Radiology: Artificial Intelligence ORIGINAL RESEARCH

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End-to-End Autonomous Quantification of Brain Aneurysm and Parent Artery Morphology at CT Angiography[8]

8 Please verify all author names, degrees, and affiliations are correct, as printed. Please add academic degrees for XX.

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See also commentary by Maiter in this issue.

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Purpose: To develop and validate an end-to-end autonomous platform for the quantification and visualization of brain aneurysm and parent artery morphology at CT angiography (CTA).

Materials and Methods: A total of 2980 CTA scans performed between 2004 and 2025 containing 2585 aneurysms from 2980 patients obtained from five international high-volume stroke centers were included. The model was trained using expert hand-annotated vascular segmentations spanning the cervical internal carotid and vertebral arteries through the A4, M3, and P3 segments. Internal prospective and multicenter external testing assessed aneurysm detection performance and compared morphology measurements with expert-derived values obtained with digital subtraction angiography–verified CTA. Statistical analysis used paired *t* tests or Wilcoxon signed rank tests, with sensitivity, specificity, and 95% CIs reported. A public web-based platform was developed to allow further validation.

Results: Internal and multicenter external testing yielded a patient-level sensitivity of 87.9% (290 of 330; 95% CI: 83.6[7], 91.3) and specificity of 86.6% (395 of 456; 95% CI: 83.3, 89.4). Physician-performed morphology extraction required 24.3 minutes ± 6.6 per scan, whereas the model completed the task autonomously in 90 seconds ± 12 ($P < .001$). At the aggregate level, no statistically significant differences were observed for aneurysm volume, neck diameter, parent artery diameter, flow angle, aspect ratio, size ratio, height-width ratio, undulating index, ellipticity index, or nonsphericity index. Dome height (mean difference, 0.1 ± 1.1; $P = .03$) and surface area (mean difference, −5.3 mm^2 ± 29.5; $P = .04$) differed but had minimal effect sizes.

Conclusion: The developed autonomous system for rupture-related morphology metric acquisition substantially reduced physician workload.

Supplemental material is available for this article.

7 In the abstract, I changed 83.3 to 83.6 to match the Results and table. OK?

Quantitative, lesion-specific metrics continue to be underused in clinical risk stratification for unruptured intracranial aneurysms. In the mid-2010s, the population, hypertension, age, size, earlier subarachnoid hemorrhage, site (PHASES) score provided the first prospective, multicenter estimates of aneurysm rupture risk (1). Subsequent external validations, however, demonstrated limited generalizability, contributing to declining confidence in its use for clinical decision-making (2). A central limitation of the PHASES score is its reliance on just five crude patient demographic and clinical variables combined with a single morphologic parameter—maximum aneurysm diameter—thereby failing to capture the aneurysm's true geometry and local hemodynamics, which are now recognized as major determinants of rupture risk (3). In contrast, two- and three-dimensional morphologic parameters incorporating both aneurysm and parent artery characteristics more accurately reflect biomechanical stress and have consistently been shown to outperform PHASES score predictors alone (4). Specifically, recent systematic reviews and meta-analyses have demonstrated that morphology-based parameters—particularly aspect ratio, size ratio, neck geometry, and surface irregularity—are among the strongest independent predictors of aneurysm instability and rupture, consistently outperforming maximum diameter alone (4–6). These findings provide the rationale for focusing on comprehensive two- and three-dimensional aneurysm and parent artery morphology as core outputs of automated risk assessment systems.

Despite this evidence, morphology-based assessment remains uncommon in routine practice because many rupture-relevant metrics—particularly those incorporating volumetric and surface-based geometry—cannot be derived within standard picture archiving and communication system environments. Their acquisition instead requires time-intensive manual three-dimensional segmentation using dedicated software outside the clinical workflow, effectively precluding routine integration into treatment decision-making.

Advancements in computational hardware have made automated gathering of these parameters feasible, but progress on this front is stalled for two primary reasons. First are segmentation limitations: Accurate computation of morphology requires precise delineation of both the aneurysm dome and its parent artery, a task that remains challenging for all existing deep learning models owing to extreme class imbalance and vessel-aneurysm continuity requirements. Second are annotation barriers: High-quality reference standard data demand annotators with both cerebrovascular expertise and the time required for voxel-level three-dimensional segmentation, a resource combination available to only a few research groups worldwide. Consequently,

Abbreviations

BAM = Brain Aneurysm Morphology, CFD = computational fluid dynamics, CTA = CT angiography, DSA = digital subtraction angiography, PHASES = population, hypertension, age, size, earlier subarachnoid hemorrhage, site

Summary

An end-to-end autonomous artificial intelligence–based system was developed and validated at five international stroke centers to enable rapid, standardized quantification of rupture-relevant brain aneurysm and parent artery morphology metrics directly from CT angiography.

Key Points

- An end-to-end autonomous system was developed to quantify aneurysm and parent artery morphologic features from 2194 CT angiography (CTA) scans from two stroke centers and then tested on 786 CTA scans from four international stroke centers. In internal and external testing, the model yielded a patient-level sensitivity of 87.9% and a specificity of 86.6%.
- System processing time was 90 seconds ± 12 [SD] per scan, compared with 24.3 minutes ± 6.6 for physicians.
- There was no evidence of a difference between the majority of morphology measurements and expert-derived values.

Keywords

Intracranial Aneurysm, CT Angiography, Artificial Intelligence, Morphology, Rupture Risk

to our knowledge, there are no attempts to solve these problems autonomously at scale in the literature, and commercial efforts have produced only early concept models—none of which has received Food and Drug Administration 510(k) clearance for volumetric analysis or undergone independent, peer-reviewed external testing.

To address these limitations, Brain Aneurysm Morphology[1] (BAM), an end-to-end autonomous system for joint arterial and aneurysm segmentation with quantitative morphology reporting, was developed. The system enables rapid, fully automated extraction of rupture-relevant morphologic parameters directly from CT angiography (CTA), eliminating the need for manual segmentation and substantially reducing workflow burden. By facilitating scalable and standardized morphology assessment, BAM provides a practical pathway for integrating advanced quantitative metrics into routine aneurysm evaluation and future rupture-risk models.

1 Correct that "Brain Aneurysm Morphology" is the proper name of a system? Meaning, correct it should presented with capital letters ("Brain Aneurysm Morphology") instead of "brain aneurysm morphology".

Materials and Methods

This multicenter study was approved by the institutional review board at all participating institutions. Retrospective data collection and prospective internal evaluation were conducted under institutional review board approval with a waiver of informed consent, as the study posed minimal risk and did not influence clinical care. A subset of the CTA data (approximately 2000 scans) partially overlaps with a previously published aneurysm detection study (7); however, these scans were reannotated de novo to include full arterial vasculature and aneurysm morphology for quantitative analysis. These overlapping scans were used exclusively for model training, whereas all internal and external validation cohorts consisted of separate, nonoverlapping scans acquired subsequently and not used in prior studies. All imaging data were de-identified before analysis, and the study was conducted in compliance with the Health Insurance Portability and Accountability Act. No animal subjects were included. Methods and reporting follow Standards for Reporting of Diagnostic Accuracy Studies 2015 guidelines and Checklist for Artificial Intelligence in Medical Imaging 2024 recommendations (8,9). No industry provided financial, material, or technical support, and the authors had full control over the data and manuscript preparation.

Study Design

Participating centers contributed raw head or head and neck CTA scans. Scans with clips, coils, catheters, or other intracranial hardware; giant arteriovenous malformations or fistulas, dolichoectasias, or moyamoya disease with Suzuki grade of 3 or more; markedly degraded image quality; duplicate scans; or scans not extending to or fully capturing the circle of Willis were excluded. Scans with other cerebrovascular conditions (ischemic stroke, occlusion, dissection, smaller arteriovenous malformations or fistulas, or moyamoya disease with Suzuki grade ≤ 2) were not excluded. Scans either contained an aneurysm or were aneurysm negative. Section thickness was 1.6 mm or less. Scans with saccular and fusiform aneurysms were included. No fixed contrast density threshold was applied for scan inclusion; adequacy of contrast opacification was assessed qualitatively on the basis of neuroradiologist review.

All scans from consecutive patients with unruptured intracranial aneurysms at center 1 (Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts) from January 2004 to June 2024 and at center 2 (University Clinical Center, Medical University of Gdansk, Gdansk, Poland) from January 2015 to 2024 were used for training the artificial intelligence model, BAM. Prospective internal real-world validation was performed on scans from all patients presenting at center 1 for any suspicions of stroke from June 2024 to June 2025. Among the centers participating in external validation, a target of 300 of the most recent aneurysm-positive and -negative digital subtraction angiography (DSA)–verified CTA scans acquired up to June 2025 were requested. External validation was performed at three high-volume stroke centers: center 3 (Vienna General Hospital, Vienna, Austria), center 4 (Hospital Beneficência Portuguesa de São Paulo, São Paulo, Brazil), and center 5 (Buffalo General Medical Center, University at Buffalo, Buffalo, New York).

Scan Annotation Protocol

The annotation protocol was developed by two neuroradiologists (P.L. and Y.M.C.) (with 4 and 15 years of experience in neuroradiology, respectively) and one cerebrovascular neurosurgeon (C.S.O., with 35 years of experience). Arterial segmentation included all vessels from the cervical segments of the internal carotid artery and vertebral artery through the intracranial circulation, terminating at the A4, M3, and P3 branches to ensure full coverage of all clinically relevant aneurysm sites.

All voxel-level vascular and aneurysm segmentations were performed on CTA volumes. When available, DSA was used as a reference standard to confirm aneurysm presence and morphology, but DSA was not used for direct voxel-level annotation.

For the training dataset, all CTA scans were initially annotated by two final-year MD candidates (S.D.P and J.F.), who underwent a structured training period on cerebrovascular CTA segmentation and performed annotations under continuous neuroradiologist supervision, after which a randomly selected subset of 25% of scans underwent blinded quality-control review and correction by the two neuroradiologists. If any scans among the subset were deemed unsatisfactory, an additional subset of 25% of scans was reviewed by the neuroradiologists. When available, DSA served as the reference standard. For patients without corresponding DSA images, the neuroradiologists had full access to all CTA Digital Imaging and Communications in Medicine series, clinical reports, prior and follow-up imaging, and patient history to establish the most accurate anatomic reference. Disagreements were adjudicated by the cerebrovascular neurosurgeon (C.S.O.).

During internal and external validation, all BAM-detected true-positive aneurysms were manually annotated by a cerebrovascular neurosurgeon (K.S., with 8 years of clinical and 3D Slicer annotation experience). These annotations were independently reviewed by a second neurosurgeon (P.S., with XX years of experience[2]), and any discrepancies were resolved by two senior clinicians (C.S.O. and P.Z., with 30 years of neurosurgical experience). The same annotation protocol used for model training was applied across cohorts to ensure consistency. In addition, all BAM-detected aneurysms were cross-referenced with original CTA reports and corresponding DSA studies when available. Cases not described in the initial CTA reports underwent independent expert review using DSA as the reference standard to confirm true-positive findings. For detection analysis, radiologist performance was based on the original CTA reports, and BAM performance was based on CTA alone; sensitivity was calculated relative to the total number of aneurysms confirmed by DSA.

2 Please add the experience for P.S.

Model versus Physicians Timing Comparison

For the comparative timing analysis, the physician's workflow was defined as the interval from the loading of the CTA scan into 3D Slicer to the completion of manual segmentation following the standardized protocol previously described. BAM's processing time was measured from the input of the CTA volume into the pipeline until automatic generation of the full morphology report.

Because BAM generates morphologic parameters automatically from its predicted segmentation masks, a conservative comparison was performed: The physician's additional time required to export their manual segmentation and run the same arithmetic module was excluded, as this step is negligible for the model but nonnegligible for the human operator. Use of 3D Slicer rather than picture archiving and communication system workstations was necessary because all current commercial picture archiving and communication systems lack the capability to compute three-dimensional aneurysm morphology, making dedicated segmentation software the reference standard for this task. 3D Slicer was the standard software used in the previous study in which the three-dimensional morphology predictors for rupture were investigated and identified (5).

Model Development and Training

The full details of BAM's architecture are presented in Appendix S1. In brief, BAM comprises two models and a mathematical algorithm in series. The first model takes the raw CTA scan as an input and outputs a binary segmentation of cerebral vasculature. The second model, using a novel approach to tackle high class imbalance, takes the same raw CTA scan along with the first model's vascular output, stacks the two as one input, and outputs a multiclass segmentation where the aneurysm and the rest of the vasculature are two different classes separated by the aneurysm neck (Fig 1A–1C2). Last, this final segmentation is used by the automated morphology parameter acquisition algorithm, which produces two-dimensional and three-dimensional parameters essential for aneurysm characterization and rupture risk prediction. These parameters are illustrated in Figure 1D and 1E. Of note, the entire system requires zero human input.

Statistical Analysis

Differences between model-derived and expert-derived morphology metrics were assessed using paired statistical comparisons and Bland-Altman analysis. A two-sided $P < .05$ was considered statistically significant. Statistical analysis was conducted by authors (S.D.P. and J.F.) Full statistical methods are provided in Appendix S1 (Statistical Analysis).

Web Platform and Data Availability

Individuals interested in further testing the model may do so through the publicly available web-based platform at *https://www.findaneurysm.com/*. To test the model, please follow the instructions in Appendix S1 (Accessing and Using the Web Platform). The individual CTA scans and patient notes used in this study are not publicly available because of hospital regulations and restrictions designed to protect patient privacy.

Results

Training, Validation, and Testing Cohort Characteristics

A total of 2980 CTA scans from 2980 patients were initially identified across participating centers. After exclusion of scans with intracranial surgical hardware (n = 1008), giant arteriovenous malformations or fistulas, high-grade moyamoya disease, or dolichoectasia (n = 44), 2194[3] CTA scans were included in the training dataset (Fig 2), which was split into training (n = 1975) and internal validation (n = 219) subsets.

3 Please double-check numbers in first Results paragraph—2980 – 1008 – 44 does not equal 2194 (Figure 2 mentions additional studies from center 2).

For internal testing, 222 CTA scans were prospectively collected, of which 31 were excluded (surgical hardware, n = 18; duplicates, n = 2; giant arteriovenous malformation or dolichoectasia, n = 2; scans below the circle of Willis, n = 9), yielding 191 CTA scans from 191 patients included in the internal testing dataset.

For external testing, 731 CTA scans with corresponding DSA were obtained from three centers. After exclusion of scans with surgical hardware (n = 102); giant arteriovenous malformation or arteriovenous fistula, high-grade moyamoya disease, or dolichoectasia (n = 7); and scans below the circle of Willis (n = 27), 595 CTA scans from 595 patients were included in the external testing dataset (Fig 2). Patient demographics, aneurysm characteristics, and other factors for the training and internal and external test datasets are reported in Table 1.

Model Training and Validation Results

Model 1 within BAM for binary artery–only segmentation was trained for 15 epochs, yielding a final training Dice similarity

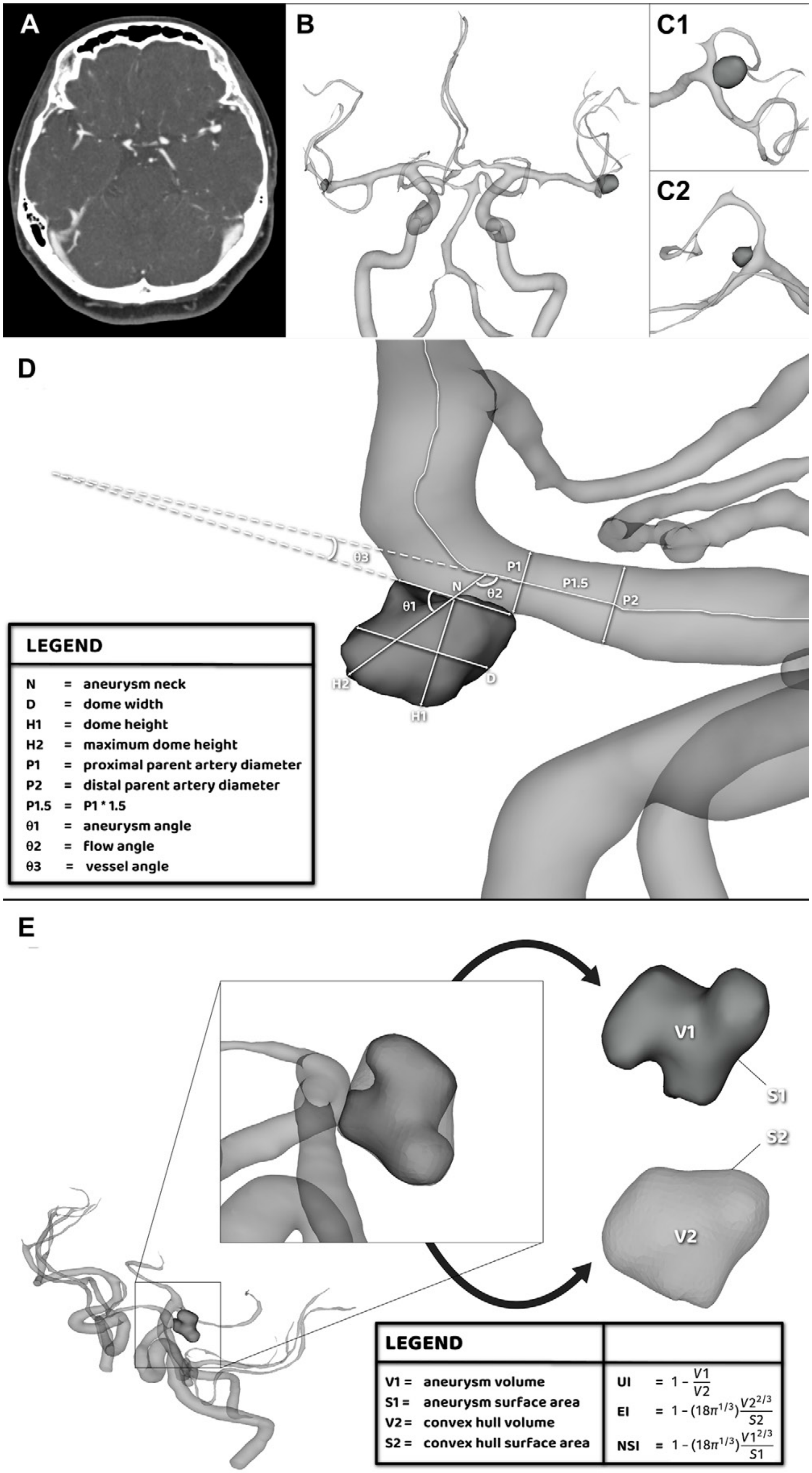

Figure 1: Example input CT angiography (CTA) scan **(A)** and output of multiclass segmentation of Brain Aneurysm Morphology (BAM) **(B)** with special emphasis on the aneurysm-to–parent artery differentiation **(C1** and **C2)**. Output aneurysm detection and morphology visualization by the BAM interface upon inputting a CTA scan with a bilobed right internal carotid artery terminus aneurysm **(D, E)**. Parameters related to the parent artery are obtained using skeleton-based artery root detection of the parent vessel **(D)**. The binary aneurysm mask and a fitted convex hull are used to obtain the volume-based parameters **(E)**. Real-world screenshots of the BAM interface with morphology metrics outputs taken during validation are shown in Figure S2.

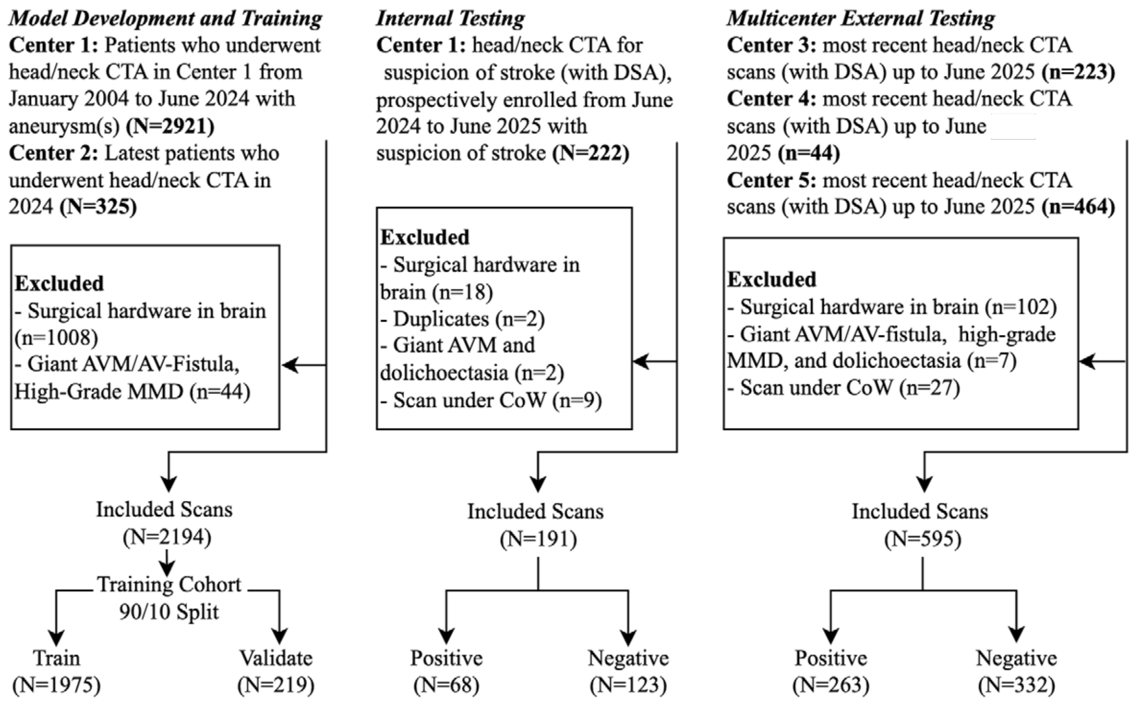

Figure 2: Flowchart of the training and validation procedures. AV = arteriovenous, AVM = arteriovenous malformation, CoW = circle of Willis, CTA = CT angiography, DSA = digital subtraction angiography, MMD = moyamoya disease.

coefficient of 0.867 and a Tversky loss of 0.136. Model 2 within BAM for multiclass artery and aneurysm segmentation achieved a Dice similarity coefficient of 0.892 for aneurysms only and an overall Dice similarity coefficient of 1.000 for aneurysms and arteries combined after 40 epochs (Fig S1). Internal and multicenter external validation on 331 aneurysm-positive and 455 aneurysm-negative CTA scans yielded a patient-level and lesion-level sensitivity of 87.9% (290 of 330; 95% CI: 83.6, 91.3) and 83.8% (351 of 419; 95% CI: 79.8, 87.1), respectively. The specificity was 86.6% (395 of 456; 95% CI: 83.3, 89.4). Further stratification of the combined validation cohorts by other coexisting pathologic findings, aneurysm size and locations, CT systems, and section thicknesses is provided in Table 2.

Comparison of Model and Radiologist Sensitivity

Several aneurysms among the CTA scans in the testing cohort were initially missed by the radiologists until performing the corresponding DSA. At internal center 1, radiologists initially reported 56 aneurysms before performing the DSA. Subsequent review of the CTA scans by three study physicians identified 30 additional aneurysms, corresponding to a radiologist-level sensitivity of 65.1% (56 of 86; 95% CI: 54.6, 74.4). At center 3, 145 aneurysms were originally reported; 37 additional aneurysms were found on review, yielding a sensitivity of 79.7% (145 of 182; 95% CI: 73.2, 84.9). At center 4, radiologists detected 36 aneurysms, and review identified four more, for a sensitivity of 90.0% (36 of 40; 95% CI: 76.9, 96.0). At center 5, 81 aneurysms were initially reported, and 30 additional aneurysms were later identified, corresponding to a sensitivity of 73.0% (81 of 111; 95% CI: 64.0, 80.4). Across all centers combined, radiologists missed 101 aneurysms. BAM detected 96 of these 101 (95.1%)[4] missed lesions. Missed aneurysms were predominantly located along the cavernous and supraclinoid internal carotid artery segments (n = 36; 35.6%), the internal carotid artery–posterior communicating artery junction (n = 33; 32.7%), and the anterior communicating artery (n = 8; 7.9%). Nearly all missed aneurysms were smaller than 3 mm in maximum diameter.

