International Journal Dental and Medical Sciences Research
Volume 3, Issue 3, May - June 2021 pp 756-763 www.ijdmsrjournal.com ISSN: 2582-6018

# Diagnostic role of computed tomography angiography and digital subtraction angiography in cases of subarachnoid haemorrhage with ruptured intracranial aneurysms

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Submitted: 25-06-2021 Revised: 04-07-2021 Accepted: 07-07-2021

**ABSTRACT**
**Background:** Subarachnoid haemorrhage due to aneurysms is one of the most alarming and catastrophic conditions known to mankind. It causes significant morbidity and mortality and poses a formidable challenge both in its diagnosis and management. The purpose of our study is to compare diagnostic accuracy of CTA with DSA for the detection of intracranial aneurysms in patients of SAH admitted to our hospital under clinical symptoms and signs suggestive of harboring intracranial aneurysms.
**Material and methods:** The prospective study included 50 patients who were referred to the radiology department with history of generalized or localized severe headache, nausea/vomiting, vertigo, lethargy, altered sensorium etc were radiologically evaluated with both CTA and DSA.
**Results:** In our study, considering DSA as the gold standard modality, 46 aneurysms were detected in 42 patients. Forty four (95.65%) aneurysms were detected by both CTA and DSA, 2 (4.35%) aneurysms were detected only by DSA and 8 (100%) aneurysms were not detected either by CTA or DSA. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of CTA for detecting aneurysms were 95.65%, 100%, 100%, 80% and 96.30% respectively in our study.
**Conclusion:** In this study, we concluded that CTA has high sensitivity, specificity, PPV, NPV and diagnostic accuracy in detecting cerebral aneurysms. CTA can be used as an initial diagnostic modality to diagnose abnormalities of cerebral vasculature and amount of SAH alongside DSA which still remains the gold standard method in detecting cerebral aneurysms.
**Key words:** Aneurysm, CTA, DSA, SAH

## I. INTRODUCTION

Subarachnoid haemorrhage (SAH) due to aneurysms is one of the most alarming and catastrophic conditions known to mankind. It causes significant morbidity and mortality and poses a formidable challenge both in its diagnosis and management.[1]

Aneurysms of the cerebral vasculature are relatively common than the other vasculature. A recent systematic review collecting data from many countries reported a prevalence of 3.6% and 0.4% in prospective and retrospective autopsy studies, respectively, and 6.0% and 3.7% in prospective and retrospective angiographic studies, respectively.[2]

Multiple aneurysms are seen in about 30% of patients. Most of aneurysms are small and asymptomatic, but when an intracranial aneurysm ruptures, more often, it will bleed into the subarachnoid space, resulting in a SAH, less likely it may bleed into the brain parenchyma resulting in a parenchymal haemorrhage.[3]

There are currently three imaging modalities widely used in the diagnosis of intracranial aneurysms: Digital subtraction angiography (DSA), Computed tomography angiography (CTA) and Magnetic resonance angiography (MRA). CTA is a technique of vascular imaging which involves obtaining a normal Computed tomography (CT) scan while intravenous contrast material is injected. The contrast material is radio-opaque, so it appears white on the CT image. The serial axial slices enhanced with contrast are analyzed by a computer program that forms a three-dimensional (3D) reconstruction of the vascular anatomy. The resultant image is a dynamic model that can be rotated in order to view the image from multiple perspectives.[4]

Cranial CTA has been increasingly used during the last 10-15 years for the early diagnosis of ruptured intracranial aneurysms. CTA is more dependent on technical parameters used, than being patient-dependent. Total scanning time is less than a minute, so it is well-tolerated by most of the

International Journal Dental and Medical Sciences Research
Volume 3, Issue 3, May - June 2021 pp 756-763 www.ijdmsrjournal.com ISSN: 2582-6018

patients. CTA can be performed after the plain CT. Positive CTA results can guide the treatment procedure.[5]

