Supplemental files

Supplemental methods

DSA protocol

Cerebral angiography was performed on a fixed digital angiographic system with a single-plane flat panel detector (FD 20 Artis; Phillips Medical Systems, Dutch). A 5-s Seldinger technique was used to puncture the femoral artery with the patient under local anesthesia. Multiple view angiography of the cranial arteries with injection of the bilateral common carotid arteries, bilateral internal carotid arteries and bilateral vertebral arteries was performed. Aortic arch injection was also performed for evaluation of arch anatomy. 3D rotational angiography was performed on the parent vessel of the UIAs to confirm detailed anatomic information. DSA acquisition protocol was performed with contrast injection at a rate of 4 ml/s.

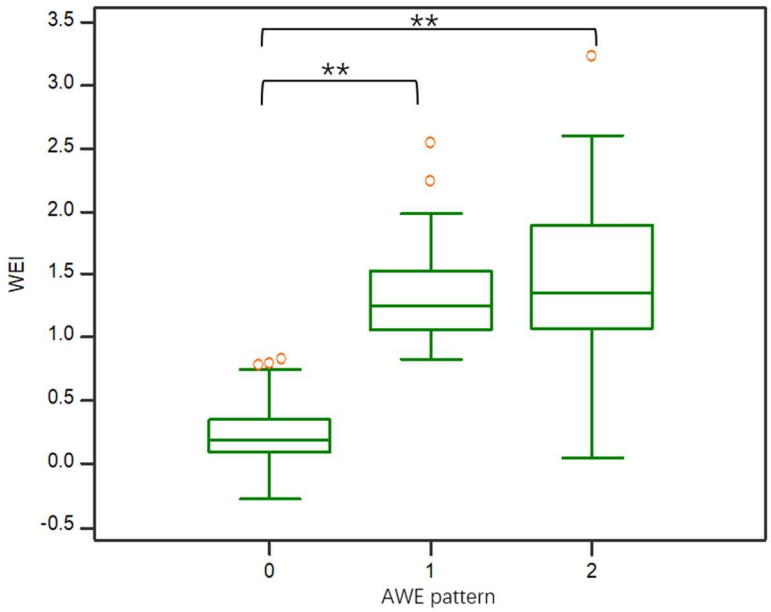
MRI protocol

All patients were scanned on one of two 3T MR scanners (MAGNETOM Prisma or Verio; Siemens Healthineers, Erlangen, Germany) with 64-channel neurovascular coils. Three-dimensional time-of-flight MRA was acquired in the axial plane for aneurysm localization. Then either 2D or 3D T1-weighted black blood fast-spin-echo vessel wall MRI were scanned before and after intravenous administration of 0.1 mmol/kg Gadopentetate chelate (Magnevist; Bayer HealthCare Pharmaceuticals). The scanning parameters were as follows: 1) Time-of-flight MRA: repetition time/echo time = 20.0/3.7 ms, field of view =200×80 mm, slice thickness =0.6 mm, and matrix =320×250. 2) 2D T1-weighted MRI: acquired in planes orthogonal or parallel to the parent artery, field of view = 430/10 ms, echo train length = 9, number of excitations = 6, 7-12 slices with 2 mm slice thickness, in-plane resolution of 0.55 mm × 0.53 mm, field of view = 140 mm×81 mm, matrix = 256×166, scan time was 4 minute and 55 seconds to 8 minutes and 34 seconds. Saturation bands were placed at inflow location for blood suppression. 3) 3D T1-weighted MRI (SPACE): acquired in sagittal plane, repetition time/echo time = 800/14ms, field of view = 192mm × 192 mm, voxel size = 0.6mm isotropic, echo train length = 60, number of slices = 224, scan time was 7 minutes and 36 seconds. Partial Fourier of 6/8 in slice direction and parallel imaging acceleration of 2 (GRAPPA) was used.

