Title-. APPLICATION OF 128 SLICE MDCT ANGIOGRAPHY IN EVALUATION OF NON TRAUMATIC SUBARACHNOID HEMORRHAGE.

Type of manuscript- original research article

Authors:

First author- Dr. S. Ranga Reddy, MD
Associate Professor, Department of Radiology,
Kamineni academy of medical sciences and research center (KAMSRC),
LB nager, Hyderabad, telangana.

second author - Dr. Shri Puja Kamineni, MD
Associate Professor, Department of Radiology,
Kamineni academy of medical sciences and research center (KAMSRC),
LB nager, Hyderabad, telangana.

third author – Dr Shashidhar Sangineni , MD
Consultant radiologist, Department of Radiology,
Kamineni hospital,king koti, Hyderabad, telangana.

Corresponding author: Dr. Shri Puja Kamineni, MD
Associate Professor, Department of Radiology,
Kamineni academy of medical sciences and research center (KAMSRC),
LB nager, Hyderabad, telangana.

ABSTRACT-

Background : Subarachnoid hemorrhage(SAH) is a subtype of cerebrovascular accident.It can be traumatic or non traumatic. Whenever SAH is diagnosed on initial non contrast computed tomography(CT) ,the next step would be CT Angiography due to being non-invasive and easily performable even though digital subtraction angiography (DSA) is still the gold standard.**Objectives** : To analyze the etiology of non traumatic SAH in MDCT Angiography . **Materials and methods:**Patients with clinically suspected or diagnosed SAH were subjected to CTA.A classification scheme for categorizing patients presenting with SAH is on the basis of etiology ,pattern,grading, characteristics of aneurysm(in case of aneurysmal SAH) and in case of arterio-venous malformations(AVM), site, feeding artery, draining vessel, type and size of nidus were assessed. **Results** :In this prospective study carried out from June 2022 to May 2023 ,A total of 50 patients including males and females of all ages with clinically suspected / diagnosed SAH referred to our department were evaluated with CTA.Headache was the most common complaint and loss of consciousness was associated with extensive SAH. Hypertension was the most common risk factor.Out of 50 patients,30 patients had aneurysm(60%),1 patient had both cerebral AVM and aneurysm and 2 patients had only AVM and few patients had other etiologies.Overall intracranial aneurysm was most prevalent in 5th and 6th decade of life, with increased female preponderance.Aneurysms are more commonly seen in anterior circulation, anterior communicating artery(ACOM) being the most common site. **Conclusion**:MDCT Brain Angiography helps us in the evaluation of non traumatic SAH, describe morphology and imaging patterns of various vascular lesions and to identify specific imaging characteristics that may portray a higher risk of rebleeding/ rupture thereby giving valid information for endovascular or surgical planning.

Key words: SAH, AVMs, Aneurysm, MDCT Angiography.

INTRODUCTION

Subarachnoid Hemorrhage (SAH) is a neurological emergency and one of severe forms of cerebrovascular accidents. It is characterized by extravasation of blood into the subarachnoid space, which is normally filled with cerebrospinal fluid . Spontaneous SAH, otherwise called non-traumatic SAH is a life-threatening condition usually identified in initial noncontrast CT. Peak incidence occurs between 40 and 60 years and Nontraumatic SAH can sometimes present with diverse clinical signs and symptoms which can overlap with other clinical entities.

Once SAH has been confirmed by non-contrast CT, CT brain angiography is performed to identify the underlying vascular abnormality if present. CT angiography (CTA) is the most common initial cerebrovascular imaging modality used in India, even though digital subtraction angiography (DSA) is considered the gold standard. Early diagnosis of vascular abnormalities is important to provide timely treatment. Intracerebral arterial aneurysm rupture accounts for 85% of non-traumatic SAH presentations and is usually catastrophic unless managed immediately.In up to 15% of patients with spontaneous SAH, a structural cause for the SAH is not identified on initial CTA, and is called as non-aneurysmal SAH (naSAH) which is less severe and needs follow up imaging to rule out persistent bleeding. Perimesencephalic SAH, is presumed to be venous etiology at the level of the brainstem.The remaining cases are caused by rare etiologies—including vascular malformations, infections,tumors,extension of intracerebral hematoma and cerebral venous thrombosis.Immediate diagnosis and treatment are of paramount importance to maximize the favorable outcomes in cases of SAH. Clinical management is guided by accurate diagnosis typically established by a step-wise application of advanced medical imaging, occasionally supplemented by invasive diagnostic procedures. If not employed judiciously, there is potential for resource overutilization and healthcare cost escalation.
we conducted this study to evaluate the efficiency of CT Brain angiography in diagnosing the various etiologies of the Nontraumatic SAH and epidemiology and various clinical presentations and factors influencing the prognosis of spontaneous SAH in my area .

