Interrelation of Cardiological and Ophthalmological Parameters in Patients with Arterial Hypertension in Combination with Coronary Heart Disease

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ABSTRACT

Hypertension is a major risk factor for cardiovascular disease and mortality, which is one of the major public health problems worldwide. Hypertension causes a number of pathophysiological ocular modifications that significantly affect the retina, choroid and optic nerve circulations, which lead to a number of ocular defects. The retina is the only site in the body where the microvascular can be directly tested, providing valuable information about hypertension associated with systemic risks. In the process of circulatory disorders in the capillaries, degeneration of the nervous tissue occurs, which is especially sensitive to any negative changes in metabolism.

Keywords: Hypertension, Pathophysiological, Ocular Modifications, Retina, Choroid, Optic Nerve Circulations, Ocular Defects.

Materials and research methods. In the group of patients with hypertension and coronary artery disease, the ejection fraction (EF) was compared with ophthalmological parameters to identify the relationship between the microcirculation of the eye and the contractility of the heart. The study revealed correlations between echocardiographic ejection fraction (EF) and ophthalmic parameters. Thus, in the control group, the ejection fraction (EF) was > 55%. In patients of the first group before stenting, EF was reduced to 49% and averaged 52.1±2.3%. 3 months after stenting, EF increased in comparison with the data before stenting and amounted to 55.3±2.1%. 6 months after stenting, EF increased further compared to the data after stenting and 3 months after stenting, and amounted to 58.6±2.1% (52.1±2.3%; 55.3±2. 1%, $p < 0.05$). Visual acuity increased after stenting, but did not undergo significant changes 3 months after coronary artery stenting ($p > 0.05$). The revealed correlations between EF and BCVA were statistically significant in comparison 6 months after surgery ($p < 0.05$).

Visual acuity in patients of the first group before coronary artery stenting was less than in the control group ($p < 0.05$). After 3 months, BCVA increased, but not statistically significant ($p > 0.05$). The revealed correlations of EF and BCVA 6 months after stenting were statistically significant compared to baseline (BCVA before stenting 0.72±0.05 $p < 0.05$, $r = 0.62$, 6 months after stenting) BCVA 0.82±0.02, $p < 0.05$, $r = 0.56$). The CTS was analyzed before and after surgical treatment of coronary vessels. Statistically significant correlations between EF and CTS were revealed in comparison 3 months after surgery and 6 months later ($p < 0.05$) .

Analysis of the CTS revealed that in healthy individuals the thickness of the retina was 253.2 ± 4.6 μm. In patients of the first group before stenting, CTS was increased in comparison with the control group and amounted to 297.6±5.1 μm. 3 months after stenting, CTS decreased in comparison with the

data before stenting and amounted to 274.8±3.4 μm. 6 months after stenting, CTS decreased even more in comparison with the data before stenting and 3 months after stenting, and was already 260.6±4.3 μm (up to – 297.6±5.1 μm, after 3 months – 274.8±3.4 μm, $p < 0.05$). Thus, statistically significant inverse correlations were found between the cardiac EF (%) and the ophthalmic CTS (μm) in comparison 3 months after surgery and 6 months ($r = -0.73$, $p < 0.05$; $r = -0.84$, $p < 0.05$; $r = -0.80$, $p < 0.05$). The central thickness of the retina decreased after the surgical intervention on the vessels of the heart. Reducing the thickness of the retina from 297.6±5.1 μm (before stenting) to 260.6±4.3 μm (6 months after stenting) indicates an improvement in retinal microcirculation due to stenting of the coronary arteries with accompanying conservative therapy (including dual antiplatelet therapy). Macular photosensitivity (SM, dB) was analyzed before and after coronary artery stenting. Statistically significant correlations between EF and SM were revealed in comparison 3 and 6 months after surgery ($p < 0.05$).

The analysis of SM revealed that in the control group, the photosensitivity of the macula (SM, dB) was 30.9±1.9 dB. In patients of the first group, before stenting, SM was reduced in comparison with the control group and amounted to 20.6±1.2 dB. 3 months after stenting, SM increased in comparison with the data before stenting and amounted to 26.1±1.3 dB. 6 months after stenting of the coronary arteries, SM continued to improve in comparison with the data before stenting and 3 months after stenting, and amounted to 28.2±1.7 dB (up to – 20.6±1.2 dB, after 3 months – 26 .1±1.3 dB, $p < 0.05$).

The data obtained coincide with the results of domestic scientists of the Research Institute. Helmholtz [2], who studied the functional state of the retina in HD of different stages. Thus, the authors noted that in patients with hypertension there is a violation of light sensitivity in the central field of vision. With the progression of HD, there is an even greater deterioration in the functions of the retina, which can be judged by a sharp decrease in SM (dB) in the fundus microperimetry of the macula. In this work, the obtained results of photosensitivity impairment are confirmed by accurate angiography data (OCT-A) and correspond to the zone of choroidal blood supply impairment. Therefore, changes in light sensitivity in the macular area reflect the progression of retinal tissue perfusion disorders and can serve as a functional marker of hypertensive retinopathy.

