EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-8 | Issue-6 | Nov-Dec-2026 | DOI: https://doi.org/10.36349/easjrit.2026.v08i06.013

Original Research Article

A Study of CT Angiography and Digital Subtraction Angiography Findings in Patients Presenting with Non-Traumatic Subarachnoid Haemorrhage

Dr. Krishna D Nandanwar[1]*, Dr. Suraj Sonawane[2], Dr. Shephali S Pawar[3]

[1]Junior Resident, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH) India
[2]Associate Professor, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH) India
[3]Professor and Head of Department, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH) India

Article History
Received: 13.09.2026
Accepted: 06.11.2026
Published: 09.11.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background*:** Non-traumatic subarachnoid haemorrhage (SAH) is a potentially life-threatening neurological emergency; most commonly associated with ruptured intracranial aneurysms. Computed tomography angiography (CTA) is widely used for vascular evaluation, whereas digital subtraction angiography (DSA) remains an important reference investigation for detecting and characterising intracranial vascular abnormalities. ***Aim***: To compare CTA and DSA findings in patients presenting with non-traumatic SAH. ***Methods*:** This prospective, hospital-based, cross-sectional analytical study included 51 adult patients with non-traumatic SAH confirmed on non-contrast computed tomography. All patients underwent both CTA and DSA. Demographic characteristics, clinical presentation, haemorrhage distribution, vascular abnormalities, aneurysm morphology and measurements were evaluated. DSA was considered the reference standard for comparison. ***Results*:** The mean age was 52.0 ± 11.4 years, with female predominance (62.7%). Thunderclap headache was reported in all patients (100%), followed by vomiting (92.2%) and neck stiffness (64.7%). Aneurysmal SAH was identified in 32 patients (62.7%), while 19 (37.3%) had non-aneurysmal SAH. CTA demonstrated 39 aneurysms, whereas DSA demonstrated 40 aneurysms. The anterior communicating artery was the most frequently reported aneurysm location in both investigations. Most aneurysms were saccular and measured 5–10 mm. DSA additionally demonstrated other vascular abnormalities, including arteriovenous malformations, dural arteriovenous fistulae, Moyamoya disease and vasculitis. A documented small basilar tip aneurysm missed on CTA highlighted the potential limitation of CTA in detecting small lesions. Two patients experienced minor DSA-related complications. ***Conclusion*:** CTA demonstrated high reported diagnostic performance and excellent morphometric reliability. Nevertheless, DSA remains important for detecting very small aneurysms and subtle non-aneurysmal vascular abnormalities, particularly when clinical suspicion persists.

Keywords: Subarachnoid Haemorrhage.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

Subarachnoid haemorrhage (SAH) is a potentially life-threatening neurological emergency characterised by bleeding into the subarachnoid space between the arachnoid and pia mater. Spontaneous or non-traumatic SAH accounts for a significant proportion of acute cerebrovascular emergencies and is most commonly associated with rupture of an intracranial aneurysm. Other recognised causes include arteriovenous malformations, dural arteriovenous fistulas, arterial dissections and non-aneurysmal haemorrhage. The condition is associated with substantial morbidity and mortality, primarily due to early brain injury, rebleeding, hydrocephalus and delayed cerebral ischaemia [1, 2].

The clinical presentation typically includes sudden-onset severe headache, often described as a thunderclap headache, accompanied by vomiting, neck

***Corresponding Author:** Dr. Krishna D Nandanwar
Junior Resident, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH)India

stiffness, altered sensorium or loss of consciousness. Early diagnosis and identification of the underlying vascular abnormality are essential for determining appropriate treatment and preventing recurrent haemorrhage. Non-contrast computed tomography (NCCT) of the brain remains the initial imaging investigation because of its rapid acquisition and high sensitivity for detecting acute subarachnoid blood, particularly when performed soon after symptom onset [3, 4].

The distribution and extent of haemorrhage on NCCT provide important diagnostic information regarding the possible underlying vascular pathology. Basal cisternal and diffuse patterns are frequently associated with aneurysmal rupture, whereas a typical perimesencephalic distribution is more commonly associated with non-aneurysmal haemorrhage. The Fisher grading system is also used to assess the amount and distribution of subarachnoid blood and provides useful information regarding the risk of subsequent cerebral vasospasm [5, 6].

Following confirmation of SAH, identification of the underlying vascular lesion becomes the principal objective of neurovascular imaging. CT angiography (CTA) has become an important first-line investigation because of its rapid acquisition, non-invasive nature, widespread availability and ability to demonstrate intracranial vascular anatomy. Multidetector CTA with multiplanar reconstruction, maximum intensity projection and three-dimensional volume-rendered images facilitates assessment of aneurysm location, size, morphology and relationship with adjacent vessels. Previous studies and meta-analyses have demonstrated high diagnostic accuracy of CTA for intracranial aneurysms, particularly those measuring 4 mm or larger [7, 8].

