovascular procedures in the aortoiliac segment are highly effective, with less invasiveness and shorter recovery periods [8,14]. The use of modern covered stents and endografts has further improved primary patency rates and reduced restenosis risk [14]. Intravascular imaging techniques now play an important role in optimizing outcomes by providing precise lesion assessment [12].

The development of hybrid approaches, combining open and endovascular interventions, deserves special attention. In patients with multifocal disease, hybrid surgery enables simultaneous correction of lesions in different regions, reducing the number of treatment stages and lowering complication risk [6,7,16]. For example, carotid endarterectomy may be combined with iliac artery stenting, or aorto-femoral bypass may be performed alongside carotid artery stenting [16]. Such strategies allow for complete revascularization, reducing the risk of stroke and limb amputation [6,7,16].

Comparative analysis shows that treatment strategies must be strictly individualized. In some patients, a staged approach is appropriate, with priority given to addressing the most life-threatening lesion, such as internal carotid artery stenosis, followed by reconstruction of the aortoiliac segment [3,10,11]. In others, simultaneous interventions are optimal [4,6,16]. Decision-making should involve a multidisciplinary team including vascular surgeons, cardiologists, neurologists, and anesthesiologists [19].

Despite significant progress in vascular surgery, unresolved issues remain. Criteria for choosing between open and endovascular approaches in patients with multifocal atherosclerosis are not yet fully defined [8,9,14]. Further studies are needed to evaluate long-term outcomes of hybrid procedures and stent patency [6,7,10,11]. Increasing attention is being paid to the integration of personalized medicine, including the use of inflammatory biomarkers and genetic predictors for risk stratification [17,20].

In conclusion, combined occlusive lesions of the brachiocephalic arteries and the terminal aorta should be regarded as a multifocal form of systemic atherosclerosis, characterized by a high degree of clinical significance and an unfavorable prognosis [17]. Their relevance is determined not only by their high prevalence but also by the fact that this pathology represents one of the leading causes of stroke, critical limb ischemia, and multiorgan complications, which ultimately directly affects mortality and disability rates [1,2,3].

Optimization of diagnostics in this category of patients requires the integration of anatomical and functional imaging methods, which allow not only the

determination of the extent and morphological features of the lesion but also the assessment of its hemodynamic significance, the risk of atherosclerotic plaque destabilization, and the likelihood of ischemic events [12,13]. Modern approaches include the use of multislice computed tomography, magnetic resonance angiography, as well as functional methods such as perfusion CT and MRI, which provide opportunities for more accurate risk stratification and selection of patients for surgical or endovascular treatment [12].

The treatment strategy should be based on the principles of an individualized approach, taking into account the localization and extent of the lesions, the functional state of the patient, and the presence of comorbidities [19]. It has been demonstrated that optimal outcomes are achieved through a rational combination of traditional open reconstructive operations, endovascular technologies, and hybrid techniques, which allow simultaneous intervention in several vascular territories [6,7,14–16]. A particularly promising direction is the use of hybrid interventions, as they provide complete revascularization, reduce the number of treatment stages, and decrease the risk of both early and long-term complications [6,7,16]. Future prospects in vascular surgery for combined occlusive lesions are associated with the implementation of personalized medicine, based on the use of inflammatory biomarkers, molecular genetic predictors, and the assessment of individual risk factors [17,20]. Such an approach will make it possible to develop personalized patient management algorithms, optimize the choice of therapeutic strategies, improve treatment efficacy, and reduce the likelihood of adverse outcomes [17,20]. Overall, comprehensive diagnostics and individualized treatment of combined occlusive lesions of the brachiocephalic arteries and the terminal aorta represent a key direction in modern vascular medicine [1,2,17]. The implementation of strategies aimed at the integration of innovative diagnostic technologies, minimally invasive surgical methods, and personalized therapeutic algorithms will significantly improve the quality of medical care for this category of patients and enhance their long-term prognosis [19,20].

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