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KIRCHOFF-LOVE THIN-SHELLS PRESTRESSED STATE ESTIMATION BY MULF: APPLICATION TO INTRACRANIAL ANEURYSMS

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Abstract. When an intracranial aneurysm is diagnosed, physicians found themselves in the dichotomy of treating it or monitoring it, as while subarachnoid hemorrhage presents a 45% of mortality rate, the endovascular occlusion of cerebral aneurysms is not a risk-free procedure. In particular, it is believed that the aneurysm neck and its surroundings are very sensitive to applied loads, causing structural instabilities which increase the intraoperative rupture risk. For a better understanding of this issue, in previous work we performed simulations of localized loads in the neck neighboring area for a database of patient-specific aneurysm models. Deformation kinematics were described using a geometrically nonlinear thin shell model under Kirchhoff-Love's assumptions in conjunction with a Saint-Venant's hyperelastic material model. This simplified approach allowed us to perform the analysis in a high number of cases, and to introduce physiological phenomena to our model such as thickness and Young modulus variations between the artery and the pathological dome. Nevertheless, this model does not take into account the effect of blood flow, a major influence in the artery mechanical behavior. In this work, we show the effect of localized loads in the neighboring areas of the aneurysm neck, considering the prestressed state of the aneurysm structure due to the inner pressure exerted by blood flow. We approximated the effect of blood pressure by an adaptation of the Modified Updated Lagrangian Formulation (MULF) presented by (Gee et al 2009), implemented in a C++ in-house library. Pressure was modeled by applying a normal load to the inner surface of the aneurysm model of 85 mmHg, a mean value of the arterial pressure during the cardiac cycle.

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