AANS/CNS Joint Cerebrovascular Annual Meeting
Los Angeles, California
February 15-16, 2016

Comparison Between CTA and Digital Subtraction Angiography in the Diagnosis of Ruptured Aneurysms

Lucas R Philipp BS; D. Jay McCracken MD; Courtney E. McCracken Ph.D.; Sameer H. Halani BA MS; Brendan P. Lovasik BA; Arsalaan Salehani; Jason H Boulter BS; C. Michael Cawley MD, FACS; Jonathan Andrew Grossberg MD; Daniel L. Barrow MD; Gustavo Pradilla MD
Emory University School of Medicine

EMORY UNIVERSITY

Learning Objectives

1) Describe the limitations of CTA in the diagnosis of ruptured aneurysms

2) Understand the importance of cerebral angiography in the diagnosis and treatment of ruptured aneurysms

Introduction

Computerized tomography angiography (CTA) is commonly used to diagnose ruptured cerebral aneurysms with sensitivities as high as 97-100%. Studies validating CTA accuracy in the setting of subarachnoid hemorrhage (SAH) are scarce and limited by small sample sizes. Our objective was to evaluate the diagnostic accuracy of CTA in detecting intracranial aneurysms in the setting of SAH.

Table 1: Patient Characteristics

Characteristic	N = 401
Age (years), mean ± sd	53.8 ± 13.7
Gender, N (%)	
Male	127 (31.7%)
Female	274 (68.3%)
Race, N (%)	
White	119 (29.7%)
Black	112 (27.9%)
Asian	12 (3.0%)
Other	5 (1.2%)
Unknown/Not reported	153 (38.2%)
Hunt and Hess Grade, median (25^{th} – 75^{th})	1 (1- 3)
Patients with detected aneurysms, N	271
Post Bleed Day, median (25^{th} – 75^{th}) (n = 400)	0 (0 – 1)
Day 0	265 (66.1%)
Day 1	72 (18.0%)
Day 2	20 (5.0%)
Day 3+	43 (10.7%)
Number of aneurysm detected, median (25^{th} – 75^{th})	1 (0 – 1)
CTA performed "In House", N (%)	344 (85.8%)
CTA from Outside Hospital, N (%)	57 (14.2%)

Methods

A single-center, retrospective cohort of 643 patients was reviewed. A total of 407 patients were identified whose diagnostic workup included both CTA and confirmatory diagnostic subtraction angiography (DSA). Aneurysms missed by CTA but diagnosed by DSA were further stratified by size and location.

Table 2: Size and location of aneurysms comparatively between DSA and CTA

Characteristic	DSA Positive (Gold Standard) (N = 431)	CTA Positive (True Positives) (N = 306)	CTA Negative (False Negatives) (N = 125)	P-value
Aneurysm Location				
Anterior Circulation	387 (89.8%)	274 (89.5%)	115 (90.4%)	0.862
Internal Cerebral (ICA)	49 (11.4%)	22 (7.2%)	27 (21.6%)	**< 0.001**
Petrous Carotid	1 (0.2%)	1 (0.3%)	0 (0%)	1.00
Cavernous Carotid	27 (6.3%)	7 (2.3%)	20 (16.0%)	**<0.001**
Supraclinoidal /ICA Terminus	21 (4.9%)	14 (4.6%)	7 (5.6%)	0.633
Anterior Communicating Artery (Acomm)	80 (18.6%)	75 (24.5%)	5 (4.0%)	**<0.001**
Posterior Communicating (Pcomm)	80 (18.6%)	60 (19.6%)	20 (16.0%)	0.388
Proximal MCA (M1)	37 (8.6%)	24 (7.8%)	13 (10.4%)	0.495
Distal MCA (M2)	37 (8.6%)	25 (8.2%)	12 (9.6%)	0.707
Anterior Choroidal (Achor)	27 (6.3%)	15 (4.9%)	12 (9.6%)	0.083
Ophthalmic	32 (7.4%)	18 (5.9%)	14 (11.2%)	0.094
Proximal Anterior Cerebral (A1)	15 (3.5%)	13 (4.3%)	2 (1.6%)	0.249
Distal Anterior Cerebral (A2)	9 (2.1%)	8 (2.6%)	1 (0.8%)	0.294
Pericallosal	9 (2.1%)	7 (2.3%)	2 (1.6%)	1.00
Superior Hypophyseal (SHA)	12 (2.8%)	7 (2.3%)	5 (4.0%)	0.346
Posterior Circulation	44 (10.2%)	32 (10.5%)	12 (9.6%)	0.862
Basilar Tip	17 (3.9%)	13 (4.3%)	4 (3.2%)	0.787
Posterior Inferior Cerebellar (PICA)	15 (3.5%)	9 (2.9%)	6 (4.8%)	0.390
Superior Cerebellar (SCA)	7 (1.6%)	6 (2.0%)	1 (0.8%)	0.679
Posterior Cerebral (PCA)	2 (0.5%)	2 (0.7%)	0 (0%)	1.00
Vertebral	1 (0.2%)	1 (0.3%)	0 (0%)	1.00
Anterior Inferior Cerebellar (AICA)	2 (0.5%)	1 (0.3%)	1 (0.8%)	0.501
Aneurysm Size (n = 421)				
Height (mm), median (25^{th} – 75^{th})	3.8 (2.5 – 6.1)	4.6 (3.3 – 6.8)	2.0 (1.5 – 3.0)	**< 0.0001**
Width (mm), median (25^{th} – 75^{th})	3.7 (2.6 – 5.4)	4.3 (3.2 – 6.0)	2.1 (1.5 – 2.8)	**<0.0001**
0 – 3 mm	126 (29.9%)	41 (13.5%)	85 (72.7%)	**< 0.001**
3.01 – 4.99 mm	119 (28.3%)	100 (32.9%)	19 (16.2%)	
5 – 10 mm	147 (34.9%)	136 (44.7%)	11 (9.4%)	
10.01 – 15 mm	22 (5.2%)	21 (6.9%)	1 (0.9%)	
>15 mm	7 (1.7%)	6 (2.0%)	1 (0.9%)	