Despite its advantages, CTA has limitations in detecting very small aneurysms, particularly those measuring less than 3 mm, and lesions located near complex bony structures at the skull base. Overlapping vessels, suboptimal contrast opacification and atypical aneurysm morphology may also affect diagnostic interpretation. These limitations are clinically important because failure to identify the source of haemorrhage may delay definitive treatment and expose patients to the risk of rebleeding [8, 9].

Digital subtraction angiography (DSA) remains the reference-standard investigation for detailed evaluation of intracranial vascular abnormalities. Its high spatial and temporal resolution enables detailed visualisation of small arteries, aneurysm necks, collateral circulation and complex vascular lesions. DSA is particularly useful when CTA findings are negative or inconclusive despite a strong clinical or radiological suspicion of an underlying vascular abnormality. It also facilitates the identification of additional pathologies such as arteriovenous malformations, dural arteriovenous fistulas, vasculitis and vasospasm [10, 11].

However, DSA is an invasive catheter-based procedure and carries potential complications, including access-site haematoma, thromboembolic events, neurological deficits and contrast-related adverse reactions. Therefore, its use requires appropriate clinical justification and careful consideration of the benefits and procedural risks [12].

A combined imaging approach involving initial CTA followed by DSA when clinically indicated provides complementary information in the evaluation of non-traumatic SAH. Although CTA offers rapid and non-invasive vascular assessment, DSA provides detailed anatomical characterisation and may identify abnormalities not demonstrated on CTA. Studies evaluating patients with negative CTA findings have also highlighted the importance of considering the distribution of subarachnoid blood when deciding the need for further angiographic evaluation [13, 14].

In this context, the present study was undertaken to evaluate the imaging characteristics of non-traumatic subarachnoid haemorrhage using CTA and DSA, compare their findings in the detection and characterisation of intracranial aneurysms, and assess the additional diagnostic contribution of DSA in identifying vascular abnormalities. The study also examined the agreement between the two imaging modalities with respect to aneurysm location, morphology and morphometric parameters in patients presenting to a tertiary care teaching hospital.

MATERIALS AND METHODS

A hospital-based, prospective, cross-sectional analytical study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital over a period of 18 months. A total of 51 consecutive patients aged 18 years and above, of either sex, presenting with non-traumatic subarachnoid haemorrhage confirmed on non-contrast computed tomography (NCCT) and undergoing both CT angiography (CTA) and digital subtraction angiography (DSA) were included. Patients with traumatic SAH, contraindications to iodinated contrast, haemodynamic instability precluding DSA, refusal of consent or incomplete imaging data were excluded. Institutional Ethics Committee approval was obtained, and written informed consent was taken from all participants or their legally authorised representatives. NCCT and CTA were performed using a 128-slice multidetector CT scanner. CTA was acquired following administration of 60–80 mL of non-ionic iodinated contrast, with multiplanar, maximum intensity projection and three-dimensional volume-rendered reconstructions. DSA was performed using a biplane angiography system with selective four-vessel cerebral angiography. Imaging findings, including aneurysm detection, location, size, morphology, associated

vascular abnormalities and procedural complications, were recorded. Data were analysed using SPSS version 26.0. Diagnostic performance was assessed using DSA as the reference standard. Agreement was evaluated using Cohen's kappa and intraclass correlation coefficients. A p-value of less than 0.05 was considered statistically significant.

RESULT

Table 1: Distribution of SAH patterns according to final aetiological diagnosis (N = 51)

SAH pattern	Aneurysmal	PMH	AVM/dAVF	Idiopathic	Other	Total
Basal cisterns	16	0	1	0	1	18
Sylvian fissure	5	0	1	0	1	7
Interhemispheric	1	0	1	0	0	2
Perimesencephalic	0	8	0	3	0	11
Diffuse	10	0	0	2	0	12
Convexity	0	0	1	0	0	1
Total	32	8	4	5	2	51

Table 2: Comparative distribution of aneurysm characteristics on CTA and DSA

Part A. Aneurysm location

Location	CTA (N = 39) n (%)	DSA (N = 40) n (%)
AComA	15 (38.5)	15 (37.5)
PComA	1 (2.6)	1 (2.5)
MCA	11 (28.2)	11 (27.5)
ICA	7 (17.9)	7 (17.5)
Basilar	3 (7.7)	4 (10.0)
PICA	1 (2.6)	1 (2.5)
SCA	2 (5.1)	2 (5.0)
Pericallosal	2 (5.1)	2 (5.0)
Total aneurysms	39 (100.0)	40 (100.0)

