

## ROLE OF CT AND MRI IN EVALUATION OF INTRACRANIAL ANEURYSM: A HOSPITAL-BASED PROSPECTIVE CROSS-SECTIONAL DIAGNOSTIC STUDY

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### Abstract

**Introduction:** To compare the diagnostic performance of computed tomography (CT) and magnetic resonance imaging (MRI), individually and in combination, in detecting, characterising and evaluating intracranial aneurysms.

**Materials and Methods:** This hospital-based prospective cross-sectional study was carried out in the Department of Radiodiagnosis, Katihar Medical College and Hospital, Katihar, over two and a half years. Fifty consecutive patients with suspected or known intracranial aneurysm underwent CT angiography (16-slice multidetector scanner) and MR angiography (1.5 Tesla), with digital subtraction angiography (DSA) as the reference standard. Data were analysed in SPSS using descriptive statistics, the chi-square test and yield analysis.

**Results:** The mean age was  $43.42 \pm 11.64$  years, 58% of patients were male and 60% were from semi-urban areas. Cranial nerve palsy (36%) was the commonest presentation, followed by subarachnoid haemorrhage (30%). CT detected aneurysms in 40 of 50 patients (sensitivity 80%) and MRI in 47 of 50 (sensitivity 94%); DSA confirmed aneurysms in all 50. The middle cerebral artery (34%) and anterior communicating artery (22%) were the commonest sites. Saccular and fusiform aneurysms each accounted for 36% of cases, and 52% had ruptured at presentation. Detection by either modality was not significantly associated with aneurysm size or morphology, and rupture was not significantly associated with risk factors (all  $p > 0.05$ ).

**Conclusion:** MRI showed higher sensitivity and diagnostic accuracy than CT, particularly for small lesions, while CT remained valuable for rapid assessment in emergencies. A combined approach gives the most comprehensive evaluation.

**Recommendation:** CT angiography is suggested as the first-line investigation in acute presentations, with MR angiography added in stable patients, when CT is negative or equivocal, and for detailed characterisation. Larger multicentre studies that include aneurysm-negative patients are needed.

**Keywords:** Intracranial aneurysm, Computed tomography angiography, Magnetic resonance angiography, Digital subtraction angiography, Subarachnoid haemorrhage, Diagnostic accuracy

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## Introduction

An intracranial aneurysm is a focal outpouching of a cerebral artery wall, found most often at the points where vessels divide around the circle of Willis.<sup>1,2,3</sup> Loss of integrity in the internal elastic lamina and the muscular media, together with sustained haemodynamic stress, lets the wall bulge outward gradually.<sup>4,5</sup> The saccular form is encountered most frequently, whereas fusiform and dissecting lesions are less common.<sup>1,2</sup>

Around 3-5% of adults are believed to carry an unruptured aneurysm, and the majority are found by chance when imaging is requested for another reason.<sup>6,7</sup> Rupture produces subarachnoid haemorrhage, a severe type of stroke with high case fatality that often leaves survivors with lasting neurological deficits; the burden is greatest where specialised neurovascular services are scarce. The way aneurysm care is delivered in India has been described through a national practice survey.<sup>8</sup>

The clinical picture is variable. Unruptured lesions may cause no symptoms or only non-specific complaints such as headache and visual disturbance, while larger lesions can press on adjacent nerves and produce a cranial nerve palsy.<sup>9,10,11</sup> Rupture classically announces itself as a sudden, severe "thunderclap" headache, frequently with vomiting or a change in consciousness.<sup>9</sup> Hypertension and smoking are among the best-recognised risk factors for aneurysm formation, growth and rupture.<sup>12,13,14</sup>

Imaging therefore underpins both the incidental discovery of unruptured aneurysms and the urgent assessment of suspected rupture.<sup>15,16,17</sup> Digital subtraction angiography (DSA) remains the reference standard but is invasive.<sup>18</sup> CT and CT angiography are usually requested first in emergencies because they are quick, widely available and highly sensitive to acute blood. MRI and MR angiography provide better soft-tissue contrast and multiplanar views of the vessels, which may help with small or morphologically complex aneurysms, and vessel wall MRI can also show the aneurysm wall and the surrounding brain.<sup>19,20</sup> Comparisons of CT angiography and MR angiography against DSA have already been reported,<sup>21,22</sup> yet neither technique alone answers every clinical question. This study was therefore designed to compare the two modalities, singly and together, in a hospital population from eastern India.

## Aims and objectives

**Aim:** To examine and analyse the specific roles of CT and MRI, individually and in conjunction, for the comprehensive evaluation of intracranial aneurysms, including their effectiveness in detection, characterisation and risk assessment.

