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**Original Research Article**

# Detection of Cerebral Aneurysm in Cerebral Arteries Following Non-Invasive CT Angiogram

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**Abstract:** ***Background:*** Cerebral aneurysm is the basic cause of sub-arachnoid hemorrhage; Computed tomographic angiogram is the non-invasive approach to diagnose aneurysm by reconstructing the image in 3D dimension making it possible to locate the aneurysm and differentiate it from other arteries. ***Objective:*** Focus of this study was to investigate the accuracy of CTA to detect the aneurysm, its type, location and size. ***Material and method:*** Data of 50 patients was taken retrospectively with cost-benefit approach that undergoes non-invasive CTA through Aquilion 64-slices CT machine under post-processing work station. ***Results:*** This retrospective study is taken with 50 patients, with a 38 percent positive predictive value and a 62 percent negative predictive value, multi-slice CT properly revealed substantial aneurysm in 19 of 50 cases. ***Conclusion:*** 64-slices CT provides high diagnostic accuracy for detecting the aneurysm in cerebral arteries with a non-invasive angiogram procedure.
**Key words:** Computed Tomography, Cerebral Aneurysm, CTA, 3D recontruction.



## INTRODUCTION

Cerebral aneurysms (CA) have observed to have high prevalence rate [1, 2] and is the commonest cause of Sub-Arachnoid hemorrhage [3, 4]. Non-Invasive Computed tomography angiogram (CTA) is a common technique for the detection of aneurysms [5, 6]. Usually, it takes time for radiotherapists to distinguish aneurysms from images, predominantly those of small size. Whose outcome is the under-detection of aneurysms in clinical setting? Results in the risk of the life-threatening rupture, that why CTA is the dynamic tool to help radiotherapists to detect aneurysm in pre-earlier stage. Cerebral aneurysm is not an uncommon disease, having a prevalence rate of 0.5% to 6% in adults in general population of Pakistan. They are several in 10-30% of cases. While most of the aneurysm are small in size but they can lead to quite a lot of morbidity and mortality. Mostly the common presentation of rupture leads to subarachnoid hemorrhage [7].

Rupture of cerebral aneurysm results for most SAHs [8] but the actual origin of hemorrhage is not known in 15%–20% of patients [9, 10]. Previous studies have verified that the pattern of SAH on a non-contrast head CT may forecast the possibility of identifying a causative vascular aneurysm; however CT angiogram is been required to detect these aneurysms [11, 15].

New prospects have been opened in the management of cerebral aneurysm in Non-Invasive CTA, which offers certain advantages over DSA. CTA is readily available and non-invasive procedure which produces sufficient amount of information to allow effective therapeutic decision-making. The development of 3D-CTA has the potential to help clinicians consistently detect clinically significant of aneurysms and to provide radiologists, neurosurgeons, and other clinicians an easily reachable and immediately relevant diagnostic support tool [16].

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With more detectors and thinner collimation, greater resolution, and better contrast bolus timing, CTA technology is progressing. Scans will be performed more rapidly with thinner collimation, high resolution, and better timing of contrast bolus. Increases in spatial resolution will also likely improve the sensitivity of detecting aneurysms and their associated branch arteries of smaller size[17] 3DCTA, or Non-invasive Time-resolved CTA is a technique for assessing the flow dynamics of aneurysms by taking numerous images of a region of interest over time [18]. It can identify aneurysms that were previously difficult to distinguish from nearby vessels, such as those associated with arteriovenous malformations, by distinguishing between distinct phases of blood flow [19]. Additionally, specific features currently identifiable on electrocardiogram-gated 3D-CTA can detect aneurysm pulsations during the cardiac cycle and are being investigated for a higher risk of growth and rupture [20]. Another recent breakthrough is the use of computational fluid dynamics to quantify blood flow within the aneurysm in order to establish parameters such as aneurysmal wall shear stress and peak wall tension, both of which are known to be associated to rupture risk. These models are dependent on a number of mathematical assumptions, and a consensus method for predicting rupture has yet to be devised. Without a question, computational fluid dynamics has a lot of potential in the future for aiding with the management of cerebral aneurysms [21].