4 Per my calculation, 96 of these 101 (95.1%) should be 96 of these 101 (95.0%). Please verify math.

Model-derived versus Physician-derived Morphologic Parameters

Among the 14 morphologic variables consistently shown in the literature as predictors for rupture, statistically significant differences were not observed at the aggregate level for aneurysm volume, neck diameter, neck surface area, convex hull, parent artery diameter, flow angle, aspect ratio, size ratio, height-width ratio, undulating index, ellipticity index, and nonsphericity index. Bland-Altman analysis demonstrated a small positive bias for aneurysm volume and minimal systematic bias for neck diameter (Figs S3–S4). Statistically significant discrepancies were observed only for aneurysm dome height (mean difference, 0.1 mm ± 1.1; P = .03) and surface area (mean difference, −5.3 mm^2 ± 29.5; P = .04) (Table 3, Tables S1–S8). Regarding the time to acquisition of these parameters, the model averaged approximately 90 seconds ± 12, whereas physicians averaged 24.3 minutes ± 6.6 per scan, with a mean difference of −22.8 minutes ± 6.6 (P < .001). Error analysis demonstrated that misclassifications primarily occurred in scans outside validated operating conditions (eg, incomplete cranial coverage, poor arterial opacification, presence of intracranial hardware, or complex vascular pathology such as giant arteriovenous malformations or dolichoectasia) as well as in very small aneurysms near the resolution limit. Detailed usage constraints and known failure modes for which

Table 1: Patient Demographic and Aneurysm Characteristics among Training and Testing Cohorts[10]

10 Are all of the added denominators correct throughout Table 1?

	Training Dataset		Internal Testing Cohort	External Testing Cohorts			
Characteristics	Center 1 (*n* = 1891)	Center 2 (*n* = 303)	Center 1 (*n* = 191)	Center 3 (*n* = 143)	Center 4 (*n* = 36)	Center 5 (*n* = 416)	Testing Cohort Total (*n* = 786)
Patient information							
Age (y)	68.5 ± 15.0	59.5 ± 17.4	64.6 ± 16.8	57.7 ± 13.7	51.7 ± 11.8	64.7 ± 16.5	62.8 ± 16.3
Female sex	1397 (73.9)	184 (60.7)	122 (63.9)	92 (64.3)	32 (88.9)	248 (59.6)	494 (62.9)
Scans with IAs	1891 (100)	77 (25.4)	68 (35.6)	141 (98.6)	32 (88.9)	90 (21.6)	331 (42.1)
Multiple IAs	340 (18.0)	22 (7.3)	15 (7.9)	31 (21.7)	6 (16.7)	19 (4.6)	71 (9.0)
No. of IAs	2063	103	86	182	40	111	419
DSA present	956 (50.5)	303 (100)	191 (100)	143 (100)	36 (100)	416 (100)	786 (100)
Confounding on scan							
Ischemic stroke	324 (17.1)	48 (15.8)	108 (56.5)	0	0	119 (28.6)	227 (28.9)
Hemorrhagic stroke	152 (8.0)	40 (13.2)	47 (24.6)	21 (14.7)	6 (16.7)	14 (3.4)	88 (11.2)
SDH	147 (7.8)	25 (8.3)	14 (7.3)	0	0	0	14 (1.8)
AVM, AVF, or MMD	147 (7.8)	1 (0.3)	0	1 (0.7)	0	6 (1.4)	7 (0.9)
Aneurysm size (mm)							
Mean	5.2 ± 3.6	5.7 ± 3.7	3.9 ± 4.0	5.4 ± 4.2	5.2 ± 5.8	6.0 ± 7.1	5.2 ± 5.3
<3	550/2063 (26.7)	13/103 (12.6)	46/86 (53.5)	62/182 (34.1)	14/40 (35.0)	42/111 (37.8)	164/419 (39.1)
3 to <4	513/2063 (24.9)	27/103 (26.2)	11/86 (12.8)	22/182 (12.1)	7/40 (17.5)	15/111 (13.5)	55/419 (13.1)
4 to <6	492/2063 (23.8)	30/103 (29.2)	15/86 (17.4)	42/182 (23.1)	11/40 (27.5)	21/111 (18.9)	89/419 (21.2)
6 to <10	292/2063 (14.2)	20/103 (19.4)	11/86 (12.8)	34/182 (18.7)	5/40 (12.5)	21/111 (18.9)	71/419 (16.9)
≥10	216/2063 (10.5)	13/103 (12.6)	3/86 (3.5)	22/182 (12.1)	3/40 (7.5)	12/111 (10.8)	40/419 (9.5)
Aneurysm location							
ACoA	354/2063 (17.2)	17/103 (16.5)	10/86 (11.6)	31/182 (17.0)	6/40 (15.0)	9/111 (8.1)	56/419 (13.4)
ACA	58/2063 (2.8)	0	1/86 (1.2)	10/182 (5.5)	2/40 (5.0)	2/111 (1.8)	15/419 (3.6)
MCA	633/2063 (30.7)	30/103 (29.1)	17/86 (19.8)	57/182 (31.3)	11/40 (27.5)	5/111 (4.5)	90/419 (21.5)
ICA	737/2063 (35.7)	38/103[11] (27.2)	40/86 (46.5)	63/182 (34.6)	18/40 (45.0)	63/111 (56.8)	184/419 (43.9)
PCoA	121/2063 (5.9)	13/103 (12.6)	13/86 (15.1)	7/182 (3.8)	1/40 (2.5)	25/111 (22.5)	46/419 (11.0)
PCA	23/2063 (1.1)	3/103 (2.9)	2/86 (2.3)	3/182 (1.6)	0	1/111 (0.9)	6/419 (1.4)
BA, SCA, VA, and PICA	137/2063 (6.6)	12/103 (11.6)	3/86 (3.5)	11/182 (6.0)	2/40 (5.0)	6/111 (5.4)	22/419 (5.3)
Aneurysm type							
Saccular	1863/2063 (90.3)	89/103 (86.4)	81/86 (94.2)	169/182 (92.9)	40/40 (100)	101/111 (91.0)	391/419 (93.3)
Fusiform	200/2063 (9.7)	14/103 (13.6)	5/86 (5.8)	13/182 (7.1)	0	10/111 (9.0)	28/419 (6.7)
CT scanner manufacturer							
Siemens	120/1587 (7.6)	269 (88.8)	46 (24.1)	143 (100)	3 (8.3)	0	192 (24.4)
Toshiba	295/1587 (18.6)	0	5 (2.6)	0	33 (91.7)	416 (100)	454 (57.8)
Philips	30/1587 (18.9)[12]	0	4 (2.1)	0	0	0	4 (0.5)
General Electric	1140/1587 (71.8)	34 (11.2)	127 (66.5)	0	0	0	127 (16.2)
Other	2/1587 (0)	0	11 (5.8)	0	0	0	11 (1.4)

Note.—Data are number with percentage in parentheses or mean ± SD. ACA = anterior cerebral artery, ACoA = anterior communicating artery, AVF = arteriovenous fistula, AVM = arteriovenous malformation, BA = basilar artery, DSA = digital subtraction angiography, IA = intracranial aneurysm, ICA = internal carotid artery, MCA = middle cerebral artery, MMD = moyamoya disease, PCA = posterior cerebral artery, PCoA = posterior communication artery, PICA = posterior inferior cerebellar artery, SCA = superior cerebellar artery, SDH = subdural hematoma, VA = vertebral artery.

11 Should 38/103 (27.2) be 38/103 (36.9)?

12 Should 30/1587 (18.9) be 30/1587 (1.9)?

Table 2: Aneurysm Screening Performance Validation at One Internal and Three External Institutions

Dataset	True Positive	False Negative	False Positive	True Negative	Sensitivity	Specificity
Center						
1 (*n* = 191 scans)						
Patient level	57	11	20	103	83.8 (73.3, 90.7)	83.7 (76.2, 89.2)
Lesion level	69	17	36	…	80.2 (70.6, 87.3)	
3 (*n* = 143 scans)						
Patient level	125	16	0	2	88.7 (82.4, 92.9)	100 (34.2, 100)
Lesion level	158	24	14	…	86.3 (80.5, 90.5)	
4 (*n* = 36 scans)						
Patient level	29	3	0	4	90.6 (75.8, 96.8)	100 (51.0, 100)
Lesion level	33	7	3	…	82.5 (68.1, 91.3)	
5 (*n* = 416 scans)						
Patient level	79	10	41	286	88.8 (82.2, 95.3)	87.5 (83.9, 91.1)
Lesion level	91	20	57	…	82.0 (74.8, 89.1)	
Total (*n* = 786 scans)						
Patient level	290	40	61	395	87.9 (83.6, 91.3)	86.6 (83.3, 89.4)
Lesion level	351	68	110	…	83.8 (79.8, 87.1)	
Aneurysm size (mm)						
<3	131	33	…	…	79.9 (73.7, 86.0)	…
3 to <4	43	12	…	…	78.2 (67.3, 89.1)	…
4 to <6	75	14	…	…	84.3 (76.7, 91.8)	…
6 to <10	66	5	…	…	93.0 (87.0, 98.9)	…
≥10	37	3	…	…	92.5 (84.3, 100)	…
Aneurysm location						
ACoA	50	6	…	…	89.3 (81.2, 97.4)	…
ACA	12	4	…	…	75.0 (53.8, 96.2)	…
MCA	67	15	…	…	81.7 (73.3, 90.1)	…
ICA	152	30	…	…	83.5 (78.1, 88.9)	…
PCoA	40	6	…	…	87.0 (77.2, 96.7)	…
PCA	6	0	…	…	100.0 (100.0, 100.0)	…
BA, SCA, VA, and PICA	25	6	…	…	80.6 (66.7, 94.6)	…
Aneurysm type						
Saccular	332	62	…	…	84.3 (80.7, 87.9)	…
Fusiform	20	5	…	…	80.0 (64.3, 95.7)	…
CT scanner manufacturer						
Siemens						
Patient level	140	20	5	27	87.5 (81.5, 91.8)	84.4 (68.2, 93.1)
Lesion level	173	30	21	…	82.7 (76.3, 87.6)	
Toshiba						
Patient level	106	15	41	290	87.6 (80.6, 92.3)	87.6 (83.6, 90.7)
Lesion level	119	26	59	…	82.1 (75.0, 87.5)	
Philips						
Patient level	3	0	0	1	100 (43.8, 100)	100 (20.7, 100)
Lesion level	6	1	0	…	85.7 (48.7, 97.4)	
General Electric						
Patient level	38	6	13	69	86.4 (73.3, 93.6)	84.1 (74.7, 90.5)
Lesion level	44	9	26	…	83.0 (70.8, 90.8)	

Note.—For positive and negative findings, data are number; for sensitivity and specificity, data are percentage with 95% CI in parentheses. ACA = anterior cerebral artery, ACoA = anterior communicating artery, BA = basilar artery, ICA = internal carotid artery, MCA = middle cerebral artery, PCA = posterior cerebral artery, PCoA = posterior communication artery, PICA = posterior inferior cerebellar artery, SCA = superior cerebellar artery, VA = vertebral artery.

BAM may underperform or is not validated are provided in Appendix S1 (Accessing and Using the Web Platform).

Discussion

BAM enables fully automated extraction of aneurysm and parent artery morphology metrics directly from CTA, addressing key barriers that have historically limited clinical adoption, including the technical difficulty of reliably delineating aneurysm–parent vessel geometry and the lack of scalable, high-quality annotated datasets. In multicenter testing, BAM achieved a patient-level sensitivity of 87.9% and specificity of 86.6%. Across 14 morphology parameters, no statistically significant

Table 3: Artificial Intelligence Model to Physician Congruence of All True-Positive Detected Saccular Aneurysm Morphologic Parameters and Comparison of the Duration of Acquisition

Characteristics	Center 1 (*n* = 65)	Center 3 (*n* = 152)	Center 4 (*n* = 33)	Center 5 (*n* = 81)	Total (*n* = 331)
Aneurysm volume (mm^3)					
BAM mean	42.4 ± 83.3	138.6 ± 327.0	82.2 ± 134.2	86.6 ± 220.8	101.3 ± 255.4
Physician mean	47.9 ± 121.7	139.0 ± 307.9	86.3 ± 136.3	94.3 ± 230.7	104.9 ± 249.4
Mean difference	−5.6 ± 49.0	−0.4 ± 42.7	−4.1 ± 31.5	−7.7 ± 49.5	−3.6 ± 44.7
P value	.06	.75	.13	.37	>99
Aspect ratio					
BAM mean	1.0 ± 0.5	1.5 ± 1.0	1.4 ± 0.8	1.0 ± 0.7	1.3 ± 0.9
Physician mean	0.9 ± 0.6	1.3 ± 0.7	1.7 ± 1.4	1.1 ± 1.0	1.2 ± 0.8
Mean difference	0.0 ± 0.4	0.2 ± 0.9	−0.2 ± 1.0	0.0 ± 0.7	0.1 ± 0.8
P value	.35	.02	.10	.75	.21
Height-width ratio					
BAM mean	1.1 ± 0.6	1.6 ± 1.8	1.8 ± 2.7	1.29 ± 0.	1.4 ± 1.6
Physician mean	1.2 ± 1.2	1.6 ± 2.1	2.9 ± 6.2	1.3 ± 2.0	1.6 ± 2.7
Mean difference	−0.1 ± 1.1	0.1 ± 2.6	−1.1 ± 6.6	−0.2 ± 1.9	−0.1 ± 2.9
P value	.12	.03	.11	.47	.07
Size ratio					
BAM mean	0.9 ± 0.5	1.4 ± 0.9	1.4 ± 0.8	1.0 ± 0.7	1.2 ± 0.8
Physician mean	0.9 ± 0.5	1.2 ± 0.6	1.6 ± 1.3	1.1 ± 0.9	1.1 ± 0.8
Mean difference	0.0 ± 0.4	0.2 ± 0.8	−0.2	0.0 ± 0.7	0.1 ± 0.8
P value	.31	.01	.12	.63	.16
Undulating index					
BAM mean	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Physician mean	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Mean difference	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.1
P value	.77	.57	.35	.53	.18
Nonsphericity index					
BAM mean	0.3 ± 0.0	0.3 ± 0.0	0.4 ± 0.0	0.4 ± 0.0	0.3 ± 0.0
Physician mean	0.3 ± 0.0	0.3 ± 0.0	0.3 ± 0.0	0.4 ± 0.0	0.3 ± 0.0
Mean difference	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.0
P value	.76	.70	.76	.42	.39
Flow angle					
BAM mean	86.7 ± 33.4	86.7 ± 37.8	71.8 ± 37.3	77.8 ± 40.8	83.0 ± 37.9
Physician mean	89.5 ± 37.3	87.3 ± 37.2	88.0 ± 40.2	83.8 ± 37.4	86.9 ± 37.4
Mean difference	−2.8 ± 43.5	−0.5 ± 49.3	16.2 ± 40.6	−6.0 ± 55.2	−3.9 ± 49.0
P value	.61	.71	.04	.33	.15
Parameter acquisition time (min)					
BAM mean	1.5 ± 0.2	1.5 ± 0.2	1.5 ± 0.2	1.5 ± 0.2	1.5 ± 0.2
Physician mean	25.0 ± 5.0	30.0 ± 6.0	20.0 ± 4.0	20.0 ± 3.5	24.3 ± 6.6
Mean difference	−23.5 ± 5.0	−28.5 ± 6.0	−18.5 ± 4.0	−18.5 ± 3.5	−22.8 ± 6.6
P value	<.001	<.001	<.001	<.001	<.001

Note.—Data are mean ± SD. Additional results covering all 18 morphology variables are shown in Table S9. BAM = Brain Aneurysm Morphology.

differences were observed at the aggregate level for key metrics, including aneurysm volume, neck diameter, parent artery diameter, and flow angle, with statistically significant differences limited to dome height (*P* = .03) and surface area (*P* = .04) with negligible effect sizes. The system reduced analysis time from 24.3 minutes ± 6.6 to approximately 90 seconds ± 12 per scan (*P* < .001), substantially reducing workflow burden and enabling standardized integration of morphology-based assessment into clinical practice and future rupture-risk models.

Few attempts have been made to automate aneurysm morphology extraction, and existing approaches largely remain at the proof-of-concept stage. Snyder et al (10) reported the first peer-reviewed study evaluating semiautomated morphology extraction, demonstrating good agreement between model-derived and expert measurements for three basic parameters: dome height, dome width, and neck width. However, these variables alone are not among the morphology metrics significantly associated with rupture risk. In addition, arterial segmentation in that study was not fully autonomous, and manual expert verification of parent vessel delineation was required, reintroducing the same time burden that has historically limited clinical adoption of morphology-based analysis. Despite these limitations, the study provided an important early demonstration of the feasibility of semiautomated morphology extraction.

More recently, Yang et al (11) reported near-complete morphology extraction with good agreement between physician- and artificial intelligence–derived measurements. For their arterial segmentation pipeline, they relied on skull and brain subtraction using an open-source model, followed by intensity-based thresholding to isolate arteries. This preprocessing strategy facilitates rapid generation of large, annotated datasets by simplifying vessel isolation and avoiding the need for voxel-level expert arterial segmentation during model development. However, such pipelines are not end-to-end pipelines and are known to introduce limitations in routine CTA, particularly at the skull base, where arteries are often misclassified as cortical bone, resulting in subtraction artifacts and loss of arterial continuity (12). In addition, threshold-based vessel isolation is highly sensitive to contrast material bolus timing and venous contamination—factors that vary substantially across scanners, technologists, and institutions in real-world clinical practice. These constraints limit generalizability and are a primary reason why major end-to-end autonomous aneurysm detection systems in both the literature and industry avoid skull-subtraction–based preprocessing approaches (7,13–16). Although validation of generalizability is of interest, the trained model was neither made publicly available nor deployed on an accessible platform, precluding independent external validation.

The PHASES score was derived from a meta-analysis pooling six large prospective cohort studies, none of which incorporated morphologic features aside from maximum dome size. The lack of reliability of the score experienced among physicians likely contributed to the surge in morphology-focused research over the past decade, as clinicians sought more accurate and precise methods to estimate rupture risk. Although most studies validating or identifying morphology-related risk factors have been retrospective, sufficient prospective investigations confirm that variables such as aspect ratio, size ratio, flow characteristics, and neck–parent vessel geometry are among the strongest independent predictors of aneurysm rupture (17–19). With BAM providing the first fully autonomous and scalable extraction of these morphology-based variables, the cerebrovascular field is now positioned to perform an updated pooled analysis analogous to the original PHASES score development. Such an effort could yield a next-generation 5-year rupture-risk model that integrates both population-level epidemiologic factors and aneurysm-specific biomechanical features, enabling more precise individualized risk estimation for improving treatment decision-making.

A key next step enabled by BAM is automated computational fluid dynamics (CFD) modeling. CFD-derived metrics, including wall shear stress and flow impingement, are strongly associated with aneurysm instability and rupture (20). Current CFD workflows require manual vascular segmentation and substantial computational resources, limiting clinical feasibility. By automatically generating CFD-ready geometries, BAM lowers this barrier, although occasional loss of continuity in low-contrast or very small vessels was observed during external validation, which is expected to diminish with expanded training. With declining computational costs and increasing availability of graphics processing unit–based CFD solvers, extension of BAM into a real-time automated CFD framework is technically feasible in the near term.

Our study has limitations. First, given the difficulty in data acquisition owing to strict patient-protection laws, the external participating centers had heterogeneity in the extent of data available to validate BAM. External centers 3 and 4 sent only aneurysm-positive scans (a few of which were found to be negative scans) because priority was given to scans containing aneurysms for morphology-congruence evaluation. Thus, the true specificity remains unknown for centers 3 and 4. However, in comparison to the Food and Drug Administration 510(k)–cleared aneurysm detection models (14–16), which have only one to two external centers for validation and a sample size of only approximately 250–300 scans, our study's external validation is profoundly robust and is further strengthened by validation through the web-based platform. Second, all external scans had section thicknesses between 0.5 and 1.0 mm, whereas the section thicknesses in the internal cohort ranged from 1.0 to 1.5 mm. This difference may have contributed to the slightly higher model performance observed externally. Future users are therefore encouraged to upload scans of varying section thickness to better define the model's performance envelope. Finally, although our study demonstrates strong technical and diagnostic performance of BAM, we did not fully evaluate real-world clinical impact. A prospective deployment study integrated directly into the radiology workflow will be required to measure effects on reading time, decision-making, downstream management, and cost-effectiveness.

In conclusion, BAM enables automated extraction of clinically relevant aneurysm morphologic parameters while substantially reducing physician workload. By reducing annotation time from approximately 25 minutes to 90 seconds per scan and providing standardized quantitative outputs, this system supports integration of morphology-based assessment into clinical workflows and future rupture-risk modeling for individualized patient treatment decision-making.

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Data sharing: Data generated by the authors or analyzed during the study are available at: (author provides citation to data).[6]

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References

1. Greving JP, Wermer MJH, Brown RD, et al. Development of the PHASES score for prediction of risk of rupture of intracranial aneurysms: A pooled analysis of six prospective cohort studies. Lancet Neurol 2014;13(1):59–66.
2. Pettersson SD, Skrzypkowska P, Pietrzak K, et al. Evaluation of PHASES Score for Predicting Rupture of Intracranial Aneurysms: Significance of Aneurysm Size. World Neurosurg 2024;184:e178–e184.
3. Sahlein DH, DeNardo AJ, Amuluru K, et al. The Role of AI-driven Volumetric Aneurysm Analysis in the Management of Cerebral Aneurysms. Neuroimaging Clin N Am 2025;35(3):349–358.
4. Pettersson SD, Salih M, Young M, Shutran M, Taussky P, Ogilvy CS. Predictors for Rupture of Small (<7mm) Intracranial Aneurysms: A Systematic Review and Meta-Analysis. World Neurosurg 2024;182:184–192.e14.
5. Johnson MD, Palmisciano P, Yamani AS, Hoz SS, Prestigiacomo CJ. A Systematic Review and Meta-Analysis of 3-Dimensional Morphometric Parameters for Cerebral Aneurysms. World Neurosurg 2024;183:214–226.e5.
6. Sanchez S, Hickerson M, Patel RR, et al. Morphological Characteristics of Ruptured Brain Aneurysms: A Systematic Literature Review and Meta-Analysis. Stroke Vasc Interv Neurol 2023;3(2):e000707.
7. Pettersson SD, Filo J, Liaw P, et al. Addressing Limited Generalizability in Artificial Intelligence-Based Brain Aneurysm Detection for Computed Tomography Angiography: Development of an Externally Validated Artificial Intelligence Screening Platform. Neurosurgery 2025;97(6):1388–1396.
8. Bossuyt PM, Reitsma JB, Bruns DE, et al. STARD 2015: An Updated List of Essential Items for Reporting Diagnostic Accuracy Studies. Radiology 2015;277(3):826–832.
9. Tejani AS, Klontzas ME, Gatti AA, et al; CLAIM 2024 Update Panel. Checklist for Artificial Intelligence in Medical Imaging (CLAIM): 2024 Update. Radiol Artif Intell 2024;6(4):e240300.
10. Snyder SJ, Gauden A, Copeland K, Spiotta AM, Heit JJ. RAPID aneurysm accurately measures aneurysm size on CT angiography compared to three-dimensional digital subtraction angiography. Interv Neuroradiol 2023. 10.1177/15910199231222676. Published online December 27, 2023.
11. Yang Y, Chang Z, Nie X, et al. Integrated Deep Learning Model for the Detection, Segmentation, and Morphologic Analysis of Intracranial Aneurysms Using CT Angiography. Radiol Artif Intell 2025;7(1):e240017.
12. Mahmutoglu MA, Rastogi A, Yun YC, et al. Robust Brain Extraction Tool for Nonenhanced CT and CT Angiography: CTA-BET. Radiol Artif Intell 2026;8(1):e240847.
13. Hu B, Shi Z, Lu L, et al. A deep-learning model for intracranial aneurysm detection on CT angiography images in China: a stepwise, multicentre, early-stage clinical validation study. Lancet Digit Health 2024;6(4):e261–e271.
14. U.S. Food and Drug Administration. 510(k) Premarket Notification K213319. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K213319. Accessed October 11, 2024.
15. U.S. Food and Drug Administration. 510(k) Premarket Notification K230074. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K230074. Accessed October 11, 2024.
16. U.S. Food and Drug Administration. 510(k) Premarket Notification K213721. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K213721. Accessed October 11, 2024.
17. Suzuki T, Takao H, Rapaka S, et al. Rupture Risk of Small Unruptured Intracranial Aneurysms in Japanese Adults. Stroke 2020;51(2):641–643.
18. Kashiwazaki D, Kuroda S, Sapporo SAH Study Group. Size Ratio Can Highly Predict Rupture Risk in Intracranial Small (<5 mm) Aneurysms. Stroke 2013;44(8):2169–2173.
19. Zhou J, Guo Q, Chen Y, et al. Irregular Pulsation of Intracranial Aneurysm Detected by Four-Dimensional CT Angiography and Associated With Small Aneurysm Rupture: A Single-Center Prospective Analysis. Front Neurol 2022;13:809286.
20. Loly VTR, Cintra A, Ramirez-Velandia F, et al. Computational Fluid Dynamics Approaches for Analyzing Rupture and Growth of Intracranial Aneurysms: A Systematic Review. Biomedicines 2025;13(12):2914.

SUPPLEMENTARY MATERIALS

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I. APPENDIX S1: SUPPLEMENTARY METHODS

A. Image Preprocessing and Patch Generation

All de-identified CTA data passed through a unified preprocessing pipeline before being seen by any neural network:

1. **HU clipping and intensity normalization.** Each volume was clipped to $[-2000,3000]$Hounsfield units to suppress extreme outliers and standardized scanner differences, then linearly normalized to $[0,1]$.
2. **Spatial resampling.** Volumes were resampled with trilinear interpolation to a common voxel spacing of

$$0.488 \times 0.488 \times 0.625 \text{ mm}^3$$

in the x, y, and $z$directions respectively, corresponding to the median spacing of the validation cohort.[7]

3. **Label encoding.** Ground-truth labelmaps were stored as integer volumes with values:
   - 0 = background
   - 1 = artery
   - 2 = aneurysm

4. **Patch extraction for training.** For both models, training was performed on overlapping 3D patches of size $160 \times 160 \times 160$voxels extracted from the resampled CTA volume:
   - Overlap between neighboring patches was 50% along each axis.
   - Patches containing only background were subsampled to avoid trivial negatives; patches containing arteries or aneurysms were fully retained.
5. **Data augmentation.** On-the-fly augmentations were applied identically to the image patch and label patch:
   - Random rotations by multiples of 90° around each principal axis.
   - Random axis-aligned flips (left–right, anterior–posterior, superior–inferior).[21]

This produced a diverse set of volumetric examples while preserving anatomical plausibility.

B. Model Design Rationale and Training Strategy

Severe class imbalance between aneurysm voxels, arterial voxels, and background presents a major challenge for single-stage multiclass segmentation. During early model development, multiple commonly used loss functions were evaluated, including focal loss, Dice loss, and class-weighted cross-entropy. While these approaches achieved reasonable voxel-level accuracy, they did not reliably preserve arterial continuity while maintaining high aneurysm sensitivity. A Tversky-based loss formulation provided the most stable balance between minimizing false-negative aneurysm detections and preserving uninterrupted arterial geometry and was therefore selected for the final models.

Training data were augmented using standard three-dimensional transformations, including rotations and axis reflections, to improve generalization across scanners and acquisition protocols. No synthetic aneurysm generation or lesion simulation was performed.

A two-stage architecture was adopted in which Model 1 performs artery-only reconstruction and Model 2 subsequently performs aneurysm–artery co-segmentation using a stacked input composed of the raw CTA volume and the predicted arterial probability map. Compared with single-stage multiclass segmentation approaches, this design substantially improved training stability and convergence under extreme class imbalance. By explicitly providing vascular context, Model 2 can focus on the more challenging task of aneurysm–parent artery separation and neck delineation, which is critical for accurate morphology quantification.

Informal ablation experiments conducted during development, including CTA-only inputs and segmentation-only inputs to Model 2, demonstrated inferior convergence behavior and reduced aneurysm segmentation performance compared with the stacked-input configuration. As such, the two-stage stacked-input design was adopted for the final BAM pipeline.

C. Model 1 – Arterial Reconstruction Network

Model 1 performs binary segmentation of the intracranial vasculature (artery vs. background) and is the backbone for Model 2.

C.1 Architecture

Model 1 is a 3D attention U-Net implemented in TensorFlow/Keras. Inputs are preprocessed patches of size $160 \times 160 \times 160 \times 1$.

Encoder (contracting path).
Four encoder levels are used, each consisting of a residual-style convolutional block followed by 3D max-pooling:

- Level 1: 16 filters, 2 convolutions
- Level 2: 32 filters, 3 convolutions
- Level 3: 64 filters, 3 convolutions
- Level 4: 128 filters, 3 convolutions

Within each block, for an input feature map $\mathbf{F}^{(l,0)}$, each convolution layer is:

$$\mathbf{F}^{(l,i)} = \mathrm{ReLU}(\mathrm{BN}(\mathrm{Conv3D}_{3\times3\times3}(\mathbf{F}^{(l,i-1)})))$$

where Conv3D uses “same” padding and He initialization. MaxPooling3D with a pool size $2 \times 2 \times 2$ halves the spatial resolution between levels.

Bottleneck.
The bottleneck applies two $3 \times 3 \times 3$ convolutions with 256 filters, batch normalization, and ReLU.