DSA is the gold standard method for the assessment of intracranial aneurysms; however it is an invasive method, may be time consuming, operator dependent and carries a 4% complication risk.[6] The reported rate of negative angiography in SAH ranges from 10 to 20%.[7] The subtracted images may fail to depict some of the morphological features of the aneurysm, like the neck, vessels arising from the sac, mural calcifications or luminal thrombus.[8]

The purpose of our study is to compare diagnostic accuracy of CTA with DSA for the detection of intracranial aneurysms in patients of SAH admitted to our hospital under clinical symptoms and signs suggestive of harboring intracranial aneurysms such as generalized or localized severe headache, nausea/vomiting, vertigo, lethargy, altered sensorium etc.

## II. AIM AND OBJECTIVES

To find out sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of computed tomography angiography in cases of subarachnoid haemorrhage with ruptured intracranial aneurysms considering digital subtraction angiography as gold standard.

## III. MATERIAL AND METHODS

After clearance from the institutional ethics committee a total of 50 patients fulfilling the inclusion criteria were included in this prospective study spanning a period of 12 months. After giving full explanation regarding the study, patients (with a clinical diagnosis of spontaneous SAH with ruptured intracranial aneurysm) were asked to give written informed consent and subjected to a protocol that include the presence of a clinical indication for angiographic evaluation. Patients who underwent both CTA and DSA were included. CTA results were evaluated blindly and independently from those of DSA.

**CT ANGIOGRAPHY:** Once SAH was confirmed the CTA was performed on a 64-row detector Computed tomography (64 slice) scanner (Brilliance 64, Philips, Netherlands) with the following parameters; collimation, 64X0.625 mm; pitch, 0.891; rotation time, 0.75 sec; 120 kVp; 300 mAs, and with a slice thickness of 0.625 mm.

**DIGITAL SUBTRACTION ANGIOGRAPHY:** Digital subtraction angiographies were carried out on a Philips Allora Xper FD 10 unit by experienced endovascular surgeon. A selective four-vessels angiography via femoral artery catheterization was performed. Anteroposterior, lateral, oblique and if necessary additional views of each vessel were obtained by the manual injection of 8-10 ml nonionic contrast media. The field of view for cerebral angiography was 20 cm and the matrix size 1024×1024.

CTA results were compared with the results of DSA to determine the diagnostic role of CTA in cases of SAH detecting intracranial aneurysms. DSA findings were considered as the gold standard. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of CTA were calculated.

**STATISTICAL ANALYSIS:** Continuous variables were summarized as mean and standard deviation while nominal/categorical variables as proportions (%).

Unpaired t-Test was used for continuous variables where as Chi-Square test /Fisher exact test was used for nominal / categorical variables.

Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of CTA were calculated as per standard formulae.

P value < 0.05 was taken as significant.

Medcalc 16.4 version software was used for all statistical calculations.

## IV. OBSERVATION AND RESULTS

This study was carried out in the Department of Radiodiagnosis, Santokba Durlabhji Memorial Hospital, Jaipur, Rajasthan. A total of 50 patients were included in the study. The following observations were made during the study.

**Table 5.9: Distribution of aneurysms on CTA and DSA.**

| CTA | DSA | | | | Total | |
|---|---|---|---|---|---|---|
| | Negative | | Positive | | | |
| | No. | % | No. | % | No. | % |
| **Negative** | 8 | 100.00 | 2 | 4.35 | 10 | 18.52 |
| **Positive** | 0 | 0.00 | 44 | 95.65 | 44 | 81.48 |
| **Total** | 8 | 100.00 | 46 | 100.00 | 54 | 100.00 |

International Journal Dental and Medical Sciences Research
Volume 3, Issue 3, May - June 2021 pp 756-763 www.ijdmsrjournal.com ISSN: 2582-6018

| CTA | Percentage |
|---|---|
| **Sensitivity** | 95.65 |
| **Specificity** | 100.00 |
| **PPV** | 100.00 |
| **NPV** | 80.00 |
| **Accuracy** | 96.30 |

