Cardiovascular diseases are the most common cause of death in Poland and worldwide, about one third of which is caused by diseases of vessels supplying blood to the brain. In many cases, death is preceded by a long-term illness marked by reduced physical and intellectual capabilities, reduced work capacity, and dependence on third party care. Vascular diseases mainly affect people over 50 years of age, so given the progressive ageing of the population, this problem is expected to increase further.

In recent years, vascular diseases have been the subject of extensive, interdisciplinary research combining medicine, physics, mathematics and chemistry. Thanks to the application of methods of mathematical modelling of blood flow, many physical laws describing the interaction of flowing blood with vessel walls have been learned, which help to explain the development of many diseases and improve treatment methods.

Particularly noteworthy are the small arteries supplying the critical brain structures responsible for consciousness, movement of limbs, feeling, seeing, speaking, etc. They are called the middle branches - perforators, and their closure leads to small strokes (so-called lacunar strokes), which, despite their small size, can lead to serious complications (paresis, coma, speech disorders). They also contribute to the development of vascular dementia by progressively reducing physical and intellectual performance. The reduction of blood flow through perforators may result from the development of atherosclerosis or closure of the vessel by an embolism and also from implantation of flow-changing stents (flow diverters).

Despite its important clinical role, the issue of flow through small cerebral vessels remains only superficially examined. The main aim of the project is to investigate the laws governing the flow of blood through perforators and the influence of various flow-disturbing factors (e.g. different blood pressure and heart rate values, stents, aneurysms, etc.).

Typically, research on blood flow in vessels begins with the imaging of human vessels, followed by the stage of computer modelling. The technology used so far has been limited by the resolution of classical imaging methods (e.g. CT scans), which made it impossible to assess perforators whose diameter is below 1 mm. The authors of the project proposed to depict properly prepared anatomical preparations using computerd microtomography with resolution below 0.02 mm.

An important issue in the context of flow modelling remains the issue of comparing the results with the values measured in the experimental model. For this purpose, physical models of the tested systems are built, fluid is passed through them and measurements are made using appropriate cameras. Due to the high labour intensity and the need for access to advanced equipment, such tests are rarely performed. Also, the resolution of standard cameras does not allow for measurements on small vessels. Therefore, the authors of the project intend to use a higher generation technique, supplemented by an optical microscope (microPIV method), which will enable the analysis of perforator models.

The result of the project will be the development of techniques for mathematical modelling and analysis of experimental blood flow through small brain vessels, and its use will provide information on the profile of blood flow through perforators. Analyses containing various types of disruptors (e.g. stents, aneurysms, atherosclerotic plaques) will provide knowledge about their effect on the flow through the examined vessels. This will clarify the hitherto unexplored areas of pathophysiology of the above mentioned diseases, and may serve to develop more effective treatment methods in the future. Interdisciplinary research will be possible thanks to the cooperation of the teams of the Institute of Mechanics and Computational Engineering of the Military University of Technology and the Department of Descriptive and Clinical Anatomy of the Medical University of Warsaw.

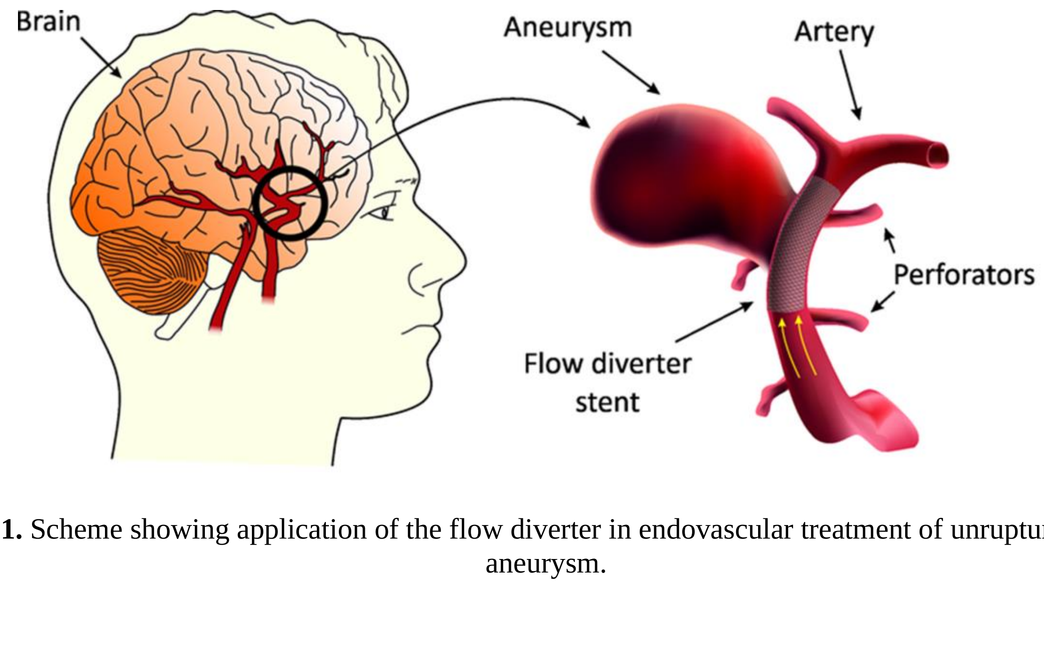


**Fig. 1.** Scheme showing application of the flow diverter in endovascular treatment of unruptured brain aneurysm.