## Objectives:

To evaluate the sensitivity of CT and MRI in detecting intracranial aneurysms.

To compare the ability of CT and MRI to characterise the size, location and morphology of intracranial aneurysms.

To assess the accuracy of CT and MRI in identifying factors associated with aneurysm rupture risk.

To evaluate the clinical utility of CT angiography and MR angiography in visualising the vascular anatomy surrounding intracranial aneurysms.

## Materials and methods

**Study Design and Setting:** This was a hospital-based, prospective, cross-sectional observational diagnostic study conducted in the Department of Radiodiagnosis, Katihar Medical College and Hospital (KMCH), Katihar, Bihar. KMCH is a private tertiary care teaching hospital on the Katihar-Purnia road, established in 1987 and run by the Al-Karim Educational Trust. It is 600-bed general hospital that provides outpatient, inpatient and emergency care across the major medical and surgical specialties and runs undergraduate (MBBS) and postgraduate (MD/MS) teaching programmes. The hospital serves rural and semi-urban communities in and around Katihar. The Department of Radiodiagnosis provides the CT, MRI and angiographic services used in this study.

**Study Duration:** The study was conducted over a period of two and a half years, from January 2024 to June 2026, covering patient recruitment, imaging, and data analysis.

**Study Population and Sample Size:** The study population comprised patients with suspected or known intracranial aneurysm who were referred to the department for radiological evaluation during the study period. Fifty patients were enrolled. A total of 50 patients were included in the study based on the number of eligible patients who underwent CT angiography, MR angiography, and digital subtraction angiography (DSA) during the two-and-a-half-year study period. No formal statistical sample size calculation was performed because the study included all patients who met the predefined eligibility criteria during the study period. Participants were selected using a consecutive sampling method, whereby eligible patients presenting during the study period were enrolled consecutively until the end of the study period. Patients were included only if they fulfilled the inclusion criteria and had the necessary imaging investigations available for analysis. Patients who did not meet the eligibility criteria or had incomplete imaging data were excluded. Thus, the final sample size of 50 patients represented the total number of eligible patients included during the study period.

**Participant Selection:** Patients were identified at the time of referral and screened against the inclusion and exclusion criteria below. All eligible patients who gave written informed consent were enrolled consecutively, without selecting on age, sex, residence or clinical severity.

**Inclusion Criteria:** (i) patients with suspected or known intracranial aneurysm; (ii) patients undergoing both CT angiography and MR angiography; (iii) availability of complete clinical and imaging data.

**Exclusion Criteria:** (i) patients with contraindications to MRI such as a cardiac pacemaker or severe claustrophobia; (ii) patients with contrast allergy or renal impairment; (iii) patients with incomplete clinical or imaging data.

**Bias:** Several measures were implemented to minimize potential sources of bias. Selection bias was reduced by consecutively enrolling eligible patients throughout the study period and applying predefined inclusion and exclusion criteria uniformly. Verification bias was minimized by ensuring that all included patients underwent CT angiography, MR angiography, and digital subtraction angiography (DSA), with DSA serving as the reference standard for all participants. To reduce measurement bias, standardized imaging protocols were followed, and images were independently evaluated by experienced radiologists who were blinded to the findings of the other imaging modalities, wherever applicable. Information bias was minimized by systematically recording clinical and imaging findings using a structured data collection proforma. Furthermore, the same reference standard was applied to all participants to maintain consistency in diagnostic assessment. However, spectrum bias could not be excluded because the study population consisted exclusively of patients with aneurysms confirmed by DSA. Consequently, the findings may not be generalizable to patients without aneurysms or to populations with a broader clinical spectrum. This limitation has been acknowledged in the Limitations section.

**Imaging Protocol:** All patients underwent CT angiography using a 16-slice multidetector CT scanner with intravenous non-ionic iodinated contrast. MR angiography was performed on a 1.5 Tesla MRI system using time-of-flight sequences supplemented by routine T1-weighted, T2-weighted and fluid-attenuated inversion recovery (FLAIR)

sequences, with gadolinium-based contrast used when required. DSA served as the reference standard for confirmation of aneurysms. Imaging studies were independently analysed by experienced radiologists for aneurysm presence, size, shape, location and morphological features.

**Data Collection and Statistical Analysis:** Data were collected using a structured proforma covering demographic details, clinical presentation, imaging findings and final diagnosis, entered into Microsoft Excel and analysed using SPSS software. Descriptive statistics (frequency, mean, standard deviation) were computed, and the chi-square test was applied to assess associations between categorical variables, with a p-value < 0.05 considered statistically significant. Yield analysis (sensitivity, specificity, positive and negative predictive value, and diagnostic accuracy) was used to compare CT and MRI.