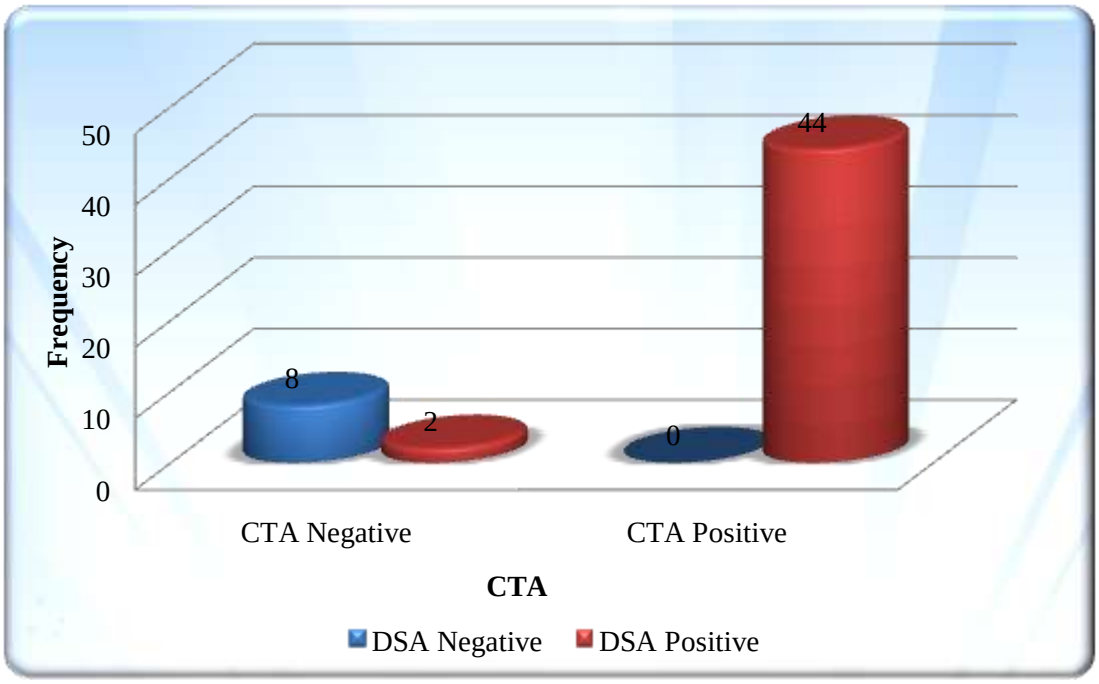


**Figure 5.9: Distribution of aneurysms on CTA and DSA.**

In our study, considering DSA as the gold standard modality, 46 aneurysms were detected in 42 patients. Forty four (95.65%) aneurysms were detected by both CTA and DSA, 2 (4.35%) aneurysms were detected only by DSA and 8 (100%) aneurysms were not detected either by CTA or DSA. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of CTA for detecting aneurysms were 95.65%, 100%, 100%, 80% and 96.30% respectively in our study.

**Table 5.6: Distribution of cases according to number of Aneurysms.**

| No. of Aneurysms | No. | Percentage (%) |
|---|---|---|
| **1** | 38 | 76.00 |
| **2** | 4 | 8.00 |
| **Nil** | 8 | 16.00 |
| **Total** | 50 | 100.00 |

