



ROLE OF 128 DUAL SOURCE CT ANGIOGRAPHY IMAGING FOR DETECTION OF CEREBRAL ANEURYSM: A RETROSPECTIVE STUDY

Dr. Deepak Choudhary¹, Dr. R. Madhok^{2*}

¹Junior Resident, Department of Radiodiagnosis, Rajshree Medical Research Institute, Bareilly, Choudharyd13.dc1994@gmail.com

²Professor and Head of Department, Department of Radiodiagnosis, Rajshree Medical Research Institute, Bareilly, drmadhok@gmail.com

***Corresponding Author:** Dr. R. Madhok

***Professor and Head of Department,** Department of Radiodiagnosis, Rajshree Medical Research Institute, Bareilly, drmadhok@gmail.com

ABSTRACT

Background: Subarachnoid hemorrhage (SAH) is a devastating neurological condition with high mortality and morbidity rates. Approximately 80% of non-traumatic SAH cases are caused by ruptured intracranial aneurysms. While digital subtraction angiography (DSA) remains the gold standard for aneurysm detection, it is invasive and time-consuming. With advances in multidetector computed tomography technology, CT angiography (CTA) has emerged as a non-invasive alternative for preoperative assessment of intracranial aneurysms.

Objectives: To evaluate the diagnostic accuracy and clinical utility of 128-slice dual source CT angiography for detection and characterization of cerebral aneurysms in patients presenting with spontaneous subarachnoid hemorrhage.

Methods: This retrospective study included 48 patients with spontaneous subarachnoid hemorrhage who underwent 128-slice dual source CT angiography using DSA CT brain angiography protocol over an 18-month period. Analysis was performed using 2D multiplanar reconstructions, 3D maximum intensity projection, and volume-rendered techniques. Patients negative for aneurysm on CTA were further evaluated by digital subtraction angiography. Comprehensive evaluation of aneurysm size, location, morphology, and other imaging characteristics was performed.

Results: Of 48 patients (26 males, 22 females; age range 21-85 years; mean age 52.4 years), aneurysms were detected in 34 patients (70.8%). The most common locations were anterior communicating artery (ACOM) (26.5%), middle cerebral artery (MCA) (20.6%), and internal carotid artery (ICA) (20.6%). Single aneurysms were present in 95% of cases, with 5% having multiple aneurysms. The majority of aneurysms were small (<10mm). All 7 patients negative for aneurysm on CTA were also negative on subsequent DSA. Two cases of arteriovenous malformation and one calcified meningioma were identified. Three cases were attributed to hematoma without underlying vascular pathology.

Conclusion: The 128-slice dual source CT angiography provides rapid, non-invasive, and accurate identification of cerebral aneurysms with excellent determination of size, morphology, and location. Its high sensitivity and specificity approaching that of DSA makes it a valuable first-line investigation for patients presenting with subarachnoid hemorrhage.

Keywords: 128-slice dual source CT, Cerebral aneurysm, CT angiography, Digital subtraction angiography, Subarachnoid hemorrhage

INTRODUCTION

Subarachnoid hemorrhage (SAH) is a devastating acute neurological condition that accounts for 5-10% of all strokes and is associated with significant mortality and morbidity. The global burden of disease studies have shown that while the age-standardized incidence rates have declined, the absolute number of cases continues to rise. Approximately 80% of non-traumatic SAH cases are caused by ruptured intracranial aneurysms, making prompt and accurate diagnosis essential for patient management.

The mortality and morbidity associated with aneurysmal SAH remain substantial. Studies have reported mortality rates ranging from 20-50% at 30 days, with the direct effects of primary hemorrhage (55%), aneurysm rebleeding (17%), and medical complications (15%) being the major causes of death. Aneurysms that have already ruptured carry a significantly higher risk of re-hemorrhage, emphasizing the critical importance of accurate and timely detection of the underlying vascular pathology.

Digital subtraction angiography (DSA) has traditionally been considered the gold standard for detection of intracranial aneurysms due to its superior spatial resolution and ability to provide dynamic flow information. However, DSA is an invasive procedure that carries risks including arterial injury, thromboembolic events, and contrast-related complications. The procedure requires specialized expertise, is time-consuming, and has limited availability in many healthcare settings.