**Ethical Considerations:** The study was approved by the Institutional Ethics Committee of Katiyar Medical College, and written informed consent was obtained from all patients. Patient confidentiality was maintained throughout the study.

## Results

During the two-and-a-half-year study period, 50 patients with suspected or known intracranial aneurysms were consecutively enrolled. All 50 patients underwent CT angiography, MR angiography, and digital subtraction angiography (DSA). All enrolled patients completed the required imaging examinations and were included in the final analysis. No participants were lost after enrolment. The total number of patients assessed for eligibility before enrolment and the number of patients excluded before enrolment could not be established because screening records were unavailable.

**Figure 1**

*Flow of Participants Through the Study*

|                                                                                                                              |   |                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Patients with suspected or known intracranial aneurysm referred for radiological evaluation during the study period ( n=50 ) |   |                                                                                                                                                                                                                                                                                                                      |
| ↓                                                                                                                            |   |                                                                                                                                                                                                                                                                                                                      |
| Assessed for eligibility ( n=50 )                                                                                            | → | <b>Excluded (n = 0 )</b> <ul style="list-style-type: none"> <li>• Did not meet inclusion criteria (n = __)</li> <li>• MRI contraindication (n = __)</li> <li>• Contrast allergy or renal impairment (n = __)</li> <li>• Incomplete clinical or imaging data (n = __)</li> <li>• Declined consent (n = __)</li> </ul> |
| ↓                                                                                                                            |   |                                                                                                                                                                                                                                                                                                                      |
| Enrolled consecutively (n = 50)                                                                                              |   |                                                                                                                                                                                                                                                                                                                      |
| ↓                                                                                                                            |   |                                                                                                                                                                                                                                                                                                                      |
| Underwent CT angiography, MR angiography and DSA (n = 50)                                                                    |   |                                                                                                                                                                                                                                                                                                                      |
| ↓                                                                                                                            |   |                                                                                                                                                                                                                                                                                                                      |
| Included in the final analysis (n = 50)                                                                                      |   |                                                                                                                                                                                                                                                                                                                      |

*Note.* CT = computed tomography; MR = magnetic resonance; DSA = digital subtraction angiography.

The mean age of the study population was  $43.42 \pm 11.64$  years (range 26-64 years), with a slight male preponderance (58% male, 42% female). The majority of patients (60%) belonged to semi-urban areas, followed by rural (24%) and urban (16%) populations (Table 1).

**Table 1**

*Distribution of Age, Gender and Residence of the Study Participants*

| Parameter    | Category   | f         | %            | Mean $\pm$ SD     |
|--------------|------------|-----------|--------------|-------------------|
| Age (years)  | <30        | 9         | 18.0         | $43.42 \pm 11.64$ |
|              | 31-40      | 13        | 26.0         |                   |
|              | 41-50      | 10        | 20.0         |                   |
|              | >50        | 18        | 36.0         |                   |
| Gender       | Male       | 29        | 58.0         | -                 |
|              | Female     | 21        | 42.0         |                   |
| Residence    | Semi-urban | 30        | 60.0         | -                 |
|              | Rural      | 12        | 24.0         |                   |
|              | Urban      | 8         | 16.0         |                   |
| <b>Total</b> |            | <b>50</b> | <b>100.0</b> |                   |

*Note.* N = 50. f = frequency; SD = standard deviation.

Clinically, cranial nerve palsy was the most frequent presentation (36%), followed by subarachnoid haemorrhage (30%), headache (18%) and visual symptoms (16%) (Table 2).

**Table 2**

*Distribution of Clinical Presentation*

| Clinical presentation    | f         | %            |
|--------------------------|-----------|--------------|
| Cranial nerve palsy      | 18        | 36.0         |
| Subarachnoid haemorrhage | 15        | 30.0         |
| Headache                 | 9         | 18.0         |
| Visual symptoms          | 8         | 16.0         |
| <b>Total</b>             | <b>50</b> | <b>100.0</b> |

Note. N = 50. f = frequency.

Among risk factors, a combination of hypertension and smoking was most common (36%), while 26% of patients had no identifiable risk factor. Hypertension alone and

smoking alone were noted in 20% and 18% of patients, respectively (Table 3).