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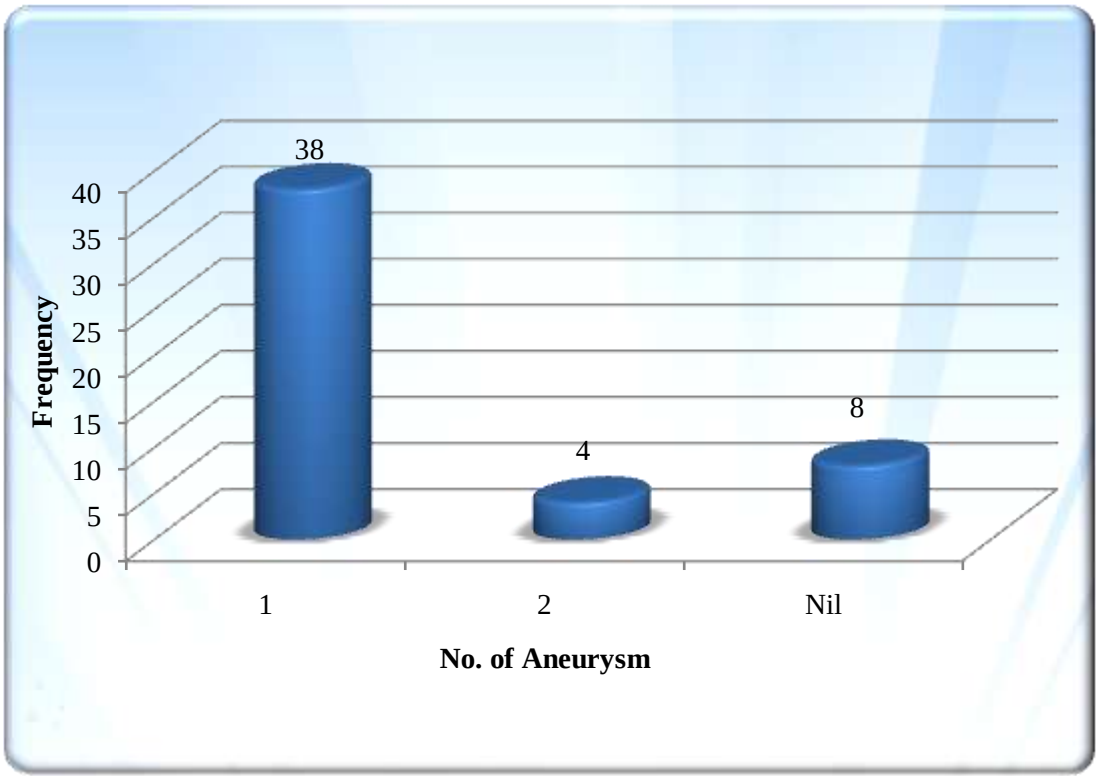


**Figure 5.6: Distribution of cases according to number of Aneurysms.**

In our study majority of the patients had single aneurysm constituting 76% of the cases, 4 patients (8%) had two aneurysms and 8 patients (16%) had no aneurysm. Out of 50 patients 42 had aneurysms, so the frequency of aneurysms was 84%.

## V. DISCUSSION

The ideal imaging modality for detection and characterization of an aneurysm should be noninvasive, easy to perform, reproducible, readily available and accompanied by minimal complications. It should also depict aneurysms with a high degree of accuracy.[9]

DSA has been considered as the standard reference method for detection of intracranial aneurysms. DSA has some advantages like large field of view, high spatial resolution and temporal imaging capabilities; yet it is time consuming, invasive, and operator-dependent tech technique. It also has temporary or permanent neurologic complication rates of 0.6% and 0.3% respectively.[10]

CTA is an easy to perform method, time saving and it is tolerated well by patients with acute SAH.[1] CTA has proven to be an effective imaging method for detection of aneurysms.[11] Immediately after the confirmation of SAH at CT, and in the absence of contraindications of contrast material, CTA can be performed, which provides a reliable early diagnosis when positive. If it is negative, the patient can undergo DSA for further investigation. Both CTA and DSA use ionizing radiation. The amount of radiation is lower in DSA.[12]

With this background, our study was conducted to evaluate cerebral aneurysms with CTA and its correlation with DSA in cases of subarachnoid haemorrhage.