Part B. Aneurysm size

Size category	CTA (N = 39) n (%)	DSA (N = 40) n (%)
Less than 3 mm	3 (7.7)	4 (10.0)
3–5 mm	14 (35.9)	13 (32.5)
5–10 mm	21 (53.8)	22 (55.0)
Greater than 10 mm	1 (2.6)	1 (2.5)
Mean ± SD (mm)	5.64 ± 2.40	5.69 ± 2.40
Median (IQR)	5.4 (3.8–7.2)	5.4 (3.7–7.3)
Range	1.9–13.7	2.0–13.6

Part C. Aneurysm morphology

Morphology	CTA (N = 39) n (%)	DSA (N = 40) n (%)
Saccular	36 (92.3)	37 (92.5)
Fusiform	2 (5.1)	2 (5.0)
Blister-like	1 (2.6)	1 (2.5)
Total	39 (100.0)	40 (100.0)

Table 3: Diagnostic performance and CTA–DSA concordance

Part A. CTA versus DSA: 2 × 2 contingency table

CTA findings	DSA Positive	DSA Negative	Total
CTA Positive	32	0	32
CTA Negative	0	19	19
Total	32	19	51

Part B. Diagnostic performance of CTA

Parameter	Value	95% CI (%)
Sensitivity	100%	89.3–100.0
Specificity	100%	83.2–100.0
Positive predictive value	100%	89.3–100.0

Parameter	Value	95% CI (%)
Negative predictive value	100%	83.2–100.0
Diagnostic accuracy	100%	93.0–100.0
True positive	32	—
True negative	19	—
False positive	0	—
False negative	0	—

Part C. Overall CTA–DSA concordance (as reported in Table 21)

Parameter	Concordant n (%)	Discordant n (%)	κ / ICC
Detection	50 (98.0)	1 (2.0)	0.961
Location	32 (100.0)	0 (0.0)	1.000
Morphology	32 (100.0)	0 (0.0)	1.000
Size	32 (100.0)	0 (0.0)	See Table 20
Neck width	32 (100.0)	0 (0.0)	See Table 20

Part D. Paired morphometric comparison

Parameter	CTA	DSA	Difference
Aneurysm size, mean ± SD (mm)	5.73 ± 2.63	5.86 ± 2.61	−0.12 ± 0.17
Aneurysm size, median (IQR)	5.5 (3.2–7.9)	5.7 (3.5–8.0)	—
95% CI of difference (size)	—	—	−0.18 to −0.06
Limits of agreement (size)	—	—	−0.45 to 0.21
Neck width, mean ± SD (mm)	3.32 ± 1.83	3.38 ± 1.78	−0.07 ± 0.15
Neck width, median (IQR)	2.8 (2.2–4.4)	2.9 (2.1–4.4)	—
95% CI of difference (neck width)	—	—	−0.12 to −0.01
Limits of agreement (neck width)	—	—	−0.36 to 0.23

Paired N = 32. Aneurysm size: Wilcoxon W = 37.5, $p < 0.001$; ICC = 0.998. Neck width: Wilcoxon W = 102.0, $p = 0.036$; ICC = 0.996.

Table 4: Additional vascular abnormalities, CTA-negative findings and DSA complications

Part A. Non-aneurysmal vascular pathology detected on DSA (N = 51)

Vascular abnormality	Number	Percentage (%)
AVM	3	5.9
dAVF	1	2.0
Moyamoya	1	2.0
Vasculitis	1	2.0
Vasospasm	8	15.7
None	0	0.0

Part B. Characteristics of findings missed or subtle on CTA

Patient	DSA finding	CTA quality	SAH pattern
Case 46	Multifocal vasculitis, subtle on CTA	Good	Sylvian fissure
Case 48	Basilar tip saccular aneurysm (2.8 mm)	Good	Diffuse

Part C. CTA image quality (N = 51)

Image quality	Number	Percentage (%)
Good	33	64.7
Adequate	18	35.3
Poor	0	0.0
Total	51	100.0

Part D. DSA-related complications (N = 51)

Complication	Number	Percentage (%)	95% CI (%)
None	0	0	—
Groin haematoma	1	2.0	0.3–10.3
Transient neurological deficit	1	2.0	0.3–10.3
Mild contrast reaction	0	0	—
Overall complication rate	2	3.9	1.1–13.2

A total of 51 patients with non-traumatic subarachnoid haemorrhage were included in the study. The mean age of the participants was 52.0 ± 11.4 years, with a median age of 54 years (IQR: 46–60) and an age range of 23–75 years. The highest representation was observed in the 41–50 and 51–60 year age groups, comprising 16 patients (31.4%) each, followed by 11 patients (21.6%) in the 61–70 year age group. Females constituted 32 (62.7%) of the study population, while males accounted for 19 (37.3%), with a male-to-female ratio of 1:1.68.