Attention gates.
Skip connections from each encoder level to the decoder are modulated by 3D attention gates. For encoder features **x** and a gating signal **g** coming from a deeper decoder layer, the gate computes:

1. Downsampled encoder features:

$$\boldsymbol{\theta} = \mathrm{Conv3D}_{2\times2\times2,\ \mathrm{stride}=2}(\mathbf{x})$$

2. Projected gating features:

$$\boldsymbol{\phi} = \mathrm{Conv3D}_{1\times1\times1}(\mathbf{g})$$

3. Element-wise addition and nonlinearity:

$$\mathbf{z} = \mathrm{ReLU}(\boldsymbol{\theta} + \mathrm{UpConv}(\boldsymbol{\phi}))$$

4. Scalar attention coefficients:

$$\psi = \sigma(\mathrm{Conv3D}_{1\times1\times1}(\mathbf{z})), \psi \in [0,1]$$

5. The coefficients are upsampled and broadcast along channels, then applied multiplicatively to **x**:

$$\mathbf{x}^{\mathrm{attn}} = \mathrm{BN}(\mathrm{Conv3D}_{1\times1\times1}(\mathrm{UpSample}(\psi) \odot \mathbf{x}))$$

Decoder (expanding path).
The decoder mirrors the encoder with transpose convolutions:

- From 256 → 128 → 64 → 32 → 16 channels.
- Each step applies Conv3DTranspose (kernel $3 \times 3 \times 3$, stride 2) to upsample, concatenates with the corresponding attention-gated encoder features, and passes the result through the same UnetConv3D block structure.

Output layer.
The final layer is a $1 \times 1 \times 1$convolution with 1 filter followed by a sigmoid activation:

$$\hat{y} = \sigma(\text{Conv3D}_{1\times1\times1}(\mathbf{F}_{\text{dec}}))$$

where $\hat{y} \in [0,1]$approximates the probability of "artery."

C.2 Loss Function: Binary Tversky Loss

Let $y_i \in \{0,1\}$be the ground truth for voxel i(1 = artery, 0 = background) and $\hat{y}_i \in [0,1]$the model prediction. Define

$$\text{TP} = \sum_i y_i \hat{y}_i, \text{FN} = \sum_i y_i(1 - \hat{y}_i), \text{FP} = \sum_i (1 - y_i)\hat{y}_i$$

The Tversky index is

$$\text{TI} = \frac{\text{TP}}{\text{TP} + \alpha\,\text{FN} + \beta\,\text{FP}}$$

with $\alpha > \beta$to penalize missed arterial voxels more strongly than spurious vessel voxels. The loss minimized is

$$\mathcal{L}_{\text{Tversky}} = 1 - \text{TI}$$

C.3 Optimization and Training Regimen

Model 1 was implemented in TensorFlow 2.x and trained with:

- Optimizer: Adam (initial learning rate 10^{-4}; $\beta_1 = 0.9$, $\beta_2 = 0.999$).
- Learning-rate schedule: the learning rate was halved if the validation loss did not improve over 3 consecutive epochs.
- Batch size: 16.
- Epochs: up to 15, with early stopping on validation loss.
- Hardware: NVIDIA H200 GPU with mixed-precision training.

Dice score and loss performance metrics during training of Model 1, and the overall architecture of Model 1 and the complete end-to-end pipeline of BAM is illustrated in Figure S1.

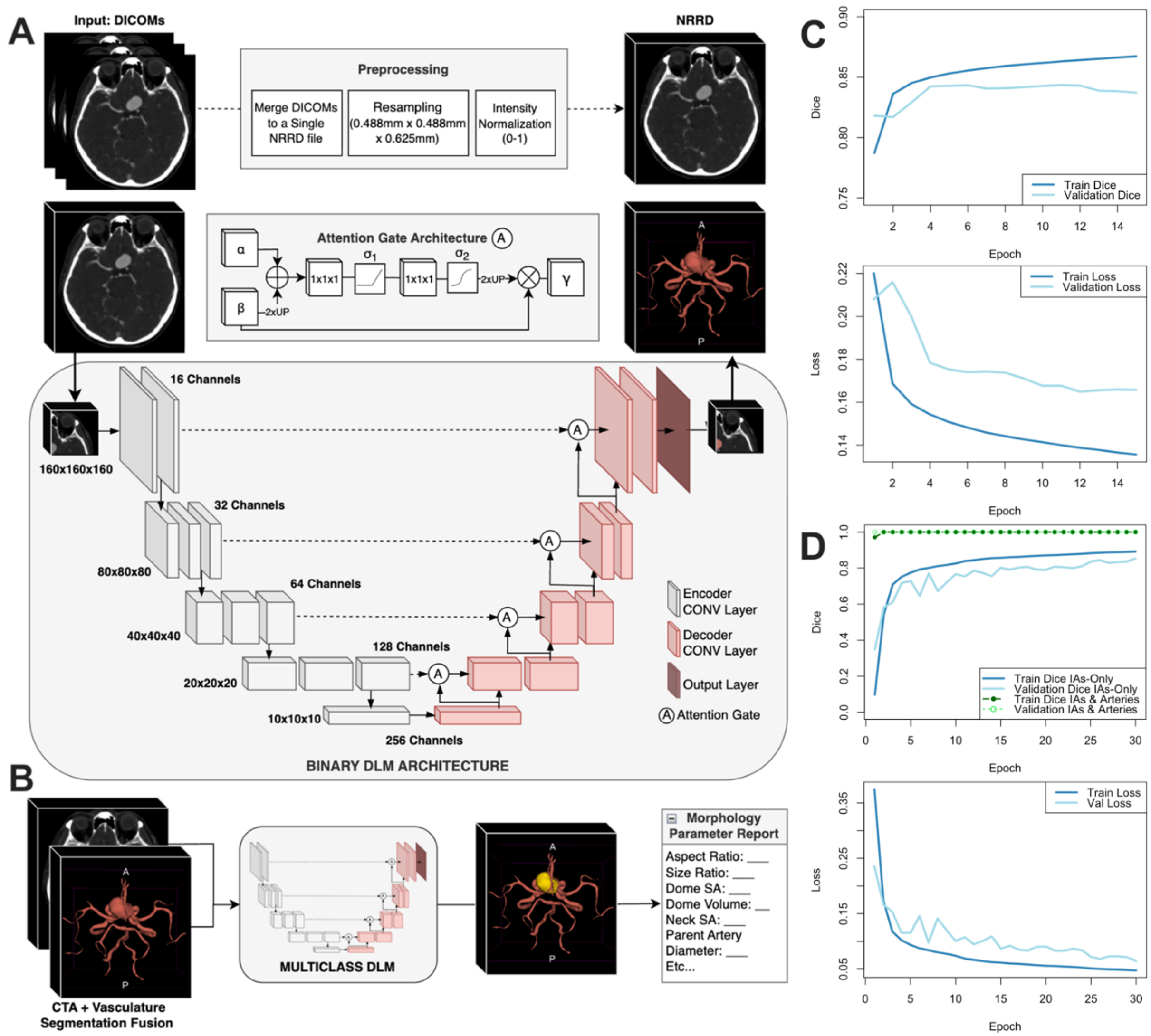
A
Input: DICOMs
Preprocessing
Merge DICOMs to a Single NRRD file
Resampling (0.488mm x 0.488mm x 0.625mm)
Intensity Normalization (0-1)
NRRD
Attention Gate Architecture
16 Channels
160x160x160
32 Channels
80x80x80
64 Channels
40x40x40
128 Channels
20x20x20
10x10x10
256 Channels
Encoder CONV Layer
Decoder CONV Layer
Output Layer
Attention Gate
BINARY DLM ARCHITECTURE
B
CTA + Vasculature Segmentation Fusion
MULTICLASS DLM
Morphology Parameter Report
Aspect Ratio: ___
Size Ratio: ___
Dome SA: ___
Dome Volume: ___
Neck SA: ___
Parent Artery Diameter: ___
Etc...
C
Train Dice
Validation Dice
Train Loss
Validation Loss
Epoch
D
Train Dice IAs-Only
Validation Dice IAs-Only
Train Dice IAs & Arteries
Validation IAs & Arteries
Train Loss
Val Loss

Figure S1. Overview of the Brain Aneurysm Morphology (BAM) pipeline and training performance results. A) Preprocessing and inputting into Model 1 for arterial-only semantic segmentation. B) Fusion of original computed tomography angiography scan (CTA) with predicted arterial tree from Model 1 fused into one input and fed into Model 2 for refined and enhanced arterial semantic segmentation with aneurysm detection. C) Model 1's training and validation performance shown via the Dice score and Loss metrics over 15 epochs. D) Model 2's training and validation performance shown via the Dice score and Loss metrics over 30 epochs. CONV, convolutional; DICOM, Digital Imaging and Communications in Medicine; NRDD, nearly raw raster data.

D. Model 2 – Aneurysm and Artery Co-segmentation Network

Model 2 refines the vascular representation by jointly segmenting background, artery, and aneurysm. It ingests both the original CTA and the artery prediction from Model 1.

D.1 Inputs and Overall Design

For each training or inference patch, two channels are stacked:

1. Channel 1: intensity-normalized CTA patch ($[0,1]$).
2. Channel 2: artery probability map from Model 1 (optionally binarized).

These form an input tensor of shape $160 \times 160 \times 160 \times 2$.

Model 2 is also a 3D U-Net with attention gates, but uses a slightly different building block (with explicit dropout) while maintaining the same four-level encoder–decoder structure.

D.2 Encoder and Bottleneck

Each **encoder block** consists of:

- Two or three repeated layers (depending on depth) of:

$$\mathbf{F}^{(l,i)} = \text{ReLU}(\text{BN}(\text{Conv3D}_{3\times3\times3}(\mathbf{F}^{(l,i-1)})))$$

- followed by a Dropout layer with rate 0.2, and then a 3D max-pooling (kernel $2 \times 2 \times 2$, stride 2).

Filter counts per level:

- Level 1: 16 filters, 2 convolutions
- Level 2: 32 filters, 3 convolutions
- Level 3: 64 filters, 3 convolutions
- Level 4: 128 filters, 3 convolutions

The **bridge** (bottleneck) block applies two Conv3D–BN–ReLU layers with 256 filters and Dropout(0.2).

D.3 Decoder with Attention

Each **decoder block** performs:

1. Up-sampling via Conv3DTranspose with kernel $2 \times 2 \times 2$, stride 2, to reduce the number of channels to the target level (128, 64, 32, or 16 filters).
2. A gating signal computed from the decoder input:

$$\mathbf{g} = \mathrm{ReLU}(\mathrm{BN}(\mathrm{Conv3D}_{1\times1\times1}(\mathbf{F}_{\mathrm{dec\_in}}))).$$

3. An attention gate (same AttnGatingBlock form as Model 1) applied to the corresponding encoder skip feature map, yielding $\mathbf{x}^{\mathrm{attn}}$.
4. Concatenation of the upsampled decoder features with $\mathbf{x}^{\mathrm{attn}}$.
5. A conv_block with Conv3D → BN → ReLU repeats and Dropout(0.2).

This process is repeated for four decoder levels, gradually reconstructing the full spatial resolution.

D.4 Output Layer and Multiclass Predictions

Let $C = 3$denote the number of classes: background (0), artery (1), and aneurysm (2). The final layer is a $1 \times 1 \times 1$Conv3D with Cfilters and a softmax activation:

$$\widehat{\mathbf{p}}_i = \mathrm{softmax}(\mathbf{z}_i)$$

where $\mathbf{z}_i \in \mathbb{R}^3$is the logits vector at voxel i, and

$$\widehat{\mathbf{p}}_i = (p_i^{(0)}, p_i^{(1)}, p_i^{(2)})$$

are estimated class probabilities.

D.5 Multiclass Tversky Loss

To manage the extreme imbalance (aneurysm voxels are orders of magnitude rarer than artery voxels, which themselves are rare relative to background), we use a class-weighted multiclass Tversky loss.

Let $y_i^{(c)} \in \{0,1\}$be the one-hot ground-truth label and $p_i^{(c)}$the predicted probability for class $c \in \{0,1,2\}$at voxel i. For each class:

$$\mathrm{TP}_c = \sum_i y_i^{(c)} p_i^{(c)}, \mathrm{FN}_c = \sum_i y_i^{(c)} (1 - p_i^{(c)}), \mathrm{FP}_c = \sum_i (1 - y_i^{(c)}) p_i^{(c)}$$

The class-specific Tversky index is

$$\mathrm{TI}_c = \frac{\mathrm{TP}_c}{\mathrm{TP}_c + \alpha_c\, \mathrm{FN}_c + \beta_c\, \mathrm{FP}_c}$$

Weights $\alpha_c$and $\beta_c$are chosen with $\alpha_2 > \alpha_1 \geq \alpha_0$to heavily penalize missed aneurysm voxels (class 2) while preserving reasonable control of false positives. The overall loss is

$$\mathcal{L}_{\text{multi-Tversky}} = 1 - \sum_{c=0}^{2} w_c\, \mathrm{TI}_c$$

where $w_c$are class weights (largest for aneurysm).

D.6 Training Details

Model 2 was trained on the same patches and augmentations as Model 1, with:

- Input shape: $160 \times 160 \times 160 \times 2$(CTA + artery mask).
- Optimizer: Adam with the same hyperparameters and learning-rate schedule as Model 1.
- Epochs: up to 30.
- Batch size: 8.
- Hardware: NVIDIA H100 GPU with mixed precision.

Dice score and loss performance metrics during training of Model 2, and the overall architecture of Model 2 and the complete end-to-end pipeline of BAM is illustrated in Figure S1.

E. Inference, Patch Stitching, and Final Labelmaps

At test time, each whole CTA volume passes through:

1. **Preprocessing** as in Section 2.
2. **Patch tiling.** The volume is sliced into overlapping 160^3patches with 50% overlap.
3. **Model 1 inference.** For each patch, Model 1 produces an artery probability map. Probabilities are stored, and where necessary a threshold is applied to obtain a binary artery channel.
4. **Model 2 inference.** The CTA patch and Model-1 artery channel are stacked as two channels and passed through Model 2, which outputs softmax probabilities for the three classes.

Overlapping predictions are merged back into the full volume by averaging probabilities in overlapping voxels. The final discrete label is given by:

$$\hat{c}_i = \arg \max_{c \in \{0,1,2\}} p_i^{(c)}$$

Very small isolated aneurysm components (below a user-defined voxel threshold) are removed as likely noise. Each remaining connected component with label 2 is treated as a distinct aneurysm and forwarded to the morphology module.

F. Automatic Aneurysm Morphology Quantification

F.1 Mesh Extraction

Each local binary mask is converted to a triangular surface mesh via **Marching Cubes at isovalue 0.5** using anisotropic sampling (s_z, s_y, s_x). Mesh vertices $(z, y, x)$are mapped to physical space by:

$$p_{\text{phys}} = R \begin{bmatrix} x s_x \\ y s_y \\ z s_z \end{bmatrix} + o$$

followed by optional **scrubbing jitter**:

$$p_{\text{scrub}} = p_{\text{phys}} + \mathcal{N}(0, \sigma^2), \sigma = 0.05\text{–}0.15 \text{ mm}$$

to produce stable report meshes without leaking coordinate precision.

F.2 Surface Area and True Volume

For all triangles (a_t, b_t, c_t)in physical space, surface area is computed as:

$$S = \sum_t \frac{1}{2} \parallel (b_t - a_t) \times (c_t - a_t) \parallel$$

Aneurysm volume is directly accumulated in mm³ from the voxelized local mask using the physical voxel volume:

$$V_{\text{true}} = N_{\text{vox}} \cdot s_x s_y s_z$$

F.3 Parent Artery Component Isolation and Cost Volume

All measurement steps below operate on the **parent artery connected component (6-connectivity)** containing the voxel most spatially proximal to the detected neck centroid.

A physical-space **Euclidean distance transform** $d(v)$is computed from the **parent component only**, forming the path-routing cost:

$$C(v) = \frac{1}{(d(v) + \varepsilon)^5}, \varepsilon = 0.25 \text{ mm}$$

Additionally, ultra-narrow regions are aggressively penalized:

$$C'(v) = 100 \cdot C(v), \forall v \in M_{\text{parent}} \wedge d(v) < 0.40 \text{ mm}$$

Routing is executed via fully-connected Dijkstra search but constrained to the parent component voxels, guaranteeing strict lumen adherence.

F.4 Neck Plane, H1, H2, Width (D), and Parent Calibers (P1, P2)

- **Neck centroid and normal.**
  A KD-tree is built on artery surface mesh vertices. Distances from each aneurysm vertex to its nearest artery vertex are computed. A neck threshold is chosen by

  $$d_{\text{neck}} = \min\left(d_{\text{abs}}, Q_p(d_i)\right), d_{\text{abs}} = 1.6 \text{ mm}, p = 8\%$$

  Vertices satisfying $d_i \leq d_{\text{neck}}$form the neck cloud. SVD on the neck cloud $\mathcal{N} = \{p_i\}$yields:

  - Centroid c_{neck}
  - Plane normal n(smallest principal component, normalized)

  The **neck plane** is defined as:

  $$\Pi_{\text{neck}} = \{x : n^\top (x - c_{\text{neck}}) = 0\}$$

- **Neck boundary in plane.**
Aneurysm vertices are projected into Π_{neck}. A **2D convex hull polygon** is fitted to the projected points to avoid Delaunay hangs, and the **neck diameter (N)** is the longest chord of this polygon:

$$N = (\max_{i,j}) \parallel w_i - w_j \parallel, w \in \text{ConvexHull}_{\text{2D}}(u', v')$$

- **Maximum dome height (H2).**
Aneurysm mesh vertices are bisected into the two half-spaces of Π_{neck}; the side whose furthest point from c_{neck} has the maximal distance defines the initial dome axis toward apex a. To ensure precise boundary termination, a voxel-clamped line search is applied along this axis and resolved by bisection until the first non-aneurysm voxel is reached:

$$H_2 = \parallel a' - c_{\text{neck}} \parallel$$

where a' is the parent-component-restricted bisection boundary point.

- **Perpendicular dome height (H1).**
From c_{neck}, voxel marching is then performed along the neck normal **on the same side as** H_2 so that

$$H_1 = \parallel h - c_{\text{neck}} \parallel$$

where h is the last in-aneurysm voxelwise midpoint on this preferred side.

- **Dome width (D).**
Only aneurysm vertices on the dome side of Π_{neck} are projected into the plane, and their convex hull is computed. Maximal in-plane span gives:

$$D = (\max_{i,j}) \parallel w_i - w_j \parallel, w \in \text{ConvexHull}$$

- **Parent calibers (P1, P2).**
The proximal point c_1 is the first in-parent-component point on $\gamma(t)$ near the neck. Cross-section at c_1 is intersected with the parent vessel mesh and **restricted to 7-mm radial inclusion**. The maximal clamped chord gives endpoints p_1, q_1 and

$$P_1 = \| q_1 - p_1 \|$$

Upstream arclength traverse by $1.5 \cdot P_1$ leads to point c_2. Cross-section at c_2 yields endpoints p_2, q_2 and

$$P_2 = \| q_2 - p_2 \|$$

F.5 Bloodflow Arc Trimming

For display overlay, the final 2 mm of the parent centerline is trimmed:

$$\gamma_{\text{draw}} = \gamma_{(\quad :cut)} \cup ((1-\delta)p_{\text{inside}} + \delta c_{\text{neck}})$$

with $\delta = 0.02$ ensuring a snug but non-shrinking visual fit.

E.6 Scalar Morphology Indices

Let $P_{\text{avg}} = (P_1 + P_2)/2$. We compute:

- **Aspect Ratio (AR)**: $\text{AR} = H_1/N$
- **Size Ratio (SR)**: $\text{SR} = H_2/P_{\text{avg}}$
- **Height/Width Ratio**: $\text{HW} = H_1/D$
- **Flow Angle (FA)**:

$$\text{FA} = \arccos(\hat{u}_{H2} \cdot \hat{u}_{15}) \cdot \frac{180°}{\pi}$$

- **Vessel Angle (VA)**:

$$\text{VA} = 90° - \arccos(\hat{u}_{15} \cdot n) \cdot \frac{180°}{\pi}$$

- **Undulating Index (UI)**:

$$\mathrm{UI} = 1 - V_{\mathrm{true}}/V_{\mathrm{hull}}$$

- **Ellipticity Index (EI)**:

$$\phi_{\mathrm{hull}} = \_sphericity(V_{\mathrm{hull}}, S_{\mathrm{hull}}), \mathrm{EI} = 1 - \phi_{\mathrm{hull}}$$

- **Non-Sphericity Index (NSI)**:

$$\phi_{\mathrm{ane}} = (\_sphericity)(V_{\mathrm{true}}, S), \mathrm{NSI} = 1 - \phi_{\mathrm{ane}}$$

All scalar indices are **dimensionless**, with all underlying linear and volumetric primitives reported in mm, mm^3, and mm^2 respectively.

G. Rendering and HTML Morphology Reports

For each aneurysm, the pipeline outputs a single HTML report comprising:

1. **Static full-vasculature view.** A smoothed 3D mesh of the entire cerebrovascular tree and aneurysm(s) is rendered using Plotly's `Mesh3d`, with a wireframe box indicating the aneurysm's local crop in physical space.
2. **Interactive aneurysm-level view.** Within the crop, the parent artery and aneurysm meshes are rendered with depth-aware shading, semi-transparent coloring (arteries gray, aneurysm dark red), and a fixed camera whose viewing direction is aligned to the parent artery and neck, so that structures closest to the viewer appear brightest. Geometric constructs (H1, H2, N, P1, P2, centerline segment, and flow-angle arc) are overlaid as double-lined polylines with textual tags (e.g., "H1", "P2").
3. **Morphology card and legend.** All scalar parameters listed in Section 6.6 are printed in a right-hand panel, with units. A separate legend defines each parameter and the three shape indices.

The HTML is fully self-contained and can be opened in any modern browser without additional software. Real-world screenshots of the BAM interface during external validation are shown in Figure S2.

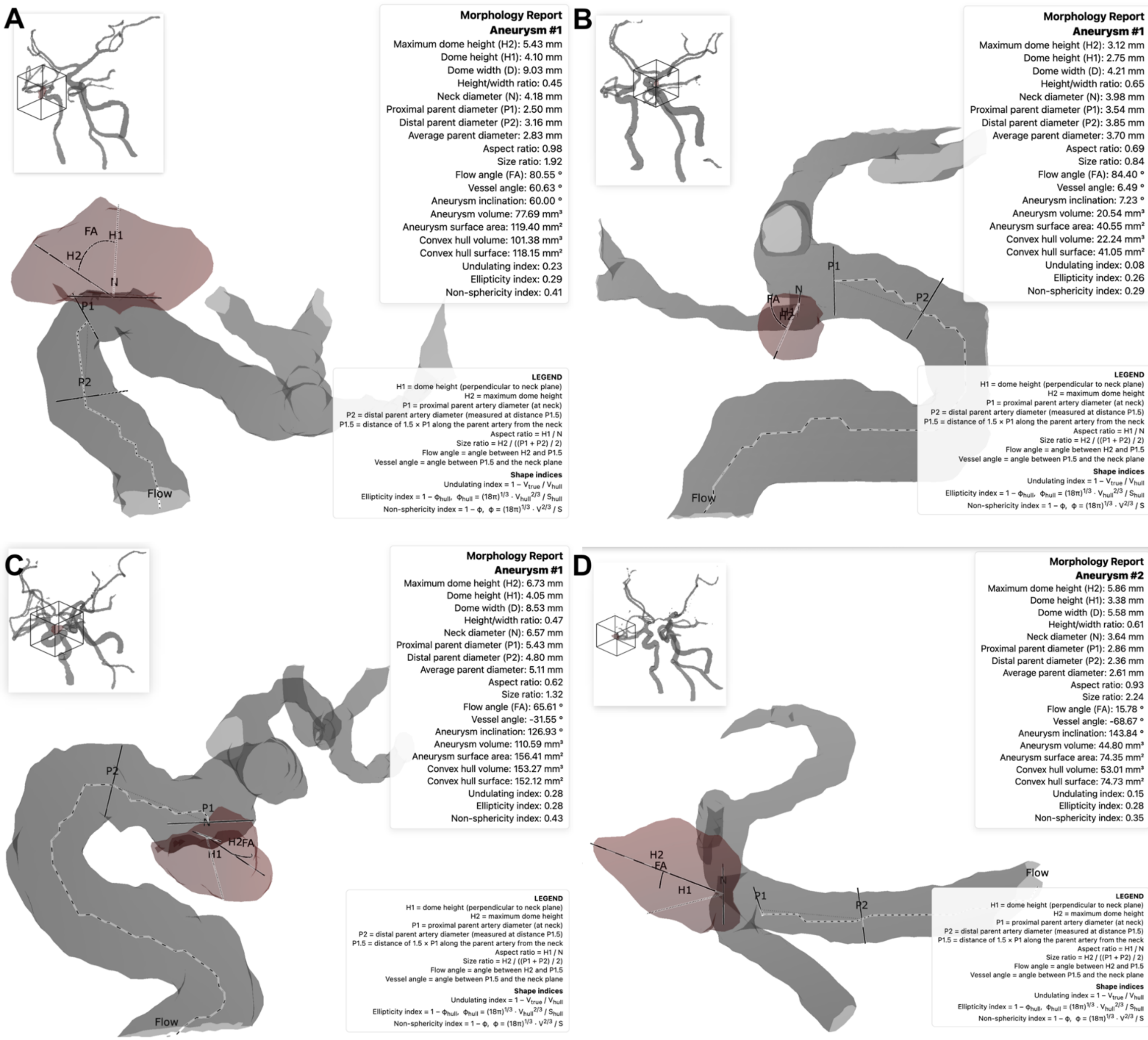
A
Morphology Report
Aneurysm #1
Maximum dome height (H2): 5.43 mm
Dome height (H1): 4.10 mm
Dome width (D): 9.03 mm
Height/width ratio: 0.45
Neck diameter (N): 4.18 mm
Proximal parent diameter (P1): 2.50 mm
Distal parent diameter (P2): 3.16 mm
Average parent diameter: 2.83 mm
Aspect ratio: 0.98
Size ratio: 1.92
Flow angle (FA): 80.55 °
Vessel angle: 60.63 °
Aneurysm inclination: 60.00 °
Aneurysm volume: 77.69 mm³
Aneurysm surface area: 119.40 mm²
Convex hull volume: 101.38 mm³
Convex hull surface: 118.15 mm²
Undulating index: 0.23
Ellipticity index: 0.29
Non-sphericity index: 0.41
FA
H1
H2
N
P1
P2
Flow
LEGEND
H1 = dome height (perpendicular to neck plane)
H2 = maximum dome height
P1 = proximal parent artery diameter (at neck)
P2 = distal parent artery diameter (measured at distance P1.5)
P1.5 = distance of 1.5 × P1 along the parent artery from the neck
Aspect ratio = H1 / N
Size ratio = H2 / ((P1 + P2) / 2)
Flow angle = angle between H2 and P1.5
Vessel angle = angle between P1.5 and the neck plane
Shape indices
Undulating index = $1 - V_{true} / V_{hull}$
Ellipticity index = $1 - \Phi_{hull}$, $\Phi_{hull} = (18\pi)^{1/3} \cdot V_{hull}^{2/3} / S_{hull}$
Non-sphericity index = $1 - \phi$, $\phi = (18\pi)^{1/3} \cdot V^{2/3} / S$
B
Morphology Report
Aneurysm #1
Maximum dome height (H2): 3.12 mm
Dome height (H1): 2.75 mm
Dome width (D): 4.21 mm
Height/width ratio: 0.65
Neck diameter (N): 3.98 mm
Proximal parent diameter (P1): 3.54 mm
Distal parent diameter (P2): 3.85 mm
Average parent diameter: 3.70 mm
Aspect ratio: 0.69
Size ratio: 0.84
Flow angle (FA): 84.40 °
Vessel angle: 6.49 °
Aneurysm inclination: 7.23 °
Aneurysm volume: 20.54 mm³
Aneurysm surface area: 40.55 mm²
Convex hull volume: 22.24 mm³
Convex hull surface: 41.05 mm²
Undulating index: 0.08
Ellipticity index: 0.26
Non-sphericity index: 0.29
P1
P2
FA
N
H1
H2
Flow
LEGEND
H1 = dome height (perpendicular to neck plane)
H2 = maximum dome height
P1 = proximal parent artery diameter (at neck)
P2 = distal parent artery diameter (measured at distance P1.5)
P1.5 = distance of 1.5 × P1 along the parent artery from the neck
Aspect ratio = H1 / N
Size ratio = H2 / ((P1 + P2) / 2)
Flow angle = angle between H2 and P1.5
Vessel angle = angle between P1.5 and the neck plane
Shape indices
Undulating index = $1 - V_{true} / V_{hull}$
Ellipticity index = $1 - \Phi_{hull}$, $\Phi_{hull} = (18\pi)^{1/3} \cdot V_{hull}^{2/3} / S_{hull}$
Non-sphericity index = $1 - \phi$, $\phi = (18\pi)^{1/3} \cdot V^{2/3} / S$
C
Morphology Report
Aneurysm #1
Maximum dome height (H2): 6.73 mm
Dome height (H1): 4.05 mm
Dome width (D): 8.53 mm
Height/width ratio: 0.47
Neck diameter (N): 6.57 mm
Proximal parent diameter (P1): 5.43 mm
Distal parent diameter (P2): 4.80 mm
Average parent diameter: 5.11 mm
Aspect ratio: 0.62
Size ratio: 1.32
Flow angle (FA): 65.61 °
Vessel angle: -31.55 °
Aneurysm inclination: 126.93 °
Aneurysm volume: 110.59 mm³
Aneurysm surface area: 156.41 mm²
Convex hull volume: 153.27 mm³
Convex hull surface: 152.12 mm²
Undulating index: 0.28
Ellipticity index: 0.28
Non-sphericity index: 0.43
P2
P1
N
H1
H2
FA
Flow
LEGEND
H1 = dome height (perpendicular to neck plane)
H2 = maximum dome height
P1 = proximal parent artery diameter (at neck)
P2 = distal parent artery diameter (measured at distance P1.5)
P1.5 = distance of 1.5 × P1 along the parent artery from the neck
Aspect ratio = H1 / N
Size ratio = H2 / ((P1 + P2) / 2)
Flow angle = angle between H2 and P1.5
Vessel angle = angle between P1.5 and the neck plane
Shape indices
Undulating index = $1 - V_{true} / V_{hull}$
Ellipticity index = $1 - \Phi_{hull}$, $\Phi_{hull} = (18\pi)^{1/3} \cdot V_{hull}^{2/3} / S_{hull}$
Non-sphericity index = $1 - \phi$, $\phi = (18\pi)^{1/3} \cdot V^{2/3} / S$
D
Morphology Report
Aneurysm #2
Maximum dome height (H2): 5.86 mm
Dome height (H1): 3.38 mm
Dome width (D): 5.58 mm
Height/width ratio: 0.61
Neck diameter (N): 3.64 mm
Proximal parent diameter (P1): 2.86 mm
Distal parent diameter (P2): 2.36 mm
Average parent diameter: 2.61 mm
Aspect ratio: 0.93
Size ratio: 2.24
Flow angle (FA): 15.78 °
Vessel angle: -68.67 °
Aneurysm inclination: 143.84 °
Aneurysm volume: 44.80 mm³
Aneurysm surface area: 74.35 mm²
Convex hull volume: 53.01 mm³
Convex hull surface: 74.73 mm²
Undulating index: 0.15
Ellipticity index: 0.28
Non-sphericity index: 0.35
H2
FA
H1
N
P1
P2
Flow
LEGEND
H1 = dome height (perpendicular to neck plane)
H2 = maximum dome height
P1 = proximal parent artery diameter (at neck)
P2 = distal parent artery diameter (measured at distance P1.5)
P1.5 = distance of 1.5 × P1 along the parent artery from the neck
Aspect ratio = H1 / N
Size ratio = H2 / ((P1 + P2) / 2)
Flow angle = angle between H2 and P1.5
Vessel angle = angle between P1.5 and the neck plane
Shape indices
Undulating index = $1 - V_{true} / V_{hull}$
Ellipticity index = $1 - \Phi_{hull}$, $\Phi_{hull} = (18\pi)^{1/3} \cdot V_{hull}^{2/3} / S_{hull}$
Non-sphericity index = $1 - \phi$, $\phi = (18\pi)^{1/3} \cdot V^{2/3} / S$

