



ANALYSIS OF VASCULAR FLOWS WITH OPTICAL TECHNIQUES

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Fluid: biological flows

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ABSTRACT: Cardiovascular diseases (CVD) are the main cause of life lost in developed countries and one of the main causes of disability in the population. The objective of this work is to measure the influence of flow velocity and vessel shape in the formation of atheroma plaques and brain aneurisms, using PIV and digital holography. The simultaneous measurement of the velocity field (3D-3C measurement) and of the vessel shape and deformation would allow the study of the fluid-wall interaction which provides the wall shear stress, one of the most important parameters in the development of these diseases.

Two set of experiments were carried out. In the first set, the velocity field in a spherical brain aneurism model made of silicone is analyzed using high speed PIV (with a double-cavity high speed laser) and digital image plane holography, in order to obtain the 2D-3C velocity field. Due to the different velocities in the balloon and in the vein, figure 1 (a) shows a combination of the in-plane displacement measured with PIV in the balloon (blue vectors) and in the vein (green vectors). Displacement in the balloon is measured correlating consecutive images recorded with the same laser ($\Delta T = 2000 \mu s$), while the displacement field in the vein (green vectors) comes from the analysis of images recorded with consecutive pulses from each laser ($\Delta T = 90 \mu s$). The phase maps obtained from the holograms provide information not only of the out-of-plane component but also about the deformation produced in the model wall (figure 1b).

In other set of experiments, the influence of a prototype of antithrombotic filter for vena cava is being evaluated. In figure 1 (c) five velocity fields, measured with PIV, have been overlapped to obtain the 2D-2C velocity field in a vein with an antithrombotic filter. Due to the presence of the filter a clear deceleration of the flow is measured. A numerical model is being developed, which will use these experimental data for validating the code.

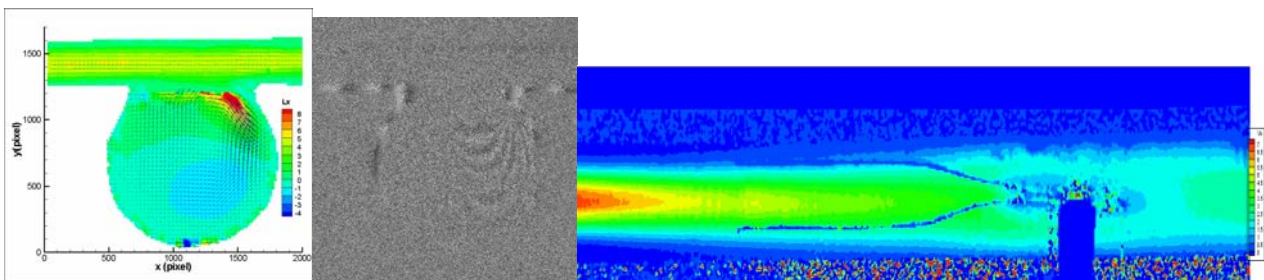


Fig. 1 (a) In-plane displacement in a brain aneurism model; b) Phase map, showing the out-of-plane displacement and deformation in the aneurism wall; c) Velocity field in a vein with an antithrombotic filter

References

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