Aneurysm wall transparency can be measured using dynamically contrast-enhanced (DCE)-MRI and the perfusion factor K trans, a size-independent indicator of rupture risk [22]. More monitoring and assessment are being designed to help with aneurysm characterization and the determination of features connected to rupture risk. In higher field strength 7 T MRI scanners with an extraordinarily high signal-to-noise ratio, the spatial resolution needed to distinguish oscillations in aneurysm wall thickness, that may be a indicator of rupture risk [23]. Other techniques can identify abnormalities in aneurysmal wall motion that are linked to a higher risk of rupture [24].

## DETECTION OF CEREBRAL ANEURYSM

Non-invasive CTA uses multi-detector helical CT scanners with multi-planar reformats, sub-millimeter slice thickness, or three-dimensional reconstructions. According to specific researchers, current multidetector scanners offer spatial resolution that successfully detect aneurysms larger than 4 mm with 100 percent sensitivity. The overall sensitivity rate for all aneurysm diameters was 97 percent in a meta-analysis of studies utilising 64-slice CT scanners with sub-millimeter accuracy to detect brain cerebral aneurysms [25]. Early CT technology, on the other hand, was shown to be ineffective for aneurysms 3 mm and smaller, having sensitivity figures as lower as 84 percent from 4-channel multi-row detector CT scanners [26]. Studies using more contemporary technology have yielded more promising outcomes, with 16-slice CT scanners achieving 99.6% sensitivity [27]. Using a 64-slice CT scanner, Xing *et al.* [28] were able to detect small aneurysms with even greater sensitivity. Than conventional nonrotational digital subtraction angiography; however, when using a 320-slice CT, Wang et al. found that aneurysms smaller than 3 mm had an 81.8 percent sensitivity [29].

3D-CTA is a new technology that has been widely studied in patients with cerebral aneurysms. This technique has the advantage of being non-invasive, easily accessible and convenient. Unlike DSA, it is also used to identify the relation of vascular structure with surrounding bony anatomy. In this study, we have established the effectiveness of 3D-CTA in the diagnosis of cerebral aneurysms. CTA scans images were used to plan and perform the surgery. CTA was found to be an accurate diagnostic method with over 90% sensitivity and 100% specificity when pre-operative results were compared and post-operative follow-up was performed. Studies on the utility and accuracy of 3D-CTA technique in detecting and managing aneurysm have been conducted all over the world since its recent introduction. It also gives you the anatomical details you need for a better surgical approach. The use of 3D-CTA in treatment planning is extremely beneficial [30].

The quantitative evaluation and assessment of intracranial aneurysms is fundamentally important for bisection of intracranial aneurysms in CTA. Most intracerebral aneurysm CTA images reveal not just the lumen (which appear as a defined substance), as well as the embolism (which presents as a scattered entity with low contrast in comparison to normal tissue, making manually or automated delineation difficult). On a sequence of cross-sectional CTA images, a radiologist visualizes the bulging sections of artery vessels to locate an intracerebral aneurysm. The radiographer must manually identify the morphology of the aneurysm and thrombus on each image in order to obtain a full volumetric estimation of an intracerebral aneurysm and concomitant thrombus. This extremely time-consuming technique can take 30 to 45 minutes for radiologist [31].

The division of cerebral aneurysms is an important element of medical treatment. It enables the reconstruction of three-dimensional patient-specific configurations, which can help with measurement gathering at various stages of treatment. These geometries, in particular, can help with rupture risk assessment, which is typically based on aneurysm diameter and dome-neck area ratio (AR) [32, 33]. Surgical planning, such as surgical intervention and stent insertion, is influenced by the geometric features of intracerebral aneurysms [34]. Finally, the variation in aneurysm diameter can be identified as a major marker of rupture risk in postoperative follow-up studies [35].

The size and location of unruptured intracerebral aneurysms detected incidentally were indicative of subsequent rupture risk, according to the International Study of Unruptured Incidental Aneurysms (ISUIA) [36]. Aneurysms who have already burst are started to eventually re-hemmorhage [37, 38]. Uneven domes, daughter sacs, and moderate wall shear stress have all been associated to aneurysm Angio morphology, which can impact future hemorrhage risk factors. As a result, accurately determining aneurysmal morphology is key for directing therapy, making neuroimaging an important part of assessing and treating patients with intracranial aneurysms. Each neuroimaging method has its own number of features, drawbacks, and recent developments. Three major imaging modalities are employed for intracerebral aneurysm neuroimaging: CT angiography, MRI angiography, and digital subtraction angiography are three types of angiography [39, 40]. The role of CT brain angiography and 3D-CTA in the detection of intracerebral aneurysms is discussed in this research.

