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Original Article

Role of 128 Dual Source Computed Tomography Angiography Imaging for Detection of Cerebral Aneurysm – Retrospective Study

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Abstract

Background: Multislice computed tomography (CT) has great potential for use in vascular studies. Multislice 128 slice CT angiography is an excellent non-invasive screening test in the assessment of intracranial aneurysms, both on a per-aneurysm and per-patient basis.

Purpose: The aim of the study was to evaluate non-invasive CT angiography (CTA) on 128 dual sources CT scan for detecting the aneurysm in spontaneous cases of subarachnoid bleed.

Materials and Methods: We evaluated 51 cases with spontaneous subarachnoid bleed by 128 slice dual-source CT in digital subtraction angiography (DSA) CT brain angiography protocol for the detection of aneurysms. The analysis of the scan for aneurysm detection was performed using 2D, multi-planar reconstructions, volume rendered techniques, and 3D maximum intensity projection. Aneurysms were evaluated for size, location, and other imaging characteristics. Patients with subarachnoid bleeds who were negative for aneurysm were further evaluated by the DSA.

Result: Fifty-one patients with age group of 23–85 (mean age 53.60 ± 13.76 years) were investigated. In 42 patients, aneurysms were identified in CT angiography, and their comprehensive evaluation such as location, size, and neck direction status were appropriately done, and information guided the neurosurgeons/interventionist for the proper management. Nine cases that were negative for aneurysm were also negative in DSA.

Conclusion: The faster high-resolution multislice 128 slice dual-source CT scan allows for non-invasive, safer, and accurate identification of cerebral aneurysms and accurately determines their size, morphology, and location. Specificity and sensitivity of 128 dual-source CT angiography in DSA protocol are near to the DSA which is the gold standard.

Key words: 128 Slice dual-source computed tomography, Cerebral aneurysm, Digital subtraction angiograph, Imaging, Subarachnoid bleed

INTRODUCTION

Subarachnoid hemorrhage (SAH) is a devastating acute neurological disease with a 43.0% risk of death and a 57.0% mortality rate at 6 months.[1] The three most common causes of mortality were direct effects of the primary hemorrhage (55.0%), aneurysm rebleeding (17.0%), and medical complications (15.0%).[2] Aneurysms that have ruptured already have a greater risk of re-hemorrhage. Thus, it is essential to detect aneurysm, describes its morphology to guide treatment accurately. It makes neuro-imaging a critical element in assessing and curing patients with cerebral aneurysms.

Magnetic resonance angiography, CT angiography, and digital subtraction angiography (DSA) are used for detection of a cerebral aneurysm. Each neuro-imaging technique has its weaknesses, strengths, and current developments. In this article, we studied the accuracy of 128 dual source CT angiography and DSA protocol in detecting cerebral aneurysm and compared it with DSA imaging, where CT Angiography was negative to detect the aneurysm.

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The 128 dual-source CT performs the investigation in <1.9 s from base to the vertex and the special resolution of the machine is 0.5 mm with a high temporal resolution. DSA neuromode removes the bones in one click without causing any loss in image resolution. This gives us an easy, quick, and accurate analysis of the aneurysm.

This study's aim and objective was, does faster high resolution 128 slice dual-source CT scan allow accurate identification of cerebral aneurysms including tiny ones and can it be used as the first-line investigation to replace DSA which is the gold standard.

MATERIALS AND METHODS

It is a retrospective study, and cases admitted in our 950-bedded hospital were included in the study. We collected 1½ year data for the analyses. All patients with spontaneous subarachnoid bleed on NCCT or strong clinical suspicion for SAH based on patients' symptoms even if NCCT was negative for subarachnoid bleed were included in the study. CT has the high sensitivity (91.0–98.0%) for detecting SAH, though the sensitivity of CT for SAH decreases with time.

CT Protocols

All the scans of the studied patients were performed as per department protocols in DSA CT brain angiography protocols, a non-contrast sequence to subtract from post-contrast sequences obtained from base to top of the skull. Pre-monitoring ROI was placed in the air in a section taken just below the skull base. The post-contrast scan was planned from base to the top of the skull with a scan time of approximately 1.90 s and a delay of 02 s. 50–60 CC IV non-ionic contrast was given using a dual pressure injector at a rate of 5 ml/s followed by 30 cc saline chase with a similar rate. Post-contrast triggering was started manually by seeing the contrast in the internal carotid arteries in pre-mentioned section below the base of skull section, and a scan was taken.