In our study, majority of the patients belonged to the age group 40-60 years constituting about 56.00%. In this study, the mean age was 51.98 ±13.93 years; the youngest patient was 20 years of age and oldest was of 80 years. A similar study was conducted by Peker et al[7] having a similar mean age of 52 ±15.79 years.

In our study, out of the total 50 patients, 33 patients (66%) were male and 17 patients (34%) were female. Male to female ratio was 1.94 which is similar to a study conducted by Hasan et al[20] with 60% male and 40% female.

Severe headache and nausea/vomiting are usually the most common presenting symptoms of patients with SAH. In our study, a total of 48 (96%) patients had severe headache, 38 (76%) had nausea/vomiting as the presenting symptoms. In a similar study conducted by Petridis et al[54], severe headache was the main clinical feature in acute SAH.

In our study, 42 (84%) patients were positive for aneurysms and 8 patients were negative for aneurysms which was comparable to the studies done by Ergun et al[18], Teksam et al[14] and Ramjin et al[16] who found 32/37 (86.48%), 85/100 (85%) and 88/108 (81%) patients positive for aneurysms respectively. Approximately 80% SAH are caused by ruptured intracranial aneurysms according to previous literature and similar results were observed in our study.[13]

Majority of the patients in this study with SAH had single aneurysm constituting 76% of the cases, 4 patients (8%) had two aneurysms and 8 patients (16%) had no aneurysm. In the study done by Peker A et al[7] single aneurysm was found in 36 patients (72%), 2 aneurysms in 13 patients (26%) and 5 aneurysms were documented in 1 patient (2%). In our study detection of multiple aneurysms was less, probably due to small sample size and sampling bias.

In our study, considering DSA as the gold standard imaging modality, 46 aneurysms were detected in 42 patients. Forty four (95.65%) aneurysms were detected by both CTA and DSA, 2 (4.35%) were detected only by DSA but not by CTA, and 8 (100%) were not detected either by CTA or DSA. Two aneurysms which were not detected by CTA were present in Right PCom and Right PICA, probably due to close proximity with the bone. For detecting aneurysms by CTA sensitivity, specificity, PPV, NPV and diagnostic accuracy were 95.65%, 100%, 100%, 80% and 96.30% respectively.

**Table 6.1: Comparison of Sensitivity, Specificity, PPV and NPV of CTA to detect aneurysms in current study and other studies.**

| Study | Year | Sensitivity % | Specificity % | PPV% | NPV% |
|---|---|---|---|---|---|
| Karamessini et al[10] | 2004 | 87.8 | 98 | 97.7 | 89.1 |
| Romjin et al[16] | 2008 | 99 | 90 | 98 | 95 |
| Prestigiacomo et al[17] | 2010 | 99.6 | 100 | 100 | 92.6 |
| Ergun et al[18] | 2011 | 92.8 | 83.3 | 71.4 | 91.2 |
| MacKinnon et al[19] | 2013 | 95.2 | 97.2 | 98.1 | 93.2 |
| Current study | 2019 | 95.65 | 100 | 100 | 80 |

As shown in the above table, the sensitivity of CTA to detect aneurysms was 95.65% in current study which was comparable to the studies done by MacKinnon et al[19] (95.2%) and Ergun et al[18] (92.8%). It was less than that of Romjin et al[14] (99%) and Prestigiacomo et al[17] (99.6%) while higher than the study done by Karamessini et al[10] (87.8%).

The specificity of CTA in current study was 100% which was comparable to the studies conducted by Prestigiacomo et al[17] (100%), Karamessini et al[10] (98%) and MacKinnon et al[19] (97.2%). It was higher than that of Romjin et al[4] (90%) and Ergun et al[18] (83.3%).