AIMS AND OBJECTIVES

AIM : To assess the role of 128 Slice MDCT Brain Angiography in diagnosing Non traumatic Subarachnoid Hemorrhage .

OBJECTIVES:

1) To identify presence of subarachnoid hemorrhage on 128 slice multi-Detector Computed Tomography Angiography (CTA).
2) To determine the cause of non traumatic subarachnoid hemorrhage .

MATERIALS

Source of data:

The subjects of this study included patients attending Kamineni Hospital, King Koti referred to the Department of radiodiagnosis with clinically suspected non-traumatic subarachnoid hemorrhage, for computed tomography Brain Angiography or patients with incidental subarachnoid hemorrhage findings on Non contrast brain CT scan.

Duration of study:-The study was done over a period of 12 months from June 2022 to May 2023.

Sample size: 50.

Radiological investigation: All patients who met the study inclusion criteria were evaluated by CT angiography.CT examinations were performed on a 128 slice CT machine (Siemens, Somatom perspective, G-XL 124251).

Inclusion criteria:
- Patients with high clinical suspicion for Non traumatic SAH or patients with incidental subarachnoid hemorrhage findings on Non contrast brain CT scan.

Exclusion criteria:

-Allergy to contrast agent

-Impaired renal function tests

-Pregnancy

-Patient refused to be included in the study.

METHODOLOGY:

Study design: Prospective descriptive study

Data collection: A data collection sheet (proforma) was specially designed for this study to collect information from each patient including the age, gender, clinical presentation, risk factors, NECT and CT Angiography findings with description of size, site, shape, location and number of aneurysm ,AVM types and other etiologies.Data collected after obtaining a written informed consent, the patients were evaluated with CTA.

Statistical analysis: All the data obtained from 50 cases was entered into and analyzed using google sheets.

RESULTS AND OBSERVATIONS

The study was carried out on 50 participants, whose ages ranged from 8 to 82 years with mean age of 51.86 with a SD of 17.59. Majority of the patients were in the 6th decade accounting for 17 cases which is 34% , followed by the 5th decade accounting for 11 cases which is 22% of total cases. Among these 50 participants, 24 were males and 26 were females.

Headache was the most common presenting symptom reported by 88% of the study population,loss of consciousness at ictus was reported by 38% , while 30% of the patients had complaints of weakness ,16% had vomiting, giddiness in 14% and neck pain contributing to 2% .

In this study out of the 50 participants , 76% had hypertension predominantly seen in the female population..36% of the participants had a history of Diabetes mellitus.Alcoholism was observed in around 26% of patients and smoking was observed only in the male participants.Past history of SAH presented in 6% of the cases.

In this study all the 50 participants who had positive NECT with SAH underwent CTA and out of which CTA was positive in 16 (32%)male participants and 22 (44%)female participants and negative in 8(16%) male participants and 4 (8%) female participants.

In this study, among 50 participants major diagnostic abnormality detected was isolated cerebral aneurysms in 30 participants followed by intra cerebral hematoma with no vascular abnormality in 3 participants, isolated cerebral venous sinus thrombosis in 2 participants, cerebral arteriovenous malformations in 1 participant and venous angioma in 1 participant. A few study participants had multiple coexisting pathologies in which 1 participant had both aneurysm and AVM and 1 participant had aneurysm and CVST.

In this study out of the 50 participants, Grade I SAH was seen in 28(56%) participants,Grade II SAH in 2 (4%) participants,Grade III SAH in 7 (14%) participants and Grade IV SAH in 13 (26%) participants.

