# ETIOPATHOGENESIS OF ANTERIOR ISCHEMIC OPTIC NEUROPATHY

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**ABSTRACT**
At present the number of people of working age suffering from hypertension, atherosclerosis, coronary heart disease and diabetes mellitus is considerably growing. These diseases are often accompanied by circulatory disorders in the retinal vessels and the vessels supplying the optic nerve, age-related dystrophic changes, etc. A significant percentage of these patients become disabled.

**Keywords:** neuropathy, ischemia, optic nerve, etiology.

## INTRODUCTION

Ischemia is the most common basis of pathology in these diseases. The risk of eye ischemia is conditioned by anatomical features of the microcirculatory channel and to some extent depends on the degree of collateral circulation which exists in prelaminar, laminar and postlaminar parts of the optic nerve. General characteristics of ischemic diseases of the eye. There is currently no classification of ocular ischaemia. Close relationship between lesions of different parts of circulation system as well as between ischemic development mechanisms does not allow to divide ischemic processes in eye by etiological and pathogenetic features. Due to the fact that ischaemic eye diseases are polyetiological, have different pathogenesis and a multifaceted clinical picture, a perfect classification is difficult to present. The only clear division of all ischaemic processes in the eye is between acute and chronic. Retinal dystrophic changes are among the most severe lesions of the eye. They occur in both young and old age and are often characterised by a progressive course, leading to a decrease in visual function and often to disability. The question of the classification of degenerations has not been finally resolved. Without going into a discussion about existing classifications, as a working alternative, it is advisable to take as a basis the Duke-Elder (1967) proposal dividing all retinal dystrophic changes into degenerations primarily related to the disturbance of vascular circulation in the choriocapillary layer and retinal vessels, and hereditarily deterministic lesions and degenerations. In the first group of diseases, chronic ischaemia is the main pathogenetic link. In the second group of retinal degenerations the ischemic component is secondary. But it is very important to consider its presence when selecting a treatment package. Among the most severe degenerative, dystrophic changes of the retina, there are macular lesions. These lesions occur in 25-40% of patients, more often in the elderly. This may be explained by the fact that the macular region is generally in worse feeding conditions than the peripheral parts of the retina. In the pathogenesis of age-related macular dystrophy, sclerotic changes in the chorioidea vessels, haemodynamic shifts in the ocular artery may be observed in arterial hypertension as well as in hypotension. Hoyng (1998) found that 1% of patients with senile central macular degeneration become practically blind by the age of 65-74 years, with a visual acuity of 0.01-0.02. In the age group over 85 years, the number of blind patients reaches 11%. A significant problem is the treatment of glaucomatous optic atrophy. Most ophthalmologists believe that optic atrophy is largely due to circulatory disorders. This problem is especially acute in treatment of advanced glaucoma when vascular disorders often combined with this eye disease (atherosclerosis, hypertension or diabetes mellitus) lead to an acute deficit of blood supply, and compensatory possibilities are completely exhausted. After surgical treatment, IOP is most often normalised in these patients. However, long-term results show that the decline in visual function continues despite the normalization of IOP. Acute ischaemia of the posterior segment is manifested by circulatory disturbances in the CAC and its branches, anterior and posterior ischaemic neuropathy. It can be a consequence of pre-existing chronic ocular ischaemia (diabetic or hypertensive angioretinopathy, degenerative retinal changes, carotid stenoses, ocular artery stenoses, temporal arteritis). Arterial blood flow disorders may also be based on general angiospastic diseases, ocular trauma. Cases of ischemic neuropathy and circulatory disturbances in the CAC and branches against the background of hypotension, taking some medications and after cardiac surgery (predisposing risk factors in this case are