The area of the foveolar avascular zone of the retina (FAZ, mm2) was analyzed according to angiography data (OCT-A) before and after stenting of the coronary arteries. Statistically significant correlations between EF and FAZ were revealed in comparison 3 months after surgery and 6 months later ($p < 0.05$) (Figure 3.22).

Results. Analysis of the FAZ revealed that in the control group the area of the foveolar avascular zone was (FAZ, mm2) 0.29±0.04 mm2. In patients of the first group before stenting, the FAZ area was increased in comparison with the control group and amounted to 0.41±0.04 mm2. Three months after stenting, the FAZ area decreased in comparison with the data before stenting and amounted to 0.37±0.04 mm2. Six months after coronary artery stenting, the FAZ area decreased statistically significantly and amounted to 0.33±0.02 mm2 (0.41±0.04 mm2 before surgery).

Statistically significant inverse correlations were found between the cardiological indicator of EF (%) and the ophthalmological indicator of the FAZ area (mm2) in comparison 3 months after surgery and 6 months after coronary artery stenting ($r = -0.74$, $p < 0.05$, $r = -0.86$, $p < 0.05$, $r = -0.81$, $p < 0.05$) (Figure 3.22).

Perifoveolar vasculature, with impaired tissue perfusion of the retina and with impaired choroidal blood supply. Thus, chronic high blood pressure and myocardial ischemia affect microcirculatory structure and function.

Thus, the study revealed a decrease in the density of the vessels of the superficial plexus (PSPS) of the retina in patients with

hypertension and coronary artery disease. The data obtained in the study on a decrease in the density of the vessels of the superficial plexus in patients with HD with coronary heart disease are consistent with foreign studies that studied PSPS of the retina in HD (Lim et al., 2019; Takayama et al., 2018, H. M. Lee et al., 2018; S. H. Lee et al., 2018). But foreign authors analyzed the vessel density (PV) only in patients with HD of different groups, and in this work, for the first time, an analysis of the superficial plexus vessel density (PSPS) of the retina was performed before and after coronary artery stenting followed by conservative therapy in patients with HD and IHD. . The decrease in the density of the vessels of the superficial plexus (PSPS) of the retina, observed in this study, can be explained by a violation of the microcirculation of the retina - rarefaction (rarefaction) of capillaries and / or a violation of the rheological properties of blood due to the presence of long-term GB.

A decrease in capillary density, as a rule, causes an increased resistance to blood flow and leads to a decrease in microvascular blood flow and, accordingly, to a decrease in the density of retinal vessels according to OCT-A. These changes were revealed in the work in patients with stenosis of the coronary vessels. In addition, due to a decrease in blood flow in the vessels of the retina and a decrease in perfusion, oxygen consumption by tissues decreases, which leads to dysfunction of the retinal structure. For the first time, a statistically significant increase in retinal PSPS was noted after stenting of the coronary arteries followed by

conservative therapy. An increase in retinal PSPS can be explained by an improvement in retinal microcirculation during the treatment of patients with hypertension and coronary artery disease. OCT-A of the macular zone of the retina makes it possible to assess changes in the microcirculatory bed of the retina in patients with hypertension and coronary artery disease.

The density of deep retinal plexus vessels (PSGS, %) was analyzed according to angiography data (OCT-A) before and after stenting of the coronary arteries and subsequently against the background of conservative therapy. The revealed correlation relationships of EF and PSGS of the retina in comparison 3 months after surgery and 6 months later were statistically significant ($p < 0.05$) (Figure 3.24).

Statistically significant direct correlations were found between the cardiological index of EF (%) and the ophthalmological index of PSGS of the retina (%) in comparison 3 months after surgery and 6 months after coronary artery stenting ($r = 0.82$, $p < 0$ .05; $r = 0.81$, $p < 0.05$; $r = 0.74$, $p < 0.05$) (Figure 3.24).

In this study, when analyzing the results of the density of vessels in the superficial and deep retinal plexuses using OCT-A, a more pronounced decrease in the density of retinal vessels in the deep plexus compared with the superficial plexus in patients with EH and IHD before coronary artery stenting was noted. arteries.

According to angiography data (OCT-A), the density of vessels inside the optic disc (PSVDZN, %) was analyzed before and after stenting of the coronary arteries. The revealed correlations of EF and PSVDZN in comparison 3 months after surgery and 6 months later were statistically significant ($p < 0.05$) (Figure 3.25).

In the analysis of PSVDD in the control group, the density of vessels inside the optic disc (PSVDD, %) was 57.3±2.2%. In patients of the first group, before stenting, PSVDD was reduced in comparison with the control group and amounted to 43.1±2.7%. 3 months after stenting with subsequent conservative therapy, PSVDD increased statistically significantly in

compared with the data before stenting and amounted to 45.5±2.1%. 6 months after stenting of the coronary arteries, PSVDD increased and amounted to 48.2±2.5% (before surgery, 43.1±2.7%).