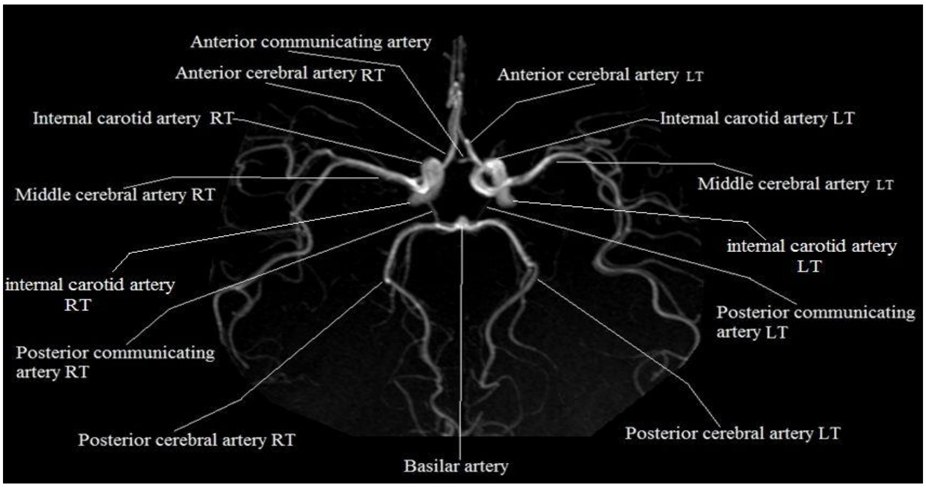



**Figure 1: Normal anatomy of cerebral arteries on non-invasive CT angiogram**

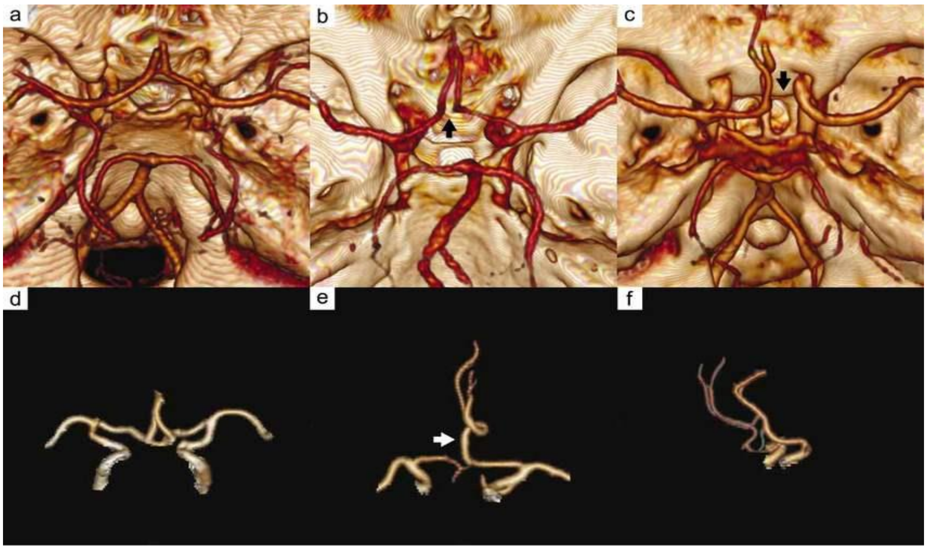



**Figure 2: Figure shows 3D reconstruction of Circle of Willis showing different cerebral arteries differentiating from each other**

## OBJECTIVE

1. To visualize pre-operative cerebral aneurysm in cerebral arteries by using Non-Invasive CT angiogram for evaluation of causative vascular lesion, its volume, location, rupture status, as well as other imaging characteristics help clinicians make early and suitable treatment guidelines.
2. To measure the accuracy of 64-slice MDCT by 3D-reconstruction of CT brain angiogram.

## RATIONALE

1. The majority of our community members are diabetic, hypertensive, have a family history of diabetes, are smokers, are fat, have high cholesterol levels, do not exercise, and so on
2. Cerebral aneurysm is the main cause of sub-arachnoid hemorrhage.
3. In those cases, CT angiography is the first method for imaging or screening a cerebral aneurysm.