Figure S2. Screenshots of four real-world outputs generated by the Brain Aneurysm Morphology (BAM) system during multicenter external validation. Panels demonstrate the fully interactive three-dimensional vascular reconstruction and automated morphology report for patients with a superior projecting left sidewall internal carotid artery aneurysm (A), an inferior projecting right sidewall internal carotid artery aneurysm (B), an inferior projecting left sidewall internal carotid artery aneurysm at a distinct anatomical configuration (C), and a branch-point left middle cerebral artery aneurysm (D). Each panel displays the BAM-generated aneurysm and parent-artery segmentation with corresponding quantitative morphological metrics.

H. Statistical Analysis

Morphology agreement was evaluated by computing paired differences (BAM − Physician) for each metric across saccular aneurysms. To evaluate automatic aneurysm detection performance, results were expressed patient-level sensitivity, specificity and lesion-level sensitivity. Voxel-level segmentation performance during model training and internal validation was assessed using Dice similarity coefficients (Figure S1), whereas external validation focused on agreement between BAM-derived and expert-derived quantitative morphology parameters. Normality of paired differences was assessed using the Shapiro–Wilk test when $n \leq 5{,}000$, and otherwise by empirical skewness and kurtosis criteria. If the normality assumption was met, a paired t-test was used; if not, a Wilcoxon signed-rank test with Pratt handling of zero differences was applied. A *P*-value less than 0.05 was considered statistically significant and 95% confidence intervals were used.

Agreement was further evaluated using Bland–Altman analysis. Because aneurysm volume spanned several orders of magnitude, Bland–Altman analysis for volume was performed on log-transformed values and reported as back-transformed ratios. Linear measurements, including neck diameter, were analyzed on the raw scale.

For every metric, we report the raw two-sided p-value, the number of paired observations, the mean and standard deviation (SD) for each method, and the mean ± SD of the paired differences (BAM − Physician). No a priori threshold for clinically acceptable agreement was predefined, as no consensus thresholds exist for automated three-dimensional aneurysm morphology measurements; agreement was therefore evaluated using paired statistical testing and descriptive error reporting, consistent with prior AI-based quantitative imaging studies.[22,23] No multiplicity correction or effect-size estimation was performed. Analyses were conducted in Python (NumPy, pandas, SciPy) using an a priori pipeline that excluded fusiform aneurysms and applied a fixed global geometric scaling factor and unitless micro-centering offsets learned from the pooled dataset.

I. Accessing and Utilizing the Web Platform

BAM is designed to perform robustly across a wide range of contrast doses, timing relative to the bolus, and CT scanners ranging from the latest models to models dating back to the mid-2000s from all 4 major manufactures TOSHIBA, SIEMENS, GENERAL ELECTRIC, and PHILIPS. The model is accessible via the following link: https://www.findaneurysm.com/. To test the model, simply upload your CTA scan by selecting the folder containing all of your CTA image slices and choosing all files within it; the platform will then process the scan automatically. The BAM interface is fully interactive, allowing visualization of the aneurysm and parent artery from any angle.

Before you run BAM, ensure:

- The CTA covers the entire skull (skull base through vertex).
- Slice thickness ≤ 1.6 mm (≤ 1.5 mm preferred).
- Sufficient contrast was administered allowing visibility up to the A4, M3, and P3

Do not use BAM on scans with:

- Intracranial surgical/endovascular hardware (clips, coils, stents/flow diverters, shunts).
- Vertebrobasilar dolichoectasia or diffuse intracranial dolichoectasia.
- Giant arteriovenous malformations/fistulas (AVMs/AVFs)**.**

Important Points to Note:

- Variable contrast timing/dose is acceptable; however, severely poor arterial opacification may degrade performance.
- If a scan fails any criterion above, results are not validated and should not be used.
- BAM is designed to not segment regions of arterial stenosis or thrombosis in arteries or in aneurysms.
- BAM has shown underperformance on patients with head rotated axially beyond ±30 degrees.
- Morphological parameters reported in the literature—and implemented in BAM—are defined and validated exclusively for saccular aneurysms. These metrics do not apply to fusiform or dissecting aneurysms, and morphology reports for such lesions should not be used or interpreted clinically.

II. SUPPLEMENTARY TABLES AND BLAND–ALTMAN PLOTS

A. Individual Aneurysm Morphological Parameter Measurements by Physician

A.1 Center 1: Beth Israel Deaconess Medical Center, Harvard Medical School

Table S1. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	2.679	9.184	2.679	9.194	0.000	0.195	0.194	3.840	1.413	1.745	2.041	2.010	165.184	160.412	160.678	0.703	0.692	0.810
1	4.019	13.762	4.019	14.023	0.000	0.308	0.295	5.402	1.517	2.407	2.574	2.414	11.915	49.456	127.736	0.628	0.589	0.630
1	2.977	10.950	2.977	11.646	0.000	0.318	0.275	5.945	1.442	2.384	2.798	2.743	4.539	87.579	96.945	0.526	0.515	0.605
2	5.656	20.502	7.175	20.240	0.212	0.294	0.406	4.821	1.934	2.761	2.760	2.552	142.679	82.786	107.363	0.758	0.701	0.701
3	21.284	41.196	21.613	41.047	0.015	0.274	0.284	9.764	2.187	3.679	3.519	3.482	145.248	108.139	42.725	0.628	0.622	0.595
3	28.280	53.934	30.922	54.250	0.085	0.303	0.339	15.003	2.812	5.187	5.188	5.114	157.627	92.390	65.405	0.550	0.542	0.542
5	9.377	26.441	10.735	26.676	0.127	0.300	0.354	6.317	1.579	1.537	3.297	3.141	80.391	82.848	36.331	0.503	0.479	1.028
6	5.358	17.083	5.563	17.461	0.037	0.310	0.312	5.707	1.007	0.684	2.873	2.831	83.666	82.801	117.688	0.356	0.351	1.473
6	6.400	18.529	6.400	18.935	0.000	0.301	0.286	7.240	0.969	2.445	3.071	2.934	117.621	77.525	139.109	0.330	0.316	0.396
7	5.061	16.044	5.092	16.303	0.006	0.303	0.295	3.430	1.274	1.460	2.323	2.232	77.335	89.142	49.452	0.571	0.548	0.873
8	25.303	50.379	30.190	50.470	0.162	0.263	0.343	4.003	3.798	1.396	2.693	2.492	51.476	24.106	136.871	1.524	1.411	2.721
9	2.828	10.891	2.884	11.176	0.019	0.304	0.295	3.192	1.336	1.977	1.990	1.938	154.109	104.376	98.802	0.689	0.671	0.676
9	3.423	11.341	3.423	11.513	0.000	0.243	0.231	5.164	1.031	1.819	2.423	2.372	132.365	69.527	158.045	0.435	0.426	0.567
10	4.763	16.185	5.166	16.628	0.078	0.310	0.329	3.393	1.347	2.167	2.312	2.238	102.799	94.906	135.369	0.602	0.583	0.622
11	4.465	14.399	4.465	14.579	0.000	0.286	0.277	3.668	1.667	1.043	2.323	2.316	73.430	90.000	62.917	0.720	0.718	1.598
12	7.740	24.681	8.980	25.510	0.138	0.350	0.391	7.479	1.438	2.517	3.186	3.171	121.085	111.294	126.531	0.454	0.451	0.571
12	7.740	22.602	8.106	22.844	0.045	0.322	0.336	5.954	2.187	3.140	3.086	2.971	18.120	116.385	117.085	0.736	0.709	0.697
13	3.423	12.372	3.523	12.341	0.028	0.280	0.295	2.173	1.456	1.729	1.593	1.475	136.576	156.981	122.096	0.987	0.914	0.842
14	11.312	28.679	11.839	28.931	0.045	0.311	0.326	10.165	1.534	2.807	3.403	3.359	110.641	90.868	135.207	0.457	0.451	0.546
15	8.037	24.398	9.185	24.981	0.125	0.326	0.369	4.241	1.081	2.105	2.285	2.283	76.876	6.285	108.766	0.473	0.473	0.513
16	8.186	25.388	10.121	25.908	0.191	0.307	0.386	4.821	2.341	0.469	2.991	2.784	82.282	109.653	68.532	0.841	0.783	4.991
17	5.358	17.776	5.805	17.746	0.077	0.301	0.339	4.487	0.982	1.427	3.333	3.302	73.636	80.135	146.491	0.297	0.295	0.688
17	3.721	13.087	3.721	13.570	0.000	0.321	0.296	3.564	1.049	0.474	2.948	2.863	74.640	119.955	72.019	0.366	0.356	2.212
18	4.465	16.836	5.749	17.487	0.223	0.296	0.382	2.858	0.937	1.416	1.760	1.725	57.523	51.987	107.477	0.544	0.533	0.662
19	10.865	25.946	11.120	26.363	0.023	0.275	0.274	2.916	2.151	2.678	1.981	1.827	41.376	89.308	58.809	1.177	1.086	0.803
19	6.847	20.896	7.597	20.685	0.099	0.283	0.338	4.583	1.785	2.512	2.954	2.727	83.887	100.251	72.322	0.655	0.604	0.711
20	30.810	55.160	33.235	54.789	0.073	0.276	0.316	4.479	3.591	2.584	2.816	2.780	60.180	100.732	22.712	1.292	1.275	1.390

21	275.354	247.808	332.998	248.848	0.173	0.259	0.344	11.072	7.457	4.900	4.818	4.275	73.290	61.807	57.487	1.744	1.548	1.522
22	9.377	23.697	9.563	23.647	0.019	0.269	0.280	3.564	2.104	2.521	2.782	2.529	37.985	61.872	80.606	0.832	0.756	0.834
22	37.061	61.090	40.950	60.457	0.095	0.246	0.302	10.111	3.843	4.015	3.375	3.305	15.205	44.720	49.319	1.163	1.139	0.957
23	106.123	130.786	122.471	128.248	0.133	0.262	0.342	6.555	3.573	5.011	3.329	3.294	58.093	140.372	92.603	1.084	1.073	0.713
24	11.014	27.414	11.182	27.884	0.015	0.312	0.307	8.974	1.618	3.507	3.514	3.502	142.170	44.076	101.578	0.462	0.461	0.461
24	8.633	24.129	9.941	24.927	0.132	0.288	0.331	7.984	1.617	0.466	3.404	3.340	84.021	41.625	75.439	0.484	0.475	3.469
25	34.382	64.072	42.996	63.631	0.200	0.260	0.367	10.900	3.013	4.819	4.250	4.060	33.135	98.202	48.694	0.742	0.709	0.625
26	117.286	143.365	136.846	138.602	0.143	0.265	0.359	15.617	4.191	7.355	4.522	4.322	35.905	110.387	96.631	0.970	0.927	0.570
27	102.848	126.290	118.762	122.891	0.134	0.245	0.333	7.663	4.570	2.213	4.282	4.084	62.056	124.969	115.561	1.119	1.067	2.065
28	169.231	212.562	227.179	203.940	0.255	0.299	0.448	7.508	2.195	7.814	3.518	3.439	52.518	53.669	73.829	0.638	0.624	0.281
29	28.577	56.676	36.714	57.961	0.222	0.268	0.367	11.021	2.830	4.779	5.109	5.048	19.636	62.457	60.541	0.561	0.554	0.592
30	153.305	158.242	167.383	154.815	0.084	0.247	0.305	2.649	6.497	2.445	1.991	1.905	63.882	90.000	40.719	3.409	3.263	2.657
30	8.782	25.314	10.549	25.598	0.168	0.279	0.355	2.678	2.576	2.568	2.230	2.204	21.433	78.407	122.743	1.169	1.155	1.003
31	17.265	41.101	20.664	40.737	0.164	0.290	0.376	5.335	2.001	2.424	2.955	2.713	81.160	75.608	42.415	0.738	0.677	0.826
32	37.954	72.830	48.441	72.357	0.216	0.295	0.405	8.891	2.866	4.292	4.202	3.969	78.619	120.241	160.965	0.722	0.682	0.668
33	7.293	20.179	7.293	20.507	0.000	0.296	0.285	2.716	2.125	2.632	2.179	2.176	155.279	79.688	124.622	0.976	0.975	0.807
34	7.442	23.259	9.135	24.146	0.185	0.305	0.371	6.117	1.221	2.173	2.746	2.565	80.780	99.647	22.380	0.476	0.445	0.562
35	7.144	21.752	8.254	22.231	0.134	0.295	0.345	4.688	1.589	2.562	2.567	2.522	100.779	67.033	95.565	0.630	0.619	0.620
36	39.889	69.565	49.006	70.343	0.186	0.269	0.356	4.821	4.311	1.898	2.996	2.963	66.241	121.261	40.074	1.455	1.439	2.271
37	6.400	17.734	6.400	17.961	0.000	0.263	0.254	4.048	2.187	2.128	2.182	2.089	167.153	90.000	86.124	1.047	1.002	1.028
38	6.995	18.725	6.995	18.941	0.000	0.259	0.250	4.174	2.149	2.154	2.144	2.140	156.473	86.123	99.161	1.004	1.002	0.998
39	38.103	67.036	45.725	66.630	0.167	0.263	0.352	5.193	3.462	2.181	2.799	2.777	82.561	40.410	114.984	1.246	1.237	1.587
40	225.344	225.574	270.176	211.334	0.166	0.241	0.370	7.433	5.086	6.947	3.722	3.402	41.918	64.125	155.696	1.495	1.367	0.732
41	6.102	18.622	6.413	18.880	0.048	0.298	0.312	2.239	2.092	2.749	1.529	1.453	20.329	59.887	43.270	1.440	1.368	0.761
41	17.563	40.694	21.464	41.196	0.182	0.280	0.363	7.938	2.104	2.717	3.486	3.351	72.149	111.436	57.171	0.628	0.604	0.774
41	24.559	51.247	29.402	51.168	0.165	0.285	0.367	4.107	2.758	5.216	2.182	2.156	11.659	85.678	95.044	1.279	1.264	0.529
42	7.442	23.548	8.571	23.712	0.132	0.322	0.379	2.001	1.477	2.847	1.782	1.741	44.405	80.366	61.760	0.849	0.829	0.519
44	908.519	614.047	1185.591	623.786	0.234	0.311	0.414	29.522	15.372	6.567	10.885	10.874	55.147	119.719	136.374	1.414	1.412	2.341

45	10.568	26.808	11.510	27.288	0.082	0.283	0.311	2.678	2.846	2.306	1.858	1.613	153.448	68.460	50.347	1.765	1.532	1.234
45	57.303	82.267	63.176	81.331	0.093	0.251	0.307	3.192	5.167	0.623	2.113	2.048	71.614	87.545	111.375	2.523	2.445	8.293
46	80.225	111.323	97.186	112.023	0.175	0.276	0.359	7.144	5.937	6.107	3.086	2.964	36.724	83.368	85.132	2.003	1.924	0.972
47	27.833	56.385	32.887	56.100	0.154	0.298	0.375	10.646	2.319	3.420	4.497	4.450	71.680	90.000	55.113	0.521	0.516	0.678
48	54.773	89.854	69.297	86.943	0.210	0.255	0.384	7.232	3.616	4.975	3.351	3.282	35.821	50.647	103.490	1.102	1.079	0.727
49	6.549	17.333	6.549	17.354	0.000	0.226	0.225	3.355	2.205	2.089	2.295	2.166	169.517	116.754	109.105	1.018	0.961	1.055
50	2.381	8.809	2.381	8.962	0.000	0.236	0.223	2.887	1.561	1.515	1.931	1.853	168.253	90.000	79.175	0.842	0.808	1.030
51	171.017	178.966	195.216	174.675	0.124	0.261	0.339	14.130	7.504	6.898	4.273	4.272	11.279	82.313	89.621	1.757	1.756	1.088

A.2 Center 3: Vienna General Hospital, Medical University of Vienna

Table S2. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	9.972	25.393	10.896	25.740	0.085	0.267	0.300	4.984	1.744	1.066	2.548	2.235	64.066	106.107	9.866	0.781	0.685	1.636
1	8.633	24.177	9.848	24.142	0.123	0.270	0.332	4.174	1.056	2.411	2.099	2.017	59.854	126.888	125.515	0.523	0.503	0.438
2	50.159	78.112	57.192	76.626	0.123	0.256	0.332	4.717	3.238	3.709	3.764	3.588	86.352	43.595	120.727	0.902	0.860	0.873

3	765.335	475.082	858.143	458.743	0.108	0.244	0.324	36.571	11.905	2.883	8.420	8.181	80.581	65.075	158.078	1.455	1.414	4.130
4	85.881	110.964	96.318	109.413	0.108	0.263	0.327	15.049	4.764	3.702	5.913	5.756	77.860	77.830	142.376	0.828	0.806	1.287
5	34.233	63.193	38.748	63.706	0.117	0.310	0.360	3.288	4.760	3.683	2.238	2.171	41.128	80.031	140.779	2.193	2.127	1.292
6	549.815	375.503	609.965	362.088	0.099	0.238	0.314	17.623	11.562	10.534	6.419	6.269	12.424	67.914	75.241	1.844	1.801	1.098
7	327.746	267.071	362.971	259.759	0.097	0.248	0.317	9.083	6.840	10.832	4.123	3.856	26.054	98.749	80.657	1.774	1.659	0.631
7	26.047	51.082	30.587	51.514	0.148	0.271	0.340	5.594	3.293	4.363	3.775	3.714	20.074	61.319	80.966	0.886	0.872	0.755
8	36.168	63.148	40.931	60.847	0.116	0.251	0.335	4.003	3.027	3.329	2.107	1.985	55.247	60.628	72.318	1.524	1.437	0.909
9	25.303	49.736	28.118	48.994	0.100	0.276	0.335	5.937	2.932	0.310	3.724	3.290	84.398	94.760	96.508	0.891	0.787	9.459
10	2977.544	1311.513	3516.326	1178.798	0.153	0.247	0.394	42.984	12.023	17.347	13.322	13.134	37.400	51.315	102.402	0.915	0.903	0.693
12	18.158	40.657	20.490	41.013	0.114	0.299	0.348	4.003	2.702	1.956	2.639	2.625	68.801	142.763	86.093	1.029	1.024	1.381
13	9.972	26.308	10.555	25.530	0.055	0.277	0.324	6.718	2.818	0.352	2.464	2.381	77.739	44.109	144.893	1.183	1.144	8.006
14	202.274	198.408	231.961	188.542	0.128	0.231	0.333	14.527	5.312	5.716	6.849	6.388	45.202	110.595	138.563	0.832	0.776	0.929
15	7.740	24.034	8.831	24.187	0.124	0.322	0.375	4.450	1.223	2.487	2.746	2.709	63.111	79.851	120.858	0.451	0.445	0.492
15	12.056	28.898	12.868	29.152	0.063	0.277	0.302	2.783	2.128	1.338	1.749	1.692	72.896	106.885	92.837	1.258	1.217	1.591
16	6.400	18.922	6.958	19.538	0.080	0.284	0.301	2.143	1.562	2.608	1.543	1.464	74.889	66.776	49.265	1.067	1.013	0.599
17	38.847	69.623	47.139	67.754	0.176	0.261	0.368	11.569	3.326	3.060	4.808	4.725	53.141	112.219	107.224	0.704	0.692	1.087
18	4.614	14.453	4.614	14.507	0.000	0.267	0.264	1.934	1.302	2.006	1.858	1.778	47.866	66.749	75.213	0.732	0.701	0.649
18	6.549	19.501	6.840	19.643	0.043	0.296	0.311	2.478	1.844	2.310	1.854	1.799	43.280	116.837	27.646	1.025	0.995	0.798
19	52.243	84.882	62.128	84.376	0.159	0.286	0.368	4.174	6.119	0.578	2.279	2.194	83.590	120.835	40.753	2.788	2.685	10.586
20	558.299	386.391	616.483	368.632	0.094	0.246	0.326	12.931	9.153	6.157	4.993	4.582	74.534	101.957	117.319	1.997	1.833	1.487
21	77.694	119.401	101.379	118.148	0.234	0.294	0.415	6.376	3.948	7.368	4.126	3.584	62.781	158.911	52.461	1.102	0.957	0.536
22	48.820	75.697	54.674	75.163	0.107	0.264	0.323	6.146	4.922	2.505	3.253	3.166	61.840	125.506	147.214	1.555	1.513	1.965
23	16.819	39.693	19.839	38.719	0.152	0.274	0.365	7.529	2.560	2.240	3.507	3.312	58.334	77.082	19.511	0.773	0.730	1.143
24	596.997	408.007	669.600	401.496	0.108	0.268	0.333	3.326	11.667	10.241	2.780	2.479	33.260	144.010	38.721	4.707	4.197	1.139
24	6.251	20.940	8.211	22.424	0.239	0.303	0.378	3.288	2.956	2.167	1.620	1.513	154.253	90.000	112.056	1.954	1.824	1.364
25	15.777	35.956	17.278	35.727	0.087	0.282	0.328	2.983	3.818	2.981	2.305	2.234	20.827	83.557	73.572	1.709	1.657	1.281
25	5.061	16.618	5.402	16.520	0.063	0.285	0.319	3.564	1.647	2.250	2.782	2.432	16.846	90.000	100.222	0.677	0.592	0.732
26	36.912	61.356	40.187	60.015	0.081	0.250	0.306	3.764	3.747	1.943	2.407	2.369	76.571	51.447	128.018	1.582	1.556	1.928