The analysis of the scan for aneurysm detection was performed as per department protocol using 2D, multiplanar reconstructions, volume-rendered techniques, and 3D maximum intensity projection, on the syngovia platform. A comprehensive assessment of aneurysm location, size, and other characteristics of images were evaluated. Patients who were negative for aneurysm were further assessed by DSA.

Inclusion Criteria

The following criteria were included in the study:

1. All patients referred with spontaneous subarachnoid bleed on NCCT.
2. The patient presenting late with a history of sudden severe headache and clinically with high suspicion of aneurysm.

Exclusion Criteria

As such none

Confounders

Present demonstration of cerebral aneurysm was done by spontaneous subarachnoid bleed on NCCT or strong clinical suspicion for SAH. A comprehensive assessment of aneurysm location, size, and other characteristics of images will be evaluated.

Ethical Clearance

The research procedure followed was in accordance with the approved ethical standards of the Department of Radiodiagnosis, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India Ethics Committee (Human).

Statistical Methods

All analyses were performed with Statistical Package for the Social Sciences version 23.0 statistical program. Quantitative variables were stated as mean ± SD and categorical variables as frequencies or percentages. For normally distributed data, a two sample student's *t*-test was used to examine the difference in the radiation dose between dual energy CTA and the digital subtraction CTA. To assess diagnostic performance of the dual energy CTA compared with the 3D DSA in detection of the intracranial aneurysms, data were examined on the basis of per-patient to differentiate patients with minimum one aneurysm and the patients with zero aneurysm. $P < 0.05$ was considered significant for all the tests.

RESULTS/OBSERVATION

Of 51 patients, 42 were positive for the aneurysm, nine were negative for the aneurysm on CT angiography. All nine cases were negative for an aneurysm on CT underwent DSA [Chart 1].

The mean-age of the studied patients was 53.60 ± 13.76 years, and the majority of patients were of the age group of 50–59 years (33.33%), followed by the age 60–69 years (23.53%) and 40–49 years (17.65%) while only 5.88% were affected in age group of 20–29 years and 7.84% of the age group of 30–39 years and also the patients were equally divided, that is, out of the total 51 patients, 25 (49.02%) were males and 26 (50.98%) were females [Table 1].

In the present study in the majority of patients, the location was ACOM (33.33%) followed by MCA and ICA (13.73% each) [Table 2] and the mean aneurysm size was found to be 6.52 ± 5.46 mm with a majority of patients having size of aneurysm below 5 mm (48.7%), followed by 5-10 mm size (38.5%) and more than 10 mm (12.8%) [Chart 2].