4. Using CT angiography, physicians can establish the nature, size, and specific location of aneurysms in the cerebral arteries. This is a non-invasive method that uses CT angiography to provide quick scanning with high spatial resolution and the smallest slice thickness possible.
5. Despite the fact that in Digital Subtraction Angiography is an intrusive procedure for diagnosing aneurysms that is both costly and risky due to the possibility of arterial rupture. As a result, a CT angiography is a technique for visualizing the origin of an aneurysm and determining its size and type.
6. Reduces discrepancies between imaging and intraoperative findings.

# MATERIAL AND METHODS

This was a hospital-based retrospective study, conducted in radiology department of MEDCARE INTERNATIONAL HOSPITAL, Gujranwala after getting approval from the radiological committee. The duration of the study was from December 2020 to March 2022. Data of 50 patients was taken with cost-benefit approach. Scan was performed under Aquilion 64-slices CT machine with 370 mg Ultravist contrast media injected through Nemoto injector under post processing work station.

**Inclusion Criteria**

Inclusion criteria will be age between 10 - 75 years who have severe headache with blurred vision, vertigo and further symptoms of cerebral aneurysm.

**Exclusion Criteria**

Patients with uncooperative behavior, pregnant women. Decrease GFR, decrease creatinine level and is allergic to contrast media.

All patients were subjected to the following: Patients were taken according to inclusion criteria and exclusion criteria. Whole procedure was explained to the patient and family members and the informed consent was taken from patient and family members. A detailed history of patient was taken with physical examination findings and lab reports.

# RESULTS

Data of 50 patients having CT angiograms collected between December 2020 and March 2022, with 19 having positive aneurysms. The average age was 11.38 + 75.59 years, with 52 percent of men and 48 percent of women. In the radiology department of Medcare International Hospital, Gujranwala, all patients received a non-invasive CT angiography. The following were the clinical symptoms: Vertigo was reported by 22%, blurred vision by 18%, hypertension by 68 percent, and headache by 58 percent.

**Table 1: Frequency of patient data set according to gender**

| GENDER | | | |
|---|---|---|---|
| | | Frequency | Percent |
| Valid | Male | 26 | 52.0 |
| | Female | 24 | 48.0 |
| | **Total** | **50** | **100.0** |

**Table 2: Frequency of aneurysm positive or negative in patient data set**

| ANEURYSM | | | |
|---|---|---|---|
| | | Frequency | Percent |
| Valid | Positive | 19 | 38.0 |
| | Negative | 31 | 62.0 |
| | **Total** | **50** | **100.0** |

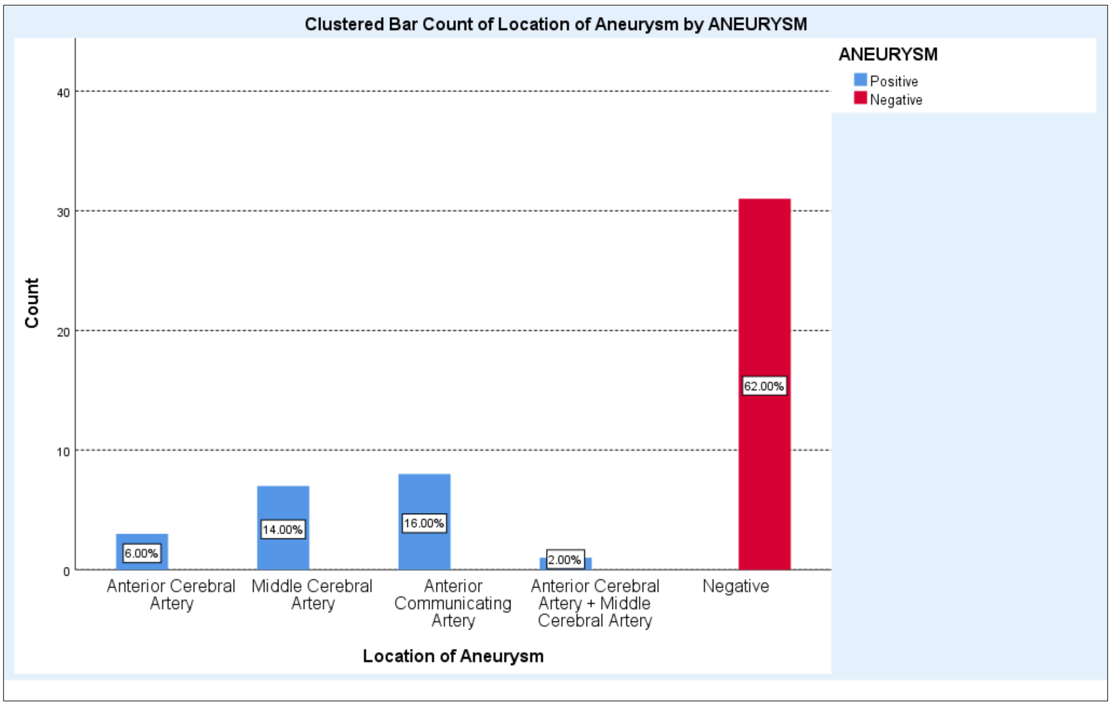
**Table 3: Frequency of patient data set according to age group**

