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Comparison of the Role of CT Angiography and DSA in Detecting Aneurysms in Cases with Spontaneous Subarachnoid Hemorrhage

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Abstract

Background and Purpose: Subarachnoid hemorrhage (SAH) due to rupture of aneurysms is one of the most alarming and catastrophic condition as it can cause significant morbidity and mortality and poses a formidable challenge both in its diagnosis and management. The present study is to compare the role of computed tomography (CT) angiography in detecting ruptured aneurysm with spontaneous SAH and the role of digital subtraction angiography (DSA).

Materials and Methods: During the period of 5 years from September 2012 to August 2017, patients presented with spontaneous SAH were studied. These patients underwent both 3 D - computerized tomography angiography (CTA) and 4 - vessel cerebral DSA. CTA and DSA findings were evaluated and compared in terms of the existence of aneurysm, size, shape, number, location, and major vessel branching.

Results: Total 32 cases only 17 cases were positive with 19 aneurysms, 2 patients having 2 aneurysms each and 15 were negative. CTA has sensitivity of 89% in imaging aneurysms and in 86% of negative CTA cases DSA also negative for delineating aneurysm.

Conclusion: CTA is a good procedure with a sensitivity of 89% in the detection and delineation of cerebral aneurysms. Owing to the lower specificity of CTA in some cases, DSA remains the gold standard in evaluating patients with cerebral aneurysms. In complex aneurysms, DSA supplements CTA images in planning their management.

Key words: Computerized tomography angiography, Digital subtraction angiography, Intracranial aneurysms, Subarachnoid hemorrhage

INTRODUCTION

Subarachnoid hemorrhage (SAH) due to rupture of aneurysms is one of the most alarming and catastrophic conditions as it can cause significant morbidity and mortality and poses a formidable challenge both in its diagnosis and management. The earliest reference about SAH was found in Avicenna's records (980–1037 AD) where he describes "apoplexy due to sanguineous tumor effusing suddenly about the ventricles." Morgagni (1682–1771) gave the first description of aneurysm as the cause of SAH. The incidence of SAH is reportedly 6–10.9/100,000.[1,2] In India, though initially reported low, the numbers have been increasing steadily.

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An autopsy series found 21% of SAH due to aneurysms in the cerebral vasculature. While the clinical entity of SAH was known, its cause remained an enigma for long as diagnostic methods were not available. Quincke ushered in a new era in the diagnosis of SAH with his lumbar puncture procedure in 1891. Egaz Moniz in 1927 developed the technique of cerebral angiography. In 1933, he demonstrated an aneurysm in a living patient. This anatomical localization of the cause of SAH by

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angiography helped to move the treatment of SAH from medical to the surgical mode and presently the evolving field of endovascular therapy. The 20th century saw the evolution of newer imaging modalities, namely, computerised tomography (CT), magnetic resonance imaging, and digital subtraction angiography (DSA). This study attempts to compare the use of CT angiography (CTA) in the diagnosis of cerebral aneurysms with DSA in CTA negative cases.

Significant morbidity and mortality occur due to the first bleeding or repetitive bleeding.[3,4] For this reason, fast and accurate evaluation of the patients is of great importance in planning the therapeutic interventions. CTA is a faster and a more easily applied method as compared to DSA. Another advantage of CTA is its applicability following routine non-enhanced cranial CT in patients with suspected SAH in emergency conditions. DSA is invasive, time-consuming and expensive.[5] In this study, we aimed to compare the effectiveness of CTA to DSA in diagnosis and evaluation of intracranial aneurysms in cases with spontaneous SAH. The presence of an aneurysm, its location, number, size, shape, and orientation were studied in both the imaging modalities.