Hypertension was the most common comorbidity, observed in 24 patients (47.1%). Type 2 diabetes mellitus and dyslipidaemia were each reported in four patients (7.8%). Regarding substance use, 12 patients (23.5%) were current smokers, 11 (21.6%) were former smokers and 28 (54.9%) had never smoked. Alcohol consumption was reported by 14 patients (27.5%), while 37 (72.5%) did not report alcohol use.

Thunderclap headache was the predominant presenting symptom and was reported in all 51 patients (100%; 95% CI: 93.0–100.0). Vomiting was observed in 47 patients (92.2%), followed by neck stiffness in 33 (64.7%). Altered sensorium was present in 12 patients (23.5%), loss of consciousness in 11 (21.6%), focal neurological deficit in eight (15.7%) and seizures in seven (13.7%). The mean Glasgow Coma Scale (GCS) score was 12.0 ± 2.6, with a median of 13 (IQR: 10–14). Mild impairment (GCS 13–15) was observed in 27 patients (52.9%), moderate impairment (GCS 9–12) in 17 (33.3%) and severe impairment (GCS 3–8) in seven (13.7%). According to the Hunt and Hess grading system, 35 patients (68.6%) had good-grade haemorrhage (Grades I–III), while 16 (31.4%) had poor-grade haemorrhage (Grades IV–V). On Fisher grading, 16 patients (31.4%) each were classified as Grade III and Grade IV, 10 (19.6%) as Grade II and nine (17.6%) as Grade I.

Non-contrast CT demonstrated basal cisternal haemorrhage in 18 patients (35.3%), making it the most frequently reported distribution. Sylvian fissure and diffuse haemorrhage patterns were each reported in 12 patients (23.5%), followed by perimesencephalic haemorrhage in 11 (21.6%). Interhemispheric and convexity haemorrhage were reported in two (3.9%) and one patient (2.0%), respectively. Aneurysmal haemorrhage was the predominant aetiology, accounting for 32 patients (62.7%), while 19 patients (37.3%) had non-aneurysmal haemorrhage.

CT angiography detected aneurysms in 32 patients (62.7%), with a total of 39 aneurysms reported. The anterior communicating artery (AComA) was the most frequently reported site, accounting for 15 aneurysms (38.5%), followed by the middle cerebral artery (MCA) with 11 (28.2%) and the internal carotid artery (ICA) with seven (17.9%). Basilar artery aneurysms accounted for three (7.7%), while two each (5.1%) were reported in the superior cerebellar and pericallosal arteries. One aneurysm each (2.6%) was reported in the posterior communicating and posterior inferior cerebellar arteries. Most aneurysms measured 5–10 mm (21; 53.8%), followed by 3–5 mm (14; 35.9%), less than 3 mm (three; 7.7%) and more than 10 mm (one; 2.6%). The mean aneurysm size on CTA was 5.64 ± 2.40 mm, with a range of 1.9–13.7 mm. Saccular morphology was predominant, accounting for 36 aneurysms (92.3%), while two (5.1%) were fusiform and one (2.6%) was blister-like. CTA image quality was rated as good in 33 patients (64.7%) and adequate in 18 (35.3%); no examination was classified as poor quality.

Digital subtraction angiography detected aneurysms in 32 patients (62.7%), with a total of 40 aneurysms reported. The AComA was the most frequently reported location, accounting for 15 aneurysms (37.5%), followed by the MCA with 11 (27.5%) and the ICA with seven (17.5%). Four aneurysms (10.0%) were reported in the basilar artery, two each (5.0%) in the superior cerebellar and pericallosal arteries, and one each (2.5%) in the posterior communicating and posterior inferior cerebellar arteries. Most aneurysms measured 5–10 mm (22; 55.0%), followed by 3–5 mm (13; 32.5%), less than 3 mm (four; 10.0%) and more than 10 mm (one; 2.5%). The mean aneurysm size on DSA was 5.69 ± 2.40 mm, with a range of 2.0–13.6 mm. Saccular morphology was observed in 37 aneurysms (92.5%), while two (5.0%) were fusiform and one (2.5%) was blister-like.

In addition to aneurysms, DSA demonstrated three arteriovenous malformations (AVMs; 5.9%) and one case each of dural arteriovenous fistula, Moyamoya disease and vasculitis (2.0% each). Vasospasm was identified in eight patients (15.7%). The final aetiological diagnosis showed saccular aneurysm in 29 patients (56.9%), non-aneurysmal perimesencephalic haemorrhage in eight (15.7%) and idiopathic angiographically negative SAH in five (9.8%). AVMs were identified in three patients (5.9%), while fusiform aneurysm was reported in two (3.9%). Blister-like aneurysm, dural arteriovenous fistula, Moyamoya disease and vasculitis were each reported in one patient (2.0%). Among the 32 aneurysm-positive patients, 24 (75.0%) had a single aneurysm and eight (25.0%) had multiple aneurysms. The mean number of aneurysms per patient was 1.25 ± 0.44.