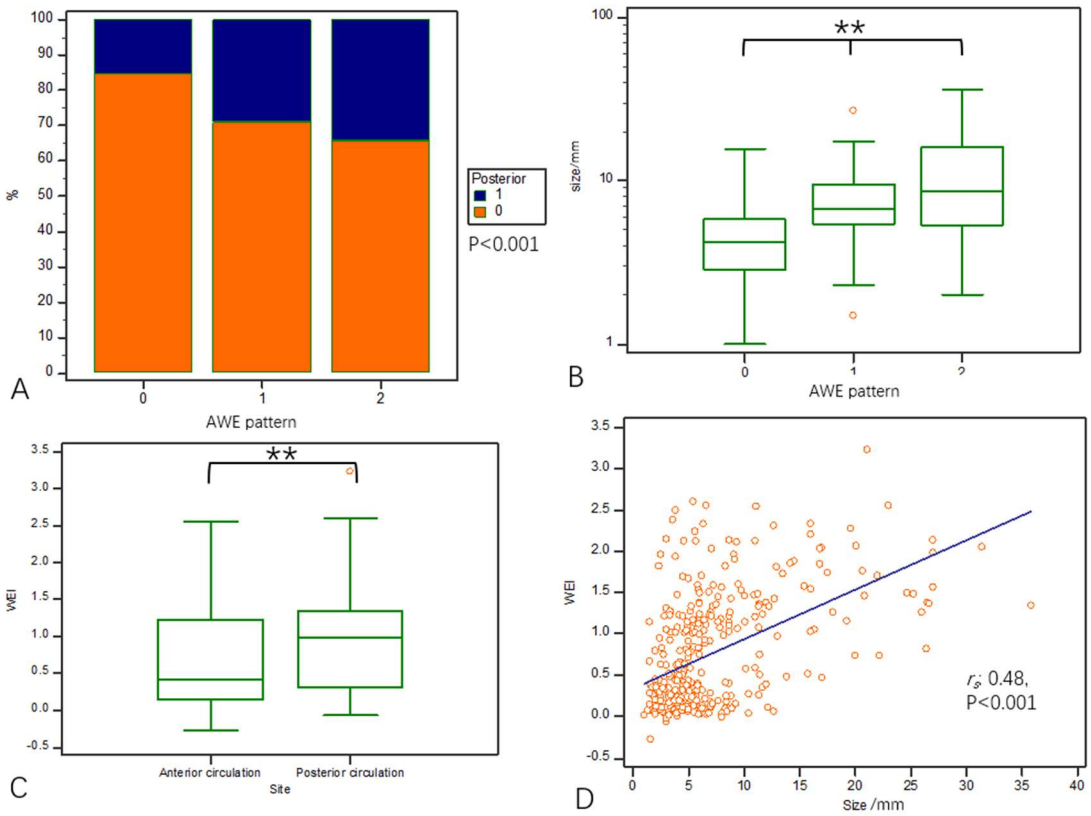
Quantitative analysis of VW-MRI images

Three slices with the most significant enhancement on post-contrast VW-MRI were selected by the raters who then traced the lumen and outer boundaries of the aneurysm wall through the optimally displayed angle (coronal, sagittal or axial based on the specific geometry of the aneurysm). The software automatically matched the slice locations of the corresponding pre-contrast imaging. The inner lumen and outer wall contours of aneurysm were automatically segmented by the software, with manual adjustment of the contours if the neuroradiologist considered the tracings unsatisfactory. Subsequently, all obtained contours of each layer of aneurysm were automatically