MATERIALS AND METHODS

During the period of September 2012–August 2017, 32 patients admitted with spontaneous SAH in King George Hospital, Andhra Medical College, Visakhapatnam underwent 3 D - CTA and 4 - vessel cerebral DSA in CTA negative and doubtful cases. These patients reported with spontaneous SAH and had a high index of suspicion of harboring an aneurysm. All the patients were assessed clinically based on the Glasgow coma scale (GCS) and the World Federation of Neurosurgical Societies (WFNS) scale at the time of admission. Out of 32 patients 4 patients presented with GCS score of 15 WFNS Grade 1, 2 patients presented with GCS 14 with no motor deficit WFNS Grade 2, 22 patients presented with GCS 13 or 14 with focal deficits WFNS Grade 3, 2 patients presented with GCS 12 and 8 with focal deficit WFNS Grade 4, and 2 patients presented with GCS 5 with deficit WFNS Grade 5.

Patients were immediately subjected to CTA at the time of admission, and if CTA is negative, the DSA was taken on the next day to 3 days depending on the general condition of the patient. If DSA is also negative, then CTA and DSA were repeated after 1–3 months interval depending on patient condition and amount of suspicion of harboring an aneurysm. The liver and renal function tests were done along with an echocardiogram to assess the cardiac status of the patients These tests were done as high doses of contrast was administered rapidly which requires good left ventricular function, liver and renal function to metabolize and excrete the contrast.

16 slice CT of GE Health Care was used in all the cases with Iohexol (Omnipaque) as intravenous contrast. Image processing consisted of standardized axial, coronal, sagittal, multiplanar, and 3D reconstructions were taken.

DSA was performed using a neuroangiography unit of GE Medical Systems with 4-vessel study with standard Towne and lateral views as well as rotational spin angiograms. The dye used is Iohexol (Omnipaque) as intravenous contrast.

Out of 32 patients, 19 are male with ages from 26 to 72 and 13 are female with age range from 31 to 81.

CTA which is faster and easily applied was carried out in all the patients with SAH. DSA positive cases in initial CTA negative were studied. No complications were encountered during DSA procedures. CTA and DSA negative cases were followed and in cases where there is strong suspicion of harboring a ruptured aneurysm, repeat CTA was done during the follow-up period ranging from 1 to 3 months. Again, DSA was repeated in negative CTA cases during follow-up [Figure 1].

RESULTS

The data from this study have been analyzed under the parameters such as clinical presentation, findings on CT scan with grading, findings of CTA, findings of DSA in CTA negative cases, and results of repeat CTA/DSA during follow-up.

Of the 32 patients who presented with spontaneous SAH, there was a history of a severe headache in 29 patients and in 3 patients presented in unconscious state, patient attendants could not give history of complaining headache before illness. Focal deficits are seen in 18 patients. 4 patients presented with loss of consciousness, 4 patients presented with symptoms of raised intracranial pressure and seizures in 1 patient. In 24 patients, there was a history of chronic, episodic headache.

According to modified Fisher grading out of the 32 patients, 13 patients were presented in Grade 1, 9 in Grade 2, 6 in Grade 3, and 4 Grade 4.

Of the 32 patients who underwent CTA, 17 aneurysms were seen in 15 patients. Among these 15 patients, 2 patients were having 2 aneurysms each, in which one patient had middle carotid artery (MCA) and basilar tip aneurysms and in the other ICA and DACA aneurysms were seen. Out of

17 aneurysms, 7 are Acoma, 3 MCA, 2 PCOM, 2 ICA, 2 basilar tip, and 1 DACA. All the negative CTA patients are subjected to DSA in 1–3 days after initial SAH and 4 of CTA positive patients were also subjected to DSA for detailed study of aneurysm and major vessel branching visualization. In CTA negative patients, DSA could detect aneurysm in 2 patients 1 DACA and 1 ICA. Retrospectively ICA aneurysm could also be made out in CTA. Out of 4 patients with CTA positive cases, DSA could give additional imaging findings to help the treatment plan in 3 cases. DSA depicted two lobes of the Acoma aneurysm where CTA showed only one lobe [Figure 2]. For one PCOM aneurysm delineated in CTA, DSA could detect the branching of major vessel from aneurysm. For MCA aneurysm in CTA, the neck could not be seen clearly which is with wide neck and incorporating major branches as seen in DSA [Figure 3].