**Table 3**

*Distribution of Risk Factors*

| Risk factor            | f         | %            |
|------------------------|-----------|--------------|
| Hypertension + smoking | 18        | 36.0         |
| None                   | 13        | 26.0         |
| Hypertension alone     | 10        | 20.0         |
| Smoking alone          | 9         | 18.0         |
| <b>Total</b>           | <b>50</b> | <b>100.0</b> |

Note. N = 50. f = frequency.

On imaging, CT angiography detected aneurysms in 40 of the 50 patients (80%), while MR angiography detected aneurysms in 47 of the 50 patients (94%). DSA, used as the

reference standard, confirmed the presence of an aneurysm in all 50 patients (100%) (Table 4).

**Table 4**

*Comparison of Aneurysm Detection by CT Angiography, MR Angiography and DSA*

| Modality       | Detected | Not detected | Detection rate (%) | Total |
|----------------|----------|--------------|--------------------|-------|
| CT angiography | 40       | 10           | 80.0               | 50    |
| MR angiography | 47       | 3            | 94.0               | 50    |
| DSA            | 50       | 0            | 100.0              | 50    |

Note. CT = computed tomography; MR = magnetic resonance; DSA = digital subtraction angiography.

The middle cerebral artery (34%) and anterior communicating artery (22%) were the most common sites of aneurysm, followed by the basilar artery (18%), posterior communicating artery (16%) and internal carotid artery (10%). The mean aneurysm size was  $7.16 \pm 3.50$  mm, with

the majority measuring between 7-10 mm (26%) or less than 5 mm (28%). Saccular and fusiform morphologies were equally represented (36% each), with irregular morphology in 28% of cases. Rupture had occurred in 52% of patients at presentation (Table 5).

**Table 5**

*Distribution of Aneurysm Site, Size, Morphology and Rupture Status*

| Parameter      | Category                       | n (%)     |
|----------------|--------------------------------|-----------|
| Aneurysm site  | Middle cerebral artery         | 17 (34.0) |
|                | Anterior communicating artery  | 11 (22.0) |
|                | Basilar artery                 | 9 (18.0)  |
|                | Posterior communicating artery | 8 (16.0)  |
|                | Internal carotid artery        | 5 (10.0)  |
| Size (mm)      | <5                             | 14 (28.0) |
|                | 5-7                            | 12 (24.0) |
|                | 7-10                           | 13 (26.0) |
|                | >10                            | 11 (22.0) |
| Morphology     | Saccular                       | 18 (36.0) |
|                | Fusiform                       | 18 (36.0) |
|                | Irregular                      | 14 (28.0) |
| Rupture status | Ruptured                       | 26 (52.0) |
|                | Unruptured                     | 24 (48.0) |

Note. N = 50. Mean aneurysm size = 7.16 mm (SD = 3.50). On statistical analysis, neither CT detection nor MRI detection showed a significant association with aneurysm size (CT:  $\chi^2 = 3.545$ ,  $p > 0.05$ ; MRI:  $\chi^2 = 1.051$ ,  $p > 0.05$ ) or morphology (CT:  $\chi^2 = 0.397$ ,  $p > 0.05$ ; MRI:  $\chi^2$  not significant,  $p > 0.05$ ). Similarly, rupture showed no statistically significant association with risk factor category ( $\chi^2 = 3.402$ ,  $p > 0.05$ ), although rupture was numerically more frequent among patients with combined hypertension

and smoking.

Yield analysis showed that CT had a sensitivity of 80% and an overall diagnostic accuracy of 80%, whereas MRI achieved a sensitivity of 94% and an overall accuracy of 94%. As all included patients were aneurysm-positive on DSA, specificity and positive predictive value could not be meaningfully calculated for either modality, while the negative predictive value was 100% for both (Table 6).

**Table 6**

*Diagnostic Performance of CT and MRI in the Detection of Intracranial Aneurysm*

| Diagnostic parameter      | CT (%) | MRI (%) |
|---------------------------|--------|---------|
| Sensitivity               | 80.0   | 94.0    |
| Negative predictive value | 100.0  | 100.0   |
| Diagnostic accuracy       | 80.0   | 94.0    |

Note. CT = computed tomography; MRI = magnetic resonance imaging. DSA was the reference standard.

## Discussion

### Key Findings

In this series of 50 patients, MR angiography identified 47 aneurysms (94%) and CT angiography 40 (80%), against 50 confirmed by DSA (objective 1). Middle cerebral and anterior communicating artery lesions were the commonest

(34% and 22%), the mean diameter was 7.16 mm, and saccular and fusiform shapes were equally frequent (36% each); detection by either technique did not differ significantly with lesion size or shape (objective 2). Just over half the aneurysms (52%) had already ruptured at presentation, and rupture showed no significant link with

risk-factor category, although it was numerically commoner with combined hypertension and smoking (objective 3). Taken together, the results suggest complementary roles for the two techniques in clinical practice (objective 4).