Out of 30 cases of aneurysms, 15 cases (50%) are seen with grade I SAH and cases of isolated AVM, venous angiomas, CVST and intraparenchymal hematomas also associated with grade I SAH. Out of 13 cases of grade IV SAH, 9 cases are seen in isolated aneurysm and 1 case with CVST indicating clear association of aneurysmal SAH with grade IV severity and associated poor prognosis. Totally 11 cases of SAH do not have identifiable pathology where 6 cases(54%) are predominantly associated with grade I SAH, indicating good prognosis of nonaneurysmal perimesencephalic SAH.

In this study, out of 50 patients, 30 patients had isolated intracranial aneurysms. One patient had coexisting AVM & aneurysm and another patient had aneurysm with CVST.

Out of 50 cases,10 cases had complications like infarct (8%), vasospasm (8%), infarct with cerebral edema (2%) and infarct with vasospasm (2%).

In this study, out of 50 participants, 32 participants had intracranial aneurysms of which 13 were males and 19 were females.The 32 participants having aneurysms, ranged from 2 to 82 years with mean age of 51.3.1, with the majority of the patients in the 6th decade accounting for 11 cases which is 34 .3 %, followed by the 5th decade accounting for 7 cases which is 21.8 % of total cases.

The most common presenting complaints of these patients was headache seen in 87.5 % of the cases, predominantly thunderclap headache, 43.7 % of the participants presented with LOC, 28.1 % of cases had weakness as a complaint , 21.8 % of the participants had vomiting,15.6 % had giddiness and 3.1 % presented with neck pain as their chief complaint.

Among the 50 total participants, 30 participants had isolated single aneurysm ,1 participant had 2 aneurysms and another1 participant had 3 aneurysms.so totally 35 aneurysms were present in 32 participants among which 91.4 % of these aneurysms were located in anterior circulation and 8.5% in posterior circulation.(TABLE 1)

TABLE 1 : DISTRIBUTION OF LOCATION OF ANEURYSMS

SITE		**NO**
ANTERIOR CIRCULATION	ACOM	13
	ACA	4
	MCA*	8
	PCOM*	3
	ICA	4
POSTERIOR CIRCULATION	VA	1
	BA	1
	PCA	0
	AICA	0
	PICA	1
	SCA	0

ACOM with 13 cases accounting for 37 % is the most commonly involved site, followed by MCA aneurysm in 22% cases followed by ICA and ACA in 11% of aneurysmal SAH patients and 8.5% cases had PCOM aneurysms in the anterior circulation.There were 3 participants with posterior circulation aneurysms with 2.8% at basilar artery, 2.8% at vertebral artery and 2.8% at Posterior inferior cerebellar artery.

Among 35 aneurysms detected in 32 patients on CTA, 33 aneurysms were saccular in (94.3%) patients, 1 aneurysm was fusiform (2.85 %) and 1 aneurysm was a blood blister (2.85%).

Among 32 participants who had aneurysms on CTA, 26 participants had aneurysms with size <7 mm and 6 participants had aneurysms >7mm.Two participants had multiple aneurysms in which case the size of the ruptured aneurysms are considered for the purpose of correlation with grading of SAH.

In participants with aneurysms size < 7mm, 50% had grade I, 3.8% had grade II, 15.4% had grade III and 30.7% had grade IV severity SAH.In participants with aneurysms size >7mm, 50% had grade I, 16.6% had grade II, 0% had grade III and 33.4% had grade IV severity SAH.

Among 35 aneurysms encountered in 32 patients in our study, total no of patients with single aneurysm were 30 (93%) and with multiple (>1) were 2 (7%).

Among 32 patients with aneurysms on CTA, 28 patients(88%) have aneurysms with narrow necks (>4mm) and 4 patients(12%) have aneurysms with wide necks (=/> 4mm) .

Among 28 patients with narrow neck aneurysms(<4mm) on CTA, 15(54%) patients had grade I SAH, 1(3%) patient had Grade II SAH, 5 (18%)patients had grade III SAH and 7 (25%)patients had grade IV SAH.

Among 4 patients with wide neck aneurysms(=/>4mm) on CTA, 1(25%) patient had grade I SAH, 0 patients had Grade II SAH, 0 patients had grade III SAH and 3(75%) patients had grade IV SAH.

