Analysis of the behaviour of intracranial aneurysms with OpenFOAM

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Understanding physiological processes is key to treat patients, especially in emergency situations. For this reason, the understanding of the behaviour of aneurysms in the human brain has been the study of research for decades. With a better understanding of the processes involved the treatment of patients can be improved.

To computationally model the processes involved, it is of utmost important to correctly describe the behaviour of both the fluid (blood) as well as the blood vessel. For this a Fluid-Structure Interaction (FSI) toolkit is required which can correctly describe the fluid dynamic side as well as the solid mechanic side (including non-linear behaviour). The solids4Foam user developed library [1] is well suited for this purpose.

In previous works [2,3,4] the base library in foam-extend was ported to v1812/v1912 and additional features were added. With this improved FSI library the simulations show promising results to describe the processes in intracranial aneurysms.

In this works first real-life aneurysms are investigated to understand possible rupture od aneurysms. Additionally, phenomena for aneurysm onset are also investigated to start understanding the underlying phenomena. These simulations show a typical runtime of 2-10 minutes, which enables the user to guarantee a fast turnaround time of the simulations.

With the developed models and workflow in future a vast variety of aneurysms can be investigated to understand existing aneurysms as well as the possible onset behaviour (see figure below) of aneurysms.

References

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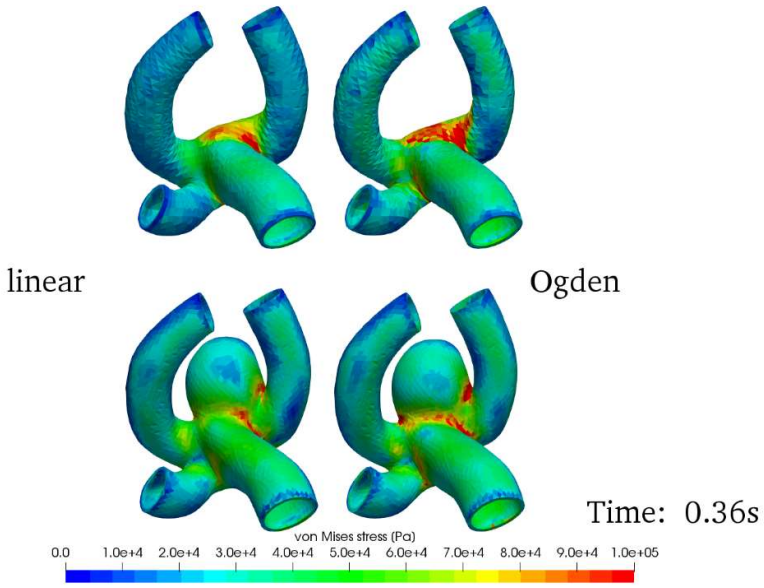

Figure: Simulation results with linear and non-linear elastic (Ogden) material models of von mises stress in the solid blood vessel at highest fluid pressure without (top) and with (bottom) aneurysm