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Results comparison of the flow analysis with PIV method using different blood substitute

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The subject of this study was to compare the results of experiments carried out with the PIV (Particle Image Velocimetry [1]) method and the stand for testing the flows in phantom vessels (Figure 1) using different blood substitutes. A common problem during PIV tests of flows in transparent channels is the presence of glare on the vessel walls. The mentioned light reflections make it impossible or extremely difficult to register the movement of marker particles near the vessel walls. On the other hand, it is in these regions that particularly interesting phenomena related to the dynamics of the flow and its impact on the vessel walls often take place. For these reasons, it has become necessary to improve the method which was used. The main aim was to find better method in designing PIV experiment which gives clearer view near the walls of a vessel. In one of them, distilled water was used as a blood substitute (medium), and in the other, an aqueous solution of sodium iodide (NaI) (Sigma-Aldrich), saturated at a temperature of 25°C. In both cases, markers in the form of glass spheres with a diameter of 10-20 μm (Microvec Pte Ltd, Singapore) were suspended in the medium. Also in both cases, the concentration of markers in the solution was the same (75 mg/L).

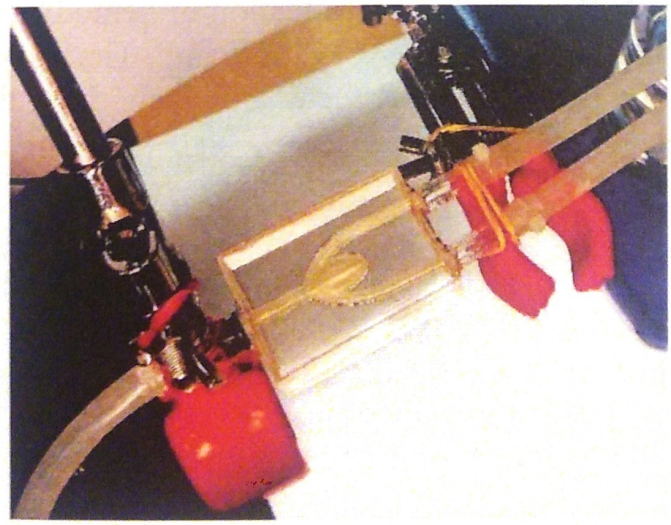

Figure 1. The phantom of cerebral aneurysm

PIV analysis was performed using two methods - CC (Cross Correlation) PIV using cross-correlation algorithms and PIV (Artificial Intelligence) PIV using artificial intelligence algorithms (Figure 2). The AI algorithm turned out to be very useful because there are often gaps in the information due to the flow characteristics between the recorded frames. The algorithm, by extrapolation, estimates the missing data, thanks to which more accurate results become possible.

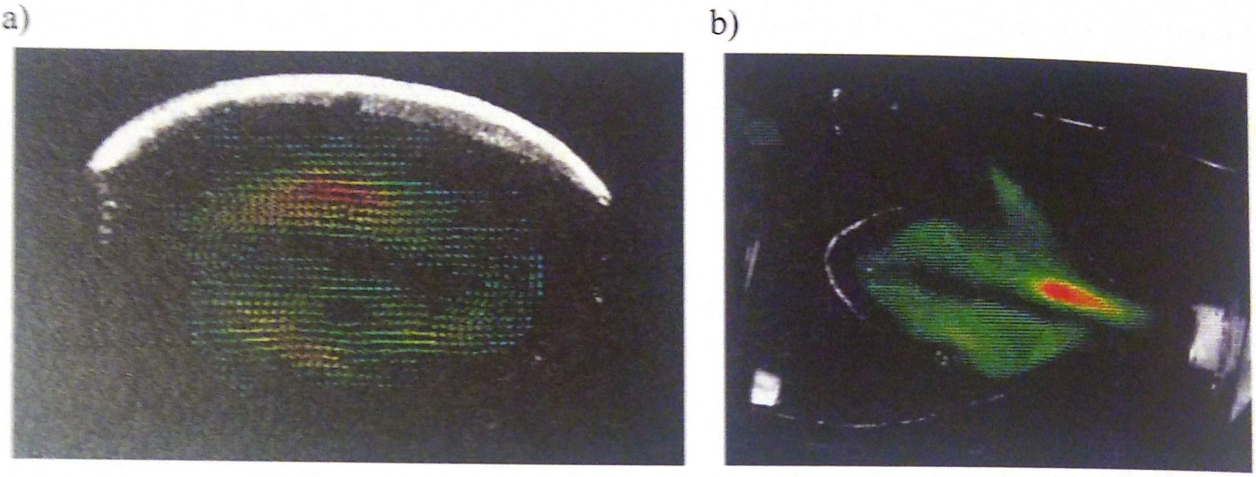

Figure 2. Results of PIV analysis using different types medium: a) water, b) sodium iodide

PIV flow measurements using distilled water show that due to the difference in refractive indexes between these materials, image distortions are produced, which makes the analysis difficult [2-4]. The use of sodium iodide solution as a medium increases the refractive index of the solution, which reduces its difference to the material of the phantom used in the research (epoxy resin) and also reduces light refraction and image distortion at the phantom-solution interface [5, 6].

The conducted research allowed us to conclude that the use of a medium based on a sodium iodide solution reduces reflections and refractions and make it possible to obtain more accurate analysis results. Based on these results, a numerical analysis of the flow of the liquid with mechanical properties used in the experiment can be performed [7]. The next step will be the validation of hemodynamic parameters, e.g. wall shear stress (WSS) using an Ansys CFX software. The same velocity will be set on inlet in simulation and PIV experiment and then the validation of obtained hemodynamic parameters will be performed.

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