Comparison of aneurysm detection by CTA and DSA showed that the diagnostic contingency table recorded 32 true-positive and 19 true-negative cases, with no false-positive or false-negative cases. Based on these figures, the reported sensitivity, specificity, positive predictive value and negative predictive value were each 100%, with an overall diagnostic accuracy of 100%. The reported 95% confidence intervals were 89.3–100.0% for sensitivity, 83.2–100.0% for specificity

and 93.0–100.0% for accuracy. The concordance summary, however, reported agreement in aneurysm detection in 50 of 51 patients (98.0%), with one discordant case and a Cohen's kappa value of 0.961. Location and morphology showed 100% concordance among the 32 aneurysm-positive patients, with a kappa value of 1.000.

Paired morphometric assessment showed a mean aneurysm size of 5.73 ± 2.63 mm on CTA and 5.86 ± 2.61 mm on DSA. The mean difference was −0.12 ± 0.17 mm (95% CI: −0.18 to −0.06), with an intraclass correlation coefficient of 0.998. The mean neck width was 3.32 ± 1.83 mm on CTA and 3.38 ± 1.78 mm on DSA, with a mean difference of −0.07 ± 0.15 mm (95% CI: −0.12 to −0.01) and an ICC of 0.996. The differences in aneurysm size and neck width were statistically significant on Wilcoxon signed-rank testing.

