Identification of a Dichotomy in Morphological Predictors of Rupture Status Between Sidewall- and Bifurcation-Type Intracranial Aneurysms

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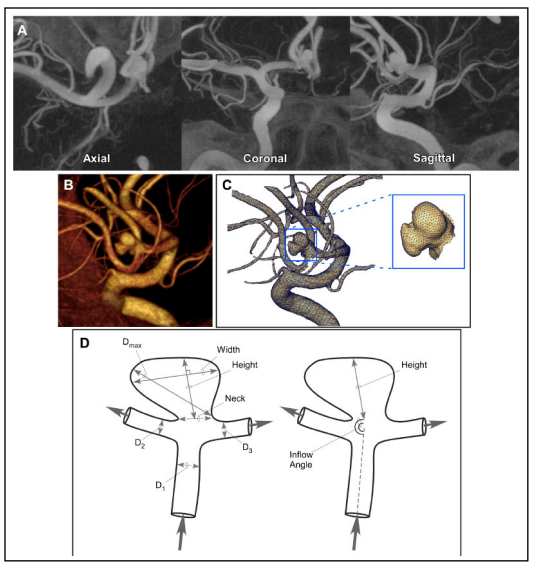
Introduction

Prediction of aneurysm rupture likelihood is clinically valuable, since more incidental unruptured aneurysms are being discovered with the advent of imaging techniques.

We set out to evaluate the relative performance of morphological features for rupture status discrimination in the context of the divergent geometric and hemodynamic characteristics of sidewall- (SW) and bifurcation-type (BIF) aneurysms.

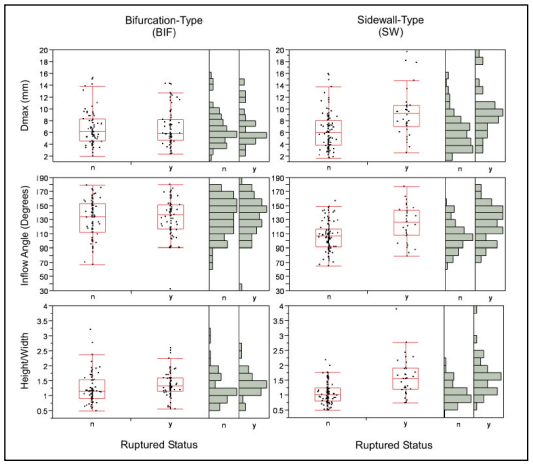


Methods

Catheter three-dimentional (3D)-rotational angiographic volumes of 271 consecutive aneurysms (101 ruptured, 135 BIF) were measured in 3D for largest diameter (Dmax), height (H), height-width ratio (H/W), aspect ratio (AR), size ratio (SR), non-sphericity index (NSI), and inflow-angle (IA).

Univariate statistics applied on BIF, SW, and combined (BIF+SW) sets, identified significant features for inclusion in multivariate analysis yielding area under the curve (AUC) and optimal thresholds in the receiver-operating characteristic.

Furthermore a computational fluid dynamics (CFD) analysis was performed to evaluate the flow and wall shear stress (WSS) conditions inside SW and BIF aneurysms at different IA.



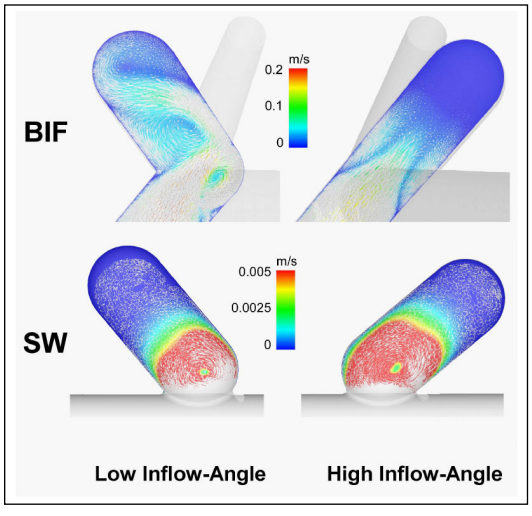
Results

Dmax, H, and IA were significantly greater among ruptured SW aneurysms, but showed no difference in BIF lesions.

All features were statistically different in the combined set. Multivariate analysis identified:

1) NSI as the only rupture predictor in BIF lesions (AUC=0.68),
2) H/W, SR, and IA as strong predictors in SW lesions (AUC=0.86), and
3) H/W, IA, and SR as intermediate predictors in the combined group (AUC=0.75).

CFD analysis showed that although increasing IA in a SW model led to deeper penetration of flow, higher velocities, and higher WSS inside the aneurysm dome, it resulted in the exact opposite results in a BIF model.

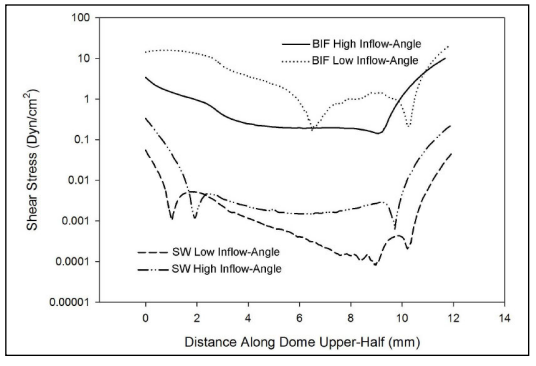


Conclusions

Morphological and hemodynamic analysis point to a dichotomy between SW and BIF aneurysms with respect to performance of shape/size parameters in identifying rupture status, suggesting the need for aneurysm type -based analysis in future studies. The current most commonly used clinical risk assessment metric, Dmax, was found to be of no value in segregating between ruptured and unruptured BIF aneurysms.

Learning Objectives

1-Identify importance of aneurysm shape in discrimating ruptured status of given intracranial aneurysm
2-Learn differences in the relative importance of aneurysm dimensions and shape parameters among different types of cerebral aneurysms



References

1-Unruptured intracranial aneurysms--risk of rupture and risks of surgical intervention. International Study of Unruptured Intracranial Aneurysms Investigators. N Engl J Med 339:1725-1733, 1998