## VI. CONCLUSION:

Computed tomography angiography is invaluable in evaluating patients with subarachnoid haemorrhage. It is non-invasive, fast and easy to perform even in non-cooperative patients. It is possible to perform CTA immediately after a non-enhanced cranial CT. Hence, the elapsed time between the patient's arrival and achieving a diagnosis has been decreased by CTA, which is of crucial importance in the patient population with SAH which requires urgent treatment.

In this study, we concluded that CTA has high sensitivity, specificity, PPV, NPV and diagnostic accuracy in detecting cerebral aneurysms. CTA can be used as an initial diagnostic modality to diagnose abnormalities of cerebral vasculature and amount of SAH alongside DSA which still remains the gold standard method in detecting cerebral aneurysms.

## REFERENCES

[1]. Locksley HB. Natural history of subarachnoid hemorrhage, intracranial aneurysms and arteriovenous malformations. Based on 6368 cases in the cooperative study. J Neurosurg. 1966;25:219-39.
[2]. Rinkel GJ, Djibuti M, Algra A, van Gijn J. Prevalence and risk of rupture of intracranial aneurysms: a systematic review. Stroke. 1998;29:251-6.
[3]. Wardlaw JM, White PM. The detection and management of unruptured intracranial aneurysms. Brain. 2000;123:205-21.
[4]. Keedy A. An overview of intracranial aneurysms. Mcgill J Med. 2006;9:141-6.
[5]. Peker A, Peker E, Akmangit I, Erden I. Comparison of 64 detector cranial

Computed tomography angiography with intra-arterial Digital subtraction angiography for detection of intracranial aneurysms. Eur J Gen Med. 2014;11:136-40.

[6]. White PM, Teasdale EM, Wardlaw JM, Easton V. Intracranial aneurysms: CT Angiography and MR angiography for detection-prospective blinded comparison in a large patient cohort. Radiology. 2001;219:739-49.

[7]. Hankey GJ, Warlow CP, Sellar RJ. Cerebral angiographic risk in mild cerebrovascular disease. Stroke. 1990;21:209-22.

[8]. Karamessini MT, Kagadis GC, Petsas T,, Karnabatidis D, Konstantinou D, Sakellaropoulos GC et al. CT angiography with three-dimensional techniques for the early diagnosis of intracranial aneurysms. Comparison with intra-arterial DSA and the surgical findings. Eur J Radiol. 2004;49:212-23.

[9]. Yoon DY, Choi CS, Kim KH, Cho BM. Multidetector-Row Computed tomography Angiography of Cerebral Vasospasm after Aneurysmal Subarachnoid Hemorrhage: Comparison of Volume-Rendered Images and Digital Subtraction Angiography. Am J Neuroradiol. 2006;27:370-7.

[10]. Wiebers DO, Whisnant JP, Meissner I, Brown RD Jr, Piepgras DG, Forbes GS et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 2003;362:103-10.

[11]. van Gijn J, van Dongen KJ. Computed tomography in the diagnosis of subarachnoid haemorrhage and ruptured aneurysm. Clin Neurol Neurosurg. 1980;82:11-24.

[12]. Boesiger BM, Shiber JR. Subarachnoid hemorrhage diagnosis by computed tomography and lumbar puncture: are fifth generation CT scanners better at identifying subarachnoid hemorrhage? J Emerg Med. 2005; 29:23–7.

[13]. Osborn AG, Hedlund GL. Arterial anatomy and strokes. In: Concannon KE, editors. Osborn's Brain. 2nd ed. Philadelphia: Elsevier Publishing; 2018. p197-252.

[14]. Azhar IS, Aghaei HN, Ghanaati H, Firouznia K, Zandi S. The Diagnostic Value of CT Angiography in the Diagnosis of Residual Aneurysm After Brain Aneurysm Surgery. Iran J Radiol. 2018;15:15843.

[15]. Petridis AK, Kamp MA, Cornelius JF, Beez T, Beseoglu K, Turowski B et al. Aneurysmal Subarachnoid Hemorrhage Diagnosis and Treatment. Dtsch Arztebl Int. 2017;114: 226–36.