27	19.796	40.113	21.923	40.031	0.097	0.249	0.300	5.223	2.737	1.233	2.864	2.836	77.068	115.824	76.611	0.965	0.956	2.220
28	95.853	118.703	106.973	116.239	0.104	0.256	0.323	15.024	4.233	6.602	6.015	5.959	12.227	135.652	33.023	0.710	0.704	0.641
29	113.267	144.229	138.217	144.428	0.181	0.290	0.377	8.573	4.062	2.929	4.169	4.135	62.654	71.802	125.880	0.982	0.974	1.387
29	8.484	22.060	8.484	22.331	0.000	0.285	0.276	6.756	1.670	3.173	3.656	3.525	132.860	85.661	66.948	0.474	0.457	0.526
30	37.954	62.241	40.695	60.898	0.067	0.254	0.304	4.650	3.548	4.561	3.187	3.015	19.622	73.512	91.990	1.177	1.113	0.778
31	6.400	19.051	6.673	19.499	0.041	0.302	0.305	4.851	1.992	2.527	2.124	2.111	151.471	134.688	72.458	0.944	0.938	0.788
32	20.540	40.547	22.239	41.054	0.076	0.261	0.290	9.137	2.896	3.346	3.630	3.350	156.374	125.627	104.645	0.864	0.798	0.865
33	1050.513	594.172	1203.886	573.974	0.127	0.243	0.332	6.986	12.066	3.870	3.418	3.407	74.867	96.577	102.829	3.542	3.530	3.118
34	99.872	117.921	107.779	115.770	0.073	0.249	0.299	3.906	6.687	5.261	2.884	2.836	160.242	126.136	51.202	2.358	2.319	1.271
35	8.186	24.873	9.631	24.697	0.150	0.296	0.373	4.621	1.571	1.662	2.626	2.584	83.361	85.669	7.378	0.608	0.598	0.945
35	12.056	32.604	14.865	32.258	0.189	0.281	0.381	3.497	1.830	3.034	1.858	1.757	45.555	24.197	68.322	1.042	0.985	0.603
36	8.335	22.776	8.986	23.049	0.072	0.280	0.307	3.497	2.428	2.495	2.179	2.086	9.760	71.229	61.476	1.164	1.114	0.973
37	10.270	24.981	10.270	24.752	0.000	0.267	0.274	0.781	1.952	2.708	1.259	1.024	46.886	160.000	119.591	1.906	1.550	0.721
37	14.437	31.414	14.698	31.693	0.018	0.273	0.276	5.239	2.812	2.748	2.846	2.800	156.525	96.732	106.363	1.005	0.988	1.023
37	41.675	69.198	46.444	66.928	0.103	0.259	0.333	3.802	3.075	3.038	2.512	2.479	58.552	66.064	94.997	1.241	1.224	1.012
38	212.990	196.040	231.725	190.139	0.081	0.238	0.302	7.337	7.700	8.085	3.518	3.374	9.605	6.973	166.713	2.282	2.189	0.952
39	19.349	41.696	23.120	42.803	0.163	0.272	0.337	3.802	3.978	3.188	2.453	2.424	19.286	72.140	52.854	1.641	1.622	1.248
40	38.698	61.175	41.477	60.335	0.067	0.238	0.282	2.440	4.313	4.183	2.142	2.139	6.160	34.423	29.397	2.017	2.014	1.031
41	13.247	32.472	14.965	32.348	0.115	0.279	0.338	6.242	2.144	0.751	4.382	4.372	73.902	36.018	71.905	0.490	0.489	2.855
41	10.716	27.648	12.348	27.956	0.132	0.267	0.325	3.259	2.715	1.081	2.110	2.042	80.348	103.948	34.062	1.330	1.287	2.512
42	521.982	409.017	662.766	412.652	0.212	0.293	0.392	9.873	11.906	3.904	5.529	5.124	52.996	119.507	76.766	2.323	2.153	3.050
44	265.828	228.806	288.514	220.730	0.079	0.241	0.306	8.176	7.443	6.153	4.402	3.925	64.759	132.660	43.869	1.896	1.691	1.210
45	29.024	54.108	33.185	54.758	0.125	0.276	0.330	5.670	2.941	4.112	4.052	4.046	38.702	90.654	62.566	0.727	0.726	0.715
46	110.588	156.411	153.274	152.115	0.278	0.277	0.435	15.467	3.558	6.887	5.376	5.350	54.638	90.056	54.903	0.665	0.662	0.517
47	164.022	176.514	193.808	174.055	0.154	0.261	0.348	7.642	4.787	3.729	3.627	3.434	76.286	114.222	94.404	1.394	1.320	1.284
47	44.801	74.353	53.012	74.730	0.155	0.275	0.349	5.975	5.389	4.655	2.938	2.883	17.802	19.968	160.544	1.869	1.834	1.158
48	10.121	28.033	11.200	27.784	0.096	0.308	0.359	5.060	1.366	2.305	2.712	2.693	68.101	117.589	57.001	0.507	0.504	0.593
49	10.121	27.005	10.977	26.333	0.078	0.280	0.335	4.679	2.125	0.484	2.616	2.448	78.782	105.555	54.297	0.868	0.812	4.390

49	105.676	138.755	133.751	133.483	0.210	0.248	0.382	9.568	4.431	6.514	5.119	5.089	16.248	62.842	112.095	0.871	0.865	0.680
50	743.605	466.970	821.591	444.719	0.095	0.243	0.325	9.004	12.383	2.647	3.926	3.906	83.161	126.579	86.200	3.170	3.154	4.678
51	1166.161	677.478	1408.554	632.069	0.172	0.237	0.372	13.712	11.209	7.868	5.393	5.301	70.542	39.398	61.204	2.115	2.078	1.425
51	9.823	26.385	9.823	26.649	0.000	0.339	0.333	10.746	0.969	2.953	3.518	3.485	120.414	69.192	109.186	0.278	0.275	0.328
52	60.727	94.269	72.715	92.874	0.165	0.280	0.371	4.851	3.386	4.631	3.286	3.112	56.482	48.409	107.579	1.088	1.031	0.731
53	514.838	395.494	611.559	368.023	0.158	0.249	0.377	14.857	7.870	12.741	6.007	5.937	25.039	68.883	83.056	1.325	1.310	0.618
54	79.332	109.848	89.484	107.201	0.113	0.284	0.355	9.764	2.187	6.786	5.937	5.396	75.907	85.750	61.511	0.405	0.368	0.322
55	165.064	175.383	189.176	168.932	0.127	0.251	0.341	24.278	5.256	4.167	8.199	8.167	78.541	36.398	114.355	0.644	0.641	1.261
56	61.769	87.347	68.361	85.827	0.096	0.252	0.313	2.916	4.836	5.555	1.979	1.867	19.313	74.640	66.210	2.591	2.444	0.871
57	331.318	274.901	376.956	268.838	0.121	0.255	0.331	11.807	7.500	3.356	6.134	5.780	74.031	113.326	84.575	1.298	1.223	2.235
59	6.102	19.142	7.089	20.191	0.139	0.299	0.330	2.954	2.457	2.367	1.857	1.740	162.195	98.519	72.204	1.412	1.323	1.038
59	193.194	186.048	212.184	180.056	0.090	0.242	0.311	8.243	6.290	4.599	4.181	3.746	72.185	102.649	137.497	1.679	1.505	1.368
59	183.669	191.994	219.570	185.517	0.164	0.247	0.354	12.597	6.827	7.904	6.179	6.149	10.711	123.617	49.746	1.110	1.105	0.864
59	26.345	57.581	34.587	58.527	0.238	0.304	0.410	7.299	3.249	0.200	4.671	4.399	85.081	90.938	88.558	0.739	0.696	16.247
59	90.644	120.403	109.552	117.990	0.173	0.255	0.357	12.217	5.107	3.137	4.191	4.101	77.664	115.181	43.693	1.245	1.219	1.628
60	15.033	33.861	16.441	34.336	0.086	0.277	0.310	5.156	3.638	2.731	2.725	2.661	21.495	68.446	55.641	1.367	1.335	1.332
61	34.680	74.032	47.926	72.744	0.276	0.304	0.449	11.615	2.412	5.243	5.357	5.249	40.463	78.847	84.355	0.459	0.450	0.460
62	5.061	16.299	5.302	17.098	0.046	0.317	0.306	1.934	1.483	0.841	1.533	1.431	81.386	94.733	97.723	1.037	0.968	1.764
63	303.187	265.980	352.689	262.835	0.140	0.271	0.349	6.317	10.619	9.165	3.840	3.830	4.347	99.612	81.288	2.772	2.766	1.159
64	164.468	207.544	232.333	199.218	0.292	0.272	0.445	7.930	4.636	6.753	4.099	4.085	50.069	23.145	36.022	1.135	1.131	0.687
65	40.782	77.175	52.596	74.169	0.225	0.274	0.411	9.167	2.928	5.451	4.572	4.542	23.831	73.363	103.976	0.645	0.640	0.537
66	102.104	121.042	112.349	117.522	0.091	0.240	0.307	4.583	5.319	5.805	3.414	3.212	15.102	89.835	95.106	1.656	1.558	0.916
66	10.121	27.043	11.442	27.550	0.115	0.293	0.336	4.851	2.140	2.009	2.938	2.806	78.121	146.490	77.415	0.763	0.729	1.065
66	52.541	89.267	67.604	85.096	0.223	0.251	0.397	11.673	3.110	4.190	5.352	5.029	39.391	88.810	117.736	0.618	0.581	0.742
67	4.912	14.794	4.912	14.968	0.000	0.259	0.250	4.383	1.567	2.093	2.108	2.094	142.220	69.281	148.404	0.748	0.744	0.749
67	6.549	19.137	6.586	18.305	0.006	0.263	0.298	2.306	1.683	0.483	1.947	1.797	86.626	148.453	109.751	0.937	0.864	3.485
68	12.949	31.614	14.698	31.881	0.119	0.278	0.331	5.498	2.985	3.267	2.418	2.301	86.850	31.996	100.770	1.297	1.234	0.914
69	26.494	47.501	27.548	47.259	0.038	0.259	0.282	3.831	3.881	3.315	2.140	2.132	16.185	59.874	116.872	1.821	1.814	1.171

70	104.635	128.291	121.094	123.254	0.136	0.238	0.336	9.049	4.062	6.315	4.806	4.536	21.052	61.555	43.581	0.896	0.845	0.643
71	125.174	156.502	160.133	154.839	0.218	0.269	0.386	14.527	4.062	8.760	6.344	5.917	26.720	114.682	135.631	0.687	0.640	0.464
72	20.242	41.188	21.960	40.813	0.078	0.263	0.308	3.497	2.760	3.722	2.470	2.414	27.993	66.042	91.373	1.144	1.118	0.742
73	257.493	253.938	310.976	240.491	0.172	0.267	0.388	8.281	6.856	7.369	5.037	4.967	40.126	128.741	51.604	1.380	1.361	0.930
74	87.369	131.634	117.118	126.419	0.254	0.273	0.426	6.430	3.437	5.259	2.968	2.825	47.101	117.063	142.781	1.217	1.158	0.654
76	10.270	29.063	12.583	30.041	0.184	0.309	0.376	3.125	2.903	3.226	1.882	1.878	20.155	71.964	91.625	1.546	1.543	0.900
76	119.519	139.643	136.127	135.890	0.122	0.253	0.333	6.668	5.312	4.102	4.024	3.675	47.727	85.269	132.412	1.446	1.320	1.295
77	189.324	200.746	231.849	199.949	0.183	0.276	0.370	8.415	5.450	4.312	4.940	4.591	75.182	108.403	60.540	1.187	1.103	1.264
78	55.517	87.152	66.916	87.961	0.170	0.281	0.359	7.136	4.761	2.470	3.404	3.398	64.202	118.680	54.517	1.401	1.399	1.927
78	17.414	39.874	20.807	40.862	0.163	0.289	0.353	10.574	2.190	1.354	4.071	4.015	79.398	109.888	31.731	0.546	0.538	1.618
79	59.238	88.209	68.287	85.487	0.133	0.250	0.339	4.984	3.874	3.471	2.694	2.544	61.495	57.560	149.523	1.522	1.438	1.116
80	14.289	36.536	17.737	37.475	0.194	0.303	0.381	5.528	2.105	3.802	3.018	2.887	45.397	57.410	84.959	0.729	0.698	0.554
80	46.438	73.539	51.846	71.878	0.104	0.258	0.326	6.317	4.906	1.531	4.103	3.974	74.214	10.146	84.229	1.235	1.196	3.204
81	64.894	93.554	73.905	91.337	0.122	0.260	0.337	8.356	4.879	5.713	5.008	5.001	133.594	85.360	105.966	0.976	0.974	0.854
82	35.275	61.331	39.114	60.960	0.098	0.274	0.327	2.991	4.087	2.180	2.182	2.060	45.511	90.000	104.878	1.984	1.873	1.875
83	66.829	95.757	77.304	93.767	0.136	0.257	0.340	7.566	4.990	3.004	3.600	3.291	57.253	111.105	86.787	1.517	1.386	1.661
84	6.102	18.197	6.270	18.191	0.027	0.283	0.296	2.582	1.015	1.253	1.592	1.460	68.361	66.357	42.795	0.695	0.638	0.810
85	13.544	30.718	13.768	30.693	0.016	0.282	0.290	7.746	3.021	3.271	3.272	3.260	1.500	70.502	110.389	0.927	0.923	0.923
86	9.377	26.258	10.785	26.672	0.131	0.298	0.350	3.601	1.876	2.029	2.182	2.054	51.596	90.000	95.253	0.913	0.860	0.925
87	37.210	65.594	43.641	65.627	0.147	0.275	0.348	12.860	2.812	1.556	4.499	4.487	80.527	77.642	150.305	0.627	0.625	1.808
88	217.009	205.234	245.902	196.413	0.118	0.233	0.325	10.240	4.687	6.305	6.901	6.265	48.085	73.256	59.129	0.748	0.679	0.743
89	99.425	129.587	122.359	128.809	0.187	0.266	0.364	5.670	3.403	5.491	2.700	2.688	67.320	124.858	50.796	1.266	1.260	0.620
90	21.284	48.421	27.734	49.196	0.233	0.285	0.391	6.443	1.772	2.847	3.744	3.669	54.679	95.195	37.396	0.483	0.473	0.623
91	10.716	26.019	11.349	26.678	0.056	0.273	0.283	4.287	2.187	2.786	2.628	2.536	73.639	30.458	67.107	0.863	0.832	0.785
91	56.262	83.132	61.527	82.772	0.086	0.277	0.322	4.583	6.239	1.656	2.758	2.534	60.370	90.211	36.302	2.463	2.262	3.768
92	22.773	47.105	27.765	47.390	0.180	0.257	0.345	5.022	2.636	3.944	3.157	3.049	25.745	33.224	48.474	0.865	0.835	0.668
93	516.326	371.513	584.253	352.573	0.116	0.239	0.335	11.907	9.062	11.076	6.849	6.162	12.805	120.388	133.098	1.471	1.323	0.818
94	157.175	163.080	176.946	159.280	0.112	0.240	0.315	15.475	5.635	4.081	5.064	5.060	61.741	58.305	62.653	1.114	1.113	1.381

95	23.368	42.907	23.535	42.473	0.007	0.258	0.269	2.373	3.360	3.080	1.724	1.688	23.508	171.071	151.497	1.990	1.949	1.091
96	38.996	63.639	42.891	63.555	0.091	0.260	0.306	4.441	3.770	1.346	2.296	2.203	76.802	101.667	31.309	1.711	1.642	2.801
97	62.959	90.615	71.263	88.065	0.117	0.251	0.330	4.688	3.359	4.096	2.271	2.207	31.500	86.217	117.190	1.522	1.480	0.820
98	459.916	347.490	522.311	324.446	0.119	0.233	0.342	9.526	4.687	9.887	6.344	5.879	36.759	117.022	109.577	0.797	0.739	0.474
99	95.853	122.250	112.560	120.038	0.148	0.255	0.342	12.998	4.302	5.338	5.651	5.573	40.414	31.977	62.239	0.772	0.761	0.806
100	102.253	150.101	144.269	148.992	0.291	0.291	0.441	50.157	4.534	5.785	7.657	7.409	68.261	130.873	69.028	0.612	0.592	0.784
101	9.675	24.797	10.251	25.390	0.056	0.287	0.297	6.793	2.217	2.858	3.640	3.242	157.682	112.970	58.621	0.684	0.609	0.776
102	5.061	16.511	5.290	17.301	0.043	0.326	0.315	5.373	1.592	2.370	2.952	2.832	136.380	112.401	70.970	0.562	0.539	0.672
103	23.963	46.798	27.008	46.706	0.113	0.260	0.318	7.976	3.798	1.178	2.994	2.648	55.541	112.512	116.378	1.435	1.268	3.224
103	69.359	105.891	88.554	102.876	0.217	0.259	0.388	23.021	4.079	6.286	5.466	5.233	10.265	87.537	102.728	0.779	0.746	0.649
104	25.600	55.784	34.202	56.213	0.252	0.281	0.402	3.497	2.980	4.241	2.423	2.398	46.676	126.978	103.629	1.243	1.230	0.703
104	23.070	45.513	26.053	46.084	0.115	0.268	0.317	5.477	4.062	3.362	2.440	2.414	19.256	118.728	126.353	1.683	1.665	1.208
105	5.358	16.116	5.358	16.434	0.000	0.285	0.271	3.564	1.784	2.513	2.484	2.302	19.504	105.219	118.010	0.775	0.718	0.710
106	478.967	388.291	609.922	370.531	0.215	0.255	0.395	16.420	9.484	7.807	7.011	6.839	58.701	94.885	122.198	1.387	1.353	1.215
107	61.024	91.040	70.395	88.526	0.133	0.261	0.347	8.832	4.449	5.524	4.497	4.146	10.592	109.658	64.007	1.073	0.989	0.805
108	76.355	112.201	95.307	110.450	0.199	0.275	0.384	20.268	3.817	7.185	5.996	5.782	21.923	77.466	92.948	0.660	0.637	0.531
108	6.995	19.937	6.995	20.269	0.000	0.307	0.296	6.748	1.675	2.786	3.180	3.032	162.238	136.499	142.690	0.552	0.527	0.601
109	45.247	92.016	68.752	89.051	0.342	0.277	0.470	9.359	2.670	4.993	3.825	3.659	45.646	76.588	90.928	0.730	0.698	0.535
109	1050.662	635.165	1234.491	574.714	0.149	0.231	0.375	27.141	7.982	14.531	5.467	5.359	17.315	155.056	27.386	1.489	1.460	0.549
110	15.777	34.675	16.558	34.583	0.047	0.279	0.304	4.688	1.638	2.491	3.382	2.842	34.051	46.847	144.743	0.576	0.484	0.658
111	215.223	201.989	241.363	194.578	0.108	0.235	0.318	15.684	7.228	7.679	4.739	4.506	10.799	80.479	84.074	1.604	1.525	0.941
112	7.591	23.443	8.304	24.085	0.086	0.346	0.368	8.841	1.584	2.776	3.953	3.830	117.549	87.212	35.755	0.414	0.401	0.571
112	382.221	308.746	440.858	294.760	0.133	0.246	0.345	5.097	6.391	10.292	4.196	4.105	40.366	102.361	37.931	1.557	1.523	0.621
113	113.714	128.771	124.244	125.167	0.085	0.236	0.300	7.738	6.053	6.224	3.449	3.418	6.615	57.578	126.499	1.771	1.755	0.973
114	123.835	141.730	141.640	140.336	0.126	0.257	0.327	4.575	6.588	1.902	2.519	2.445	70.385	151.740	42.881	2.695	2.616	3.464
115	9.823	26.183	10.797	26.498	0.090	0.292	0.328	5.156	1.333	1.847	3.034	3.029	62.039	81.224	88.148	0.440	0.439	0.722
116	13.396	38.771	19.337	39.887	0.307	0.307	0.442	7.337	2.686	3.716	3.898	3.864	24.263	169.750	18.733	0.695	0.689	0.723
117	277.735	240.835	309.445	232.967	0.102	0.246	0.322	7.358	7.512	0.892	3.979	3.853	71.051	76.996	90.254	1.949	1.888	8.421

118	51.796	84.045	61.465	82.429	0.157	0.275	0.365	6.138	3.075	4.767	4.122	4.071	56.286	57.174	84.474	0.755	0.746	0.645
119	51.796	83.888	62.103	81.616	0.166	0.262	0.364	6.860	2.847	3.565	4.073	3.796	37.511	109.476	79.520	0.750	0.699	0.799
120	11.312	26.271	11.312	26.313	0.000	0.265	0.264	2.620	2.187	2.737	2.070	1.735	126.999	83.160	148.031	1.261	1.057	0.799
121	56.113	83.197	62.172	81.926	0.097	0.265	0.324	3.936	4.556	5.580	2.987	2.944	13.687	87.520	73.835	1.548	1.525	0.816
122	34.382	62.216	40.385	62.044	0.149	0.272	0.348	6.280	3.934	2.400	3.433	3.295	73.370	77.647	56.005	1.194	1.146	1.639

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Table S3. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	136.635	151.656	154.180	147.282	0.114	0.251	0.329	8.765	5.442	3.280	3.933	3.879	67.468	137.000	132.038	1.403	1.384	1.659
2	21.284	43.892	23.256	44.121	0.085	0.291	0.328	6.117	2.654	1.788	2.995	2.990	85.237	90.000	130.812	0.888	0.886	1.484
3	24.856	47.175	27.827	48.564	0.107	0.274	0.307	8.297	4.031	3.787	3.874	3.809	153.487	127.708	62.816	1.058	1.041	1.064

4	449.348	332.813	502.062	324.135	0.105	0.252	0.323	4.650	11.634	10.212	2.485	2.442	13.343	115.040	71.708	4.763	4.681	1.139
5	37.657	70.061	48.342	72.145	0.221	0.294	0.385	0.848	5.642	2.143	0.796	0.755	65.148	106.398	69.065	7.477	7.089	2.633
6	42.122	85.649	69.328	96.608	0.392	0.329	0.457	8.222	6.033	1.903	4.696	4.676	81.153	117.104	111.334	1.290	1.285	3.170
7	5.954	18.159	5.954	18.258	0.000	0.309	0.306	5.373	1.600	2.405	2.653	2.637	148.226	95.909	65.280	0.607	0.603	0.665
8	23.368	46.099	25.104	45.709	0.069	0.280	0.319	4.241	3.586	3.785	2.415	2.302	8.958	69.212	65.561	1.558	1.485	0.947
9	200.190	226.979	261.406	221.444	0.234	0.291	0.421	14.753	4.422	5.470	5.562	5.127	75.430	59.195	159.878	0.862	0.795	0.808
10	25.154	53.557	30.041	53.196	0.163	0.303	0.385	6.823	3.406	0.781	2.714	2.678	84.101	23.335	119.230	1.272	1.255	4.361
11	51.350	79.426	58.482	78.650	0.122	0.265	0.332	6.689	4.733	4.891	2.779	2.693	11.784	106.634	100.084	1.758	1.703	0.968
12	84.541	131.667	117.379	143.097	0.280	0.357	0.438	5.477	10.312	2.354	2.846	2.600	79.505	90.000	19.296	3.966	3.624	4.381
13	11.014	28.400	12.831	29.019	0.142	0.275	0.331	4.880	2.684	0.871	2.742	2.738	63.191	105.823	67.966	0.980	0.979	3.082
14	22.624	45.089	24.869	44.908	0.090	0.272	0.319	3.944	4.644	3.225	2.147	2.043	10.764	80.464	109.124	2.273	2.163	1.440
15	137.826	146.976	147.172	144.828	0.064	0.261	0.303	5.565	6.912	1.427	4.267	3.668	63.062	138.433	68.435	1.884	1.620	4.844
15	12.651	30.950	14.810	31.147	0.146	0.257	0.327	6.041	2.605	1.077	3.335	3.247	74.237	126.851	91.821	0.802	0.781	2.418
16	565.890	424.608	674.282	396.259	0.161	0.255	0.382	19.984	10.105	10.114	5.936	5.779	32.811	122.208	30.818	1.749	1.702	0.999
17	6.698	20.062	7.578	20.927	0.116	0.292	0.320	4.859	2.569	2.369	2.485	2.443	158.179	74.296	80.957	1.051	1.033	1.084
18	28.280	53.292	32.261	52.544	0.123	0.260	0.331	4.717	3.421	4.008	2.653	2.632	37.281	157.681	133.690	1.300	1.290	0.854
19	438.631	455.717	760.244	458.931	0.423	0.303	0.514	11.502	6.947	5.775	4.544	4.480	47.704	80.829	128.514	1.550	1.529	1.203
20	19.796	38.855	20.422	38.971	0.031	0.264	0.277	6.547	3.178	3.479	3.412	3.209	13.067	137.592	124.883	0.990	0.932	0.913
21	30.959	56.402	36.416	56.823	0.150	0.258	0.329	4.316	3.318	4.542	3.003	2.953	27.756	68.799	86.876	1.124	1.105	0.731
22	86.774	107.607	94.867	105.561	0.085	0.244	0.301	3.526	5.235	6.160	2.544	2.229	172.509	117.768	55.100	2.349	2.058	0.850
23	39.740	65.353	43.325	64.680	0.083	0.268	0.316	4.993	4.459	1.664	2.686	2.573	33.955	129.176	26.774	1.733	1.660	2.679
24	14.289	34.712	15.845	34.614	0.098	0.300	0.349	3.631	2.953	0.080	1.981	1.816	74.060	106.629	22.421	1.627	1.491	36.918
25	30.363	65.201	44.999	69.927	0.325	0.306	0.427	6.346	2.635	5.283	4.013	3.868	46.492	74.969	109.411	0.681	0.657	0.499
26	13.544	32.258	15.269	32.623	0.113	0.276	0.324	2.611	2.690	2.843	1.789	1.629	14.771	47.404	59.091	1.651	1.503	0.946
27	103.295	149.253	152.679	152.485	0.323	0.281	0.434	13.186	4.806	2.784	5.642	5.571	80.855	124.883	47.420	0.863	0.852	1.726
28	47.926	75.735	53.936	74.952	0.111	0.269	0.331	9.635	4.194	1.382	3.394	3.299	75.675	94.059	85.328	1.271	1.236	3.035
29	41.824	67.972	46.686	68.143	0.104	0.270	0.320	7.053	3.687	0.817	3.242	2.956	80.412	54.295	153.864	1.248	1.137	4.513
29	17.563	39.590	20.540	39.613	0.145	0.273	0.345	7.767	2.996	1.836	4.504	4.284	68.403	78.527	136.069	0.699	0.665	1.632

30	61.471	91.479	73.440	90.563	0.163	0.257	0.346	5.795	4.636	4.676	3.638	3.448	22.549	53.070	143.350	1.345	1.274	0.991
30	12.800	30.134	13.563	30.703	0.056	0.289	0.303	6.271	1.735	1.776	2.897	2.778	80.150	72.569	36.006	0.624	0.599	0.977

A.4 Center 5: Buffalo General Medical Center, University at Buffalo

Table S4. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	59.238	116.245	88.169	110.301	0.328	0.311	0.498	7.621	3.437	7.429	6.211	5.406	33.322	82.540	87.180	0.636	0.553	0.463
2	3.721	14.288	3.771	14.072	0.013	0.339	0.355	3.668	0.944	1.820	1.988	1.783	104.720	90.000	15.921	0.529	0.475	0.519
2	26.642	51.329	28.354	52.397	0.060	0.319	0.333	13.633	2.241	3.825	4.272	4.219	127.162	64.592	32.073	0.531	0.525	0.586