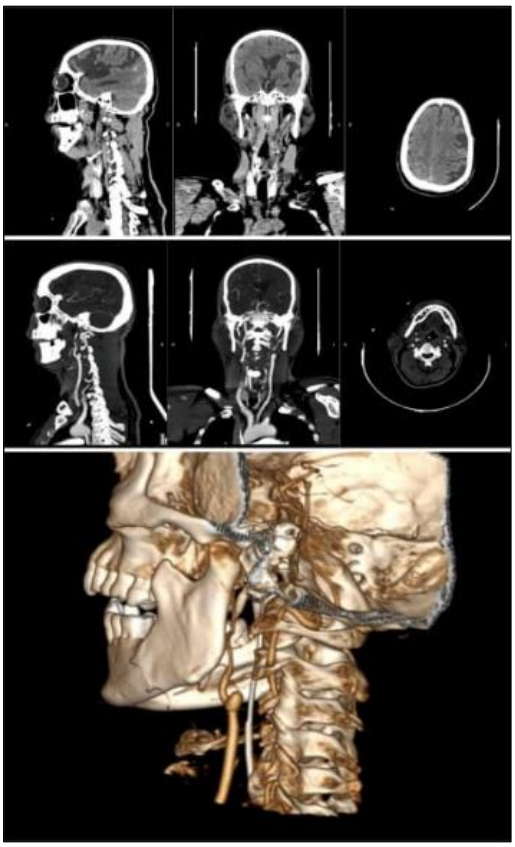


Figure 1: CTA – supraclinoid ICA aneurysm

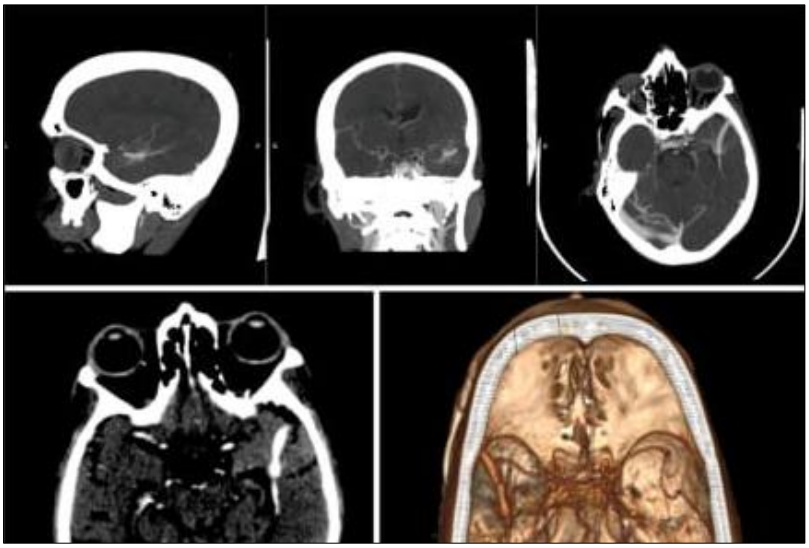


Fig. 2: Developmental Venous anamoly



Fig. 3: DSA – Anterior communicating artery aneurysm

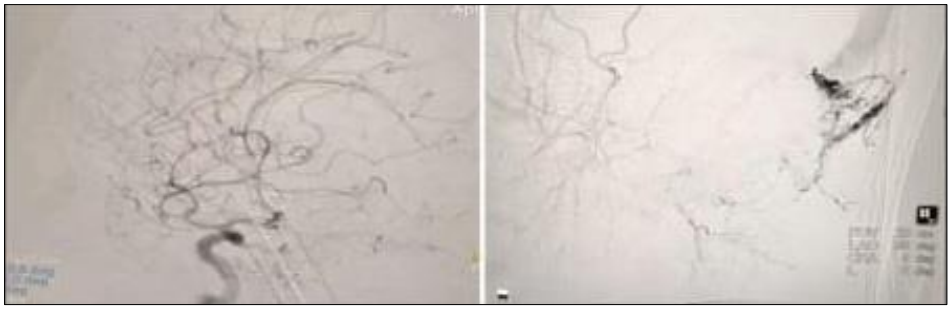


Fig. 4: Coiled Aneurism and Dural Fistula



Fig. 5: MCA Aneurism and negative angiogram

DISCUSSION

The present study evaluated the clinical profile of patients presenting with non-traumatic subarachnoid haemorrhage (SAH) and compared the diagnostic findings of CT angiography (CTA) with digital subtraction angiography (DSA). A total of 51 patients were included, with a mean age of 52.0 ± 11.4 years. The majority belonged to the 41–60-year age group, and females constituted 62.7% of the study population. Spontaneous SAH is an important cerebrovascular emergency associated with considerable morbidity and mortality. Its clinical outcome is influenced by the underlying cause, initial neurological status and complications during the subsequent course of illness [1-5]. The demographic profile observed in the present study provides an overview of the patients evaluated at the tertiary care centre.

Hypertension was the most frequently observed comorbidity, affecting 47.1% of the patients, followed by type 2 diabetes mellitus and dyslipidaemia, each reported in 7.8%. Current smoking was reported by 23.5% of patients, while 27.5% reported alcohol consumption. These findings highlight the presence of conventional vascular risk factors among patients with non-traumatic SAH. Hypertension is an important factor in the assessment of spontaneous intracranial haemorrhage, and its presence should be considered during clinical evaluation and subsequent management [2-16].

Thunderclap headache was the predominant presenting symptom and was reported in all patients (100%). Vomiting and neck stiffness were also frequent, occurring in 92.2% and 64.7% of patients, respectively. Altered sensorium, loss of consciousness, focal neurological deficits and seizures were observed in smaller proportions. The clinical presentation observed in this study is consistent with the recognised presentation of SAH, in which sudden-onset severe headache is a characteristic feature, often accompanied by vomiting and signs of meningeal irritation [1-6]. Early recognition of these symptoms is essential because timely diagnosis and identification of the underlying vascular pathology are important for appropriate management [5-7].

The mean Glasgow Coma Scale score was 12.0 ± 2.6, and 52.9% of patients had mild neurological

impairment. According to the Hunt and Hess grading system, 68.6% of patients were classified as having good-grade haemorrhage, whereas 31.4% had poor-grade haemorrhage. However, 62.8% of patients were classified as Fisher Grade III or IV, indicating a substantial radiological haemorrhage burden in the study population. The Fisher grading system is particularly relevant because the amount and distribution of subarachnoid blood are associated with the risk of cerebral vasospasm [15-16]. These findings emphasise the importance of combining clinical severity assessment with radiological evaluation in patients presenting with SAH.

On non-contrast CT, basal cisternal haemorrhage was the most frequently reported pattern, followed by Sylvian fissure and diffuse haemorrhage. Aneurysmal haemorrhage accounted for 62.7% of cases, making it the predominant aetiology in the present study. Basal cisternal and diffuse haemorrhage patterns were frequently observed among patients with aneurysmal SAH, whereas the perimesencephalic pattern was predominantly associated with non-aneurysmal haemorrhage. The distribution of subarachnoid blood can provide useful clues regarding the possible underlying vascular lesion [1-5]. Nevertheless, the haemorrhage pattern alone cannot reliably exclude an aneurysm or other vascular abnormality, and further vascular imaging remains important when clinically indicated [12, 13].

CTA detected aneurysms in 32 patients, with a total of 39 aneurysms reported. The anterior communicating artery was the most frequently reported location, followed by the middle cerebral artery and internal carotid artery. Saccular morphology was the predominant type, accounting for 92.3% of aneurysms, while most lesions measured between 5 and 10 mm. DSA also identified aneurysms in 32 patients, with 40 aneurysms reported. The distribution of aneurysm locations and morphological patterns was broadly similar between the two imaging modalities. These findings demonstrate the usefulness of CTA in identifying intracranial aneurysms and providing information regarding their location, size and morphology. Previous systematic reviews and comparative studies have also established the diagnostic value of CTA in the detection of intracranial aneurysms in patients with SAH [8-11].