## Interpretation

The advantage of MRI over CT here should be read cautiously, because the sample was small and the 95% confidence intervals around each sensitivity would be wide. Even so, the direction of the difference agrees with earlier work. Lim et al. reported that using CT angiography and MR angiography together improved detection relative to either test alone,<sup>21</sup> and the ten aneurysms missed by CT in our series are in keeping with the observation by Mkhize et al. that CT angiography can overlook small lesions.<sup>23</sup> Josephson et al. compared the two techniques for intracranial vascular malformations in patients with intracerebral haemorrhage,<sup>24</sup> but that population differs from ours, so their results are not directly comparable. Reviews of imaging for intracranial aneurysms likewise describe CT as the practical first step in emergencies and MR-based methods as a refinement for more detailed assessment.<sup>15,16</sup>

The preponderance of middle cerebral and anterior communicating artery aneurysms mirrors an earlier report from north-west India.<sup>25</sup> Rupture was seen in every risk-factor group without a statistically significant association, which fits the multifactorial picture described for aneurysm rupture and growth.<sup>13,26,27</sup> With only 50 patients, however, the study had little power to detect modest associations, so a non-significant result should not be taken as proof that these factors are unimportant. Beyond detection, vessel wall MRI has been explored for follow-up after flow diversion,<sup>19,20</sup> an application that lay outside the scope of this study.

## Generalizability

The findings come from a single tertiary care centre, from patients who were referred for imaging and who all proved aneurysm-positive on DSA, and from one 16-slice CT scanner and one 1.5 Tesla MRI system. They are most applicable to comparable referral hospitals in eastern India. Caution is needed before extending them to screening of unselected populations, to centres with different scanner technology or reader experience, or to settings in which many patients have no aneurysm.

## Conclusion

MRI demonstrated greater sensitivity and diagnostic accuracy than CT in the detection and characterisation of intracranial aneurysms in this study, particularly for smaller lesions, owing to its superior soft-tissue resolution and comprehensive vascular assessment. CT nonetheless retains an important role for rapid initial evaluation, especially in emergency settings where speed and accessibility are paramount. The two modalities should be regarded as

complementary rather than competing, with CT serving as the first-line investigation in acute presentations and MRI reserved for thorough characterisation and follow-up, particularly in haemodynamically stable patients. A combined CT-MRI approach, applied judiciously according to clinical need, offers the most comprehensive strategy for the evaluation and management of intracranial aneurysms.

## Limitations

The principal limitation of this study was its relatively small sample size of 50 patients, which limits the generalisability of the findings. In addition, since all enrolled patients were aneurysm-positive on DSA, specificity and positive predictive value could not be meaningfully assessed for either modality. Logistic constraints, including patient instability and MRI-related contraindications such as claustrophobia, also affected imaging availability in a subset of patients. The study was conducted at a single centre, which may further limit external validity.

## Recommendations

1. CT angiography should be used as the first-line investigation in acute presentations, because of its speed and availability.
2. MR angiography should be added in haemodynamically stable patients, when CT is negative or equivocal, and when detailed characterisation of small or complex aneurysms is needed.
3. Where both facilities are available, a combined CT-MRI strategy should be applied according to clinical need.
4. Larger, multicentre prospective studies that also include patients without aneurysms are recommended, so that specificity and predictive values can be reported.

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## List of abbreviations

CT - Computed tomography  
DSA - Digital subtraction angiography  
FLAIR - Fluid-attenuated inversion recovery  
KMCH - Katihar Medical College and Hospital  
MBBS - Bachelor of Medicine, Bachelor of Surgery  
MD/MS - Doctor of Medicine / Master of Surgery  
MR - Magnetic resonance  
MRI - Magnetic resonance imaging  
SD - Standard deviation  
SPSS - Statistical Package for the Social Sciences

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## Conflict of interest

The authors declare that they have no conflict of interest.

## Author contributions

Dr. Amit Kumar Gupta: conceptualisation, data collection and drafting of the manuscript. Dr. Md Shahzeb Alam: data analysis, interpretation, manuscript revision and correspondence. Dr. Manish Jaiswal: supervision, validation of imaging interpretation and critical revision. All authors read and approved the final manuscript.

## Data availability

The datasets generated and analysed during this study are available from the corresponding author on reasonable request. All data are anonymised to protect patient confidentiality.

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