3	3.870	15.219	4.918	16.129	0.213	0.312	0.378	3.096	0.937	1.281	2.440	2.399	78.865	56.688	129.728	0.391	0.384	0.732
4	6.400	22.625	7.423	23.415	0.138	0.376	0.415	5.477	0.937	1.998	3.553	3.419	76.529	90.000	128.869	0.274	0.264	0.469
5	7.144	22.045	8.180	21.974	0.127	0.291	0.354	4.211	1.312	2.052	2.613	2.565	62.122	46.997	72.921	0.511	0.502	0.639
5	3.870	14.939	4.112	14.685	0.059	0.329	0.367	3.430	1.293	2.063	2.106	1.996	103.371	73.277	117.859	0.648	0.614	0.627
6	159.408	163.622	176.741	157.946	0.098	0.235	0.310	7.098	6.931	7.043	4.077	3.960	10.870	133.407	136.282	1.750	1.700	0.984
7	53.285	82.733	62.742	82.644	0.151	0.267	0.343	3.526	3.769	3.142	2.244	2.117	65.668	71.230	124.141	1.781	1.679	1.199
8	4.614	15.678	4.707	15.770	0.020	0.316	0.321	3.735	1.089	0.439	2.321	2.232	81.802	90.000	149.191	0.488	0.469	2.481
9	95.704	127.125	119.382	125.520	0.198	0.259	0.368	12.948	5.462	2.634	5.684	5.674	79.852	122.902	150.875	0.963	0.961	2.073
10	3.423	11.807	3.423	11.694	0.000	0.254	0.262	4.725	1.011	1.951	2.423	2.321	135.073	57.627	105.430	0.435	0.417	0.518
11	5.358	15.903	5.358	15.977	0.000	0.264	0.261	4.048	1.562	2.002	2.012	1.979	141.591	90.000	54.446	0.790	0.777	0.780
12	18.158	43.196	21.222	43.073	0.144	0.317	0.386	11.765	1.574	2.985	4.746	4.699	77.310	77.703	125.786	0.335	0.332	0.527
13	12.949	31.477	13.334	31.310	0.029	0.311	0.328	6.079	2.711	3.098	3.124	3.080	143.364	90.000	92.262	0.880	0.868	0.875
14	5.507	20.331	6.921	20.540	0.204	0.321	0.411	6.593	0.946	1.709	2.745	2.723	80.095	104.265	62.480	0.347	0.344	0.553
15	494.893	435.359	622.213	384.325	0.205	0.272	0.448	19.043	4.275	10.643	7.031	6.997	61.788	108.953	129.941	0.611	0.608	0.402
15	59.536	84.120	66.141	83.244	0.100	0.246	0.304	6.405	4.148	1.241	3.077	2.979	81.793	36.395	90.234	1.392	1.348	3.342
16	13.991	31.881	15.206	32.324	0.080	0.271	0.301	5.469	3.294	2.723	2.874	2.657	17.854	80.871	95.132	1.240	1.146	1.210
17	19.349	49.772	25.080	46.997	0.228	0.300	0.444	6.727	1.223	3.649	3.124	3.113	61.414	125.002	77.743	0.393	0.391	0.335
18	23.368	47.205	24.249	47.406	0.036	0.322	0.335	17.034	2.154	4.122	4.941	4.886	142.031	83.967	62.764	0.441	0.436	0.522
20	8.186	25.484	9.885	25.349	0.172	0.303	0.388	4.613	1.600	0.782	2.635	2.320	78.162	44.247	78.689	0.690	0.607	2.046
21	35.870	77.960	61.136	87.884	0.413	0.322	0.465	4.450	3.148	2.801	2.626	2.582	69.370	118.534	55.425	1.219	1.199	1.124
22	17.712	36.076	17.712	35.734	0.000	0.270	0.277	9.426	2.638	3.441	3.794	3.741	4.689	24.170	23.117	0.705	0.695	0.767
23	9.079	25.080	10.183	25.676	0.108	0.298	0.334	3.326	1.884	2.846	2.283	2.242	39.753	8.067	47.718	0.840	0.825	0.662
24	5.805	20.779	6.915	20.666	0.161	0.326	0.403	5.774	1.400	2.552	2.842	2.835	121.439	55.989	79.637	0.494	0.493	0.549
25	310.034	301.784	350.890	291.430	0.116	0.345	0.417	76.962	5.361	11.273	12.942	12.879	28.538	90.000	62.228	0.416	0.414	0.476
26	4.465	14.481	4.465	14.541	0.000	0.284	0.281	4.278	1.548	0.169	2.229	2.154	88.216	54.487	113.036	0.719	0.694	9.158
27	6.549	19.645	7.151	20.183	0.084	0.294	0.316	6.727	1.653	2.770	3.034	2.980	147.327	77.791	92.190	0.555	0.545	0.597
28	12.949	35.477	16.069	35.599	0.194	0.313	0.403	10.574	1.572	2.000	3.953	3.872	80.828	94.902	21.989	0.406	0.398	0.786
29	6.102	19.811	6.847	19.397	0.109	0.287	0.353	2.611	1.510	1.773	1.792	1.730	78.082	66.862	113.123	0.873	0.843	0.852

30	6.995	21.705	8.403	22.798	0.168	0.304	0.353	7.650	1.552	2.557	3.224	3.204	81.234	102.008	55.113	0.485	0.482	0.607
31	7.144	21.295	7.889	21.338	0.094	0.287	0.331	4.278	1.566	2.469	2.610	2.499	96.828	48.964	116.638	0.627	0.600	0.634
32	19.052	40.504	21.842	40.356	0.128	0.257	0.324	4.554	2.744	3.193	3.809	3.723	20.697	108.262	89.873	0.737	0.720	0.859
33	10.270	27.276	11.014	28.058	0.068	0.323	0.335	9.175	2.118	2.987	3.519	3.504	145.073	70.814	143.949	0.604	0.602	0.709
34	7.144	24.978	8.738	24.514	0.182	0.336	0.430	6.384	1.308	3.391	3.519	3.236	119.688	50.455	93.257	0.404	0.372	0.386
35	2.679	9.350	2.679	9.350	0.000	0.208	0.208	1.563	1.330	1.543	1.374	1.172	88.780	133.671	42.547	1.135	0.968	0.862
36	13.396	34.687	16.236	35.238	0.175	0.302	0.376	10.508	1.608	1.231	3.553	3.451	81.915	95.401	49.549	0.466	0.453	1.306
37	20.391	43.547	22.593	44.177	0.097	0.306	0.342	7.604	2.824	2.063	3.300	3.279	73.474	122.608	51.058	0.861	0.856	1.369
38	3.870	12.895	3.870	12.998	0.000	0.272	0.266	2.716	1.798	1.735	1.816	1.763	169.899	137.429	133.207	1.020	0.990	1.037
39	23.368	46.637	26.723	47.176	0.126	0.273	0.327	6.756	3.642	0.480	2.962	2.925	87.329	111.931	28.181	1.245	1.230	7.588
40	22.475	45.799	26.010	45.903	0.136	0.266	0.333	5.223	3.036	3.879	2.714	2.601	89.860	59.952	125.802	1.167	1.119	0.783
41	51.499	86.404	64.057	85.328	0.196	0.280	0.385	7.270	3.810	6.226	3.307	3.250	27.613	76.151	77.905	1.172	1.152	0.612
42	27.684	52.553	31.889	51.959	0.132	0.257	0.332	2.649	2.313	2.894	1.803	1.752	34.112	69.472	87.214	1.320	1.283	0.799
42	7.591	20.511	7.901	20.766	0.039	0.267	0.277	2.783	2.038	2.095	2.154	2.075	37.845	86.028	96.620	0.982	0.946	0.973
44	83.946	138.237	126.458	137.136	0.336	0.295	0.468	18.325	4.170	5.283	5.712	5.571	73.392	86.984	121.091	0.748	0.730	0.789
46	132.616	148.645	150.843	145.405	0.121	0.252	0.328	8.899	6.594	6.610	4.797	4.778	15.514	85.409	81.495	1.380	1.375	0.998
47	107.165	132.086	124.871	128.400	0.142	0.253	0.344	4.308	4.589	3.764	2.358	2.168	71.915	103.539	48.923	2.117	1.947	1.219
49	27.387	56.179	34.785	59.220	0.213	0.309	0.379	9.146	3.455	3.316	3.953	3.776	117.806	108.180	32.843	0.915	0.874	1.042
49	23.368	52.411	29.818	51.857	0.216	0.288	0.401	7.337	3.528	4.425	3.305	3.141	17.278	81.100	100.029	1.123	1.067	0.797
50	166.998	193.402	214.212	186.801	0.220	0.264	0.398	14.034	6.430	8.433	5.975	5.908	19.032	135.312	25.859	1.088	1.076	0.762
51	365.253	302.921	431.003	295.190	0.153	0.258	0.353	15.634	11.000	9.618	6.521	6.506	6.100	95.705	81.473	1.691	1.687	1.144
51	1193.250	641.601	1323.510	609.290	0.098	0.241	0.327	6.376	15.079	14.077	3.515	3.475	9.530	34.346	33.872	4.340	4.290	1.071
53	1553.741	767.772	1750.817	735.281	0.113	0.242	0.329	9.931	11.356	11.461	5.206	5.049	56.306	45.397	140.781	2.249	2.182	0.991
54	256.005	242.171	305.258	232.505	0.161	0.252	0.361	8.394	6.265	8.661	3.588	3.511	32.062	143.517	30.406	1.784	1.746	0.723
54	583.155	402.711	675.975	386.252	0.137	0.235	0.335	20.957	9.687	10.694	8.296	7.818	21.251	84.833	76.695	1.239	1.168	0.906
56	31.852	57.825	37.235	58.450	0.145	0.268	0.333	4.993	3.416	4.214	3.414	3.161	19.964	85.688	81.548	1.080	1.001	0.811
57	150.180	169.385	181.380	167.851	0.172	0.267	0.360	1.934	6.049	1.404	1.858	1.778	78.145	155.757	88.748	3.402	3.256	4.308
58	53.731	94.585	72.070	93.246	0.254	0.287	0.422	9.146	2.440	5.066	4.096	4.058	46.843	129.561	41.897	0.601	0.596	0.482

59	69.062	119.746	100.436	119.760	0.312	0.308	0.460	7.328	4.874	4.038	2.995	2.866	62.578	90.000	82.466	1.701	1.628	1.207
59	28.131	62.946	41.055	63.967	0.315	0.286	0.436	6.793	2.510	4.941	4.339	4.012	21.505	114.715	86.790	0.626	0.579	0.508
60	71.890	98.349	82.346	95.817	0.127	0.242	0.325	5.841	5.095	5.414	3.269	3.138	8.917	84.343	76.879	1.624	1.559	0.941
61	14.140	38.248	18.245	37.151	0.225	0.284	0.413	6.146	2.405	3.685	3.160	3.050	20.498	94.775	67.094	0.789	0.761	0.653
61	16.670	42.682	21.929	44.444	0.240	0.323	0.413	3.526	2.127	4.600	2.496	2.383	31.391	141.833	66.775	0.893	0.852	0.462
62	25.303	58.436	35.070	57.759	0.279	0.288	0.434	6.823	2.899	4.848	4.216	4.091	77.428	82.227	24.314	0.709	0.688	0.598
63	73.973	101.630	84.157	98.070	0.121	0.248	0.334	10.111	4.993	5.674	3.569	3.470	16.487	54.629	38.219	1.439	1.399	0.880
64	139.165	172.188	178.019	179.148	0.218	0.322	0.401	12.613	5.575	3.594	4.463	4.425	83.014	87.408	88.676	1.260	1.249	1.551
64	12.354	32.219	13.755	32.048	0.102	0.312	0.363	8.765	1.604	3.585	3.633	3.459	101.659	75.231	169.043	0.464	0.442	0.447
65	55.815	85.010	65.372	83.738	0.146	0.256	0.341	3.593	3.005	4.054	2.306	2.211	54.345	44.108	100.225	1.359	1.303	0.741
66	131.872	168.711	177.740	166.808	0.258	0.273	0.411	15.684	6.755	6.882	5.636	5.612	25.414	29.215	128.572	1.204	1.199	0.982
67	65.787	94.463	76.876	96.678	0.144	0.282	0.338	1.629	6.655	0.441	0.926	0.895	77.422	91.611	33.164	7.439	7.185	15.090
68	25.452	51.968	31.250	53.798	0.186	0.292	0.361	4.278	3.588	1.438	3.224	2.971	78.010	130.361	151.579	1.208	1.113	2.495
68	6.549	18.175	6.549	18.384	0.000	0.269	0.261	4.784	2.179	2.148	2.297	2.250	16.850	117.614	70.555	0.968	0.949	1.014
69	16.968	38.417	19.163	39.095	0.115	0.297	0.340	8.937	2.255	3.644	3.916	3.627	116.507	90.061	114.525	0.622	0.576	0.619
70	33.191	58.279	36.782	57.676	0.098	0.264	0.320	3.192	2.906	2.692	1.991	1.938	78.072	49.254	80.650	1.499	1.460	1.080
71	105.081	153.664	147.370	148.606	0.287	0.279	0.444	23.589	3.580	8.179	7.232	6.871	32.181	82.294	91.964	0.521	0.495	0.438
72	95.555	125.946	118.309	123.769	0.192	0.253	0.363	7.968	4.729	3.061	3.475	3.412	77.285	38.442	85.668	1.386	1.361	1.545
73	8.335	23.561	9.681	24.406	0.139	0.286	0.330	3.660	1.708	2.593	2.114	1.985	14.539	71.654	62.216	0.860	0.808	0.659
75	19.498	46.161	24.360	44.907	0.200	0.282	0.398	6.376	2.877	3.576	3.464	3.414	21.609	13.373	31.720	0.843	0.831	0.805
76	167.743	175.913	195.799	172.360	0.143	0.249	0.336	9.509	6.716	2.850	3.722	3.699	77.515	108.111	147.264	1.815	1.804	2.356

B. Individual Aneurysm Morphological Parameter Measurements by BAM

B.1 Center 1: Beth Israel Deaconess Medical Center, Harvard Medical School

Table S5. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	14.289	32.712	15.492	32.746	0.078	0.272	0.309	5.260	2.369	3.519	2.797	2.695	15.877	138.151	141.768	0.879	0.847	0.673

1	9.823	25.122	10.413	25.256	0.057	0.275	0.299	4.136	2.083	1.416	2.512	2.472	78.139	74.836	120.275	0.843	0.829	1.471
1	12.800	30.201	13.389	30.461	0.044	0.289	0.305	5.766	2.340	1.492	3.482	3.428	80.449	140.944	119.413	0.683	0.672	1.568
2	12.354	32.563	15.355	33.995	0.195	0.302	0.370	7.203	2.670	3.106	3.297	3.274	149.430	105.200	68.623	0.815	0.810	0.860
3	35.424	60.655	40.367	60.268	0.122	0.251	0.317	8.335	3.437	2.842	3.934	3.884	61.420	116.580	88.358	0.885	0.874	1.210
3	27.387	51.848	30.413	52.682	0.100	0.290	0.327	14.823	2.792	4.054	4.745	4.732	129.229	122.330	107.367	0.590	0.588	0.689
5	5.061	16.305	5.296	16.297	0.045	0.284	0.306	4.650	1.398	0.780	2.586	2.475	79.558	70.282	108.945	0.565	0.541	1.793
6	11.163	31.973	14.996	33.524	0.256	0.304	0.400	14.941	2.137	3.585	3.954	3.946	7.691	126.136	46.619	0.542	0.540	0.596
6	11.163	26.889	11.163	27.108	0.000	0.293	0.287	7.850	1.689	2.499	2.872	2.788	132.442	85.193	47.837	0.606	0.588	0.676
7	5.507	18.121	6.071	17.954	0.093	0.289	0.339	6.585	1.624	2.518	2.769	2.728	12.864	99.126	68.205	0.595	0.587	0.645
8	32.298	56.312	35.052	55.354	0.079	0.257	0.309	4.955	2.980	3.244	3.172	2.963	58.072	82.378	91.459	1.006	0.939	0.919
9	6.102	17.663	6.102	17.859	0.000	0.282	0.274	6.526	1.578	2.437	2.955	2.874	155.418	94.826	67.335	0.549	0.534	0.648
9	4.614	14.306	4.614	14.421	0.000	0.262	0.256	5.573	1.646	2.182	2.423	2.390	148.710	92.429	69.719	0.689	0.679	0.755
10	6.251	19.173	6.382	19.112	0.020	0.309	0.321	3.564	1.681	2.852	2.487	2.465	18.268	80.922	84.573	0.682	0.676	0.589
11	8.037	22.306	8.627	22.480	0.068	0.282	0.310	6.183	2.097	2.830	2.954	2.844	167.370	111.864	55.510	0.738	0.710	0.741
12	12.800	32.524	14.264	32.993	0.103	0.316	0.354	11.615	2.071	3.597	3.731	3.591	158.937	84.232	96.206	0.577	0.555	0.576
12	11.014	29.035	12.831	29.820	0.142	0.295	0.346	4.308	1.518	1.944	2.074	2.071	34.109	100.425	106.822	0.733	0.732	0.781
13	4.316	14.951	4.837	16.072	0.108	0.317	0.319	5.812	1.589	2.368	2.658	2.606	82.300	85.089	136.796	0.610	0.598	0.671
14	13.693	34.187	15.634	34.091	0.124	0.296	0.357	9.488	1.560	2.171	4.070	3.921	74.271	87.309	127.792	0.398	0.383	0.719
15	23.666	48.460	25.135	48.419	0.058	0.320	0.347	14.343	2.507	5.711	4.658	4.483	8.894	28.963	37.857	0.559	0.538	0.439
16	11.163	29.346	13.427	30.196	0.169	0.282	0.347	8.051	2.266	2.738	3.796	3.456	36.736	99.561	43.703	0.656	0.597	0.827
17	8.186	23.422	9.625	24.543	0.149	0.292	0.334	7.270	1.675	1.495	2.992	2.967	82.808	76.019	12.523	0.564	0.560	1.120
17	5.358	16.196	5.377	16.161	0.003	0.271	0.274	3.326	1.579	2.179	1.843	1.734	142.810	85.562	103.196	0.910	0.857	0.724
18	7.591	21.838	8.118	21.889	0.065	0.292	0.321	4.821	1.659	1.346	2.955	2.863	80.058	44.732	80.645	0.579	0.561	1.232
19	6.995	19.512	6.995	19.400	0.000	0.276	0.280	3.898	1.937	2.571	2.353	2.295	154.693	84.979	67.336	0.844	0.823	0.754
19	8.633	23.760	9.817	24.382	0.121	0.278	0.320	6.793	1.790	1.435	2.944	2.796	86.609	77.392	69.224	0.640	0.608	1.247
20	30.810	55.331	34.444	55.278	0.106	0.265	0.318	6.071	4.000	2.134	3.581	3.566	79.104	86.060	55.099	1.122	1.117	1.874
21	358.407	293.716	411.307	282.274	0.129	0.248	0.341	19.073	9.119	9.247	5.877	5.635	21.495	61.484	133.706	1.618	1.552	0.986
22	14.289	33.820	16.267	33.332	0.122	0.261	0.332	4.784	3.085	3.154	2.173	2.119	11.849	79.439	91.057	1.456	1.420	0.978

22	44.057	67.274	47.145	66.113	0.066	0.242	0.288	6.108	4.584	4.373	3.013	2.804	2.692	99.440	81.096	1.635	1.521	1.048
23	114.904	133.752	129.757	131.636	0.114	0.253	0.322	8.206	5.741	7.371	4.282	4.094	18.459	101.206	106.351	1.402	1.341	0.779
24	11.461	29.497	12.546	29.842	0.087	0.306	0.339	9.785	1.638	3.171	4.326	4.275	111.203	74.744	120.789	0.383	0.379	0.517
24	6.995	20.442	7.175	20.288	0.025	0.296	0.313	5.707	2.202	2.548	2.739	2.610	163.466	137.980	48.797	0.844	0.804	0.864
25	36.466	63.926	43.722	63.764	0.166	0.253	0.340	9.985	3.315	4.668	4.359	4.210	148.959	108.732	45.375	0.788	0.761	0.710
26	163.129	171.725	182.949	166.259	0.108	0.256	0.333	5.603	5.726	7.762	2.801	2.759	27.502	69.616	83.938	2.076	2.044	0.738
27	131.277	145.115	146.874	141.811	0.106	0.247	0.317	14.247	5.161	2.439	5.113	5.004	70.258	107.076	118.316	1.031	1.009	2.116
28	58.048	99.129	84.715	104.204	0.315	0.290	0.420	8.778	4.319	5.501	4.668	4.431	35.873	146.656	126.846	0.975	0.925	0.785
29	41.229	67.670	47.207	67.126	0.127	0.253	0.323	10.127	3.281	4.441	5.021	4.745	13.995	78.619	92.486	0.691	0.653	0.739
30	163.724	163.311	175.780	160.048	0.069	0.247	0.297	2.954	7.295	6.590	2.271	2.140	22.376	36.648	25.952	3.408	3.212	1.107
30	8.484	21.753	8.502	22.084	0.002	0.276	0.266	3.393	2.338	2.480	2.315	2.220	10.523	41.051	136.661	1.053	1.010	0.943
31	25.898	51.679	30.326	52.322	0.146	0.287	0.350	5.707	2.653	4.041	3.187	3.110	41.442	82.426	57.364	0.853	0.832	0.656
32	42.122	76.253	49.799	75.419	0.154	0.311	0.391	8.490	3.600	2.643	4.723	4.591	74.367	122.097	159.554	0.784	0.762	1.362
33	10.270	26.098	11.262	26.747	0.088	0.279	0.305	5.185	2.285	0.614	2.614	2.589	82.646	134.986	90.829	0.882	0.874	3.721
34	13.098	32.795	14.555	33.127	0.100	0.309	0.350	9.538	2.169	4.095	3.975	3.944	22.337	123.054	35.552	0.550	0.546	0.530
35	8.930	23.789	9.569	24.199	0.067	0.285	0.305	6.898	2.166	2.893	3.224	3.182	161.662	74.459	88.666	0.681	0.672	0.749
36	44.801	73.577	52.553	73.589	0.148	0.268	0.342	7.291	4.893	1.646	2.733	2.573	80.089	154.919	123.705	1.902	1.790	2.972
37	5.954	16.692	5.954	16.715	0.000	0.246	0.245	4.592	1.574	2.294	2.867	2.722	153.599	138.910	66.674	0.578	0.549	0.686
38	6.251	16.852	6.251	16.987	0.000	0.233	0.227	3.326	2.171	1.986	2.250	2.163	165.168	134.979	121.893	1.004	0.965	1.093
39	47.331	74.518	54.630	73.360	0.134	0.247	0.326	9.271	4.133	1.400	3.569	3.512	81.821	108.302	64.010	1.177	1.158	2.952
40	261.958	230.276	294.437	222.689	0.110	0.237	0.318	5.833	7.200	4.830	3.470	3.342	57.667	74.763	93.650	2.155	2.075	1.491
41	5.954	17.189	6.053	17.467	0.016	0.270	0.267	5.223	1.864	2.375	2.765	2.655	17.740	75.660	60.058	0.702	0.674	0.785
41	14.884	33.660	15.554	33.704	0.043	0.290	0.310	16.524	1.915	2.175	3.907	3.875	64.482	73.287	65.566	0.494	0.490	0.880
41	60.429	88.738	69.446	87.810	0.130	0.261	0.334	7.491	4.687	5.285	3.759	3.538	30.475	88.218	61.515	1.325	1.247	0.887
42	11.758	28.813	12.775	29.161	0.080	0.281	0.311	5.223	1.565	2.102	3.861	3.833	60.909	114.863	73.126	0.408	0.405	0.745
44	625.575	472.638	781.100	461.915	0.199	0.295	0.406	15.981	10.632	5.681	7.619	7.305	66.110	48.408	85.072	1.455	1.395	1.871
45	12.651	29.591	13.234	29.690	0.044	0.277	0.296	3.735	3.377	2.512	2.425	2.359	163.908	56.438	107.583	1.432	1.393	1.344
45	74.718	99.619	83.567	97.360	0.106	0.246	0.316	9.902	5.402	1.935	4.065	3.670	82.599	95.174	111.340	1.472	1.329	2.792

46	100.467	120.317	111.140	117.797	0.096	0.247	0.311	6.384	5.882	3.485	3.732	3.694	63.091	152.480	126.653	1.592	1.576	1.688
47	40.633	67.672	46.581	68.721	0.128	0.277	0.330	6.681	3.605	3.309	3.535	3.484	70.812	89.083	25.377	1.035	1.020	1.089
48	62.959	88.044	69.304	86.080	0.092	0.248	0.310	6.793	4.659	5.176	3.643	3.294	9.539	45.910	133.978	1.415	1.279	0.900
49	6.698	17.764	6.698	17.811	0.000	0.234	0.232	3.831	2.176	2.138	2.534	2.509	170.979	71.108	104.412	0.867	0.859	1.018
50	7.889	22.696	8.856	22.836	0.109	0.281	0.330	7.098	1.672	1.650	3.253	3.225	83.728	78.198	84.241	0.519	0.514	1.013
51	193.045	191.432	220.004	186.491	0.123	0.250	0.330	13.921	8.149	7.035	4.819	4.576	9.182	119.667	54.520	1.781	1.691	1.158

B.2 Center 3: Vienna General Hospital, Medical University of Vienna

Table S6. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	8.633	23.769	9.271	23.718	0.069	0.286	0.320	4.174	1.968	2.563	2.694	2.649	124.199	49.002	158.202	0.743	0.730	0.768
1	16.075	39.307	20.317	39.324	0.209	0.273	0.378	10.604	1.602	2.571	4.538	4.502	66.767	124.466	132.831	0.356	0.353	0.623
2	64.150	91.781	73.254	89.921	0.124	0.253	0.330	11.912	3.224	4.675	5.725	5.455	25.988	116.686	129.211	0.591	0.563	0.690
3	836.630	514.832	949.754	491.921	0.119	0.246	0.338	8.273	8.928	14.868	3.493	3.469	38.040	59.850	65.004	2.573	2.556	0.600