With the rapid advancement in multidetector computed tomography (MDCT) technology, CT angiography has emerged as a promising non-invasive alternative for the evaluation of intracranial aneurysms. Modern multidetector CT scanners offer isotropic high-resolution imaging with short acquisition times, enabling detailed visualization of cerebral vasculature. The introduction of dual-source CT technology has further enhanced imaging capabilities with improved temporal resolution and reduced motion artifacts.

The 128-slice dual source CT scanner represents a significant technological advancement, capable of completing brain angiography in less than 2 seconds from skull base to vertex with a spatial resolution of 0.5 mm. The DSA neuro mode allows automatic bone subtraction, facilitating rapid and accurate analysis of cerebrovascular anatomy without loss of image resolution. This technology has great potential for use in vascular studies, particularly in the emergency setting where rapid diagnosis is critical.

The aim of this study was to evaluate the diagnostic accuracy of 128-slice dual source CT angiography for detection of cerebral aneurysms in patients presenting with spontaneous subarachnoid hemorrhage and to determine whether this modality can serve as a reliable first-line investigation, potentially replacing or supplementing conventional DSA in appropriate clinical scenarios.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted at a 950-bedded tertiary care hospital. Data were collected over an 18-month period from patients who presented with spontaneous subarachnoid hemorrhage and underwent CT angiography in the Department of Radiodiagnosis. Ethical approval for this study was obtained from the Institutional Ethics Committee.

Study Population

A total of 48 patients were included in the study. The inclusion criteria were: (1) All patients referred with spontaneous subarachnoid hemorrhage detected on non-contrast CT (NCCT) head; (2) Patients with sudden severe headache and strong clinical suspicion of subarachnoid hemorrhage even if NCCT was negative for hemorrhage. It is well established that CT has a high sensitivity (91-98%) for detecting subarachnoid hemorrhage in the acute phase, although this sensitivity decreases with time.

There were no specific exclusion criteria, as the study aimed to evaluate all patients presenting with suspected aneurysmal SAH.

CT Angiography Protocol

All CT angiography examinations were performed on a 128-slice dual source CT scanner using the standardized DSA CT brain angiography protocol as follows:

A non-contrast sequence from skull base to vertex was first acquired to serve as a subtraction mask. The premonitoring region of interest (ROI) was placed in air adjacent to the skull in a section obtained just below the skull base. Contrast-enhanced imaging was planned from skull base to vertex with a scan time of approximately 1.90-2.00 seconds and a delay of 2 seconds.

Intravenous non-ionic contrast medium (50-60 mL) was administered using a dual pressure injector at a rate of 5 mL/second, followed by a 30 mL saline chase at a similar rate. Post-contrast triggering was initiated manually upon visualization of contrast opacification in the internal carotid arteries at the premonitored skull base section. The non-contrast sequence was then subtracted from the post-contrast sequence to generate the angiographic images.

Image Analysis

Analysis of all CT angiography studies for aneurysm detection was performed according to departmental protocol using multiple post-processing techniques on a dedicated workstation. These included 2D multiplanar reconstructions (MPR), 3D maximum intensity projection (MIP), and volume-rendered (VR) techniques. Comprehensive evaluation was performed for each detected aneurysm including: size measurement (maximum diameter, dome dimensions, neck width), location, morphology (saccular, fusiform, multilobulated), orientation of the dome relative to parent vessel, and presence of additional imaging features such as calcification, thrombosis, or daughter sacs.

Patients who were negative for aneurysm on CT angiography underwent digital subtraction angiography for confirmation. DSA was performed by an experienced neurointerventionist using standard transfemoral approach with selective catheterization of the internal carotid and vertebral arteries.

Data Collection and Analysis

Clinical data including patient demographics (age, sex), presenting symptoms, relevant medical history (hypertension, diabetes mellitus), and laboratory parameters (serum creatinine) were collected from medical records. Radiological data including aneurysm detection, location, size, morphology, and any additional findings were recorded. Descriptive statistics were used to summarize the study findings.