| AGE GROUP | | | |
|---|---|---|---|
| | | Frequency | Percent |
| Valid | 11-15 years | 1 | 2.0 |
| | 16-20 years | 1 | 2.0 |
| | 26-30 years | 3 | 6.0 |
| | 31-35 years | 3 | 6.0 |
| | 36-40 years | 3 | 6.0 |
| | 41-45 years | 10 | 20.0 |
| | 46-50 years | 9 | 18.0 |
| | 51-55 years | 7 | 14.0 |
| | 56-60 years | 6 | 12.0 |
| | 61-65 years | 4 | 8.0 |
| | 66-70 years | 2 | 4.0 |
| | 71-75 years | 1 | 2.0 |
| | **Total** | **50** | **100.0** |

All 50 patients undergo CTA with a symptom of aneurysm and were analyzed for the presence of aneurysm. With a 38 percent positive predictive value and a 62 percent negative predictive value, multi-slice CT properly revealed substantial aneurysm in 19 of 50 cases.

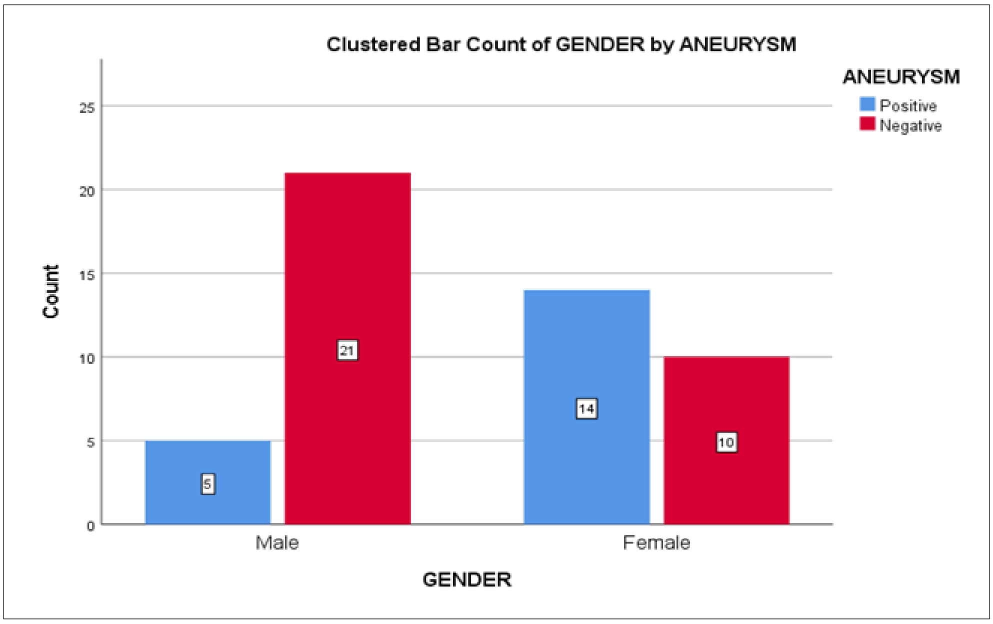
A sum of 50 CTA scans was performed prior to surgery, revealing 19 aneurysms. Out of 50 aneurysms, CTA was able to detect 19 of them (sensitivity 38 percent). Aneurysms ranged in size from 3 mm to 4.5x3.5 cm in three major cerebral arteries: anterior cerebral artery, posterior cerebral artery, middle cerebral artery, and anterior communicating artery.

