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RETINAL VASCULAR AND CHOROIDAL BIOMARKERS OF CARDIOVASCULAR RISK IN MEN AND WOMEN WITH UNCOMPLICATED HYPERTENSION

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Abstract: This study evaluated gender-related differences in retinal microvascular parameters and their associations with cardiovascular risk in patients with uncomplicated hypertension. The study included 35 patients aged 45–59 years, comprising 28 men and 7 women with stage I or II hypertension. Retinal vascular parameters, foveal avascular zone area, and subfoveal choroidal thickness were assessed using scanning laser ophthalmoscopy and optical coherence tomography angiography. Women had larger FAZ area ($p<0.001$), central retinal venular equivalent ($p=0.005$), and central retinal arteriolar equivalent ($p=0.012$) than men, while subfoveal choroidal thickness did not differ significantly. In men, retinal venular diameter correlated with the Cornell voltage product ($r=0.39$), whereas in women, higher SCORE risk was inversely associated with choroidal thickness ($r=-0.56$).

Keywords: arterial hypertension; retinal microvasculature; gender differences; foveal avascular zone; cardiovascular risk.

РЕТИНАЛЬНЫЕ СОСУДИСТЫЕ И ХОРИОИДАЛЬНЫЕ БИОМАРКЕРЫ СЕРДЕЧНО-СОСУДИСТОГО РИСКА У МУЖЧИН И ЖЕНЩИН С НЕОСЛОЖНЁННОЙ АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ

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Аннотация: Целью исследования была оценка гендерных различий ретинальных микрососудистых показателей и их взаимосвязи с сердечно-

сосудистым риском у пациентов с неосложнённой артериальной гипертензией. Обследовано 35 пациентов в возрасте 45–59 лет, включая 28 мужчин и 7 женщин с гипертонической болезнью I–II стадии. С помощью сканирующей лазерной офтальмоскопии и оптической когерентной томографии оценивали параметры сосудов сетчатки, площадь фовеальной аваскулярной зоны и субфовеальную толщину хориоидеи. У женщин площадь ФАЗ ($p < 0,001$), центральный венозный эквивалент сетчатки ($p = 0,005$) и центральный артериальный эквивалент ($p = 0,012$) были достоверно больше, чем у мужчин, тогда как различия по толщине хориоидеи отсутствовали. У мужчин диаметр ретинальных венул коррелировал с Корнельским вольтажным произведением ($r = 0,39$), а у женщин более высокий риск по SCORE обратно коррелировал с субфовеальной толщиной хориоидеи ($r = -0,56$).

Ключевые слова: артериальная гипертензия; микроциркуляция сетчатки; гендерные различия; фовеальная аваскулярная зона; сердечно-сосудистый риск.

Introduction: Arterial hypertension is a major cardiovascular condition in which persistent blood pressure elevation causes target-organ injury. The retinal circulation is particularly informative because retinal vessels can be examined directly and may reflect systemic microvascular alterations associated with hypertension. Changes in retinal arteriolar and venular caliber, together with abnormalities of the foveal avascular zone and choroidal thickness, may indicate subclinical vascular damage. These parameters are relevant to cardiovascular risk assessment because retinal microvascular remodeling may occur alongside myocardial and renal changes. Gender may influence the vascular response to hypertension through differences in vascular structure and distribution of cardiovascular risk factors. The source study investigated middle-aged patients with stage I or II hypertension and compared retinal parameters between men and women without diabetes, clinically significant ophthalmic disease, or advanced chronic kidney disease. The assessment included central retinal arteriolar

equivalent, central retinal venular equivalent, arteriovenous ratio, foveal avascular zone area, and subfoveal choroidal thickness. Cardiovascular evaluation also incorporated blood pressure, biochemical measurements, electrocardiographic markers of left ventricular hypertrophy, echocardiographic parameters, renal indicators, and ten-year SCORE risk. This integrated approach allows retinal findings to be considered in relation to cardiovascular and target-organ characteristics rather than as isolated ophthalmic measurements in clinical practice. Identification of gender-specific associations may improve interpretation of retinal biomarkers and contribute to earlier recognition of subclinical target-organ involvement in uncomplicated hypertension.

Aim of the study: To evaluate gender-related differences in retinal vascular and choroidal parameters and determine their associations with cardiovascular risk and target-organ indicators in middle-aged patients with uncomplicated arterial hypertension.