[16]. Romijn M, Sprengers ME, Venema HW, van Walderveen MA, Majoie CB, Heeten GJ et al. Diagnostic Accuracy of CT Angiography with Matched Mask Bone Elimination for Detection of Intracranial Aneurysms: Comparison with Digital Subtraction Angiography and 3D Rotational Angiography. Am J Neuroradiol. 2008;29:134-9.

[17]. Prestigiacomo CJ, Sabit A, He W, Jethwa P, Gandhi C, Russin J. Three dimensional CT angiography versus digital subtraction angiography in the detection of intracranial aneurysms in subarachnoid hemorrhage. J Neurointerv Surg. 2010;2:385-9.

[18]. Ergun E, Haberal M, Koşar P, Yılmaz A, Koşar U. Diagnostic Value of 64-slice CTA in Detection of Intracranial Aneurysm in Patients with subarachnoid haemorrhage and Comparison of the CTA results with 2D-DSA and Intraoperative Findings. Balkan J Med. 2011;28:26-32.

[19]. MacKinnon AD, Clifton AG, Rich PM. Acute subarachnoid haemorrhage: Is a negative CT angiogram enough? Clin Radiol. 2013;68:232-8.

[20]. Hasan MN, Hoque MA, Rahman KM, Masum AA, Khandaker MN and Alim MA. Distribution and Morphological Pattern of Intracranial Aneurysm in Patient with Subarachnoid Haemorrhage in a Tertiary Care Hospital of Bangladesh. Chronic Dis Int. 2017;4:1027.

**LIST OF ABBREVIATIONS**

| | | |
|---|---|---|
| SAH | : | Subarachnoid haemorrhage |
| CTA | : | Computed tomography angiography |
| DSA | : | Digital subtraction angiography |
| MRA | : | Magnetic resonance angiography |
| CT | : | Computed tomography |
| 3D | : | 3 Dimensional |
| MIP | : | Maximum intensity projection |
| SSD | : | Surface shaded display |

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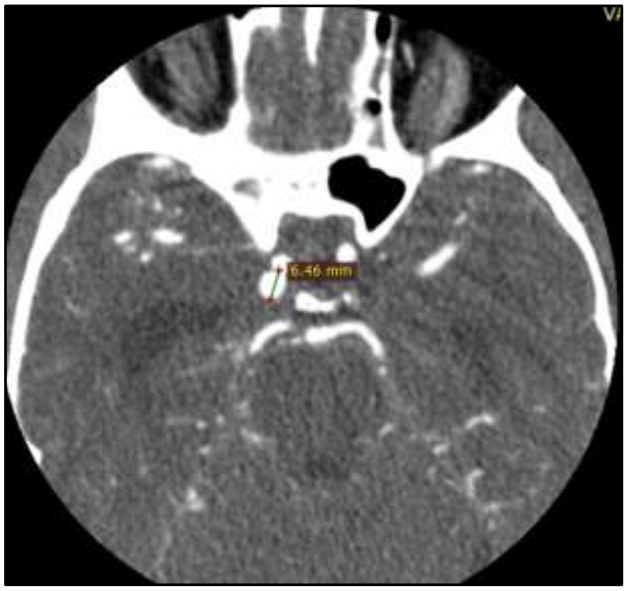
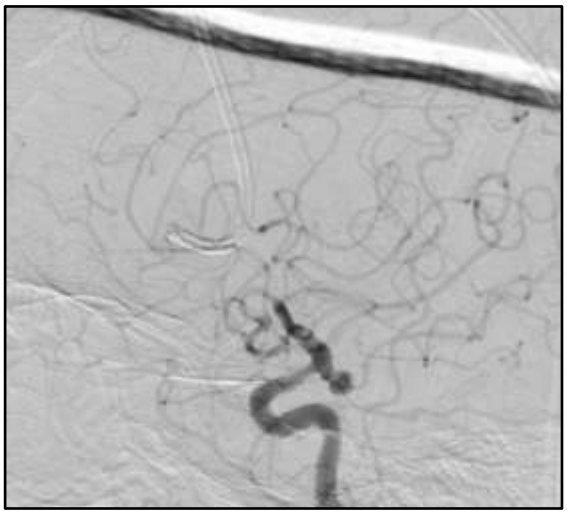
| | | |
|---|---|---|
| PPV | : | Positive predictive value |
| NPV | : | Negative predictive value |