The comparison of aneurysm measurements demonstrated a high level of agreement between CTA and DSA. The mean aneurysm size was 5.73 ± 2.63 mm on CTA and 5.86 ± 2.61 mm on DSA, with an intraclass correlation coefficient of 0.998. Similarly, the mean neck width was 3.32 ± 1.83 mm on CTA and 3.38 ± 1.78 mm on DSA, with an ICC of 0.996. These findings indicate excellent agreement between the two modalities for aneurysm morphometry in the evaluated cases. Accurate assessment of aneurysm dimensions and neck configuration is important in treatment planning, particularly when selecting between endovascular and surgical approaches. Previous studies have also demonstrated the usefulness of CTA for aneurysm characterisation while recognising that diagnostic performance may vary according to aneurysm size, location and morphology [8-11].

An important finding in the present study was the identification of a 2.8-mm basilar tip aneurysm on DSA that was not detected on CTA. This observation highlights a potential limitation of CTA in detecting very small aneurysms. Small aneurysms may be difficult to visualise because of their dimensions, complex vascular anatomy and proximity to adjacent structures [8-11]. Therefore, a negative CTA examination should be interpreted cautiously when the clinical presentation or distribution of haemorrhage continues to raise suspicion of an underlying aneurysm. Previous studies by Agid *et al*., and Heit *et al*., have demonstrated the additional diagnostic contribution of DSA in selected patients with spontaneous SAH despite negative CTA findings [12, 13]. These findings support the complementary role of DSA in cases where CTA is negative, equivocal or inconsistent with the clinical and non-contrast CT findings.

Apart from aneurysms, DSA identified other vascular abnormalities, including three AVMs and one case each of dAVF, Moyamoya disease and vasculitis. Of particular importance was the case of multifocal vasculitis, in which the vascular changes were subtle on CTA but were demonstrated on DSA. This indicates that the diagnostic evaluation of non-traumatic SAH should extend beyond aneurysm detection. Detailed evaluation of the cerebral vasculature may be necessary to identify less common vascular abnormalities that can contribute to subarachnoid haemorrhage. DSA offers detailed visualisation of cerebral arterial anatomy and can provide additional diagnostic information in selected patients [12, 13].

Vasospasm was identified in eight patients (15.7%). Cerebral vasospasm is a recognised complication of SAH and is clinically important because of its association with delayed cerebral ischaemia and adverse neurological outcomes. Fisher and colleagues established the relationship between the amount of subarachnoid blood demonstrated on CT and the development of cerebral vasospasm [15]. The 2023 American Heart Association/American Stroke Association guideline also highlights the importance of appropriate monitoring and management of complications following aneurysmal SAH [16]. The detection and assessment of vasospasm therefore form an important component of the radiological evaluation and subsequent management of these patients.

DSA-related complications were observed in two patients (3.9%), comprising one groin haematoma and one transient neurological deficit. No contrast

reactions were reported. Although DSA is an invasive procedure and carries a risk of complications, it remains an important investigation when detailed evaluation of cerebral vascular anatomy is required [1-5]. The choice of vascular imaging should therefore consider the diagnostic information required, the patient's clinical condition and the potential risks associated with the procedure. CTA offers the advantage of rapid, non-invasive vascular assessment, whereas DSA provides additional information in selected cases [8-14].

The comparison between aneurysmal and non-aneurysmal SAH showed that patients with aneurysmal haemorrhage had significantly lower mean GCS scores than those with non-aneurysmal haemorrhage. The mean Hunt and Hess and Fisher grades were also significantly higher in the aneurysmal group. These findings indicate greater initial clinical severity and radiological haemorrhage burden among patients with aneurysmal SAH in the present study. In contrast, differences in age, sex distribution and hypertension between the two groups were not statistically significant. These observations underline the importance of identifying the underlying aetiology of SAH, as clinical severity and radiological findings may differ according to the cause of haemorrhage [1-5].

The present study has certain limitations. The sample size was relatively small, and the study was conducted at a single tertiary care centre, which may limit the generalisability of the findings. The number of very small aneurysms was also limited, restricting the assessment of CTA performance in this subgroup. Furthermore, discrepancies were identified between the reported CTA–DSA diagnostic-performance table and the individual case descriptions, particularly regarding the small basilar tip aneurysm missed on CTA. These findings require verification using the original patient-level data before definitive sensitivity, specificity and accuracy estimates can be reported. Despite these limitations, the study demonstrates the diagnostic usefulness of CTA and highlights the additional role of DSA in the comprehensive evaluation of patients with non-traumatic SAH.