hypothermia, anemia, elevated IOP and microembolization) have been described. Self-recovery in ischaemic neuropathy occurs in a small proportion of cases. Acute circulatory disturbances in the retina and optic nerve lead in almost all cases to a partial loss of vision, and in some cases to complete blindness. The prognosis for vascular diseases of the optic nerve is always serious, but not hopeless. Sometimes there can be improvement or stabilisation of the disease process under the influence of treatment. However, it is not always stable, so repeated treatment in the form of regular courses is required. Visual acuity improves by 0.1-0.2, but in all cases defects in the visual field remain. If patients present late, visual acuity remains unchanged or may even decrease. Often ischaemic optic and vascular syndrome is a precursor of ischaemic coronary or cerebral incidents and therefore requires careful long-term treatment not only of the eye disease, but also of its comorbidities. Issues in the pathophysiology of ischaemic eye conditions. According to the functional principle of the vascular system there are several vascular groups. The state of each of them may affect blood circulation in the eye. The common carotid artery which supplies blood to the orbit and the eye belongs to the group of high-pressure vessels with great extensibility and transforms a rhythmic blood flow into a steady flow. Small arteries and veins (this includes the orbital artery) are pressure stabilizers. They have a well-developed smooth muscular sheath, little stretching, providing a certain basal tone, responding to multiple, mostly local, factors in the regulation of regional blood flow. The first and second order branches of CAC, large chorioid arterioles, ciliary arterioles, being distributors of capillary blood flow, block blood flow in capillary during contraction and resume it during relaxation. The exchange function between blood and tissues is performed by exchange vessels - capillaries and postcapillary veins. In this regard they have significant structural features. Retinal capillaries create an internal haematic barrier. The walls of the DZN and retinal capillaries are not fenestrated. They have a dense inner lining of endothelial cells that are only good at transporting fat-soluble substances (oxygen, $CO2$). The transport of water-soluble structures is performed by micropinocytic endothelial vesicles (by filling endothelial pores with water). Of great importance for the functioning of the retina is the fact that there are two capillary networks: a superficial one, located in the layer of nerve fibres and a deep one between inner nuclear and outer plexiform layers. There are anastomoses between them. Microcirculation and transcapillary exchange processes are greatly influenced by the state of postcapillary resistance vessels. They include venules and small veins. Active or passive changes of their lumen lead to blood accumulation or to its emergency release into circulation. The retina has only the venous type of outflow. Of definite importance, especially in case of circulatory disorders in the retina, are the bypass vessels, which are anastomoses of different types that connect the arterioles and venules bypassing the capillary network. It is these that play a significant role in the development of the bypass syndrome. Three pathophysiological links in the development of vascular ischaemic diseases of the eye can be distinguished. Disorders of the central circulation (caused by diseases of the heart, large vessels that ensure maintenance of the system blood pressure, the direction of its movement). Hypertension and atherosclerosis are among the leading etiological factors of acute ischemic eye disorders (ischemic neuropathy, disorders of blood circulation in the retinal vessels). These and other vascular diseases, as well as the age-related weakening of cardiac activity, aggravate the course of glaucoma even when IOP is normalized. In ophthalmology, there is even a concept of a primary vascular factor in the development of glaucoma. Diseases of the heart and large vessels may contribute to optic atrophy and age-related retinal degeneration. Disorders of organotissue circulation (local, regional, peripheral). Ischaemia (along with arterial, venous hyperaemia and stasis) is the most common form of pathology I. Methods of revascularisation of the posterior eye using oculomotor muscles, episcleral tissue and implants in the tenon space.