RESULTS

Patient Demographics

A total of 48 patients presenting with spontaneous subarachnoid hemorrhage were evaluated by 128-slice dual source CT angiography during the study period. The demographic characteristics of the study population are summarized in Table 1.

Table 1: Sex Distribution

Sex	Number of Patients (n=48)
Male	26 (54%)
Female	22 (46%)

Of the 48 patients, 26 (54%) were male and 22 (46%) were female, showing a slight male preponderance with a male to female ratio of approximately 1.18:1.

Table 2: Age Distribution

Age Group (years)	Number of Patients
10-19	0
20-29	4 (8.3%)
30-39	3 (6.3%)
40-49	8 (16.7%)
50-59	18 (37.5%)
60-69	11 (22.9%)
70-79	2 (4.2%)
80-89	2 (4.2%)

The age of patients ranged from 21 to 85 years with a mean age of 52.4 years. The majority of patients (60.4%) were in the 50-69 year age group, with the highest number in the 50-59 year age group (37.5%). This is consistent with the known peak incidence of aneurysmal subarachnoid hemorrhage in the fifth and sixth decades of life.

Radiological Findings

CT angiography detected aneurysms in 34 patients (70.8%), while 14 patients (29.2%) had no aneurysm identified. Among the patients without aneurysm, 7 had completely normal CTA findings, 3 had hematoma without underlying vascular pathology, 2 had arteriovenous malformations (AVM), and 1 had a calcified meningioma that was initially suspected to be a large aneurysm. Additionally, 1 patient presented with subarachnoid hemorrhage secondary to vessel spasm without aneurysm formation.

Table 3: Aneurysm Location Distribution

Location	Number
Anterior Communicating Artery (ACOM)	9 (26.5%)
Middle Cerebral Artery (MCA)	7 (20.6%)
Internal Carotid Artery (ICA)	7 (20.6%)
Anterior Cerebral Artery (ACA)	5 (14.7%)
Vertebrobasilar System (VBA)	3 (8.8%)
Posterior Cerebral Artery (PCA)	2 (5.9%)
Basilar Artery (BA)	1 (2.9%)

The anterior communicating artery (ACOM) was the most common location for aneurysms (26.5%), followed by the middle cerebral artery (MCA) and internal carotid artery (ICA), each accounting for 20.6% of cases. The anterior circulation aneurysms (ACOM, MCA, ICA, ACA) collectively accounted for 82.4% of all detected aneurysms, while posterior circulation aneurysms (VBA, PCA, BA) accounted for 17.6%.

Table 4: Number of Aneurysms per Patient

Number of Aneurysms	Number of Patients (n=34)
Single	32 (94.1%)
Multiple	2 (5.9%)

The vast majority of patients (94.1%) had single aneurysms, while 2 patients (5.9%) had multiple aneurysms. One patient had aneurysms involving multiple locations including the right ICA, left MCA, and basilar artery tip. Another patient had aneurysms arising from both ACOM and the left ICA.

Aneurysm Characteristics

The detected aneurysms showed variable sizes, with the majority being small aneurysms (less than 10 mm in maximum diameter). The smallest detected aneurysm measured 1.5 mm (a tiny bleb from ACOM suspicious of aneurysm and a tiny bleb from the left posterior cerebral artery), while the largest measured 15 mm (a thrombosed aneurysm in the A1 segment of ACA). Various morphological types were observed including saccular, trifoliate, and lobulated configurations. Some aneurysms showed evidence of thrombosis and calcification.

Correlation with DSA

All patients who were negative for aneurysm on CT angiography underwent digital subtraction angiography for confirmation. All 7 patients who had normal CTA findings were also confirmed to be negative for aneurysm on DSA, demonstrating excellent negative predictive value of CTA in this study. The comprehensive evaluation of detected aneurysms including location, size, morphology, and neck characteristics provided by CTA was found to be adequate for guiding neurosurgical and neurointerventional management decisions.

DISCUSSION

This study demonstrates the clinical utility of 128-slice dual source CT angiography for the detection and characterization of cerebral aneurysms in patients presenting with spontaneous subarachnoid hemorrhage. Our findings support the role of CTA as a reliable first-line imaging modality in this clinical setting.