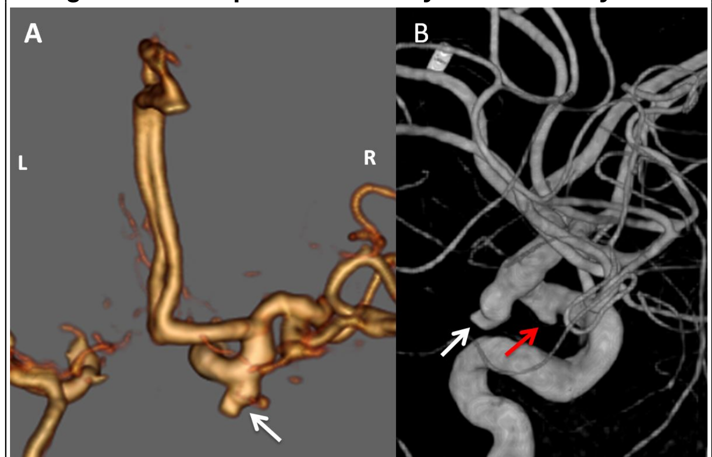
Table 3: 2x2 table showing the distribution of aneurysms picked up/missed by CTA and ultimately confirmed by angiogram.

		DSA		
		Negative	Positive	Total
CTA	Negative	125	125	250
	Positive	24	306	330
	Total	149	431	580

Results

306 aneurysms were detected by CTA while DSA detected a total of 433 aneurysms. False positive CTA results were seen for 24 aneurysms. DSA identified 127 aneurysms that were missed by CTA and 57.9% of those were determined to be <5mm. The sensitivity of CTA was 57.6% for aneurysms smaller than 5mm in size, and 45% for aneurysms originating from the ICA ($p<0.001$). The overall sensitivity of CTA in the setting of SAH was 70.7% ($p<0.001$).

Figure 1: Example of an aneurysm missed by CTA



A: CTA showing right PCoA aneurysm, without Achor aneurysm. B: 3D rotational angiography showing right PCoA and Achor aneurysms

Conclusions

The accuracy of CTA in the diagnosis of ruptured intracranial aneurysm may be lower than previously reported. CTA has a low sensitivity for aneurysms smaller than 5mm and in locations adjacent to bony structures and from small caliber parent vessels. It is our recommendation that CTA not be used alone in the diagnosis of ruptured intracranial aneurysms.

References

1. Menke J, Larsen J, Kallenberg K. Diagnosing cerebral aneurysms by computed tomographic angiography:Meta-analysis. Annals of Neurology. 2011;69(4):646-654.

2. Brisman JL, Song JK, Newell DW. Cerebral aneurysms. N Engl J Med. 2006;355(9):928-939.

3. Dammert S, Krings T, Moller-Hartmann W, et al. Detection of intracranial aneurysms with multislice CT: comparison with conventional angiography. Neuroradiology. 2004;46(6):427-434.

4. Pradilla G, Wicks RT, Hadelsberg U, et al. Accuracy of computed tomographyangiography in the diagnosis of intracranial aneurysms. World Neurosurg. 2013;80(6):845-852.

5. Molyneux A, Kerr R, Stratton I, et al. International Subarachnoid Aneurysm Trial(ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. Lancet. 2002;360(9342):1267-1274.