

# Hemodynamic Differences Found in Ruptured and Unruptured Aneurysms

## - Quantitative Comparison of 41 Cases from a Single Location

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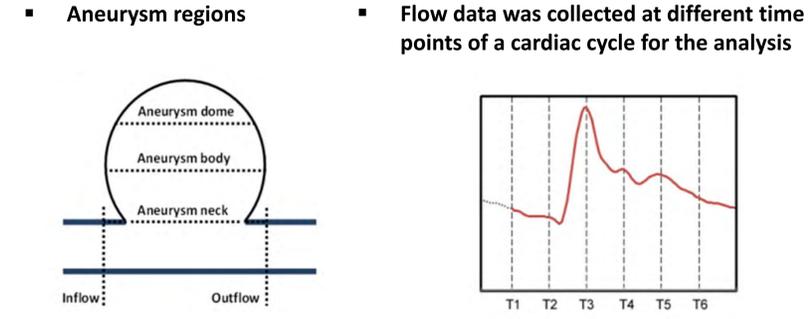
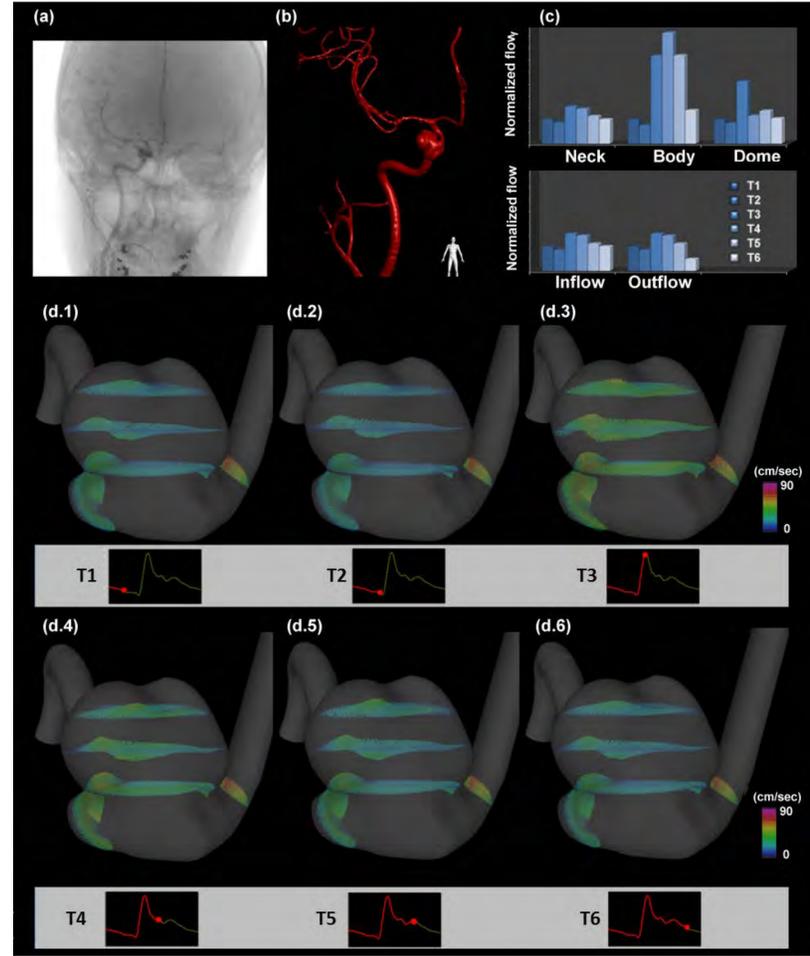
**Introduction:** Brain aneurysm growth and rupture has been reported to relate to hemodynamic properties. To understand the characteristics of high rupture risk blood flow, research has studied flow differences between ruptured and unruptured aneurysms. Although it is known that flow characteristics also vary between different aneurysm locations, due to the rarity of data for ruptured cases, previous reports which showed differences between ruptured and unruptured aneurysms have relied on the inclusion of cases from multiple locations for the comparison. [3-4]

**Hypothesis:** Our hypothesis is that hemodynamic differences between ruptured and unruptured cases can be found in aneurysms at the same anatomical location.