Of 15 patients where there is strong suspicion of aneurysm because of perimesencephalic and diffuse type of SAH with initial CTA and DSA were negative, repeat CTA and DSA were done in the follow-up period 1–3 months, and only two cases showed blister aneurysms on DSA and CTA remained negative in all [Figure 4]. Several studies like Ogawa *et al.*, JKA Hope have demonstrated the sensitivity of CTA of nearly 90%[6,7] while in this study the sensitivity was 89%.

The close proximity of supraclinoid, cavernous and ophthalmic segment aneurysms to bony structures pose difficulty in their identification in CTA and such difficulties has been reported in literature.[8]

Furthermore, CTA missed one lobe of aneurysm of Acoma, the reason for which remains obscure. CTA image of PCOM aneurysm and MCA aneurysm yielded inferior results as comparable to those of DSA in relation to adjacent major branching pattern.

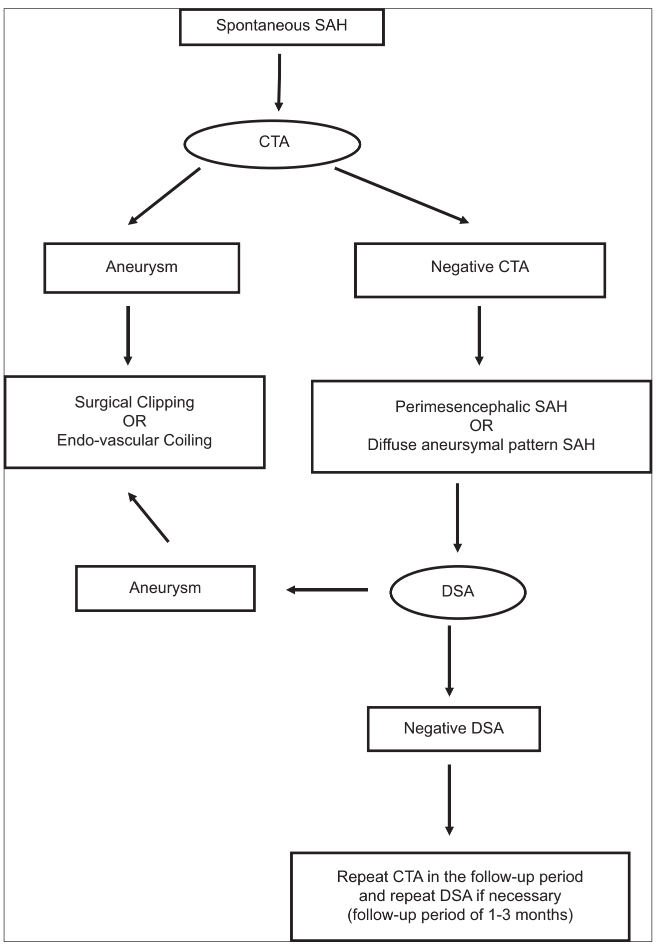

Figure 1: Imaging approach to patients presenting with spontaneous subarachnoid hemorrhage based on our study