This paper also analyzes the thickness of the retinal nerve fiber layer (RNFL, μm) according to OCT before and after coronary artery stenting. The revealed correlation relationships of EF and RNFL in comparison 3 months after surgery and 6 months later were statistically significant ($p < 0.05$) (Figure 3.26).

In the analysis of RNFL in the control group, the thickness of the retinal nerve fiber layer (RNFL, μm) was 118.7±5.4 μm. In patients of the first group before stenting, RNFL was reduced in comparison with the control group and amounted to 93.3±4.3 μm. 3 months after stenting followed by conservative therapy, the RNFL thickness increased statistically significantly in comparison with the data before stenting and amounted to 99.8±3.5 μm. Six months after coronary artery stenting, the RNFL thickness was already 108.9±3.2 μm (93.3±4.3 μm before surgery).

In the analysis of PSC in the control group, the density of vessels in the layer of choriocapillaries (PSC, %) in the fovea zone was 63.2±1.1%. In patients of the first group, before stenting, PSC was reduced in comparison with the control group and amounted to 51.1±1.2%. Three months after stenting followed by conservative therapy, PSC improved statistically significantly in comparison with the data before stenting and amounted to 55.3±1.2%. Six months after coronary artery stenting, against the background of ongoing conservative therapy, PSC increased and amounted to 59.4±1.1% (before surgery, 51.1±1.2%).

Thus, we analyzed the data obtained during the examination of 30 patients (58 eyes) suffering from hypertension (AH) with coronary heart disease (CHD) before and after coronary artery stenting with subsequent conservative therapy. The analysis included clinical and morphofunctional studies based on objective CTS data (according to OCT), functional SM (according to MAIA fundus microperimetry), retinal nerve fiber layer thickness, retinal ganglion cells, and BCVA. Particular attention is paid to the study of retinal vessels in HD and IHD using angiography (OCT-A) with an analysis of the area of the foveolar avascular zone, the density of vessels of the superficial retinal plexus in the macula, the density of vessels of the deep retinal plexus in the macula, the density of vessels inside the optic disc and density of vessels in the layer of choriocapillaries.

A decrease in the central thickness of the retina from 297.6±5.1 μm (before stenting) to 260.6±4.3 μm (after 6 months) indirectly indicates a decrease in hypoxia due to improved retinal microcirculation. The revealed low indicators of macula photosensitivity before stenting can be explained by long-term changes in the retinal microvasculature (decrease in capillary density and, as a result, decrease in blood flow, impaired perfusion and tissue hypoxia) due to long-term AH and IHD.

The increase in SM 6 months after surgery is due to improved microcirculation and improved tissue perfusion of the retina due to the effective treatment of major diseases (stenting of the coronary arteries followed by conservative therapy). As is known,

"Changes in light sensitivity in the macular area reflect the progression of retinal tissue perfusion disorders and can serve as a functional marker of hypertensive retinopathy" [2].

Angiography data (OCT-A) in dynamics, which indicate an improvement in perfusion of the perifoveolar vasculature against the background of stenting of the coronary arteries followed by conservative therapy, were obtained for the first time.

The foveolar avascular zone (FAZ) responds to chronic high blood pressure and myocardial ischemia, the microcirculatory structure and function of the retina is disturbed, which ultimately causes an increase in the area of the FAZ and adversely affects the vision of patients with hypertension and coronary artery disease. For the first time, it was noted that after coronary artery stenting followed by conservative therapy, the FAZ area decreases and this indicates an improvement in the blood supply to the perifoveolar vascular network of the retina.

In patients with hypertension and coronary artery disease after stenting of the coronary arteries followed by conservative therapy, the present study revealed for the first time a statistically significant increase in the density of the vessels of the superficial plexus (PSV) of the retina. Similar changes were found in relation to an increase in the density of vessels within the optic nerve head (PSVDD),

and the density of vessels in the choriocapillary layer.

It was also revealed for the first time that the thickness of the retinal nerve fiber layer (RNFL) increased statistically significantly after coronary artery revascularization followed by conservative therapy, which, in all likelihood, was due to improved retinal microcirculation (increased capillary density).

In the analysis of 30 patients (58 eyes) before and after stenting of the coronary arteries with hypertension and coronary artery disease, it was found that ophthalmological examination of the fundus using biomicroophthalmoscopy cannot detect hypertonic changes in the vessels of different layers of the retina, choroid and optic nerve head.

Conclusions. Modern diagnostics using angiography (OCT-A) makes it possible to assess the severity of hypertonic changes in the fundus vessels in HD and IHD, which occur in the perifoveolar vessels of the macula with an increase in the area of the FAZ, with a loss in the density of the vessels of the superficial and deep plexuses. retina, with loss of vascular density within the optic disc, retinal nerve fiber layer, in the choriocapillary layer.

Thus, it is possible to detect systemic hypertensive changes in the retina and in the choriocapillary layer using OCT-A, which are impossible

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