

Three Dimensional Geometrical Features of Saccular Intracranial Aneurysms Predicting Risk of Rupture

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Introduction

Geometrical and hemodynamic factors play major role in aneurysms growth and rupture. This study explores the interplay between different geometrical features of various types of aneurysms related to aneurysm rupture angiographically.

Aim of the work

The aim of this study is to investigate the three-dimensional geometrical features associated with 250 ruptured saccular intracranial aneurysms admitted at the neurosurgery department hospitals, Alexandria University

Patients

This study includes retrospective analysis of 250 cases of ruptured saccular intracranial aneurysms admitted to the neurosurgery department hospitals and affiliated hospitals at Alexandria University.

Methods

3D DSA studies were retrospectively analysed for 180 patients with ruptured SW and SWB aneurysms and 70 patients with ruptured endwall aneurysms, excluding AcoA aneurysms. In SW and SWB cases, relationships between maximum aneurysm depth and different geometrical features including neck diameter, parent vessel curvature angle and diameter difference between proximal and distal parent vessel segments were explored. In EW cases, maximum aneurysm depth was correlated with neck diameter, branching angle and discrepancy between daughter vessel diameters.

Results

Narrow PV curvature angle is significantly correlated with greater maximum aneurysm depth in sidewall aneurysms (p value =0.019). PV stenosis distal to sidewall aneurysms is significantly associated with greater aneurysm depth (p value<0.001). A wider branching angle is associated with smaller aneurysm depth in endwall aneurysms having daughter vessels narrower in caliber than their PV (p value=0.02). A positive significant correlation is recorded between aneurysm depth and neck width in both endwall and sidewall types (p value <0.001).

Table (1):Descriptive analysis of the studied cases according to different morphological parameters in sidewall SW and sidewall with branching vessel SWB saccular aneurysms (n = 180)

Morphological Parameter	SW and SWB (mean value ±SD)
Maximum Depth (mm)	6.34± 4.44
Neck Diameter (mm)	3.63±1.74
Pre-Aneurysm parent vessel diameter at neck (D1) (mm)	2.86± 1.03
Pre-Aneurysm parent vessel diameter at 1.5xD1 (D2) (mm)	3.15±1.08
Proximal (inflow) parent vessel average diameter (D1+D2/2) (mm)	3.00±1.00
Post-Aneurysm parent vessel diameter at neck (D1) (mm)	2.88±0.97
Post-Aneurysm parent vessel diameter at 1.5D1 (D2) (mm)	2.82±0.92
Distal (outflow) parent vessel average diameter (D1+D2/2)(mm)	2.85± 0.88
Parent vessel curvature angle (deg)	109.2± 28.4
Parent vessel diameter difference between proximal and distal segments	0.45± 0.44

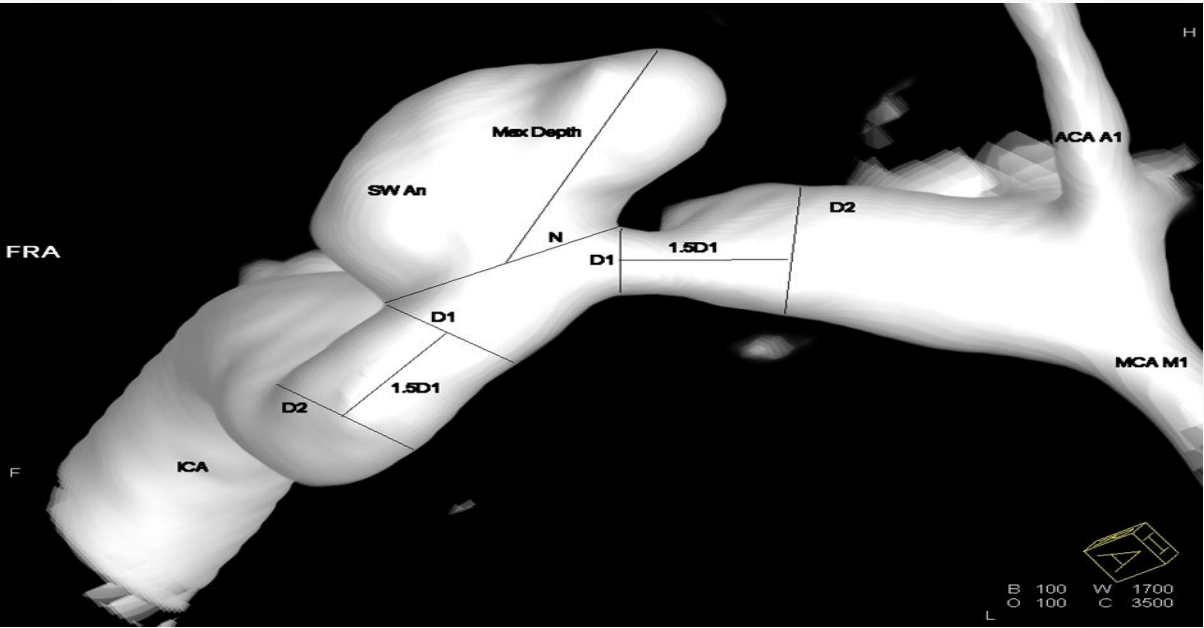


Figure (1):Representative 3D DSA image of a sidewall aneurysm (SW An) of the left internal carotid artery ophthalmic segment in a 34-year-old female. N=neck diameter. Max Depth=maximum aneurysm depth. For each parent vessel segment, D1= parent vessel diameter at proximal neck. D2= parent vessel diameter at 1.5D1 upstream of the aneurysm. ICA= internal carotid artery. ACA A1= A1 segment of anterior cerebral artery. MCA M1= M1 segment of middle cerebral ar