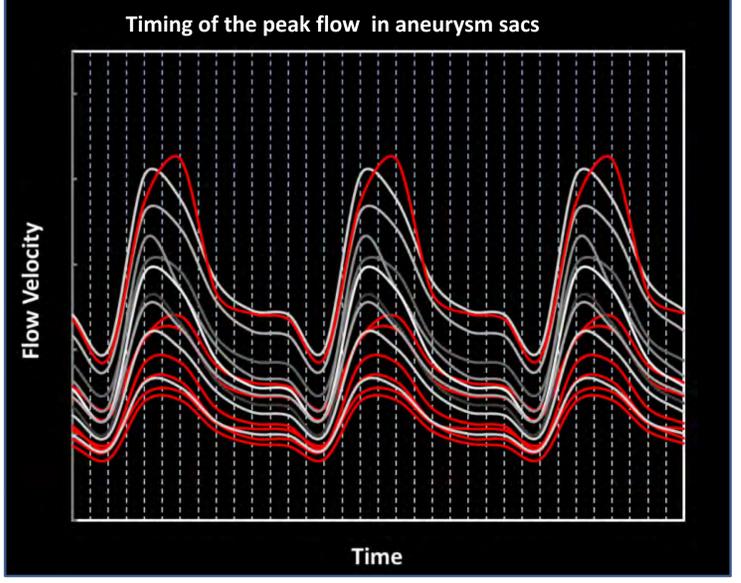
**Methods:** A total of 41 internal carotid artery-ophthalmic artery (12 ruptured and 29 unruptured) aneurysm cases treated from January 2004 to August 2011 at the UCLA Medical Center were included. Aneurysms were studied using patient-specific hemodynamic analysis. Flow changes in different aneurysm regions and their association with rupture were analyzed quantitatively.

Table : Summary of Cases			
Characteristics	Ruptured Aneurysm	Unruptured Aneurysm	Summary
Number of aneurysms	12	29	41
Patient age (mean)	58	56	57
Female	12	28	40
Size of aneurysm (no. of aneurysms)			
< 7mm	4	10	14
7-12 mm	2	16	18
>12 mm	6	3	9
Largest diameter of aneurysm sac (mm)			
Mean	11.8	8.5	9.5
Range	3.7-23.5	3.8-19.5	3.7-23.5
Aneurysm sac to neck ratio			
Mean	2.6	2.0	2.1
Range	1.1-4.9	1.3-3.8	1.1-4.9

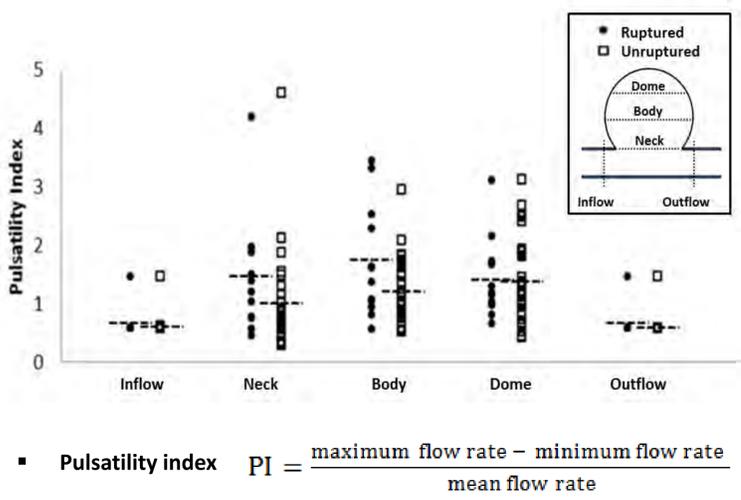
**Result 1.** Quantitative comparisons of aneurysmal blood flow showed dynamic flow changes within the aneurysm sac over the cardiac cycle. [1]



