The doctoral dissertation is a series of four thematically related publications focusing on a comparative analysis of changes in the structure and microcirculation of the retina in patients with Alzheimer's disease (AD) and primary open-angle glaucoma (POAG). The main aim of the study was the qualitative and quantitative assessment of the thickness of individual retinal layers and the density of the retinal vessels in the posterior pole of the eye in AD and POAG patients using optical coherence tomography (OCT) and OCT angiography (OCTA).

The first review paper "Diagnosis of Alzheimer's Disease by Assessing Structural and Microvasculature Changes in the Retina Using Optical Coherence Tomography Angiography – a Review of Eye Biomarkers for Alzheimer's Disease" (Klinika Oczna/Acta Ophthalmologica Polonica, MNiSW = 40 points) focuses on the presentation the current state of knowledge on the diagnosis of AD using non-invasive retinal imaging examinations. Currently, the diagnosis of AD is based mainly on the assessment of cognitive functions, because neuroimaging is still very expensive and difficult to access. This explains the rationale behind the search for new, non-invasive and cheap biomarkers. During the embryogenesis phase, the retina and the optic nerve develop as a direct extension of the diencephalon, so that brain abnormalities in AD patients can also be seen at the fundus. In postmortem studies of patients with Alzheimer's dementia, it has been proven that the disease, apart from damaging nerve cells, is also characterized by cerebrovascular pathology. Using modern imaging techniques such as OCT and OCTA, significant changes in the structure and microvessels of the retina have been demonstrated. Unfortunately, these changes in patients with dementia, observed in OCT images, may be non-specific and common to other neurodegenerative diseases, such as glaucoma. Nevertheless, combined measurements of structural changes in the retina and the assessment of microcirculation in individual retinal plexuses using OCT and OCTA may increase the diagnostic capacity of AD.

In the article "Peripapillary Retinal Nerve Fiber Layer Thickness in Patients with Alzheimer's Disease: A Comparison of Eyes of Patients with Alzheimer's Disease, Primary Open-Angle Glaucoma, and Preperimetric Glaucoma and Healthy Controls" (Medical Science Monitor, MNiSW = 70 points, IF = 1.918) OCT was used to assess and compare the thickness of the peripapillary retinal nerve fiber layer (pRNFL) in patients with AD, primary open-angle glaucoma (POAG), preperimetric glaucoma (PPG), and in healthy controls (HC). Thirty participants from each group were enrolled in the cross-sectional study. One randomly selected eye of each participant was analyzed. The mean thickness of pRNFL in patients with

POAG was 60.97 ± 12.97 µm and was significantly lower than in the HC group (106.30 ± 8.95 µm), in eyes with PPG (93.20 ± 12.04 µm) and in patients with AD (95.73 ± 13.52 µm). The mean thickness of pRNFL in AD patients was significantly lower compared to the HC group and higher compared to the eyes with POAG, but there were no significant differences compared to the eyes with PPG ($p > 0.05$). The study shows that damage to the nerve cells in the central nervous system (CNS) in AD is also associated with damage to the axons of the retinal ganglion cells. On the basis of OCT, it is not possible to distinguish the cause of a mild reduction in pRNFL thickness, but it seems that the analisis of OCT results may be an additional tool used in the diagnosis and monitoring of AD.

In the publication "Comparison of Retinal Microvasculature in Patients With Alzheimer's Disease and Primary Open-Angle Glaucoma by Optical Coherence Tomography Angiography" (Investigative Ophthalmology & Visual Science, MNiSW = 140 points, IF = 3.812), the aim of the study was to evaluate the retinal microvascular network in patients with AD, POAG and in the HC group. Twenty-seven people in each group were qualified for the study, and the eye with the better quality of the angiogram was assessed. Ophthalmic examination included OCTA, which was used for the imaging of vascular network within the layer of radial peripapillary capillaries (RPC), and also in the superficial vascular plexus (SVP) and deep vascular plexus (DVP) of the retina. In the eyes of patents with AD, the vascular density in DVP was significantly reduced and the area of the foveal avascular zone increased compared to the eyes of patients with POAG and in the HC group ($p < 0.001$). Patients with POAG had significantly reduced vascular density in RPC and SVP compared to the other studied groups ($p < 0.001$). The mean pRNFL thickness correlated with the vascular density in SVP in POAG (Pearson's $r = 0.66$; $p = 0.0002$) and was significantly lower in the POAG and AD groups than in the HC group ($p < 0.001$). AD and POAG are neurodegenerative diseases associated with apoptosis of nerve cells and impairment of retinal microvessels, which can be effectively assessed by OCTA. Despite the fact that in both diseases the abnormalities are found in the entire vascular system of the retina, the impairment of the microvascular network in the eyes with POAG mainly concerns superficial vessels, while in AD, the vessels located in the deeper layers of the retina, which may indicate a different etiopathogenesis of these diseases.

The purpose of article "Quantitative assessment of retinal thickness and vessel density using optical coherence tomography angiography in patients with Alzheimer's disease and glaucoma" (PLOS ONE, MNiSW = 100 points, IF = 2.740) was the assessment and a direct

comparison of retinal vessel density with the thickness of inner retinal layer (IRL) and outer retinal layer (ORL) in the same regions of the macula in subjects with AD and POAG. Fourty-nine eyes with AD, 71 eyes with POAG and 48 eyes with HC were included in the cross-sectional examination. In the ophthalmic examination, OCT was used to measure the thickness of IRL and ORL, as well as OCTA in the same area to analyze the vascular density in SVP and DVP. Patients with AD showed significantly greater loss of vascular density in DVP and ORL thickness compared to patients with POAG ($p < 0.001$), who had significantly greater percent loss of vascular density in SVP and IRL thickness compared to the other groups ($p < 0.001$). A positive relationship between the presence of AD was mainly observed in the outer retina, where a 1% decrease in ORL thickness was associated with an approximately 24–29% increase in the likelihood of AD occurrence. Analysis of angiograms showed that a 1% decrease in vascular density in DVP was positively associated with a 4-9% increase in the likelihood of developing AD. In POAG, a positive association between disease presence and percent loss of retinal thickness and vascular density was observed only in IRL and SVP. It was also shown that changes in the retinal vasculature in SVP and DVP were correlated appropriately with damage to the IRL and ORL layers in the eyes of AD and POAG patients. The pathologies found in the inner retina are not always specific and are found primarily in glaucoma, which distinguishes it from AD, where significant pathologies are found mainly in the outer retina. Overall, the analysis of deeper retinal layers and vascular density in DVP has the potential to improve diagnostic capabilities and represent a valuable approach in predicting the development of AD.

The final part contains summaries and the most important conclusions coming from the conducted of empirical research. They also indicate the directions of improvement that in the future may significantly contribute to the enhancements of diagnostic methods of neurodegenerative diseases.