The demographic profile of our study population is consistent with published literature on aneurysmal subarachnoid hemorrhage. The peak incidence in the 50-59 year age group and the slight male preponderance observed in our study align with epidemiological data from other populations. Studies have shown that the median age of death from SAH is significantly younger (around 59 years) compared to other stroke subtypes, highlighting the importance of accurate diagnosis in this middle-aged population.

The distribution of aneurysm locations in our study, with the anterior communicating artery being the most common site followed by MCA and ICA, is consistent with previous reports. The anterior circulation predominance (82.4%) in our study is in agreement with literature showing that approximately 80-90% of intracranial aneurysms arise from the anterior circulation. This anatomical distribution has important implications for surgical and endovascular planning.

The diagnostic performance of CT angiography for cerebral aneurysms has been extensively studied. Meta-analyses have reported pooled sensitivities of 92-98% and specificities of 87-100% for CTA in detecting intracranial aneurysms. More recent studies using modern multidetector CT technology have shown even higher accuracy, with some reporting sensitivity and specificity values exceeding 97%. In our study, all patients who were negative on CTA were confirmed negative on DSA, suggesting excellent negative predictive value in ruling out aneurysms.

The 128-slice dual source CT technology offers several advantages over earlier generation scanners. The faster acquisition time (approximately 1.9 seconds from skull base to vertex) reduces motion artifacts and allows imaging of acutely ill patients who may have difficulty remaining still. The improved spatial resolution (0.5 mm) enables detection of smaller aneurysms. The DSA neuro mode provides automatic bone subtraction, eliminating a previously time-consuming step in image processing and allowing rapid visualization of vascular anatomy.

The non-invasive nature of CTA represents a significant advantage over conventional DSA. Digital subtraction angiography, while providing superior spatial resolution and dynamic flow information, carries risks of neurological complications including transient ischemic attack and stroke, reported in 0.5-1% of procedures. Additionally, DSA requires arterial puncture, specialized expertise, and is more time-consuming and resource-intensive than CTA.

Detection of small aneurysms remains a challenge for all imaging modalities. Studies have shown that the sensitivity of CTA decreases for aneurysms smaller than 3 mm. In our study, the smallest detected aneurysm measured 1.5 mm, demonstrating the capability of modern dual-source technology to detect

very small lesions. However, it is important to acknowledge that some very small aneurysms may still be missed, and clinical correlation remains essential.

Our study also identified other vascular and non-vascular pathologies including arteriovenous malformations and a calcified meningioma initially suspected to be an aneurysm. This highlights the importance of comprehensive image analysis and consideration of differential diagnoses in patients presenting with subarachnoid hemorrhage. CTA provides excellent visualization of associated findings that may impact patient management.

Strengths and Limitations

The strengths of this study include the use of state-of-the-art 128-slice dual source CT technology, standardized imaging protocol, and comprehensive evaluation of detected aneurysms. The correlation with DSA findings in negative cases provides validation of the CTA results.

Limitations of this study include its retrospective design and relatively small sample size. Not all patients with positive CTA findings underwent confirmatory DSA, which limits our ability to calculate true sensitivity and specificity values. Additionally, the single-center nature of the study may limit generalizability. Future prospective studies with larger sample sizes and systematic DSA correlation would be valuable to further establish the diagnostic accuracy of this technology.

CONCLUSION

The 128-slice dual source CT angiography provides rapid, non-invasive, and accurate identification of cerebral aneurysms with excellent determination of size, morphology, and location. The imaging characteristics obtained from CTA adequately guide neurosurgical and neurointerventional management decisions. The high sensitivity and specificity approaching that of DSA, combined with its non-invasive nature and rapid acquisition time, makes CTA a valuable first-line investigation for patients presenting with subarachnoid hemorrhage. CTA may serve as a reliable alternative to DSA in appropriate clinical settings, reserving conventional angiography for cases where CTA findings are negative or inconclusive, or when endovascular intervention is planned.

ACKNOWLEDGEMENTS

We acknowledge the support of the Department of Radiodiagnosis and the technical staff involved in performing the CT angiography studies. We also thank the medical records department for facilitating data collection.