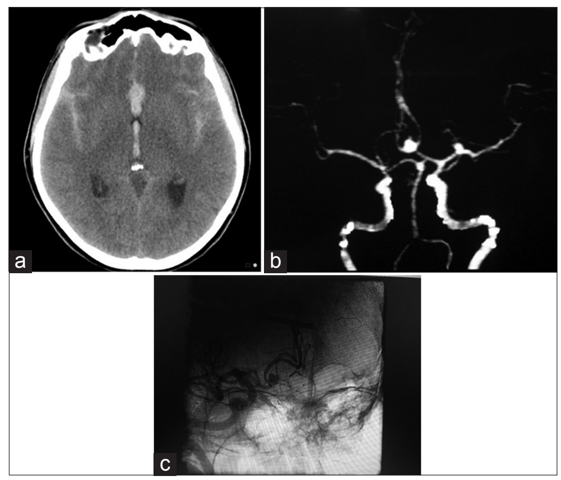

Figure 2: Case 2 – (a) Anterior interhemispheric subarachnoid hemorrhage, (b) computerized tomography angiography with AcomA aneurysm single lobe, (c) digital subtraction angiography showing bilobed AcomA aneurysm

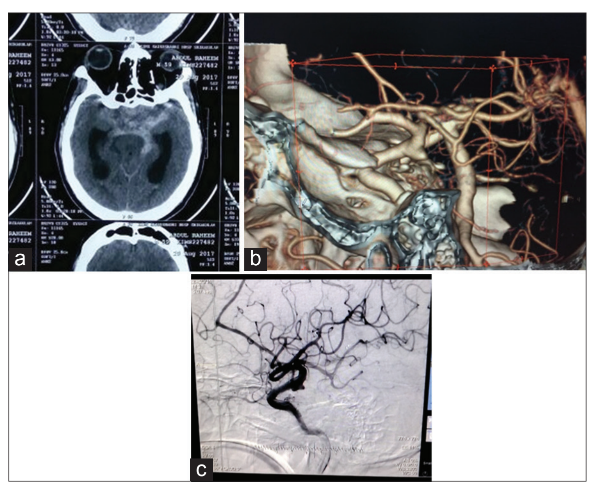

Figure 3: Case 3 – (a) Perimescencephalic subarachnoid hemorrhage, (b) 3 D computerized tomography angiography right PCOM aneurysm, (c) digital subtraction angiography showing right PCOM incoperating the neck of aneurysm

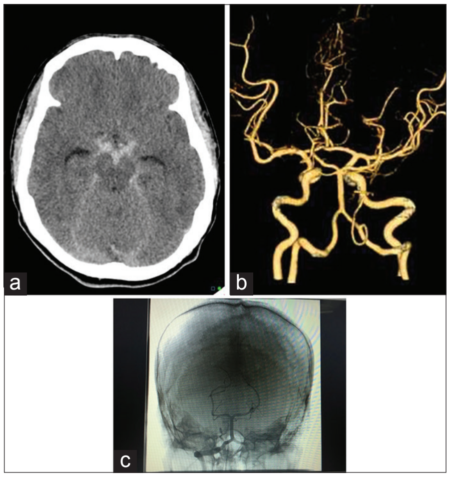

Figure 4: Case 1 – (a) Perimescencephalic subarachnoid hemorrhage, (b) computerized tomography angiography negative, (c) digital subtraction angiography negative

Another feature of SAH, namely, vasospasm is not evident on CTA. In the characterization of complex large aneurysms, CTA images were inferior with DSA in revealing the location, projection and its relationship with adjacent arteries. No cases of cerebral vasculitis on DSA imaging were seen.

DISCUSSION

Due to high mortality and morbidity rates associated with spontaneous SAH, early diagnosis and anatomic characterization of ruptured aneurysms have a vital importance for both surgical and endovascular treatment options. CTA is a highly accurate, cheap and non-invasive imaging method in the diagnosis of intracranial aneurysms in cases with SAH and can be used as a safe method when emergency surgery is needed. DSA is universally accepted as the gold standard imaging modality in the diagnosis and evaluation of aneurysms. In our study, we have done DSA for all CTA negative cases. DSA is a time consuming, an expensive and invasive procedure that may lead to complications in 1% and permanent neurologic deficit in 0.5% according to literature.[9] No complications were seen in our study during DSA.

Depending on different studies in the literature, it was reported that the sensitivity of CTA in diagnosing intracranial aneurysms ranges between 67% and 100%.[6,7,10,11] In our present study, CTA sensitivity is 89%.