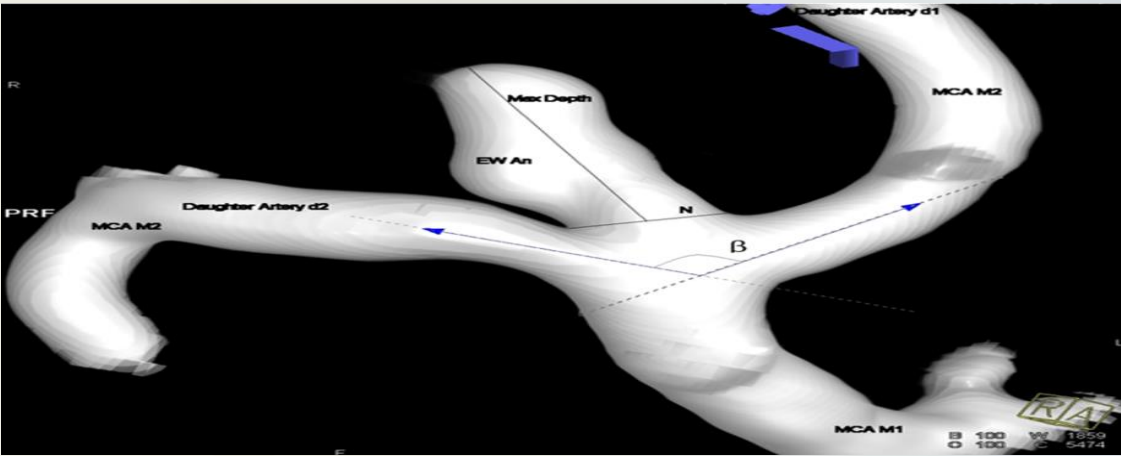


Figure (2): Representative 3D DSA image of an endwall aneurysm (EW An) arising from the right middle cerebral artery bifurcation in a 62-year-old male. The branching angle (β) is formed by the intersection of the longitudinal axis of each daughter vessel (two dotted lines on d1 and d2). Blue arrowheads represent the direction of blood flow.. Neck diameter measured 2.23 mm. N=neck diameter. Max Depth=maximum aneurysm depth. MCA M1 = M1 segment of middle cerebral artery. MCA M2= M2 segment of middle cerebral artery.

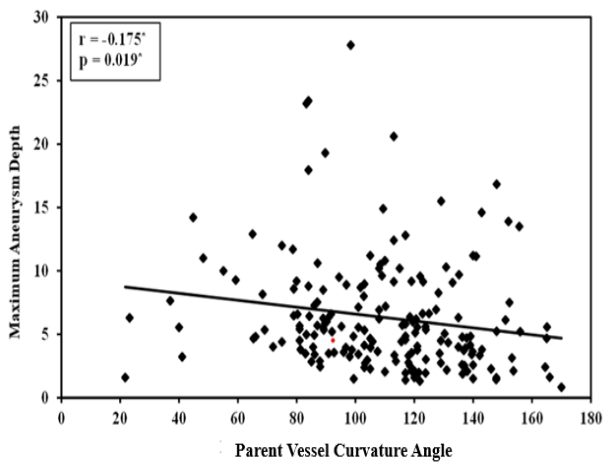


Figure (3): 2D scatter plot shows correlation between parent vessel curvature angle and Maximum depth in SW and SWB saccular aneurysm (n = 180) (*=statistically significant)

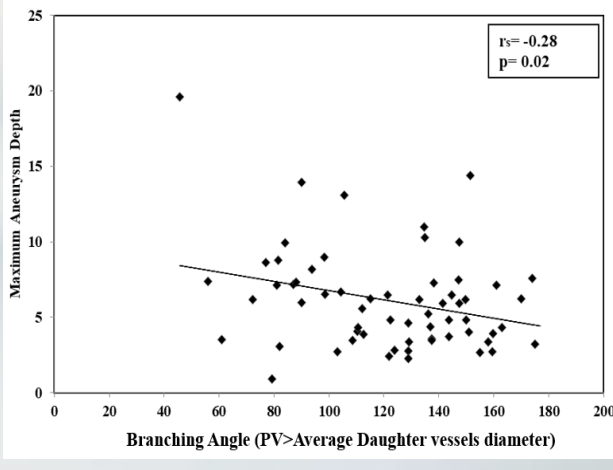


Figure (4): 2D scatter plot shows correlation between branching angle and maximum aneurysm depth in EW aneurysm cases with parent vessel diameter larger than average of both daughter vessels diameter (n = 62)

Conclusion

Geometrical factors such as parent vessel curvature angle, aneurysm neck width, and distal narrowing of the parent vessel affect the risk of growth and rupture of sidewall and sidewall with branching vessel aneurysms. A wider branching angle should be considered as a risk factor for early rupture of endwall aneurysms. Neck width is an independent risk factor for growth and rupture of both sidewall and endwall intracranial aneurysms.