II. Operations on the vessels involved in blood supply of the eye.

- By redistributing the blood flow in the internal carotid artery and ocular artery basin.
- By slowing down the outflow of venous blood - phlebodestruction.III. Decompressive surgery on the optic nerve. Revascularisation of the posterior eye. Many ophthalmologists widely used revascularisation of ocular vasculature. There are many modifications of the surgery, the general trend of which is to create additional collateral blood supply to the eye inner membranes. The surgeries were performed using oculomotor muscles, episcleral flap. Chondroplasty with using patient's auricular autocartilage was also applied in dystrophic retinal diseases.V.S. Belyaev (1983) injected pieces of donor sclera into tenon space with simultaneous microdiatermocoagulation of recipient sclera that subsequently promoted sclera thinning and appearance of newly formed vessels. The stimulating effect of materials injected into the tenon space is explained by the release of vasoactive and other physiologically active substances (histamine, serotonin, kinins, lysosomal enzymes, etc.). The development of an immune response leads to increased vascularization of the optic nerve and other tissues of the eye. The formation of bradykinin and histamine leads to vasodilation and increased local blood flow. At the same time, mast cells begin to produce heparin, which has a beneficial effect on the microcirculation. Morphological studies confirmed the presence of a large number of newly formed capillaries in the operation area in the episclera, optic nerve sheaths and other eye tissues. Retrobulbar injections or electrophoresis are mainly used for local administration of drugs to the posterior segment of the eye. A large proportion of the injected medication is absorbed into the capillaries in the fatty tissue of the orbit and escapes into the general vascular bed. Due to the painful nature of the procedure, it is undesirable to inject retrobulbar medication several times a day, and there is also a risk of haematoma or damage to the optic nerve or the eyeball with the injection needle. In order to maintain a high concentration of the drug in direct contact with the vessels of the sclera and optic nerve in the posterior segment, A.P. Nesterov and S.N. Basinski suggested introducing a collagen infusion system into the tenon space.Collagen is the main structural protein of connective tissue, insoluble in common solvents. In medicine, the most widely used collagen films and spongy collagen materials are used as wound coverings. Medical and biological research of collagen preparations has revealed a number of their valuable properties: they are non-toxic, do not cause local tissue sensitisation, and reduce the chance of allergic reactions, thanks to their low antigenicity. The excellent compatibility of collagen with

various medications makes it possible to obtain preparations and materials with targeted effects. The subtenon implantation of a collagen infusion system (CICIS) consists of administering the necessary medication directly to the posterior pole of the eye 2-3 times a day using a silicone tube laced to the collagen graft. The surgical technique has been described previously and consists of two steps. A 30 mm long and 8 mm wide collagen graft is formed from a standard sterile collagen sponge with a thickness of 10 mm. The collagen sponge flap is soaked in saline solution, squeezed out and folded in half. One end of a 10-12 cm long and 1-1.5 mm diameter polyethylene tube is placed inside the folded sponge and stitched with 8/0 mattress stitch so that the thread passes through the tube. The opening at the other end of the tube is closed tightly with a sterile plug. An incision of the conjunctiva and tenon capsule is made 6-7 mm from the limbus in the upper outer quadrant. A channel is formed through the incision in the tenon space to the posterior pole of the eye with a spatula. The prepared infusion system is inserted into the formed canal. A continuous suture is placed over the incision in the conjunctiva and capsule. The withdrawn tube is fixed to the skin of the forehead with a plaster. In CIKIS, the drug injected through the tube soaks into the pores of the sponge and partially diffuses into the tenon space. The porous structure of the sponge provides a kind of depot. In addition, there is evidence of prolongation. The presence of a tube makes it possible to administer medication 2 or more times per day. A treatment duration of up to 10-14 days can be achieved by using CICIS, provided that the tube itself is kept sterile. At the end of the treatment the tube can easily be removed by pulling on the outer end. Suturing of the conjunctival area is not necessary. According to A.P. Nesterov, A.V. Svirin and S.N. Basinski, SIKIS method was used in patients with glaucoma, optic atrophy and retinal pigment abiotrophy to improve visual function in most cases during the first days after the operation. Stabilisation of visual function was observed over the next 6 months. CIKIS may be performed more than once, but not earlier than 2-3 months after the previous operation. Surgery on the vessels involved in the blood supply to the eye Methods of redistributing the blood flow in the eye. This type of operation was first proposed in 1968 and consisted in ligation of the external carotid artery. It led to the intensification of the main blood flow in the ocular artery, increasing of the vasoconstriction blood supply and activation of the metabolic processes in the retina and optic nerve. However, this operation had a number of serious disadvantages: it could not be performed with internal carotid artery lesions, high blood pressure in the internal carotid artery system after surgery, and the need for carotid angiography. Therefore, surgeries to cross the branches of the orbital artery as well as the superficial temporal and angular arteries (branch of the external carotid artery) have been developed. Studies have shown the possibility of improving and stabilising visual function in patients with various forms of vascular pathology. However, vasoreconstructive surgery is advisable in a certain contingent of patients and depends on ultrasound Doppler and fluorescence angiography data. If the blood supply to the eye is normal or the compression test does not increase the blood flow in the orbital artery, this surgical intervention is not indicated. The degree of surgical effect and stability of the results depend on the stage of the disease. Phlebodestruction surgery In 1984 M. Bonnet published works proposing the ligation of the retinal veins in retinal dystrophies. The operation was performed in Russia with positive results. The aim of the operation was to create, through phlebodestruction, conditions for a slower flow of arterial blood through the system of precapillary arterioles to improve its irrigation of the macular zone, resulting in a prolonged contact of erythrocytes with the choriocapillary endothelium. Decompression surgery on the optic nerve sheath and scleral canal. This method of surgical treatment is widespread in cases of

