11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Intracranial aneurismal pulsatility as a new individual criterion for rupture risk evaluation: Biomechanical and numerical approach (IRRAs project).

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Key Words: FSI, cerebral aneurysms, rupture risk, pulsatility.

Objective: This study was designed to highlight by means of numerical simulations, the correlation between aneurism sac pulsatility and the risk of rupture through the mechanical properties of the wall.

Methods: In accordance to previous work[1,2] suggesting a correlation between the risk of rupture and the material properties of cerebral aneurysms, twelve fluid-structure interaction (FSI) computations were performed on 12 ”patient-specific” cases, corresponding to typical shapes and locations of cerebral aneurysms.
The variations of the aneurismal volume during the cardiac cycle (ΔV) are compared using wall material characteristics of either degraded and non-degraded tissues.

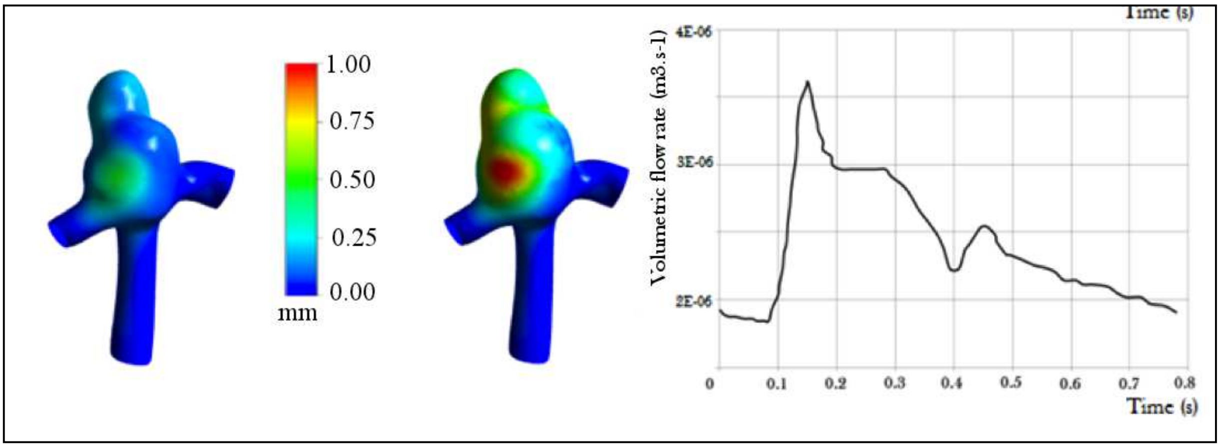
Results: Aneurysms were located on 7 different arteries: Middle Cerebral Artery (4), Anterior Cerebral Artery (3), Internal Carotid Artery (1), Vertebral Artery (1), Ophthalmic Artery (1) and Basilar Artery (1). Aneurysms presented different shapes (uniform or multi-lobulated) and diastolic volumes (from 18 to 392 mm^3). The pulsatility ($\Delta V/V$) was significantly larger for a soft aneurismal material (average of 26 %) than for a stiff material (average of 4 %) (Table 1 and Figure 1). The difference between ΔV, for each condition, was statistically significant: $p = 0.005$.

Conclusion: The difference in aneurismal pulsatility as highlighted in this work might be a relevant patient-specific predictor of aneurysm risk of rupture.

Table 1: Results for R_v and R_d for the 12 cases

aneurysm	**Volume (mm^3)**	**R$v = \Delta V^{soft} / \Delta V^{stiff}$**	**R$d = D_{max}^{soft} / D_{max}^{stiff}$**
1	61	10	2.9
2	51	16	3.5
3	161	7.3	2.7
4	188	5.3	4.7
5	392	8.3	2.2
6	45	8.25	1.5
7	212	4.3	2.2
8	232	5.4	2.1
9	79	5	3.2
10	138	5.2	2.8
11	68	4.4	3.5
12	18	8	1.9

Figure 1: FSI maximal mesh displacement results for the systolic pressure for the aneurysms 7 with the volumetric flow rate imposed at the inlet (On the left for the stiff material and on the right for the soft material).



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