Except for one patient who had multiple aneurysms in the anterior cerebral artery and middle cerebral artery, aneurysms are found in 6 percent of patients in the anterior cerebral arteries, 14 percent in the middle cerebral arteries, and 16 percent in the anterior communicating artery. Fusiform, Pyriform, Berry's type, and Giant Aneurysm were discovered in 19 of the patients.




**Bar Chart 1: Percentage of Location of Positive Aneurysm**

Out of 50 patients, 26 were male patients with 5 true positive aneurysms and 21 false negative aneurysms, whereas 24 were female patients with 14 true positive aneurysms and 10 false negative aneurysms.

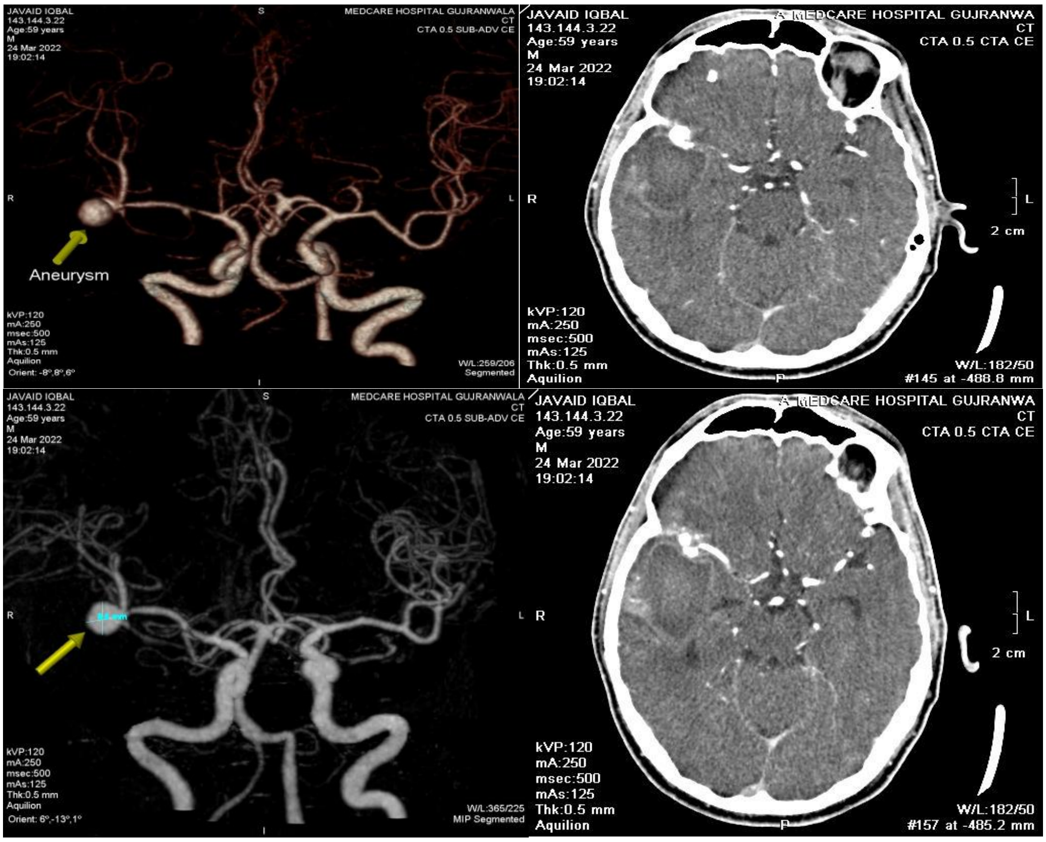



**Bar Chart 2: Variation of aneurysm according to gender**

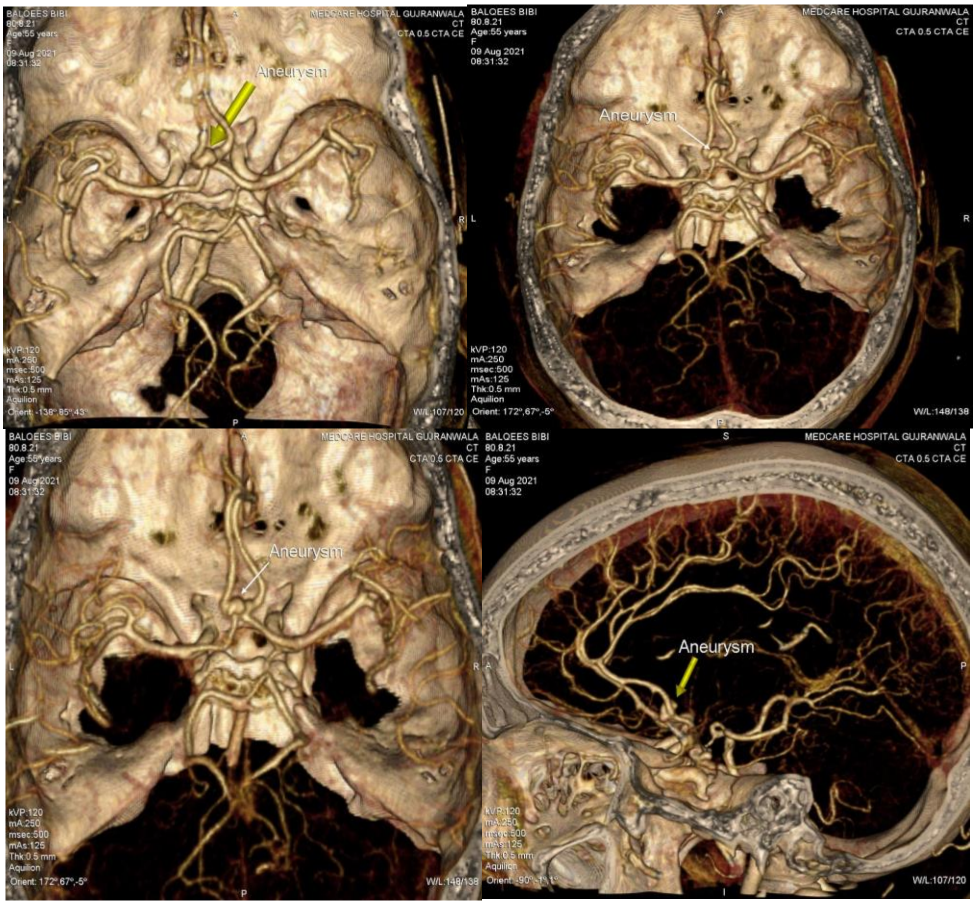
## DISCUSSION

The findings reveal that in a wide spectrum of patients, our 64-slice MSCT scanner routinely provides high-quality non-invasive cerebral angiograms that precisely delineate the presence or absence of major aneurysms throughout the whole cerebral arteries, including those with a symptom of cerebral aneurysm, high blood pressure, or obesity.