Images of CT Angiography

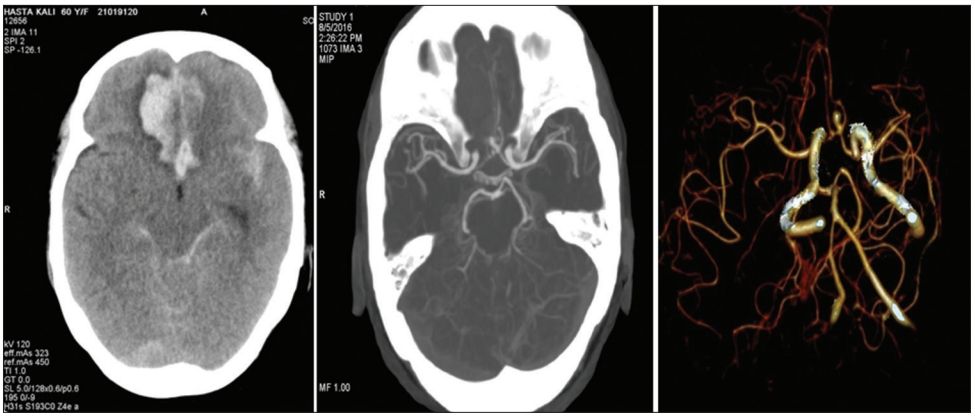

Figure 1: 60 years/F, Small aneurysm from junction of left A1, A2 with A COMM

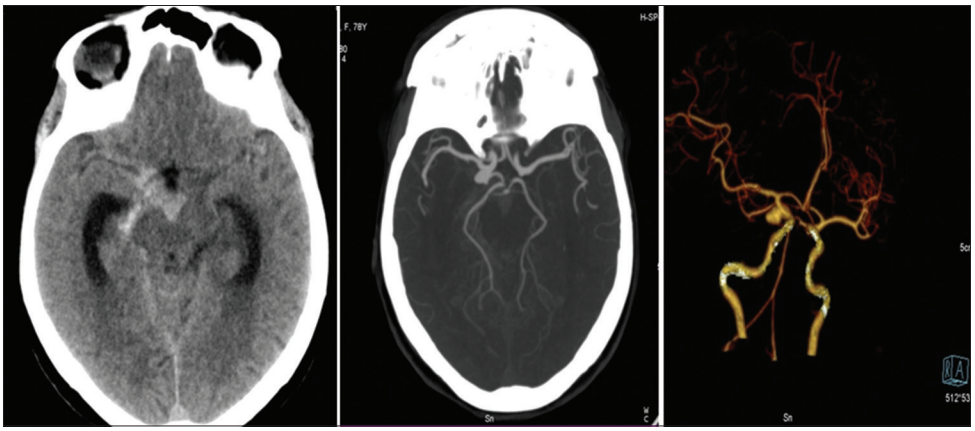

Figure 2: 78 years/F, ANEURYSM FROM RT PCOM and ICA JUNCT

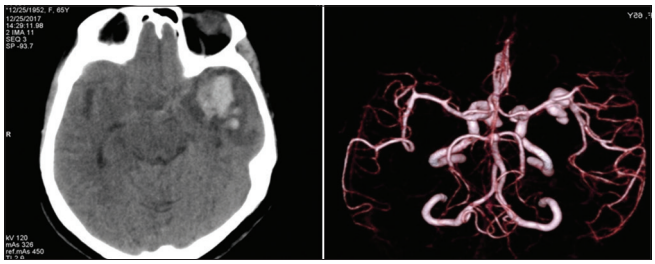

Figure 3: 65 Y/F, Multiple aneurysms from right ICA, left MCA, and tip of basilar artery

In the present study, the sensitivity of CT angiography was found to be 97.67%, specificity was 100.0%, PPV was 100.0%, NPV was 88.89%, and accuracy was 98.04% [Tables 3 and 4].

DISCUSSION

The use of a non-invasive assessment method to diagnose cerebral aneurysms in subarachnoid bleeds is one of the medical centers' goals. From the beginning of modern imaging techniques, attempts have been made to find an alternative for DSA. Efforts are being made to replace it with non-invasive methods.

One of the most important causes of SAH is a ruptured cerebral aneurysm. Cerebral DSA has been used as the gold standard for aneurysm detection.[3,4] However, DSA is an invasive study. The risk of obtaining an enduring neurologic deficits with DSA cerebral angiography in the patients with the SAH is around 0.1%.[5,6] Computed tomographic cerebral angiography is the non-invasive imaging modality that is being increasingly used to evaluate suspected intracranial aneurysms. The introduction of 128 slice CT scanners has greatly advanced CT angiography's role in neurovascular imaging with further advantage of DSA mode.[7,8]

Mean Age

In the present study, the average age of the studied patients was 53.60 ± 13.76 years and the majority of patients were of the age group of 50–59 years (33.33%), followed by the age 60–69 years (23.53%) and 40–49 years (17.65%) while only 5.88% were affected of the age group 20–29 years and 7.84% in the age group 30–39 years. Our findings are in accordance with Azhari *et al.*[9] who reported 48.3 years mean age of their patients, and in similar studies, the mean age was estimated between 49 and 55 years which makes our findings extensive.[10-13] This implies that aneurysms'