CONCLUSION

CTA demonstrated high reported diagnostic performance and excellent morphometric reliability. Nevertheless, DSA remains important for detecting very small aneurysms and subtle non-aneurysmal vascular abnormalities, particularly when clinical suspicion persists.

REFERENCES

1. van Gijn J, Rinkel GJ. Subarachnoid haemorrhage: diagnosis, causes and management. Brain. 2001;124(Pt 2):249–278. doi:10.1093/brain/124.2.249.
2. Macdonald RL, Schweizer TA. Spontaneous subarachnoid haemorrhage. Lancet. 2017;389(10069):655–666. doi:10.1016/S0140-6736(16)30668-7.
3. Maher M, Schweizer TA, Macdonald RL. Treatment of spontaneous subarachnoid hemorrhage: guidelines and gaps. Stroke. 2020;51(4):1326–1332. doi:10.1161/STROKEAHA.119.025997.
4. Ingall T, Asplund K, Mähönen M, Bonita R. A multinational comparison of subarachnoid hemorrhage epidemiology in the WHO MONICA stroke study. Stroke. 2000;31(5):1054–1061. doi:10.1161/01.STR.31.5.1054.
5. Lawton MT, Vates GE. Subarachnoid hemorrhage. N Engl J Med. 2017;377(3):257–266. doi:10.1056/NEJMcp1605827.
6. Linn FH, Wijdicks EF, van der Graaf Y, Weerdesteyn-van Vliet FA, Bartelds AI, van Gijn J. Prospective study of sentinel headache in aneurysmal subarachnoid haemorrhage. Lancet. 1994;344(8922):590–593. doi:10.1016/S0140-6736(94)91970-4.
7. Perry JJ, Stiell IG, Sivilotti MLA, Bullard MJ, Emond M, Symington C, et al. Sensitivity of computed tomography performed within six hours of onset of headache for diagnosis of subarachnoid haemorrhage: prospective cohort study. BMJ. 2011;343:d4277. doi:10.1136/bmj.d4277.
8. Westerlaan HE, van Dijk JMC, Jansen-van der Weide MC, de Groot JC, Groen RJM, Mooij JJA, et al. 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. doi:10.1148/radiol.10092373.
9. Philipp LR, McCracken DJ, McCracken CE, Halani SH, Lovasik BP, Salehani AA, et al. Comparison between CTA and digital subtraction angiography in the diagnosis of ruptured aneurysms. Neurosurgery. 2017;80(5):769–777. doi:10.1093/neuros/nyw113.
10. MacKinnon AD, Clifton AG, Rich PM. Acute subarachnoid haemorrhage: is a negative CT angiogram enough? Clin Radiol. 2013;68(3):232–238. doi:10.1016/j.crad.2012.07.004.
11. 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(3):594–602. doi:10.3174/ajnr.A0848.
12. Heit JJ, Pastena GT, Nogueira RG, Yoo AJ, Leslie-Mazwi TM, Hirsch JA, et al. Cerebral angiography for evaluation of patients with CT angiogram-negative subarachnoid hemorrhage: an 11-year experience. AJNR Am J Neuroradiol. 2016;37(2):297–304. doi:10.3174/ajnr.A4503.
13. Agid R, Andersson T, Almqvist H, Willinsky RA, Lee SK, terBrugge KG, et al. Negative CT

angiography findings in patients with spontaneous subarachnoid hemorrhage: when is digital subtraction angiography still needed? AJNR Am J Neuroradiol. 2010;31(4):696–705. doi:10.3174/ajnr.A1884.

14. Sailer AMH, Grutters JP, Wildberger JE, Hofman PA, Wilmink JT, van Zwam WH. Cost-effectiveness of CTA, MRA and DSA in patients with non-traumatic subarachnoid haemorrhage. Insights Imaging. 2013;4(4):499–507. doi:10.1007/s13244-013-0264-6.
15. Fisher CM, Kistler JP, Davis JM. Relation of cerebral vasospasm to subarachnoid hemorrhage visualized by computerized tomographic scanning. Neurosurgery. 1980;6(1):1–9. doi:10.1227/00006123-198001000-00001.
16. Hoh BL, Ko NU, Amin-Hanjani S, Chou SHY, Cruz-Flores S, Dangayach NS, et al. 2023 guideline for the management of patients with aneurysmal subarachnoid hemorrhage: a guideline from the American Heart Association/American Stroke Association. Stroke. 2023;54(7):e314–e370. doi:10.1161/STR.0000000000000436.s

Cite This Article: Nandanwar, K. D., Sonawane, S., & Pawar, S. S. (2026). A Study of CT Angiography and Digital Subtraction Angiography Findings in Patients Presenting with Non-Traumatic Subarachnoid Haemorrhage. *EAS J Radiol Imaging Technol, 8*(6), 233-242. https://doi.org/10.36349/easjrit.2026.v08i06.013