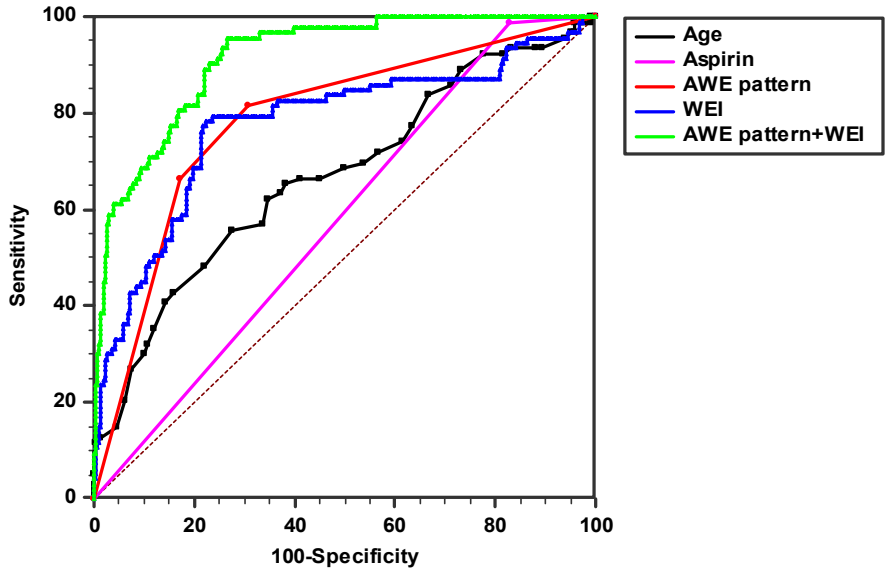
segmented into 4 quarters, and the mean signal intensity (SI) of each quarter (defined as quarter SI) was calculated automatically. The quarter with the highest mean SI was selected for each slice, and the average value of the three quarters from the corresponding three slices were used to represent the SI of the aneurysm wall. This method permitted evaluation of the most intensely enhancing segment of the aneurysm wall. The average SI of the aneurysm wall at the corresponding position on the pre-contrast vessel wall imaging was obtained by similar methods. In order to normalize the SI, similar methods were used to measure the average SI of ROIs on the adjacent white matter on the pre- and post-contrast vessel wall imaging.



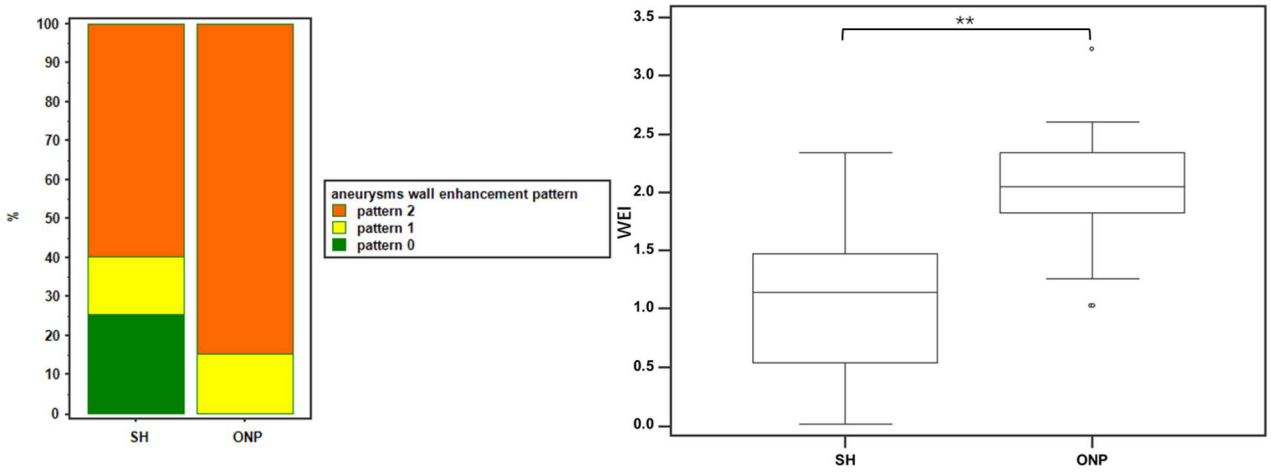
Supplemental Figure I. Box plots of wall enhancement index (WEI) among 3 aneurysmal wall enhancement (AWE) patterns. AWE pattern 0, no wall enhancement; pattern 1, focal wall enhancement; pattern 2, circumferential wall enhancement. WEI (median, IQR) of AWE pattern 0 (n=188): 0.19 (0.09, 0.35); AWE pattern 1 (n=48): 1.25 (1.07, 1.53); AWE pattern 2 (n=105): 1.36 (1.07, 1.89). Box-and-whisker plots represent medians (lines within boxes), interquartile ranges (upper and lower ends of boxes), greatest and least values (top and bottom lines), and outliers (data points beyond top and bottom lines). Among three groups, P<0.001. Between two groups, **, P<0.01; AWE pattern 1 versus AWE pattern 2, P=0.27.