optic atrophy of vascular origin. Decompression surgery - the dissection of dura mater and posterior scleral ring, suggested by J. Vasko-Posada in 1972 for thrombosis and embolism treatment of retinal vessels was later used by many ophthalmologists to treat ischemic neuropathies, CAC occlusions and glaucoma. The latter is due to the fact that progressive visual impairment is often observed despite IOP compensation. According to studies by various authors, the prelaminar and laminar parts of the optic nerve, located in the scleral canal, are the most vulnerable. The scleral ring, which penetrates into the lumen of the canal, narrows it in half. A glaucomatous excavation forms in this area, the nerve fibres are pushed to the periphery of the canal and bend over the edge of the scleral ring. Therefore, various modifications of decompression surgeries have been proposed, with the idea of dissecting the scleral ring, which results in a decrease of nerve fiber compression in the scleral canal. However, significant kinking and traction of the optic nerve can cause serious complications (including circulatory disorders in the retinal and optic nerve vessels). Foreign ophthalmologists use optic nerve sheath fenestration relatively widely for the treatment of anterior and posterior ischemic neuropathies of non-inflammatory genesis. A vicious circle is formed in acute ischaemic neuropathies. Circulatory disturbances cause swelling of the fibers, an increase in tissue pressure, which in turn leads to further circulatory disturbances (venous outflow disturbance, permeability disturbance). If local oedema is treated early, this vicious circle can be broken and secondary tissue damage can be prevented. This has prompted the proposal to surgically dissect the prelaminar part of the optic nerve sheath. However, the same effect can be achieved in the acute stage by using corticosteroids, which increase the content of substances that inhibit the action of hyaluronidase, thus reducing the permeability of the vascular wall. Data on the results of MN sheath fenestration are inconsistent. It is connected with the difficulty of accounting and statistical processing of all parameters influencing the treatment results (age groups, concomitant diseases, duration of the process, follow-up period etc.).
Conclusions. Evaluating the literature data on the treatment of ischemic diseases of the optic nerve and retina it should be noted that there are a number of questions that require further investigation. The search for the most effective vasoactive drugs with minimal side effects continues. Many ophthalmologists pay a lot of attention to the improvement of old and development of new methods of surgical treatment of ischemic processes in the eye. The use of a number of techniques in the complex treatment of ischaemia and its consequences (hypoxia, excess products of disturbed metabolism, tissue dystrophy) can improve haemodynamics of the eye and preserve visual function.

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