Lenhart *et al.* stated that CTA had supplied additional information to DSA in their study that had found the sensitivity of CTA as 98%.[12] White *et al.*, in their research of 142 cases published in 2001, had found CTA sensitivity as 69% and specificity as 80% in detection of intracranial aneurysms.[11] Ogawa *et al.* reported that they had visualized 73 aneurysms with shaded surface display and the sensitivity of CTA was 94% in detection of aneurysms.[6] CTA sensitivity was reported to be 100% by Preda *et al.* in 1998[10] and Matsumoto *et al.*[13]

Aneurysm size is an important factor in planning surgical or endovascular treatment because it affects the size of the clip or coil that is going to be used.[14] Alberico *et al.* reported that CTA and DSA have no significant difference in measurement of aneurysm sizes.[15] In our study mean aneurysm size measured by CTA is 5.2 and DSA is 5.7 had no statistically significant difference.

Due to the low spatial resolution in CTA, small arteries that are important for the surgical approach, such as anterior choroidal artery or thalamoperforator arteries cannot be visualized. CTA cannot demonstrate the collateral flow that can be evaluated by DSA. Differentiation of small aneurysms from bone that are located near the bony structures at the skull base such as posterior communicating artery and basilar artery may not be possible in some cases. Cavernous segment aneurysms of ICA may be obscured by opacified blood in the cavernous sinus. Small aneurysms located at bifurcation of MCA may be overlooked by CTA due to branching of the vascular structure. All these were encountered in our present study.

Out of 19 aneurysms in the present study, 17 could be imaged in CTA and 14 aneurysms intervention could be carried out with the findings on CTA. In 3 aneurysms additional imaging findings on DSA could help our treatment plan. 2 aneurysms were detected in DSA with negative CTA. CTA has sensitivity of 89% in imaging aneurysms and in 86% of negative CTA cases DSA also negative for delineating aneurysm. Thus, in 86% of cases, a negative CTA could rule out the presence of aneurysm. Of 15 patients where there is strong suspicion of aneurysm due to perimesencephalic and diffuse type of bleed with initial CTA and DSA were negative, repeat CTA and DSA were done in the follow-up period 1–3 months, only two cases showed blister aneurysms on DSA and CTA remained negative in all.

In the study of Rinkel *et al.*[16] the cause of Perimesencephalic hemorrhage (PMH) is likely not aneurysmal but may be venous, and the patients have no risk of rebleed.[17] Thus, Rinkel *et al.* have stated that patients with PMH do not need a repeat DSA after initial negative findings on DSA.[17] They also suggested that DSA is not needed at all in patients with PMH who had negative CTA findings.[18]

In the study of Kershenovich *et al.*[19] they retrospectively evaluated 30 patients with a perimesencephalic SAH pattern and a negative CTA finding. DSA findings were negative in all of these patients. They concluded that CTA alone is a conclusive diagnostic tool for ruling out aneurysms in patients presenting with the classic perimesencephalic SAH pattern and thus can replace DSA.

In summary, CTA is a highly sensitive, specific, fast, and non-invasive imaging method for diagnosis and evaluation of aneurysms in cases with spontaneous SAH with suspected intracranial aneurysms. CTA should be the first line of the investigation. A negative CTA finding with SAH pattern of aneurysmal rupture, DSA is indicated. In complex aneurysms, DSA supplements CTA images in planning the management decision between surgical clipping and endovascular coiling.

CONCLUSION

CTA is the first line imaging technique for the patients presented with spontaneous SAH in most of the cases with a sensitivity of 89% in the detection and delineation of cerebral aneurysms. DSA remains the gold standard in evaluating patients with cerebral aneurysms where the initial CTA is negative. In complex aneurysms, DSA supplements CTA images in planning the management decision between surgical clipping and endovascular coiling.

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