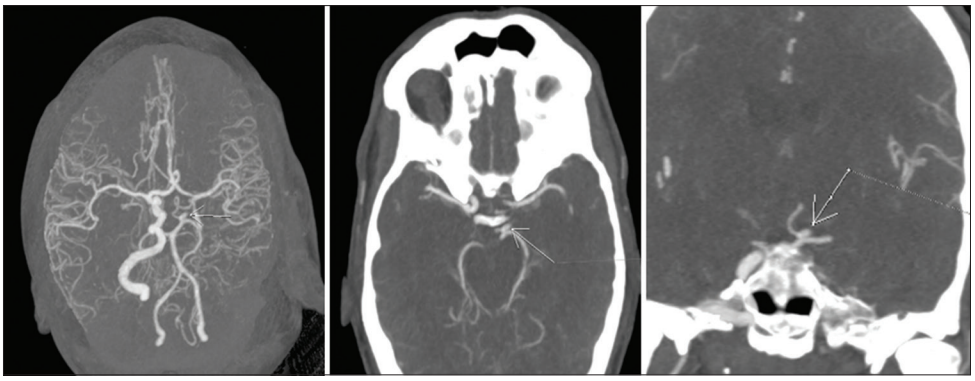

Figure 4: 30 years/M, sudden headache, Small aneurysm from junction of left p COMM and P1

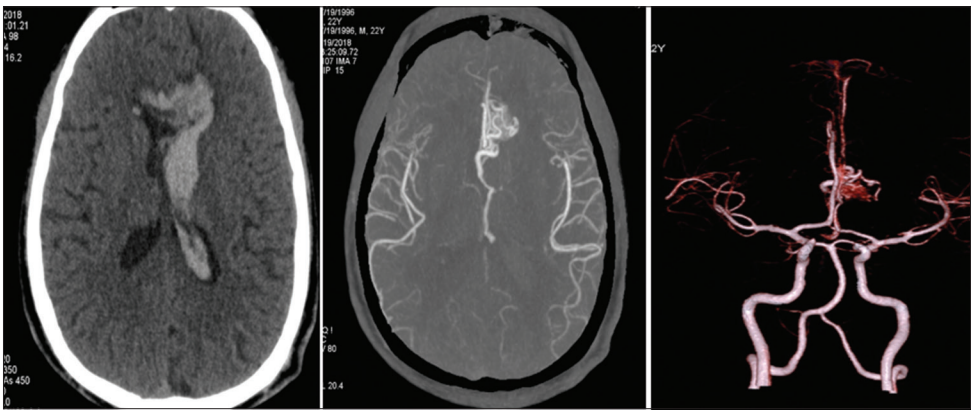

Figure 5: 22 years/male with bleed left parafalcine and ventricle. SMALL av malformation in left parafalcine region

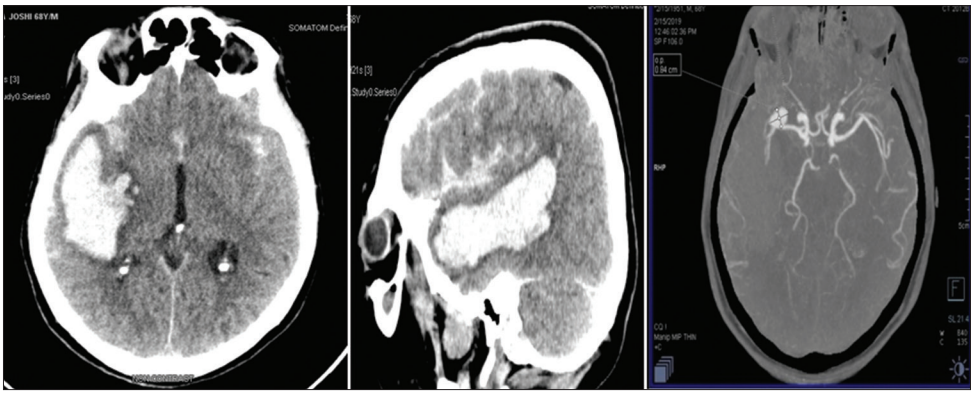

Figure 6: 68 years/M, Large 13 × 8.5 mm aneurysm from right M1 and M2

problem occurs majorly in the 6th and 7th decades of the human lifespan.

Gender Distribution

In the present study, the patients were equally divided, out of the total 51 patients, 25 (49.02%) were males and 26 (50.98%) were females. Azhari *et al.*[9] reported similar findings as in the present study, that is, 21 (52.5%) patients were men and 19 (47.5%) were women. Takesam *et al.*[13] depicted that of 42 patients with the SAH and aneurysm shown by the DSA 26 (62.0%) were female and 16 (38%) were male patients.