Materials and methods. The study included 35 patients with hypertension, comprising 28 men and 7 women, with a mean age of 49.7 ± 4.8 years. Participants had stage I or II hypertension and were 45–59 years old. Patients with diabetes mellitus, ischemic heart disease, familial hypercholesterolemia, stage III or higher chronic kidney disease, liver dysfunction, and clinically significant ophthalmic disorders were excluded. Clinical assessment included smoking status, office systolic and diastolic blood pressure, resting heart rate. Laboratory investigations included total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, glucose, creatinine, and N-terminal procollagen type III peptide. Urinary assessment comprised the albumin-creatinine ratio and 24-hour albumin excretion. Cardiovascular evaluation included quantitative ECG markers of left ventricular hypertrophy and transthoracic echocardiography. Ten-year risk of fatal cardiovascular events was estimated using SCORE. Retinal vessels were examined by scanning laser ophthalmoscopy in infrared mode centered on the optic disc. The diameters of four major branches of the central retinal artery and vein were measured 0.5–1 disc diameter from the disc margin. Optical coherence tomography

angiography determined foveal avascular zone area and subfoveal choroidal thickness. The FAZ was assessed at the superficial retinal capillary plexus, while choroidal thickness was measured at the central fovea. Statistical analysis used StatSoft Statistica 10. Quantitative variables were compared with the Mann–Whitney U-test, and associations were assessed using Spearman correlation coefficients. Statistical significance was accepted at $p < 0.05$. and detailed retinal vascular measurements were performed.

Results. The study included 35 hypertensive patients, 28 men and 7 women. Regular smoking occurred in 48.2% of men and 14.3% of women ($p < 0.001$). HDL cholesterol was lower in men than women, 1.11 ± 0.49 versus 1.52 ± 0.66 mmol/L ($p = 0.014$). Ten-year SCORE risk was higher in men, $3.8 \pm 2.45\%$ versus $1.2 \pm 0.96\%$ ($p < 0.001$). Men also had greater left ventricular myocardial mass index, 114 ± 36.3 versus 93.2 ± 23.1 g/m² ($p = 0.02$). Retinal examination demonstrated significant differences between sexes. Central retinal arteriolar equivalent measured 136 ± 14.4 μ m in men and 144 ± 4.9 μ m in women ($p = 0.012$), while central retinal venular equivalent was 220 ± 25.1 versus 232 ± 14.1 μ m ($p = 0.005$). The arteriovenous ratio was 0.61 ± 0.10 in men and 0.62 ± 0.05 in women ($p = 0.026$). FAZ area was 0.281 ± 0.08 mm² in men and 0.459 ± 0.20 mm² in women ($p < 0.001$). Subfoveal choroidal thickness did not differ significantly: 316 ± 86.2 versus 299 ± 86.1 μ m ($p = 0.503$). Venular equivalent correlated positively with RaVL amplitude ($r = 0.31$, $p < 0.05$), whereas arteriolar equivalent correlated inversely with left atrial volume index ($r = -0.30$, $p < 0.05$). The arteriovenous ratio correlated inversely with LDL cholesterol ($r = -0.30$, $p < 0.05$). FAZ area correlated positively with female sex ($r = 0.42$), PIIINP ($r = 0.30$), and 24-hour albuminuria ($r = 0.37$), all $p < 0.05$. Choroidal thickness correlated inversely with age ($r = -0.30$, $p = 0.01$). Among men, venular caliber correlated with the Cornell voltage product ($r = 0.39$, $p < 0.05$). Among women, SCORE risk correlated inversely with choroidal thickness ($r = -0.56$, $p = 0.01$), arteriovenous ratio ($r = -0.53$, $p < 0.05$), and arteriolar caliber ($r = -0.30$, $p < 0.05$). Age was also inversely associated with choroidal thickness in women ($r = -0.54$, $p < 0.05$).

Conclusions: The study demonstrated gender-related differences in retinal microvascular characteristics among patients with uncomplicated hypertension. Women had larger retinal arteriolar and venular equivalents and foveal avascular zone area, while subfoveal choroidal thickness was comparable between groups. Men had higher SCORE risk and greater left ventricular myocardial mass index, and retinal venular caliber was positively associated with the Cornell ECG marker of left ventricular hypertrophy. In women, higher cardiovascular risk was inversely associated with choroidal thickness, arteriovenous ratio, and retinal arteriolar caliber. FAZ area was related to PIIINP and 24-hour albuminuria, indicating links between retinal microvascular status and target-organ remodeling. Larger prospective clinical future studies are needed to confirm these associations and prognostic significance.

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