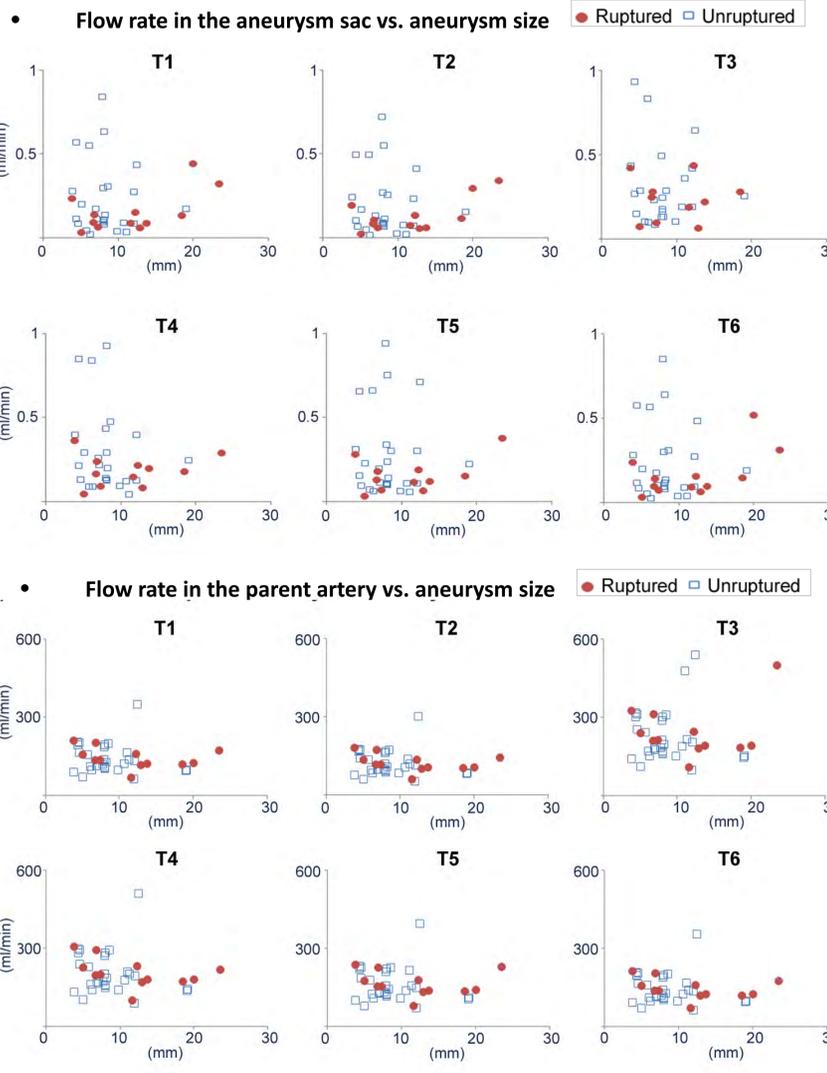
**Result 2.** Timing of the peak flow within the aneurysm sacs differs among aneurysm cases.



**Result 3.** Concentrated high blood flow pulsatility was discovered in ruptured aneurysms. [2] In contrast, the blood flow pulsatility was found to be lower and increased gradually from the neck to dome in unruptured aneurysms. Pulsatility index at neck, body, and dome averaged 1.5, 1.7, and 1.5 for ruptured cases, and 1.0, 1.2, and 1.3 for unruptured cases.



**Result 4** The average flow rate in the aneurysm sac and parent artery at different time points was studied. Aneurysm flow rate did not correlate with aneurysm size for any of the time points of the cardiac cycle.



**Conclusions:** Differences in hemodynamic characteristics were found between ruptured and unruptured cases when comparing aneurysmal flow changes during the cardiac cycle. Our study suggests that high pulsatility and the relationship between inflow and outflow may be useful to characterize rupture risk for aneurysms at the same location.

**References:** [1] A Chien, J Sayre, F Vinuela, "Quantitative comparison of the dynamic flow waveform changes in 12 ruptured and 29 unruptured ICA-ophthalmic artery aneurysms"; *Neuroradiology. In press.* [2] J Patti, F Vinuela, A Chien, "Distinct trends of pulsatility found at the necks of ruptured and unruptured aneurysms"; *J Neurointerv Surg. In press.* [3] J Cebral, M Castro, J Burgess, R Pergolizzi et al, "Characterization of cerebral aneurysms for assessing risk of rupture by using patient-specific computational hemodynamics models"; *AJNR Am J Neuroradiol* (2005) 26:2550-2559. [4] A Chien, M Castro, S Tateshima, J Sayre et al., "Quantitative hemodynamic analysis of brain aneurysms at different locations. *AJNR Am J Neuroradiol* (2009) 30:1507-1512 422.