Location of Aneurysm

In the present study, in the majority of patients, the location was ACOM (33.33%), followed by MCA and ICA (13.73% each) [Figures 1-7]. Our findings were in accordance with Anderson *et al.*[14] who reported ACOM in 47.0% cases, followed by MCA (34.0%). Azhari *et al.*[9] quoted in terms of location of aneurysms; 15 were in the anterior communicating artery (ACOA), and 21 in the middle cerebral artery (MCA). This shows that the major locations for aneurysm were ACOM and MCA.

Table 1: Demographic profile

Parameters	No. of patients (*n*=51)	Percentage
Gender		
Male	25	49.02
Female	26	50.98
Age in years		
20–29	3	5.88
30–39	4	7.84
40–49	9	17.65
50–59	17	33.33
60–69	12	23.53
70–79	5	9.80
≥.8	1	1.96
Mean age	53.60±13.76 years	

Table 2: Location of an aneurysm

Location	No. of patients (*n*=51)	Percentage
ACA	5	9.80
ICA/PCA Junction	1	1.96
PCA P1 and POST COMM JUNCTION	1	1.96
ICA	7	13.73
MCA	7	13.73
ACOM	17	33.33
VBA	3	5.88
BA	1	1.96

MCA: Middle cerebral artery

Table 3: The diagnostic performance of dual-energy CTA compared with DSA in the detection of intracranial aneurysms

CTA	DSA		Total (*n*=51)
	Positive	Negative	
Positive	42 (82.3)	0 (0.0)	42 (82.3)
Negative	1 (1.96)	8 (15.7)	9 (17.6)
Total	43 (84.3)	8 (16.9)	51 (100.0)

CTA: Computed tomography angiography

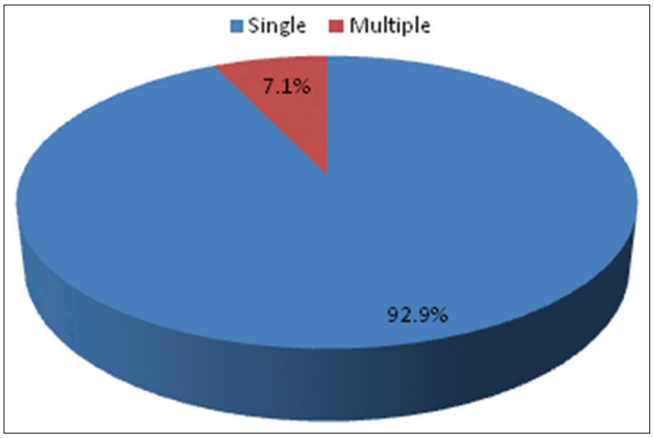

Chart 1: Number of an aneurysm (*n* = 42) [Single 39 and Multiple 3]

Size of Aneurysm

In our study, the mean aneurysm size was found to be 6.52 ± 5.46 mm with the majority of patients having size

Table 4: Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of dual-energy CTA

Sensitivity	97.67%
Specificity	100.0%
Positive predictive value	100.0%
Negative predictive value	88.89%
Accuracy	98.04%

CTA: Computed tomography angiography

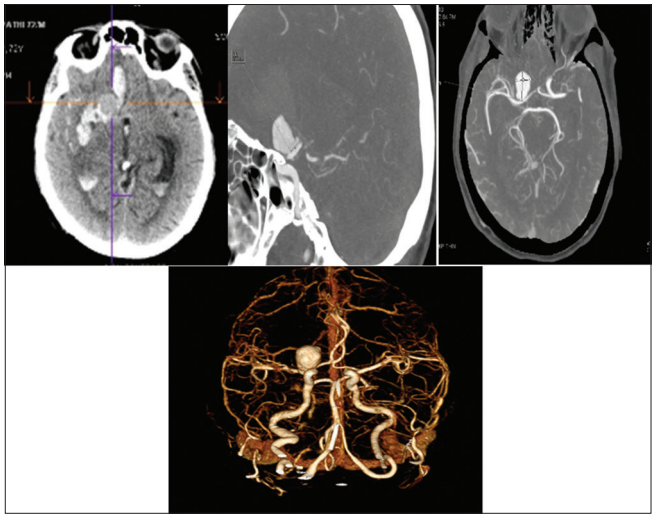

Figure 7: 70 years male, h/o vomiting, and sudden unconsciousness 1 day, large aneurysm from junction of right ICA