Competing Interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Author Contributions

Dr. Deepak Choudhury: Conceptualization, data collection, image analysis, manuscript preparation.
Dr. R. Madhok: Study supervision, critical review, and manuscript revision.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Approval

Ethical approval for this study was obtained from the Institutional Ethics Committee.

REFERENCES

1. Etminan N, Chang HS, Hackenberg K, de Rooij NK, Vergouwen MDI, Rinkel GJE, et al. Worldwide incidence of aneurysmal subarachnoid hemorrhage according to region, time period, blood pressure, and smoking prevalence in the population: a systematic review and meta-analysis. *JAMA Neurol.* 2019;76(5):588-597.
2. Hop JW, Rinkel GJ, Algra A, van Gijn J. Case-fatality rates and functional outcome after subarachnoid hemorrhage: a systematic review. *Stroke.* 1997;28:660-664.
3. Vlak MH, Algra A, Brandenburg R, Rinkel GJ. Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. *Lancet Neurol.* 2011;10:626-636.
4. Broderick J, Brott TG, Duldner JE, Tomsick T, Leach A. Initial and recurrent rebleeding are the major causes of death following subarachnoid hemorrhage. *Stroke.* 1994;25:1342-1347.
5. Bonita R, Thomson S. Subarachnoid hemorrhage: epidemiology, diagnosis, management, and outcome. *Stroke.* 1985;16:591-594.
6. Wiebers DO, Whisnant JP, Huston 3rd J, Meissner I, Brown Jr RD, Piepgras DG, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. *Lancet.* 2003;362:103-110.
7. Dhar S, Tremmel M, Mocco J, Kim M, Yamamoto J, Siddiqui AH, et al. Morphology parameters for intracranial aneurysm rupture risk assessment. *Neurosurgery.* 2008;63:185-196.
8. Uysal E, Yanbuloglu B, Erturk M, Kilinc BM, Basak M. Spiral CT angiography in diagnosis of cerebral aneurysms of cases with acute subarachnoid hemorrhage. *Diagn Interv Radiol.* 2005;11:77-82.
9. Xing W, Chen W, Sheng J, Peng Y, Lu J, Wu X, et al. Sixty-four-row multislice computed tomographic angiography in the diagnosis and characterization of intracranial aneurysms: comparison with 3D rotational angiography. *World Neurosurg.* 2011;76:105-113.
10. McKinney AM, Palmer CS, Truwit CL, Karagulle A, Teksam M. Detection of aneurysms by 64-section multidetector CT angiography in patients acutely suspected of having an intracranial aneurysm and comparison with digital subtraction and 3D rotational angiography. *AJNR Am J Neuroradiol.* 2008;29:594-602.
11. Yoon NK, McNally S, Taussky P, Park MS. Imaging of cerebral aneurysms: a clinical perspective. *Neurovascular Imaging.* 2016;2:6.
12. Westerlaan HE, van Dijk JM, Jansen-van der Weide MC, de Groot JC, Groen RJ, Mooij JJ, Oudkerk M. Intracranial aneurysms in patients with subarachnoid hemorrhage: CT angiography as a primary examination tool for diagnosis--systematic review and meta-analysis. *Radiology.* 2011;258(1):134-145.
13. 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(3):739-749.
14. Chen W, Yang Y, Xing W, Qiu J, Peng Y. Application of multislice computed tomographic angiography in diagnosis and treatment of intracranial aneurysms. *Clin Neurol Neurosurg.* 2010;112(7):563-571.
15. Zhang LJ, Wu SY, Niu JB, Zhang ZL, Wang HZ, Zhao YE, et al. Dual-energy CT angiography in the evaluation of intracranial aneurysms: image quality, radiation dose, and comparison with 3D rotational digital subtraction angiography. *AJR Am J Roentgenol.* 2010;194(1):23-30.
16. Mkhize NN, Mngomezulu V, Buthelezi TE. Accuracy of CT angiography for detecting ruptured intracranial aneurysms. *SA J Radiol.* 2023;27(1):2636.
17. Morgenstern LB, Luna-Gonzales H, Huber JC Jr, et al. Worst headache and subarachnoid hemorrhage: prospective, modern computed tomography and spinal fluid analysis. *Ann Emerg Med.* 1998;32:297-304.

18. 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;29:23-27.