4	115.202	135.442	128.982	133.077	0.107	0.264	0.329	3.355	5.266	4.781	2.113	2.074	52.234	106.877	58.290	2.539	2.493	1.102
5	43.610	72.164	49.762	71.503	0.124	0.274	0.341	4.374	5.589	4.290	2.379	2.356	12.294	55.845	66.006	2.372	2.350	1.303
6	522.875	362.850	577.140	351.720	0.094	0.244	0.313	9.442	11.526	10.278	3.934	3.857	17.745	96.448	101.141	2.988	2.930	1.121
7	357.067	283.483	395.517	275.632	0.097	0.250	0.319	4.136	8.345	11.171	2.531	2.530	14.314	111.575	55.990	3.299	3.297	0.747
7	37.805	66.089	43.474	64.598	0.130	0.265	0.346	3.698	3.213	5.414	2.318	2.262	8.151	65.057	120.166	1.421	1.386	0.593
8	39.145	62.843	42.103	62.253	0.070	0.254	0.296	4.345	4.814	4.723	2.627	2.546	81.605	104.109	111.317	1.891	1.832	1.019
9	29.619	53.655	33.687	53.455	0.121	0.251	0.315	6.271	3.081	2.031	3.183	2.918	78.176	66.032	65.209	1.056	0.968	1.517
10	3893.952	1472.869	4421.844	1351.249	0.119	0.235	0.355	11.786	16.336	7.055	5.338	5.029	84.937	108.377	27.722	3.248	3.061	2.316
12	20.242	45.181	25.377	46.218	0.202	0.283	0.369	8.757	3.605	1.257	3.178	2.935	85.271	113.652	33.930	1.228	1.134	2.868
13	26.791	53.158	31.194	53.011	0.141	0.283	0.354	15.170	2.812	0.950	4.408	4.321	85.381	139.476	44.876	0.651	0.638	2.960
14	278.331	235.981	306.598	227.476	0.092	0.233	0.307	4.441	6.635	6.120	3.240	3.173	43.353	140.767	14.366	2.091	2.048	1.084
15	10.716	28.132	12.292	28.857	0.128	0.292	0.337	5.536	1.411	2.270	2.628	2.578	73.598	140.462	93.418	0.547	0.537	0.621
15	15.331	35.818	17.234	35.256	0.110	0.274	0.339	5.966	2.661	0.725	3.162	2.990	76.486	90.741	85.089	0.890	0.842	3.670
16	6.251	20.221	7.560	21.342	0.173	0.307	0.356	7.947	1.477	3.025	3.829	3.654	11.164	60.021	120.116	0.404	0.386	0.488
17	12.205	32.104	14.028	33.568	0.130	0.335	0.366	3.898	1.757	1.941	2.296	2.234	68.234	59.585	106.068	0.787	0.765	0.905
18	7.442	20.471	7.529	20.515	0.012	0.281	0.285	4.717	1.988	2.561	2.876	2.746	36.136	62.068	28.389	0.724	0.691	0.776
18	8.484	22.079	8.713	22.530	0.026	0.279	0.277	4.888	1.907	2.661	2.782	2.744	34.954	97.895	50.843	0.695	0.686	0.717
19	52.094	81.261	61.148	80.348	0.148	0.259	0.341	6.443	4.439	3.338	3.076	3.071	68.812	114.689	112.973	1.445	1.443	1.330
20	586.430	394.303	642.480	375.312	0.087	0.239	0.318	6.146	11.869	3.927	2.623	2.579	64.977	152.403	128.557	4.603	4.525	3.022
21	113.714	150.751	146.812	145.847	0.225	0.268	0.402	9.204	4.119	7.734	4.752	4.735	18.607	87.954	109.246	0.870	0.867	0.533
22	65.192	91.419	72.870	90.752	0.105	0.262	0.320	5.945	4.975	2.938	3.333	2.970	58.822	136.809	158.971	1.675	1.493	1.693
23	22.028	45.114	24.987	44.255	0.118	0.259	0.331	12.321	1.722	3.075	3.731	3.698	42.997	95.662	90.087	0.466	0.462	0.560
24	622.300	419.049	694.574	408.960	0.104	0.264	0.332	4.993	13.368	10.537	3.100	3.058	13.813	74.392	100.344	4.371	4.312	1.269
24	6.251	17.971	6.251	18.111	0.000	0.281	0.275	3.735	1.826	2.431	2.781	2.700	32.913	106.618	99.226	0.676	0.656	0.751
25	18.010	40.149	20.410	40.285	0.118	0.288	0.343	9.969	2.198	3.976	4.359	4.054	23.896	126.317	102.906	0.542	0.504	0.553
25	7.740	21.241	7.740	21.240	0.000	0.293	0.293	8.527	1.628	2.798	3.858	3.456	145.501	128.773	24.388	0.471	0.422	0.582
26	46.587	70.765	50.438	69.565	0.076	0.247	0.298	5.356	4.002	1.687	2.539	2.262	78.083	99.491	154.855	1.770	1.577	2.373
27	25.005	45.025	25.811	44.811	0.031	0.252	0.271	11.205	3.207	3.685	3.853	3.836	12.199	62.370	110.031	0.836	0.832	0.870

28	140.207	153.466	162.341	150.090	0.136	0.239	0.325	15.864	5.695	7.316	5.556	5.405	20.574	107.187	70.127	1.054	1.025	0.778
29	86.774	111.726	98.898	111.085	0.123	0.261	0.327	6.643	5.612	3.002	4.106	4.000	77.621	96.701	21.059	1.403	1.367	1.869
29	17.861	39.008	20.230	39.227	0.117	0.274	0.328	7.270	3.139	3.660	3.935	3.673	21.963	85.425	116.177	0.855	0.798	0.858
30	53.731	79.114	61.558	78.913	0.127	0.242	0.309	6.204	4.310	5.402	3.385	3.365	18.119	47.845	65.891	1.281	1.273	0.798
31	5.507	17.007	5.550	17.078	0.008	0.295	0.296	4.308	1.844	2.111	2.684	2.592	88.745	24.875	105.718	0.711	0.687	0.874
32	34.531	62.069	40.553	61.406	0.148	0.262	0.344	8.527	3.673	2.179	4.073	3.915	73.195	46.091	98.551	0.938	0.902	1.686
33	1364.416	696.923	1537.176	672.217	0.112	0.239	0.322	13.562	12.977	5.296	5.404	5.217	57.470	72.142	88.016	2.488	2.401	2.450
34	107.165	126.625	121.230	124.183	0.116	0.243	0.316	6.480	4.714	4.606	4.566	4.532	75.218	7.425	97.731	1.040	1.032	1.023
35	12.949	30.873	13.501	31.312	0.041	0.305	0.314	9.889	2.167	3.228	3.551	3.509	129.737	96.294	40.211	0.617	0.610	0.671
35	14.735	34.745	17.234	34.683	0.145	0.262	0.336	4.441	2.230	2.328	2.028	1.913	71.115	104.257	115.594	1.166	1.100	0.958
36	21.135	41.209	22.295	41.393	0.052	0.265	0.288	5.164	3.481	4.129	2.424	2.395	12.980	50.257	142.415	1.454	1.436	0.843
37	6.251	18.539	6.251	18.731	0.000	0.305	0.297	6.831	1.677	2.572	3.073	2.966	137.384	50.579	124.798	0.565	0.546	0.652
37	18.456	37.693	19.684	38.143	0.062	0.266	0.289	7.412	2.866	3.153	3.185	3.174	152.894	50.876	109.234	0.903	0.900	0.909
37	47.182	71.838	51.672	71.601	0.087	0.256	0.302	5.699	3.064	2.549	3.698	3.503	76.142	69.022	134.216	0.875	0.828	1.202
38	242.907	217.860	267.924	209.638	0.093	0.239	0.314	5.954	6.562	8.175	2.928	2.851	28.233	66.787	50.926	2.302	2.241	0.803
39	32.001	57.104	36.305	57.411	0.119	0.267	0.322	7.984	4.296	3.622	3.922	3.870	26.058	168.616	31.696	1.110	1.096	1.186
40	54.773	78.595	60.026	77.277	0.088	0.239	0.296	3.898	4.516	4.628	2.333	2.260	21.280	47.319	48.821	1.999	1.936	0.976
41	26.196	49.930	30.382	50.782	0.138	0.264	0.322	8.920	2.627	1.631	4.097	3.973	79.665	116.840	102.437	0.661	0.641	1.611
41	13.991	31.621	14.679	31.212	0.047	0.263	0.295	6.213	2.987	1.181	3.133	2.881	69.536	71.568	101.580	1.037	0.953	2.529
42	587.769	432.603	723.034	427.987	0.187	0.278	0.377	9.931	10.797	5.654	5.651	5.413	46.818	116.285	143.707	1.995	1.911	1.910
44	308.992	256.176	342.078	248.242	0.097	0.244	0.315	6.242	8.681	2.780	3.035	3.034	81.022	64.782	94.439	2.862	2.860	3.123
45	47.182	76.692	55.257	75.903	0.146	0.266	0.347	7.090	2.279	5.359	4.008	3.737	37.905	101.738	57.156	0.610	0.569	0.425
46	65.638	97.125	78.197	97.563	0.161	0.281	0.357	11.531	5.537	2.130	4.373	4.240	72.659	34.009	121.999	1.306	1.266	2.600
47	198.701	199.533	237.009	198.953	0.162	0.261	0.345	10.290	4.877	9.623	5.111	4.571	25.918	67.176	92.729	1.067	0.954	0.507
47	48.968	75.340	56.888	74.518	0.139	0.238	0.318	7.596	4.229	1.979	3.079	3.034	84.322	126.955	32.887	1.394	1.374	2.137
48	12.056	28.896	12.639	28.798	0.046	0.277	0.302	5.945	2.159	2.924	2.708	2.608	112.333	118.397	128.280	0.828	0.797	0.738
49	12.949	28.625	12.949	28.720	0.000	0.263	0.261	6.175	2.501	0.503	3.247	3.166	80.077	111.290	37.570	0.790	0.770	4.973
49	132.616	142.349	144.406	138.581	0.082	0.238	0.299	14.026	6.343	6.528	4.872	4.813	17.581	77.186	97.490	1.318	1.302	0.972

50	752.237	474.190	839.954	452.354	0.104	0.245	0.330	14.807	11.944	11.379	5.095	5.001	21.689	114.443	70.083	2.388	2.344	1.050
51	1252.637	713.831	1489.126	657.255	0.159	0.238	0.375	27.162	11.511	6.690	8.655	8.603	60.062	20.039	61.450	1.338	1.330	1.721
51	13.396	31.463	14.531	31.475	0.078	0.274	0.312	3.288	2.871	3.256	2.638	2.505	9.708	90.000	98.348	1.146	1.088	0.882
52	48.522	77.244	54.252	75.994	0.106	0.276	0.339	6.860	5.255	0.672	3.746	3.734	84.571	97.512	139.615	1.407	1.403	7.820
53	581.369	389.304	641.507	370.818	0.094	0.230	0.313	9.288	9.062	7.199	3.451	3.444	53.334	106.045	52.822	2.632	2.626	1.259
54	83.648	112.664	97.385	111.084	0.141	0.269	0.348	7.604	4.695	3.515	3.330	3.300	81.712	72.001	109.381	1.423	1.410	1.336
55	173.250	174.779	192.940	169.671	0.102	0.245	0.318	3.831	6.113	1.763	2.559	2.211	75.936	140.456	96.810	2.764	2.389	3.467
56	64.299	89.696	72.032	89.167	0.107	0.255	0.313	3.764	5.241	5.659	2.502	2.468	1.816	57.489	56.822	2.124	2.095	0.926
57	343.969	279.735	384.999	269.324	0.107	0.246	0.326	3.593	7.894	2.910	2.249	2.144	77.089	126.306	101.848	3.683	3.510	2.713
59	7.889	21.438	8.044	21.767	0.019	0.292	0.291	6.785	2.440	0.206	2.412	2.241	87.735	132.595	103.792	1.089	1.012	11.844
59	245.586	218.011	270.703	210.303	0.093	0.236	0.310	7.157	6.987	0.846	3.896	3.733	66.303	65.379	151.030	1.872	1.793	8.259
59	229.958	224.818	276.464	218.415	0.168	0.254	0.359	22.026	6.746	7.960	7.462	6.903	27.294	117.180	85.294	0.977	0.904	0.847
59	97.490	121.204	113.106	118.329	0.138	0.241	0.329	7.796	4.597	4.428	4.851	4.386	35.668	103.780	40.943	1.048	0.948	1.038
59	40.187	67.320	47.381	66.594	0.152	0.245	0.331	7.938	4.154	4.445	3.934	3.888	4.977	44.455	40.031	1.069	1.056	0.935
60	20.242	40.585	21.638	40.428	0.064	0.263	0.298	4.880	3.660	2.946	2.519	2.472	25.299	98.651	66.881	1.481	1.453	1.242
61	50.457	83.372	63.945	84.319	0.211	0.272	0.371	13.027	4.065	3.157	5.012	4.836	33.267	124.397	68.369	0.841	0.811	1.288
62	8.335	21.225	8.335	21.291	0.000	0.259	0.257	3.735	2.085	1.066	2.875	2.752	81.281	95.860	109.303	0.758	0.725	1.956
63	393.235	320.323	464.275	314.187	0.153	0.268	0.357	6.898	10.345	4.008	3.122	3.027	70.970	37.123	130.596	3.418	3.313	2.581
64	182.627	208.248	228.624	200.668	0.201	0.285	0.407	22.206	5.396	9.589	7.274	7.093	27.931	127.521	49.839	0.761	0.742	0.563
65	64.001	93.627	75.146	92.891	0.148	0.264	0.344	11.197	3.986	6.030	5.571	5.535	7.004	57.511	51.437	0.720	0.716	0.661
66	130.979	143.438	145.212	139.780	0.098	0.241	0.310	5.736	5.829	6.660	3.533	3.485	17.427	63.775	46.935	1.673	1.650	0.875
66	16.521	35.262	17.334	35.241	0.047	0.271	0.294	3.936	2.789	2.099	3.022	2.727	63.842	139.870	91.462	1.023	0.923	1.329
66	54.475	80.236	62.153	79.591	0.124	0.243	0.313	4.003	4.233	1.240	2.987	2.879	76.547	70.598	86.861	1.470	1.417	3.413
67	6.847	19.989	6.952	20.630	0.015	0.322	0.308	7.307	2.165	2.441	2.873	2.745	147.597	70.486	100.655	0.789	0.754	0.887
67	11.907	27.836	12.410	27.712	0.040	0.258	0.281	3.154	2.320	0.857	1.981	1.744	78.421	98.825	141.335	1.330	1.171	2.707
68	19.945	41.368	22.599	41.760	0.117	0.265	0.318	11.740	3.065	0.788	3.357	3.225	82.201	15.804	95.503	0.950	0.913	3.889
69	37.508	61.036	39.957	60.401	0.061	0.257	0.295	3.898	4.682	3.776	2.615	2.596	9.407	111.225	104.125	1.804	1.791	1.240
70	108.207	123.493	117.739	120.652	0.081	0.236	0.294	7.119	4.813	3.470	4.197	4.066	58.691	91.369	124.876	1.184	1.147	1.387

71	146.310	160.960	167.315	158.343	0.126	0.264	0.338	10.290	5.295	8.585	4.475	4.445	6.841	80.323	106.502	1.191	1.183	0.617
72	28.726	51.151	31.827	51.438	0.097	0.251	0.296	5.736	3.553	4.139	2.611	2.491	10.681	72.056	115.518	1.426	1.361	0.858
73	334.890	279.472	384.882	275.749	0.130	0.263	0.338	5.051	8.486	3.926	2.296	2.126	64.423	114.342	106.391	3.991	3.696	2.162
74	98.979	130.165	125.019	130.076	0.208	0.262	0.369	6.175	6.555	2.399	3.031	2.812	77.795	77.696	60.567	2.331	2.163	2.732
76	137.677	150.186	156.679	149.032	0.121	0.251	0.319	3.021	6.220	1.975	2.968	2.855	64.960	55.235	77.848	2.179	2.096	3.150
76	2.828	11.001	3.144	11.863	0.101	0.306	0.302	6.451	1.426	1.255	2.405	2.208	69.753	90.102	22.758	0.646	0.593	1.136
77	185.306	198.989	226.448	196.513	0.182	0.274	0.373	8.786	5.349	3.361	4.430	4.147	78.596	56.297	47.004	1.290	1.207	1.592
78	57.452	83.484	63.325	83.051	0.093	0.266	0.315	4.679	5.484	4.226	3.031	2.900	19.175	116.738	54.367	1.891	1.810	1.298
78	22.028	46.237	25.359	46.829	0.131	0.293	0.348	13.253	2.190	0.948	4.792	4.726	82.241	112.046	31.341	0.463	0.457	2.311
79	73.527	97.367	81.434	96.081	0.097	0.249	0.308	6.146	4.049	3.983	4.408	4.189	24.652	104.808	57.471	0.967	0.919	1.017
80	13.842	31.475	14.785	31.931	0.064	0.276	0.297	5.156	3.011	3.435	2.510	2.479	11.716	87.221	95.684	1.215	1.200	0.877
80	54.922	80.115	60.559	78.891	0.093	0.250	0.308	7.424	4.599	3.139	4.641	4.633	66.392	135.035	96.152	0.993	0.991	1.465
81	66.829	93.590	74.811	92.515	0.107	0.263	0.325	3.288	4.878	2.845	2.131	1.915	65.199	119.776	55.253	2.547	2.290	1.715
82	71.294	96.719	79.164	95.780	0.099	0.261	0.318	9.538	5.829	0.376	3.306	3.197	86.419	100.263	20.756	1.823	1.764	15.504
83	82.011	110.297	97.769	108.790	0.161	0.251	0.343	10.073	5.035	4.003	4.095	3.896	79.315	76.946	9.689	1.292	1.230	1.258
84	3.721	15.309	4.279	14.418	0.130	0.298	0.398	2.954	0.850	1.196	1.665	1.502	68.145	73.112	36.162	0.566	0.511	0.711
85	27.833	51.365	30.041	50.784	0.073	0.270	0.314	12.158	3.471	3.822	4.229	4.157	15.077	60.675	127.279	0.835	0.821	0.908
86	11.312	28.891	12.472	28.320	0.093	0.271	0.331	3.898	1.728	1.281	2.050	1.983	72.767	105.230	126.160	0.871	0.843	1.349
87	37.508	68.155	46.364	68.483	0.191	0.277	0.369	10.240	2.812	2.431	4.198	4.165	65.142	77.261	138.464	0.675	0.670	1.157
88	292.024	249.396	331.088	241.803	0.118	0.240	0.323	5.126	7.404	6.628	2.968	2.928	49.429	90.000	131.931	2.529	2.495	1.117
89	101.807	129.130	121.590	127.214	0.163	0.259	0.352	6.852	6.244	3.720	4.686	4.460	38.471	63.726	77.892	1.400	1.332	1.679
90	20.986	48.903	28.490	50.533	0.263	0.291	0.403	6.748	1.925	2.380	3.781	3.699	66.761	112.935	127.679	0.520	0.509	0.809
91	15.628	33.504	16.583	33.638	0.058	0.258	0.284	3.572	2.812	1.346	2.846	2.521	72.480	90.000	140.426	1.116	0.988	2.090
91	72.336	100.207	82.377	98.209	0.122	0.260	0.335	6.108	6.220	2.264	2.623	2.617	73.516	58.822	66.498	2.377	2.371	2.747
92	18.158	38.660	21.352	39.484	0.150	0.252	0.314	8.101	2.788	3.161	3.399	3.352	20.924	36.972	47.714	0.832	0.820	0.882
93	543.117	374.158	602.852	360.754	0.099	0.241	0.317	10.813	10.534	11.238	4.604	4.595	18.815	88.592	108.362	2.292	2.288	0.937
94	157.175	162.294	175.631	158.047	0.105	0.238	0.311	12.722	6.171	7.640	4.839	4.583	4.816	149.247	35.348	1.347	1.275	0.808
95	35.722	58.890	38.159	59.136	0.064	0.264	0.293	5.966	4.454	3.779	2.873	2.799	15.920	100.077	94.577	1.592	1.550	1.179

96	49.415	74.352	55.238	73.497	0.105	0.243	0.305	4.755	3.705	3.236	3.124	3.064	44.293	67.219	53.850	1.209	1.186	1.145
97	90.644	117.296	107.587	116.190	0.157	0.253	0.340	17.565	4.870	2.488	5.023	4.861	63.831	65.955	125.111	1.002	0.969	1.957
98	501.293	350.092	551.737	336.397	0.091	0.232	0.308	8.987	9.462	4.977	6.599	6.212	31.209	112.837	64.009	1.523	1.434	1.901
99	107.165	129.463	122.799	127.788	0.127	0.258	0.331	12.262	5.870	5.543	4.632	4.293	30.575	70.145	81.548	1.367	1.267	1.059
100	4.763	14.596	4.763	14.747	0.000	0.263	0.256	1.324	2.452	1.648	1.250	1.231	17.412	93.976	105.896	1.992	1.962	1.488
101	19.200	40.838	21.191	40.646	0.094	0.277	0.326	4.583	2.963	1.441	3.731	3.673	77.198	76.748	30.715	0.807	0.794	2.056
102	4.019	13.998	4.149	14.379	0.031	0.311	0.307	3.230	1.593	0.976	2.423	2.380	58.412	106.120	15.589	0.669	0.657	1.632
103	31.256	56.858	35.393	55.934	0.117	0.260	0.330	4.821	2.741	2.250	2.741	2.566	66.740	90.000	67.526	1.068	1.000	1.218
103	79.778	104.206	90.972	103.390	0.123	0.249	0.317	3.898	5.144	6.343	2.348	2.300	3.921	138.361	138.718	2.236	2.190	0.811
104	66.383	96.098	75.400	95.151	0.120	0.280	0.345	6.727	3.849	5.932	3.333	3.320	39.943	97.332	44.464	1.159	1.155	0.649
104	41.973	75.501	53.037	76.895	0.209	0.295	0.386	6.748	3.034	2.860	3.818	3.678	69.214	61.569	60.615	0.825	0.795	1.061
105	9.823	24.470	9.861	24.683	0.004	0.285	0.281	3.698	2.454	2.745	2.774	2.725	20.024	52.887	118.683	0.901	0.885	0.894
106	668.292	443.416	761.199	423.647	0.122	0.245	0.338	7.901	8.998	13.810	4.281	3.928	21.887	141.240	121.370	2.291	2.102	0.652
107	36.317	68.281	41.328	70.483	0.121	0.349	0.384	35.212	2.174	5.413	6.251	6.100	35.759	134.695	24.180	0.356	0.348	0.402
108	84.541	118.770	104.014	116.114	0.187	0.269	0.377	18.237	3.467	7.007	7.043	6.133	35.138	59.275	127.693	0.565	0.492	0.495
108	6.102	17.935	6.102	18.384	0.000	0.303	0.285	6.271	1.690	2.517	2.987	2.949	165.272	54.085	53.801	0.573	0.566	0.672
109	35.870	65.620	43.486	65.902	0.175	0.280	0.364	10.408	3.078	2.754	4.202	4.148	79.428	116.488	99.363	0.742	0.733	1.118
109	1131.631	601.678	1230.212	575.575	0.080	0.234	0.307	7.796	14.368	13.667	2.740	2.703	164.986	112.153	126.152	5.315	5.244	1.051
110	18.605	39.362	20.807	38.786	0.106	0.251	0.315	10.416	2.600	1.983	3.407	3.287	24.646	56.407	132.965	0.791	0.763	1.311
111	268.359	243.806	312.793	236.655	0.142	0.253	0.345	5.051	6.538	5.328	3.327	3.285	72.270	104.012	79.739	1.990	1.965	1.227
112	6.847	20.580	7.746	20.911	0.116	0.281	0.328	6.593	1.629	0.969	2.873	2.736	80.144	87.930	33.913	0.595	0.567	1.681
112	379.244	300.124	427.611	287.670	0.113	0.243	0.330	2.440	9.516	10.990	1.586	1.486	9.886	46.793	36.976	6.403	6.000	0.866
113	122.049	134.176	132.406	130.867	0.078	0.238	0.296	4.107	6.360	6.357	2.798	2.790	9.034	51.887	136.076	2.280	2.273	1.000
114	144.970	157.501	165.901	154.363	0.126	0.249	0.327	6.785	7.203	2.354	2.987	2.873	59.652	106.349	109.994	2.507	2.412	3.060
115	6.847	21.544	8.521	23.010	0.197	0.304	0.358	11.444	1.097	1.671	3.485	3.067	54.084	90.224	73.593	0.358	0.315	0.656
116	8.186	21.185	8.273	21.451	0.010	0.268	0.264	3.154	2.378	2.725	2.397	2.282	15.925	55.009	67.601	1.042	0.992	0.873
117	342.034	280.133	392.324	272.604	0.128	0.245	0.330	5.594	8.514	2.435	3.919	3.697	68.169	106.594	106.973	2.303	2.172	3.496
118	66.531	93.158	75.400	92.345	0.118	0.258	0.323	4.383	2.756	4.145	3.827	3.654	62.104	73.882	90.057	0.754	0.720	0.665

119	59.089	84.642	66.792	84.045	0.115	0.248	0.312	8.310	4.646	1.222	3.430	3.299	79.256	118.593	130.658	1.408	1.355	3.802
120	17.117	35.226	17.644	35.282	0.030	0.263	0.276	3.468	2.145	1.759	3.070	2.859	68.040	108.854	43.297	0.750	0.699	1.220
121	76.504	98.439	82.600	96.083	0.074	0.242	0.297	3.831	5.047	5.874	2.675	2.587	13.570	112.970	105.116	1.951	1.887	0.859
122	38.401	64.885	43.139	63.846	0.110	0.261	0.327	6.756	4.719	3.923	3.118	3.071	21.060	93.408	69.573	1.537	1.513	1.203

B.3 Center 4: Hospital Beneficência Portuguesa de São Paulo

Table S7. Individual aneurysm morphological parameter values extracted by physicians. P, patient. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	94.960	116.522	106.061	114.166	0.105	0.247	0.314	4.040	6.309	5.989	2.656	2.494	4.425	150.020	27.176	2.530	2.375	1.053
2	22.475	47.017	26.419	47.189	0.149	0.278	0.350	5.060	2.931	3.237	2.746	2.726	46.425	55.794	33.674	1.075	1.067	0.905
3	31.108	54.597	34.487	54.957	0.098	0.260	0.305	8.974	4.560	4.059	3.552	3.531	11.053	133.081	55.853	1.292	1.284	1.123
4	551.006	384.415	617.128	371.648	0.107	0.251	0.329	5.908	11.691	11.650	2.883	2.841	10.096	71.912	80.456	4.115	4.056	1.004

5	47.480	79.749	58.351	80.386	0.186	0.282	0.369	3.831	4.743	2.641	1.890	1.850	59.233	64.294	63.566	2.563	2.510	1.796
6	12.205	29.876	13.780	30.694	0.114	0.281	0.319	5.640	2.269	1.193	2.994	2.685	67.409	62.541	84.611	0.845	0.758	1.902
7	8.782	23.433	9.123	24.015	0.037	0.302	0.303	9.442	1.553	2.420	3.732	3.694	130.414	91.002	54.233	0.421	0.416	0.642
8	25.749	47.692	27.883	47.691	0.077	0.260	0.298	4.583	3.748	4.062	3.196	3.173	5.339	98.904	79.379	1.181	1.172	0.923
9	381.179	319.043	462.502	315.320	0.176	0.272	0.368	5.118	7.793	5.539	3.163	3.125	75.965	44.664	105.937	2.493	2.464	1.407
10	9.228	23.938	9.817	24.016	0.060	0.267	0.295	3.459	2.344	1.279	2.407	2.317	85.191	36.256	103.773	1.012	0.974	1.833
11	77.694	103.843	89.502	103.684	0.132	0.259	0.327	7.880	5.627	5.635	4.020	3.887	17.897	82.966	83.034	1.447	1.400	0.999
12	40.484	67.773	47.108	68.611	0.141	0.270	0.332	4.383	5.405	4.554	2.108	2.060	172.183	121.560	65.578	2.623	2.564	1.187
13	3.274	13.840	3.988	13.701	0.179	0.296	0.388	7.529	1.017	0.776	2.591	2.416	41.046	60.142	79.977	0.421	0.392	1.310
14	44.354	87.992	69.825	96.201	0.365	0.323	0.453	4.345	3.902	3.213	3.333	3.160	38.970	124.062	82.498	1.235	1.171	1.215
15	150.775	158.512	166.645	153.951	0.095	0.245	0.314	8.578	6.970	1.980	3.721	3.693	71.267	124.860	52.262	1.887	1.873	3.520
15	12.949	29.716	13.588	29.750	0.047	0.265	0.288	4.851	2.523	3.331	2.882	2.792	13.359	148.385	137.242	0.903	0.875	0.757
16	570.206	420.293	674.326	394.223	0.154	0.251	0.372	17.707	10.550	12.086	5.232	5.165	17.333	146.962	15.729	2.042	2.016	0.873
17	8.186	23.622	8.682	23.714	0.057	0.316	0.340	6.422	2.235	2.498	3.224	3.119	142.497	102.673	42.765	0.716	0.693	0.895
18	30.066	56.849	35.362	56.290	0.150	0.265	0.347	8.824	2.949	1.049	5.309	5.153	79.071	51.649	27.854	0.572	0.555	2.811
19	475.097	451.752	732.727	448.665	0.352	0.305	0.483	12.329	9.238	6.346	6.015	5.913	73.341	93.283	121.578	1.562	1.536	1.456
20	19.498	38.801	20.267	38.746	0.038	0.264	0.283	3.764	3.190	3.363	3.163	3.122	16.511	43.849	152.274	1.022	1.009	0.949
21	39.145	64.833	44.348	64.703	0.117	0.257	0.317	7.679	3.504	4.601	4.829	4.705	138.812	76.761	67.661	0.745	0.726	0.762
22	92.430	111.080	100.529	108.785	0.081	0.237	0.294	4.203	4.604	3.526	3.162	3.136	62.997	74.161	42.981	1.468	1.456	1.306
23	58.941	86.377	66.612	86.242	0.115	0.269	0.327	7.775	5.466	0.331	3.398	3.087	70.853	70.651	18.210	1.770	1.608	16.512
24	14.437	32.364	15.132	32.691	0.046	0.282	0.297	5.051	2.695	1.156	2.987	2.822	69.129	51.299	23.041	0.955	0.902	2.332
25	34.977	71.863	54.029	76.358	0.353	0.282	0.429	7.738	3.660	5.491	3.764	3.714	32.593	110.528	84.521	0.985	0.972	0.666
26	15.777	33.288	15.814	33.343	0.002	0.275	0.275	3.593	3.043	2.845	2.358	2.341	25.876	51.666	57.498	1.300	1.291	1.070
27	84.690	112.938	99.952	111.117	0.153	0.256	0.345	4.278	5.062	3.238	2.746	2.458	60.925	141.903	84.384	2.059	1.843	1.563
28	41.526	67.306	45.948	66.436	0.096	0.259	0.316	3.936	3.760	1.767	2.407	2.313	69.938	100.000	107.656	1.625	1.562	2.128
29	55.071	82.334	62.463	82.516	0.118	0.268	0.325	6.651	2.838	5.464	4.374	3.807	17.056	70.852	125.119	0.746	0.649	0.519
29	14.735	32.904	15.628	33.396	0.057	0.282	0.299	5.051	2.695	1.156	2.987	2.822	69.129	51.340	21.328	0.955	0.902	2.332
30	70.848	95.017	78.848	94.985	0.101	0.257	0.308	8.644	5.021	4.732	3.971	3.872	19.731	140.018	137.537	1.297	1.264	1.061