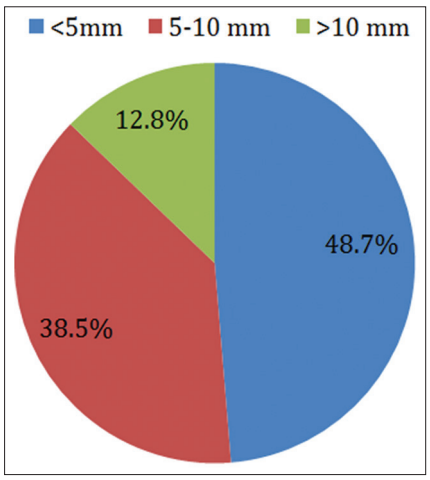

Chart 2: Size of an aneurysm (single aneurysm only) with mean size 6.52±5.46 mm

of aneurysm below 5 mm (48.7%), followed by 5–10 mm size (38.5%) and more than 10 mm (12.8%). Our findings were in accordance with Azhari *et al.*[9] who reported the mean size of the aneurysm as 6.3–2.1 mm. Furthermore, the mean size of aneurysms in a study performed by Luo *et al.*[15] was 6.4 mm and in a study performed by Chen *et al.*[16] was 5.5 mm.

Diagnostic Performance of the Dual Energy CTA and 3D DSA

In the present study, the sensitivity, specificity, PPV, NPV, and accuracy of the CT angiography were 97.67%, 100.0%, 100.0%, 88.89%, and 98.04%, respectively, which was similar to the findings of Wintermark *et al*.[17] who reported that the overall performance of the spiral CT scanning technique was dramatically improved by the technological development of multidetector-row CT scanners, particularly in CT angiography. In this study, the sensitivity, specificity, and accuracy of MSCT angiography for detection of the intracranial aneurysms were 94.8%, 95.2%, and 94.90%, respectively, on per-aneurysm basis and 99.0%, 95.2%, and 99.0%, respectively, on a per-patient basis. The interobserver agreement was 98.0%.

In an analysis by Guo *et al*.,[18] a sensitivity of 97.0% and specificity of 91.0% were found for CT angiography. The sensitivity, specificity, and accuracy of CT angiography were 95.1%, 94.1%, and 95.0%, respectively, by Donmez *et al*.[19] study. Chen *et al*.[10] reported sensitivity, specificity, and accuracy of the CT angiography as 98.3%, 98.0%, and 97.9%, respectively. In a study performed by Teksam *et al*.,[13] accuracy, sensitivity, and specificity of detecting recurrent or residual aneurysms on the MSCTA were 0.80, 0.60, and 1.00, respectively, also negative and positive predictive values were 0.71 and1.00, respectively. The sensitivity, specificity, accuracy, PPV, and NPV for CT angiography were achieved as 99.0%, 99.0%, 90.0%, 96.0%, and 98.0% by Westerlaan *et al*.[19] Uysal *et al*.[20] reported the sensitivity and specificity of CT angiography in detecting aneurysm as 98.6 and 97.6, respectively. In all the previous quoted studies, the sensitivity and specificity were high and were consistent with our study. The differences may relate to the type of device, image quality, and neuroradiologists.

Recent studies observed overall higher detection rates of up to 97.0%, and few authors already exclusively rely on the results of CT angiography in patients with SAH.[21] Imaging after the surgical aneurysm clipping has conventionally been achieved with the conventional catheter based angiography, CT angiography may provide an adequate alternative in several cases.[22,23]

Pitfalls of the CT angiography consist of lack of the visibility of the small arteries, complexity in differentiating infundibular dilatation at origin of an artery from aneurysm, kissing vessel artifact, and demonstration of the venous structures which can imitate aneurysms, failure to identify the thrombosis and calcification on 3-dimensional images, and beam hardening objects produced by aneurysm clips.[24] Few of them are overcome by 128 slice dual sources CT.

CONCLUSION

Multislice 128 slice CT angiography is an excellent non-invasive screening test in assessment of intracranial aneurysms, both on a per-aneurysm and per-patient basis. It provides a precise characterization of intracranial aneurysms, including size, structure, and orientation and can also depict the presence of thrombosis and rupture. Because of excellent image quality, high diagnostic accuracy, and lower radiation dose, dual energy CTA can be used regularly for the clinical purposes. CT angiography can be the preferred non-invasive modality for the measurement of intracranial aneurysms in the patients with the acute SAH and has the potential to substitute, in most cases, for DSA.

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