**ILLUSTRATIONS**




**(A)**



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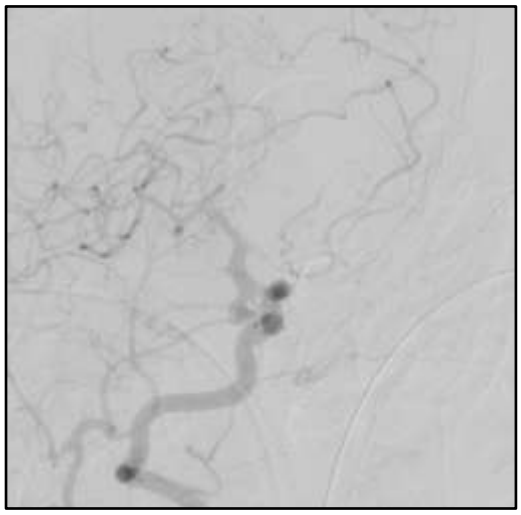

**(B)**

**Figure 1: (A) CTA axial image showing a right ICA aneurysm, (B) DSA image showing right PCom aneurysm which was missed on CTA, (C) DSA image showing right ICA aneurysm which was detected by CTA (shown in image A).**

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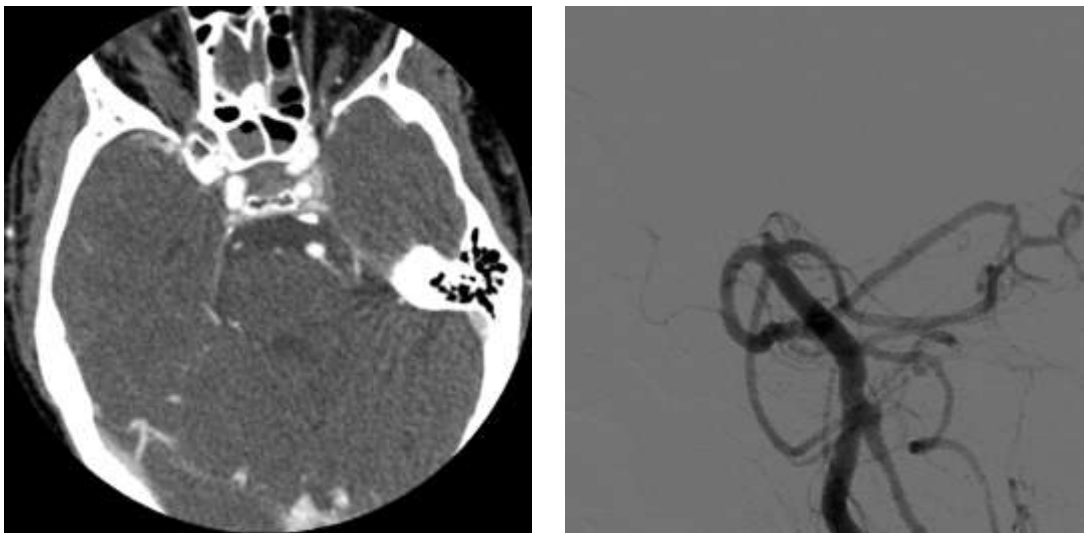

**(A)** **(B)**

**Figure 9: (A) and (B) CTA and DSA mages showing small saccular basilar top aneurysm.**