30	14.289	32.971	16.403	33.475	0.129	0.260	0.315	7.291	2.193	1.891	3.687	3.478	77.693	69.695	50.024	0.631	0.595	1.160

B.4 Center 5: Buffalo General Medical Center, University at Buffalo

Table S8. Individual aneurysm morphological parameter values extracted by physicians. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

P	V	SA	CH_V	CH_SA	UI	EI	NSI	N_SA	DH	DW	PAD	ND	AA	VA	FA	AR	SR	H-WR
1	68.913	98.979	80.287	98.330	0.142	0.274	0.348	8.711	5.514	5.970	3.473	3.421	12.371	99.579	91.861	1.612	1.588	0.924
2	8.633	22.918	8.689	23.093	0.006	0.298	0.295	8.565	1.573	2.907	3.507	3.461	143.865	92.921	67.097	0.455	0.448	0.541
2	3.274	16.635	4.242	14.621	0.228	0.312	0.491	4.888	1.533	1.998	2.182	2.119	12.593	148.416	19.343	0.724	0.703	0.767
3	3.572	12.567	3.721	12.947	0.040	0.288	0.286	3.326	1.543	1.923	1.943	1.905	152.299	147.815	14.152	0.810	0.794	0.802

4	8.335	25.096	10.146	25.714	0.178	0.300	0.371	7.947	0.906	2.176	3.602	3.355	61.215	83.816	34.808	0.270	0.251	0.416
5	15.777	36.402	18.090	36.545	0.128	0.276	0.337	8.222	2.216	1.394	3.831	3.604	82.796	72.188	10.728	0.615	0.579	1.590
5	12.651	30.653	13.482	31.134	0.062	0.302	0.320	7.575	2.127	2.996	3.829	3.667	105.584	100.991	35.121	0.580	0.556	0.710
6	171.017	168.933	186.298	163.732	0.082	0.235	0.300	3.192	7.000	7.649	2.178	2.129	88.025	80.739	97.777	3.288	3.214	0.915
7	45.992	71.819	50.389	70.809	0.087	0.261	0.314	4.383	4.649	1.086	2.799	2.767	79.505	60.371	48.230	1.680	1.661	4.281
8	9.377	25.815	10.065	25.444	0.068	0.297	0.339	6.555	1.573	3.517	3.603	3.271	21.807	74.883	110.216	0.481	0.437	0.447
9	94.811	114.604	105.546	113.644	0.102	0.246	0.304	19.206	5.267	1.875	5.638	5.199	82.151	127.421	66.180	1.013	0.934	2.809
10	4.912	18.304	5.755	17.522	0.147	0.297	0.394	5.745	1.000	1.501	2.745	2.639	76.222	80.728	54.622	0.379	0.364	0.666
11	13.991	30.712	14.177	30.802	0.013	0.270	0.274	6.271	2.701	2.803	2.548	2.545	157.444	123.364	140.545	1.061	1.060	0.964
12	23.070	49.579	28.850	49.445	0.200	0.270	0.373	16.294	2.443	2.130	4.393	4.374	72.064	49.825	29.718	0.559	0.556	1.147
13	9.526	28.063	11.535	27.585	0.174	0.290	0.385	7.441	1.658	1.417	3.331	3.198	82.223	63.874	141.630	0.518	0.498	1.170
14	4.019	13.268	4.019	13.412	0.000	0.277	0.269	5.745	0.969	2.011	2.746	2.705	103.041	87.635	164.223	0.358	0.353	0.482
15	93.174	157.767	201.381	188.338	0.537	0.300	0.500	41.960	3.110	7.024	8.325	8.098	50.088	113.524	65.033	0.384	0.374	0.443
15	59.238	87.002	67.282	85.657	0.120	0.259	0.330	13.391	4.619	2.239	4.566	4.484	83.945	14.126	95.319	1.030	1.012	2.063
16	14.735	32.797	16.546	34.250	0.109	0.272	0.297	6.422	3.511	2.713	2.884	2.630	9.425	65.514	115.758	1.335	1.217	1.294
17	15.926	39.451	18.475	39.586	0.138	0.322	0.384	9.747	1.669	2.090	4.266	4.196	81.887	46.003	68.226	0.398	0.391	0.799
18	18.605	43.862	23.597	44.269	0.212	0.287	0.386	10.002	1.562	3.499	4.198	4.146	81.083	90.000	139.704	0.377	0.372	0.447
20	4.763	14.775	4.763	14.900	0.000	0.271	0.265	4.516	1.200	2.009	2.422	2.289	53.368	109.007	152.295	0.524	0.495	0.597
21	28.726	54.693	32.143	54.020	0.106	0.282	0.342	5.803	2.641	3.646	4.195	4.145	65.978	59.298	139.618	0.637	0.629	0.724
22	9.675	25.448	10.196	25.487	0.051	0.292	0.315	6.547	1.792	3.330	3.138	3.098	17.326	36.893	46.542	0.578	0.571	0.538
23	8.930	24.369	9.805	24.803	0.089	0.291	0.322	6.643	1.731	2.954	3.700	3.628	26.631	41.038	14.407	0.477	0.468	0.586
24	7.889	21.781	7.932	22.284	0.005	0.315	0.302	8.260	1.525	2.777	3.224	3.193	139.497	90.800	128.443	0.478	0.473	0.549
25	427.617	364.557	556.482	345.975	0.232	0.249	0.402	15.221	7.809	7.537	6.709	6.628	62.685	85.698	45.857	1.178	1.164	1.036
26	6.400	19.098	6.741	19.665	0.051	0.303	0.307	4.479	1.526	2.425	2.642	2.483	86.531	124.379	136.832	0.615	0.577	0.629
27	9.526	28.003	11.752	28.565	0.189	0.305	0.384	7.270	2.247	2.664	3.639	3.430	80.778	129.431	71.826	0.655	0.618	0.844
28	14.289	36.575	18.531	37.790	0.229	0.289	0.382	6.622	2.205	1.647	3.464	3.437	78.249	55.565	82.073	0.642	0.637	1.339
29	2.381	11.336	2.989	11.541	0.203	0.310	0.396	4.679	0.751	1.151	1.857	1.761	58.990	110.708	39.882	0.427	0.404	0.653
30	12.949	34.016	15.064	33.860	0.140	0.309	0.378	9.108	1.629	2.345	4.188	3.750	80.181	127.477	53.794	0.434	0.389	0.695

31	18.605	48.799	27.926	53.396	0.334	0.338	0.448	15.241	1.562	5.463	5.876	5.812	81.260	107.664	45.671	0.269	0.266	0.286
32	16.968	35.342	17.464	35.281	0.028	0.268	0.283	3.735	2.931	3.102	2.985	2.916	158.528	33.088	167.843	1.005	0.982	0.945
33	16.670	37.922	18.754	38.591	0.111	0.298	0.340	9.309	2.750	3.757	4.486	4.166	153.809	122.028	84.050	0.660	0.613	0.732
34	39.591	66.707	45.601	66.115	0.132	0.259	0.332	14.331	2.888	3.521	5.231	4.639	16.985	71.463	61.549	0.623	0.552	0.820
35	1.340	6.527	1.340	7.178	0.000	0.350	0.285	4.784	0.614	1.572	2.455	2.404	46.960	38.504	23.286	0.255	0.250	0.391
36	16.819	38.589	17.743	38.785	0.052	0.327	0.347	15.500	1.641	3.811	4.539	4.377	122.558	44.440	107.230	0.375	0.362	0.431
37	34.977	63.524	41.173	63.191	0.150	0.276	0.354	10.357	2.890	2.449	4.268	4.057	64.154	135.437	94.979	0.713	0.677	1.180
38	6.847	20.010	7.008	19.918	0.023	0.294	0.308	4.278	1.694	0.462	2.154	2.149	88.875	134.506	55.543	0.789	0.787	3.668
39	36.466	65.685	43.641	66.527	0.164	0.285	0.357	7.746	4.162	1.593	3.800	3.749	80.816	47.851	104.488	1.110	1.095	2.613
40	9.675	23.743	9.792	23.940	0.012	0.266	0.266	4.851	2.301	2.560	2.839	2.736	25.160	89.071	63.911	0.841	0.810	0.899
41	47.331	75.344	52.578	74.692	0.100	0.279	0.333	5.975	4.201	4.945	3.840	3.836	6.821	43.542	41.331	1.095	1.094	0.850
42	30.661	56.084	34.760	54.925	0.118	0.256	0.330	4.203	3.091	2.684	3.037	2.920	65.846	34.536	105.699	1.059	1.017	1.151
42	8.335	21.931	8.521	22.296	0.022	0.282	0.281	3.698	2.385	2.142	2.695	2.445	148.475	131.660	127.900	0.975	0.885	1.113
44	108.653	158.997	172.251	163.571	0.369	0.274	0.450	43.890	3.891	6.573	7.273	6.765	37.372	75.299	91.351	0.575	0.535	0.592
46	123.240	141.756	143.252	138.932	0.140	0.244	0.329	14.585	6.670	6.224	5.489	5.256	11.428	72.704	104.758	1.269	1.215	1.072
47	133.658	146.587	148.784	143.902	0.102	0.251	0.315	4.508	5.748	7.075	2.874	2.833	22.887	116.434	52.344	2.029	2.000	0.812
49	29.619	57.400	36.001	58.405	0.177	0.283	0.360	7.307	3.506	3.533	2.873	2.829	121.828	83.855	123.741	1.239	1.221	0.992
49	5.209	16.617	5.737	17.027	0.092	0.278	0.306	5.774	2.084	2.515	2.862	2.811	1.472	126.724	125.964	0.742	0.728	0.829
50	123.091	145.582	145.212	143.758	0.152	0.262	0.348	12.789	5.299	7.386	7.568	7.536	7.196	83.676	91.833	0.703	0.700	0.717
51	410.352	321.253	477.336	313.910	0.140	0.253	0.340	22.829	10.684	10.035	6.894	6.515	10.281	122.660	67.621	1.640	1.550	1.065
51	1386.593	706.532	1533.920	669.409	0.096	0.237	0.324	8.034	13.212	14.659	3.727	3.516	26.964	45.069	22.376	3.757	3.545	0.901
53	1739.642	815.052	1923.714	776.060	0.096	0.235	0.319	13.119	15.466	15.923	5.645	5.536	19.563	93.831	69.284	2.794	2.740	0.971
54	293.810	262.372	346.028	249.560	0.151	0.242	0.353	8.176	7.592	10.107	3.730	3.645	1.810	92.998	85.194	2.083	2.035	0.751
54	615.900	410.662	692.881	389.866	0.111	0.229	0.323	11.460	10.336	11.420	5.558	5.531	11.557	110.688	58.559	1.869	1.860	0.905
56	42.122	70.290	49.278	69.391	0.145	0.257	0.339	8.557	3.946	4.541	4.572	4.449	16.081	92.038	74.589	0.887	0.863	0.869
57	148.542	168.027	180.251	165.519	0.176	0.260	0.359	6.689	4.860	5.136	3.507	3.431	63.810	80.765	39.152	1.417	1.386	0.946
58	68.764	107.066	85.347	100.169	0.194	0.257	0.398	10.550	4.285	4.403	5.161	4.619	51.733	90.534	86.469	0.928	0.830	0.973
59	56.410	84.639	64.479	83.456	0.125	0.260	0.333	4.583	5.083	4.757	2.782	2.697	169.654	137.372	37.016	1.885	1.827	1.069

59	30.661	59.238	36.150	58.089	0.152	0.278	0.365	2.716	2.983	4.713	2.178	2.061	17.679	107.482	89.805	1.448	1.370	0.633
60	70.104	94.067	77.372	92.371	0.094	0.246	0.306	4.107	4.873	5.885	2.578	2.428	86.340	96.790	99.551	2.007	1.890	0.828
61	17.563	39.179	19.864	39.576	0.116	0.289	0.338	9.434	2.742	4.084	4.127	4.123	20.335	61.287	44.902	0.665	0.664	0.671
61	20.689	41.827	23.021	41.895	0.101	0.259	0.308	8.377	2.674	0.966	4.099	3.851	79.932	130.153	112.059	0.694	0.652	2.768
62	34.233	62.387	39.827	61.828	0.140	0.276	0.351	6.823	3.688	1.062	3.809	3.540	84.168	49.534	120.083	1.042	0.968	3.472
63	85.881	116.098	104.783	114.294	0.180	0.254	0.356	17.364	3.895	7.100	5.981	5.951	17.364	121.914	40.981	0.655	0.651	0.549
64	72.634	103.581	85.422	102.768	0.150	0.276	0.355	3.021	4.244	2.558	2.093	2.018	65.813	90.000	26.964	2.103	2.027	1.659
64	11.610	31.076	14.047	31.196	0.174	0.284	0.367	8.051	1.593	0.501	3.602	3.357	79.421	62.817	120.900	0.474	0.442	3.180
65	69.508	97.278	80.262	95.897	0.134	0.255	0.333	4.984	4.198	5.872	3.048	2.934	4.852	18.855	16.729	1.431	1.378	0.715
66	215.967	253.085	311.423	256.008	0.307	0.311	0.454	6.309	7.807	8.299	3.092	2.838	44.339	97.356	107.625	2.751	2.525	0.941
67	98.681	125.463	118.222	125.796	0.165	0.265	0.347	7.842	6.884	1.842	3.160	3.068	74.804	120.463	46.669	2.244	2.179	3.737
68	30.512	55.662	35.275	55.600	0.135	0.257	0.327	6.622	3.588	4.002	3.595	3.580	13.031	67.777	60.863	1.002	0.998	0.897
68	10.419	25.120	10.419	25.237	0.000	0.274	0.271	3.526	2.345	0.964	2.155	2.048	79.687	131.842	45.930	1.145	1.088	2.433
69	25.005	48.367	28.428	47.684	0.120	0.250	0.321	8.632	2.198	2.782	4.188	4.165	42.464	136.323	101.781	0.528	0.525	0.790
70	42.717	68.289	47.468	68.476	0.100	0.265	0.313	5.193	3.773	4.794	3.857	3.549	24.453	71.892	99.133	1.063	0.978	0.787
71	148.245	173.587	184.915	165.887	0.198	0.249	0.381	13.236	5.753	3.807	7.007	6.488	78.046	125.253	147.426	0.887	0.821	1.511
72	125.621	142.902	141.429	138.590	0.112	0.248	0.326	11.970	5.607	2.060	4.331	4.105	83.602	42.067	59.378	1.366	1.295	2.722
73	12.651	29.411	13.253	29.293	0.045	0.266	0.291	2.373	2.574	3.154	1.724	1.688	148.411	80.239	130.284	1.525	1.493	0.816
75	19.498	42.304	22.270	42.128	0.124	0.279	0.343	7.596	2.530	4.051	4.481	4.452	17.399	20.927	8.238	0.568	0.565	0.624
76	200.339	194.405	227.334	189.685	0.119	0.246	0.324	8.385	6.615	3.080	3.501	3.381	73.711	68.071	58.320	1.957	1.890	2.148

C. Morphology metric acquisition by physician and BAM comparison for all centers combined

Table S9. Individual aneurysm morphological parameter values extracted by physicians. V, volume (mm^3); SA, surface area (mm^2); CH_V, convex hull volume (mm^3); CH_SA, convex hull surface area (mm^2), UI, undulating index; EI, ellipticity index; NSI, non-sphericity index; N_SA, neck surface area (mm^2); DH, dome height (mm); DW, dome width (mm); PAD, parent artery diameter (mm); ND, neck diameter (mm); AA, aneurysm inclination angle; VA, vessel angle; FA, flow angle; AR, aspect ratio; SR, size ratio; H-WR, height-width ratio.

Metric	test	stat	p_value_raw	Physicians' mean	Physicians' SD	BAM's mean	BAM's SD	Mean difference	Mean difference SD
CH_SA	wilcoxon_pratt	23940.00	0.04	99.63	129.36	94.72	123.68	-4.90	27.50
CH_V	wilcoxon_pratt	25095.00	0.17	124.08	293.08	116.66	290.36	-7.43	52.51
SA	wilcoxon_pratt	23922.00	0.04	102.22	137.46	96.90	130.90	-5.32	29.50
V	wilcoxon_pratt	27467.00	1.00	104.92	249.37	101.33	255.42	-3.59	44.72
EI	wilcoxon_pratt	26114.50	0.44	0.28	0.03	0.28	0.02	0.00	0.02
NSI	wilcoxon_pratt	25988.00	0.39	0.34	0.05	0.34	0.04	0.00	0.04
UI	wilcoxon_pratt	25110.50	0.18	0.13	0.08	0.12	0.07	-0.01	0.08
DH	wilcoxon_pratt	23701.00	0.03	3.82	2.60	3.89	2.56	0.07	1.13
DW	wilcoxon_pratt	25394.00	0.23	3.77	2.64	3.65	2.55	-0.12	1.90
N_SA	wilcoxon_pratt	26206.00	0.47	7.61	6.77	7.07	4.48	-0.54	6.85
ND	wilcoxon_pratt	25463.00	0.25	3.39	1.57	3.28	1.10	-0.10	1.41
PAD	wilcoxon_pratt	25484.00	0.25	3.52	1.61	3.40	1.14	-0.11	1.45
AA	wilcoxon_pratt	24100.50	0.05	65.33	41.36	61.36	42.83	-3.97	44.11
FA	paired_t	-1.44	0.15	86.92	37.42	83.05	37.90	-3.88	48.98
VA	paired_t	0.31	0.76	88.36	32.43	89.08	32.27	0.72	42.58
AR	wilcoxon_pratt	25291.50	0.21	1.20	0.84	1.26	0.85	0.07	0.80
H-WR	wilcoxon_pratt	24267.00	0.07	1.56	2.70	1.43	1.60	-0.13	2.94
SR	wilcoxon_pratt	25007.00	0.16	1.15	0.80	1.22	0.82	0.07	0.76

D. Bland–Altman plot comparing BAM-derived and physician-derived measurements

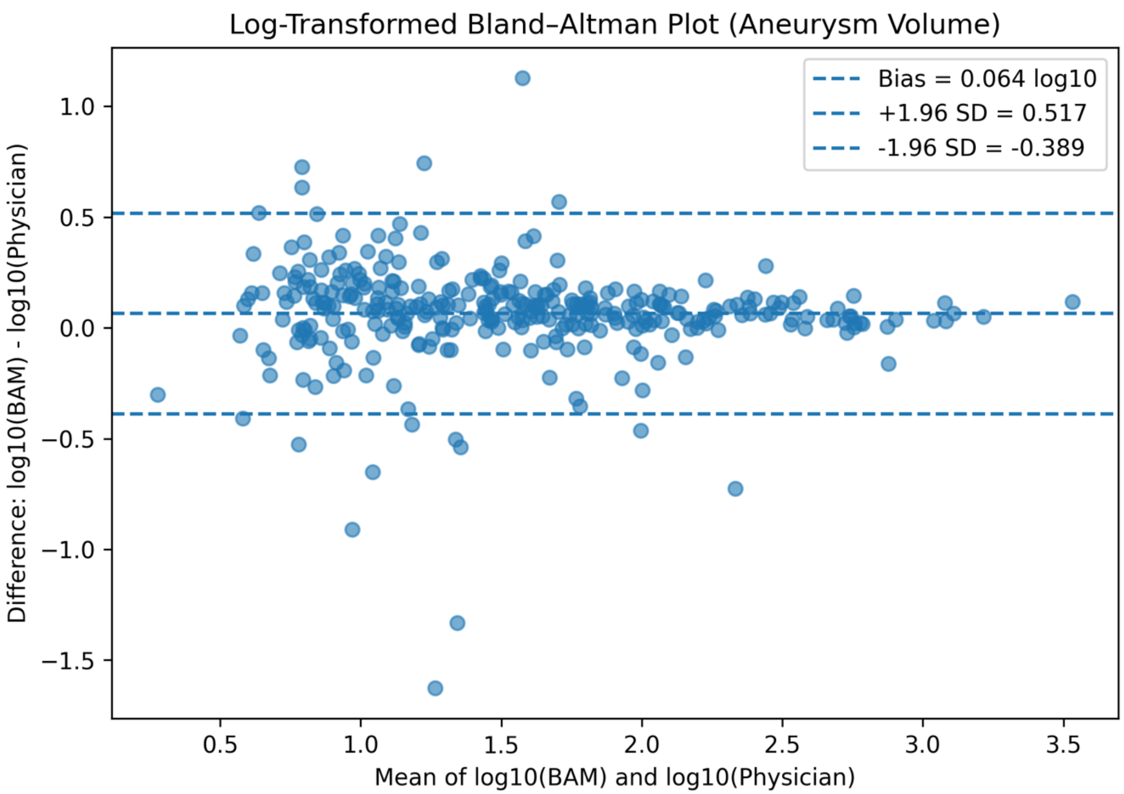

Figure S3. Bland–Altman plot comparing BAM-derived and physician-derived aneurysm volume measurements. The solid line represents the mean bias and dashed lines indicate the 95% limits of agreement.

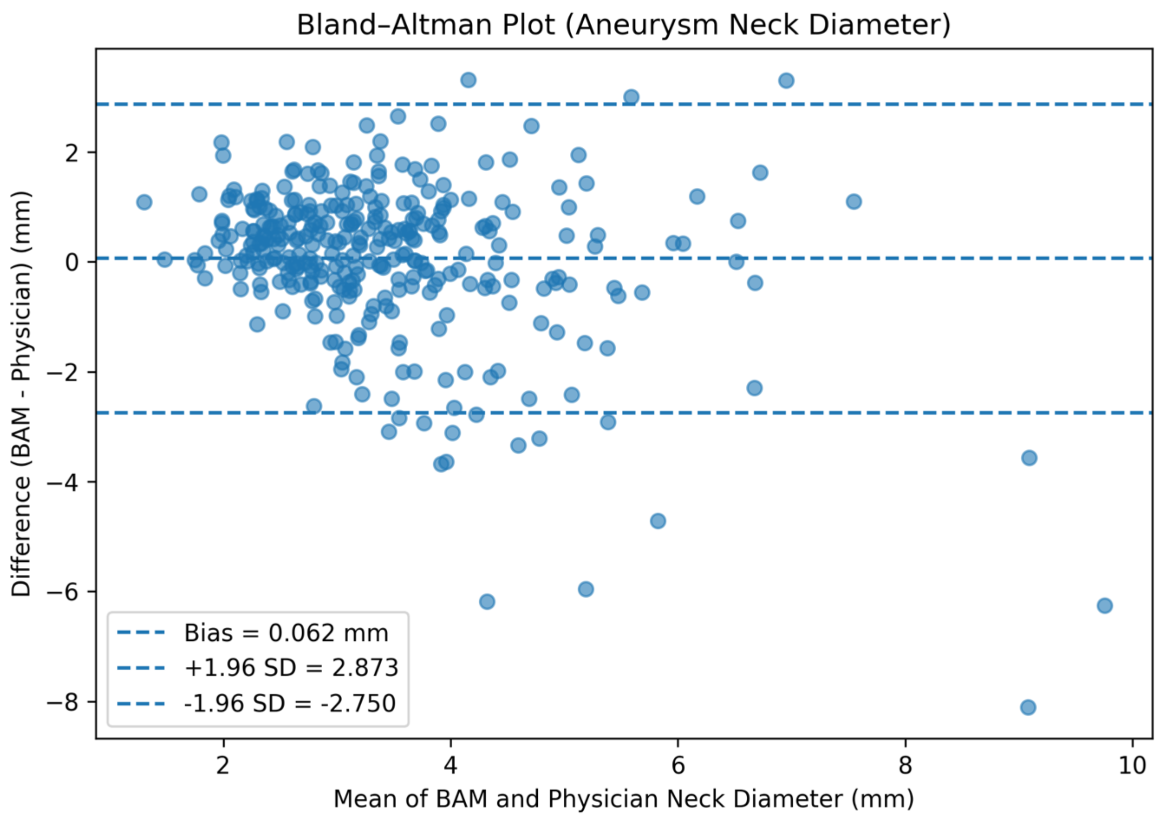

Figure S4. Bland–Altman plot comparing BAM-derived and physician-derived aneurysm neck diameter measurements. The solid line represents the mean bias and dashed lines indicate the 95% limits of agreement.

III. REFERENCES

21. Pan C, Chai X, Li XL, et al. A clinically applicable deep-learning model for detecting intracranial aneurysm in computed tomography angiography images. *Nat Commun*. Published online 2020. doi:10.1038/s41467-020-19527-w
22. Assadi H, Alabed S, Li R, Matthews G, Karunasaagarar K, Kasmai B. Development and validation of AI - derived segmentation of four - chamber cine cardiac magnetic resonance. *Eur Radiol Exp*. Published online 2024. doi:10.1186/s41747-024-00477-7
23. Pettersson SD, Koc NA, Skrzypkowska P, et al. Autonomous extraction of preoperative radiographic predictors on X-ray for cervical spine deformity following laminoplasty : a prospectively validated AI tool. 2025;(1):1-8. doi:10.5603/pjnns.105002