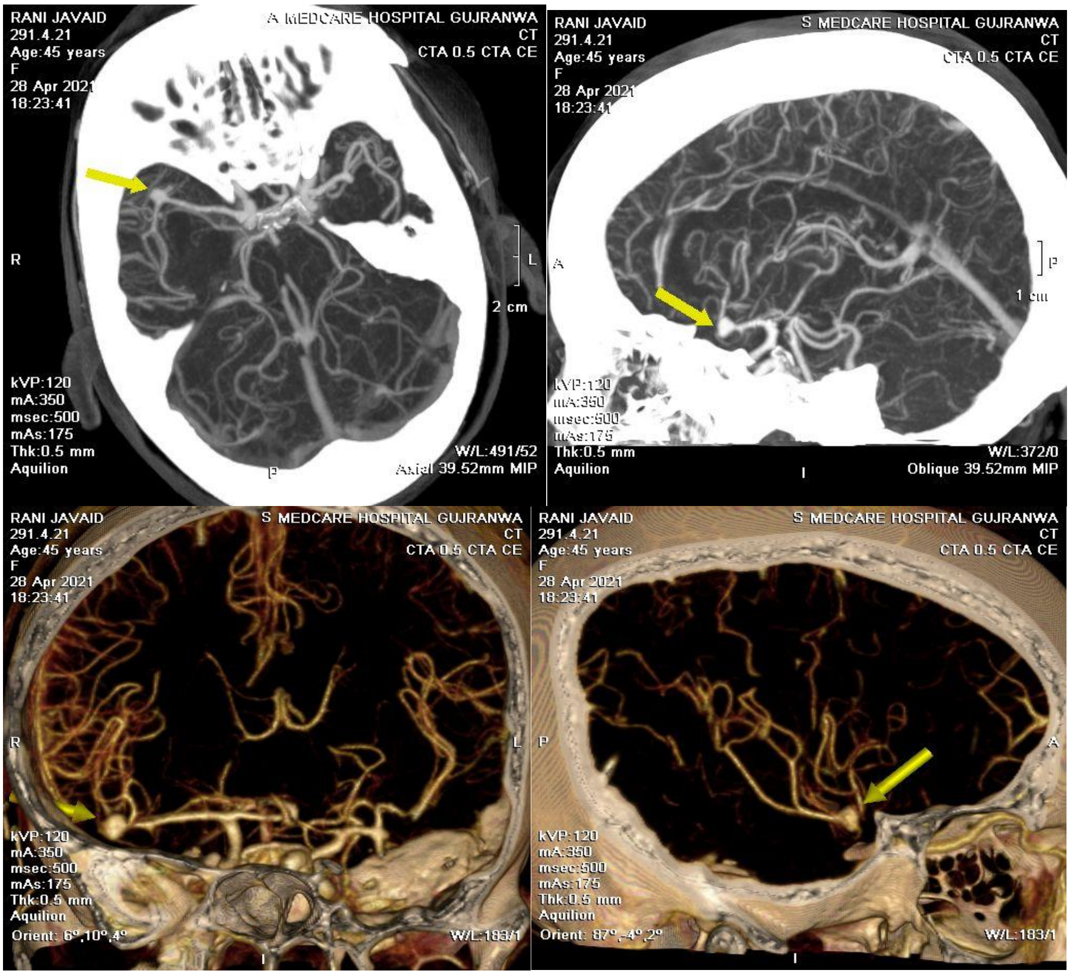
Overall, these investigations reveal that based on 3D reconstruction of the cerebral arteries, non-invasive cerebral MSCT imaging can properly diagnose the existence or absence of a cerebral aneurysm. Furthermore, prior studies had eliminated many "actual" patients due to high pulse rate, hypertension, or obesity, unlike the latest research, as well as all vessels with a diameter of less than 1.5 mm.




**Case 1: 3D reconstruction of CT brain angiogram showing fusiform aneurysm of 8.9 mm at middle cerebral artery.**




**Case 2: 3D reconstruction of CT brain angiogram showing fusiform aneurysm of 5x4 mm at anterior intercommunicating artery.**




**Case 3: 3D reconstruction of CT brain angiogram showing berry's type aneurysm of 6mm and 3x4 mm at right and left middle cerebral artery.**

The new investigative technique of 3D-CTA will make choosing and executing an ideal therapy even easier. Because it may provide information regarding dynamic aneurysmal features like flow, dome pulsations, and developing aneurysms.

The recent 64-slice scanner features more slices per gantry revolution (64 vs. 16) and a higher gantry speed (330 ms/rotation vs. 375), resulting in enhanced spatial and temporal resolution (0.4 vs. 0.5 mm) (165 vs. 188 ms). The distinction between cerebral arteries is more visible because to the lower voxel size. Partial volume effects are reduced when the voxel size is smaller, resulting in fewer beam hardening artefacts. Partial volume effects are caused by the average of varying densities within just a single voxel. Low-energy X-rays are absorbed by dense materials like bone, causing beam hardening.

As a result, a higher-energy beam penetrates adjacent pixels, giving it a darker appearance that could be misinterpreted for an aneurysm. A 64-slice scanner's lower voxel size can reduce, but not eliminate, all of these effects. The scanner's utility is demonstrated by its increased sensitivity of 95% and specificity of 90% for the identification of angiographically relevant aneurysm without even any invasive technique.

## CONCLUSION

In a wide range of patients, my findings show that 64-slice Non-invasive MSCT angiography has a high qualitative and quantitative diagnosis accuracy when compared to QCA. Cerebral CTA has a higher sensitivity for cerebral aneurysms than Invasive Cerebral Angiography since MDCT has a 0.5 collimated slice width and a temporal resolution of less than 0.33 sec, hence spatial resolution is likewise higher. Multi detector CT offers a great sensitivity for detecting aneurysms in the cerebral arteries, even if they are quite small. With the help of 3D reconstruction of pictures, MDCT can also distinguish between different types of aneurysms and their exact locations, as well as quantify the exact size of aneurysms. Invasive cerebral angiography, on the other hand, is unable to distinguish between aneurysms.

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