Supplemental Figure II. Plots showing the relationships between aneurysmal wall enhancement measures (pattern and index) and conventional features of aneurysms (size and location). AWE pattern: aneurysmal wall enhancement pattern. WEI: wall enhancement index. **, P<0.01



Supplemental Figure III. Receiver operating characteristic curves of the aneurysm wall enhancement for differentiating symptomatic from asymptomatic aneurysms. The areas under the curve for age, aspirin intake, the aneurysm wall enhancement (AWE) pattern, the wall enhancement index (WEI), and the AWE pattern + WEI were 0.67, 0.58, 0.79, 0.78 and 0.91, respectively.



Supplemental Figure IV. A. Bar graphs comparing the aneurysm wall enhancement pattern for aneurysms in patients with sentinel headache and oculomotor nerve palsy. B: Plots comparing wall enhancement index for aneurysms in patients with sentinel headache and oculomotor nerve palsy. **, P<0.01.

Supplemental Table I. Demographic and aneurysm characteristics in patients with different symptoms

Parameter	Total (n=93)	Sentinel headaches aneurysms (n=67)	Oculomotor nerve palsy aneurysms (n=26)	P Value
Age (year)	53.3±12.6	53.6±12.9	52.6±11.8	0.55
Female	61 (65.6)	40 (59.7)	21 (80.8)	0.06
Hypertension	48 (51.6)	37 (55.2)	11 (42.3)	0.27
Dyslipidemia	45 (48.4)	34 (50.7)	11 (42.3)	0.47
Diabetes	15 (16.1)	13 (19.4)	2 (7.7)	0.17
Previous SAH	2 (2.2)	2 (3.0)	0 (0.0)	0.38
Cigarette smoking	16 (17.2)	14 (20.9)	2 (7.7)	0.13
Alcohol consumption	10 (10.8)	8 (11.9)	2 (7.7)	0.56
Aspirin intake	1 (1.1)	1 (1.5)	0 (0)	0.53
Familial history of Intracranial Aneurysm	8 (8.6)	4 (6.0)	4 (15.4)	0.15
Posterior circulation	29 (31.2)	24 (35.8)	5 (19.2)	0.12
Aneurysm size (mm)	7.1 (5.0, 12.3)	6.3 (4.6, 8.7)	16.0 (8.7, 20.1)	<0.001
Thrombus	20 (21.5)	14 (20.9)	6 (23.1)	0.82
AWE pattern				0.02
Pattern 0	17 (18.3)	17 (25.4)	0 (0)	
Pattern 1	14 (15.1)	10 (14.9)	4 (15.4)	
Pattern 2	62 (66.7)	40 (59.7)	22 (84.6)	
MR imaging quantitative measures				
WEI	1.3 (1, 1.9)	1.1 (0.5, 1.5)	2.1 (1.8, 2.3)	<0.001

The data of continuous variables are mean ± SD or median (interquartile range). The data of categorical variables are expressed as n (%). SAH, subarachnoid hemorrhage; AWE, aneurysms wall enhancement; WEI, wall enhancement index.

Supplemental Table II. Multivariate logistic regression analysis for factors associated with aneurysms in patients with oculomotor nerve palsy

Parameter	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	P Value	OR	95% CI	P Value
Age	0.99	0.96 to 1.0	0.73		NA	
Female	2.8	0.95 to 8.4	0.06		NA	
Hypertension	0.60	0.24 to 1.5	0.27		NA	
Previous SAH*	NA	NA	1.00		NA	
Cigarette smoking	0.32	0.07 to 1.5	0.15		NA	
Aspirin intake*	NA	NA	1.00		NA	
Familial history of intracranial aneurysm	2.9	0.66 to 12.4	0.16		NA	
Posterior circulation	0.54	0.19 to 1.5	0.24		NA	
Aneurysm size(mm)	1.2	1.1 to 1.3	0.001	1.1	1.0 to 1.2	0.03
Thrombus	1.14	0.38 to 3.4	0.82		NA	
AWE pattern	3.2	1.3 to 8.0	0.02		NA	
WEI	23.8	6.2 to 92.1	<0.001	18.6	4.6 to 74.6	<0.001

NA: not included in the model; OR: odds ratio; 95% CI: 95% confidence intervals. SAH, subarachnoid hemorrhage; AWE, aneurysms wall enhancement; WEI, wall enhancement index.

* The positive cases were ≤ 2, and the P values were 1.00, therefore the ORs were not calculated.