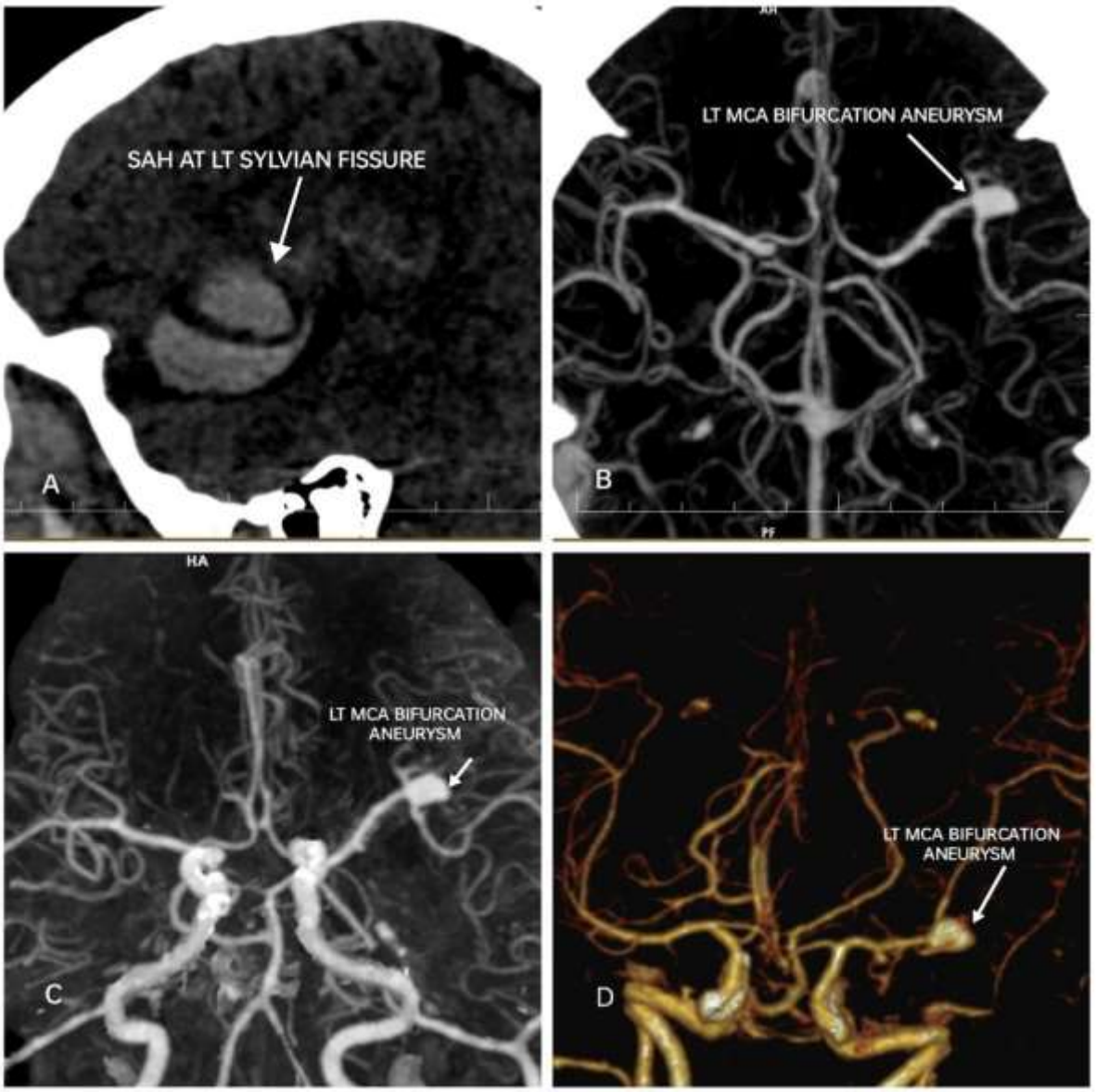
Among 35 aneurysms detected in32 patients on CTA, bifurcation type of parent artery configuration is seen in 26 (74.3%) aneurysms and side wall type of configuration in 09 (25.7 %).

In this study, out of 50 participants, 02 participants had cerebral arteriovenous malformation (AVM) in which 1 patient had a coexisting aneurysm which was the culprit of SAH .

In this study only 1 male participant was a known follow up case of venous angioma and 2 participants had cerebral venous sinus thrombosis with development of hemorrhagic infarct.1 participant has aneurysm with CVST where the culprit of SAH was identified to be the aneurysm on CTA which was characterized under aneurysms.

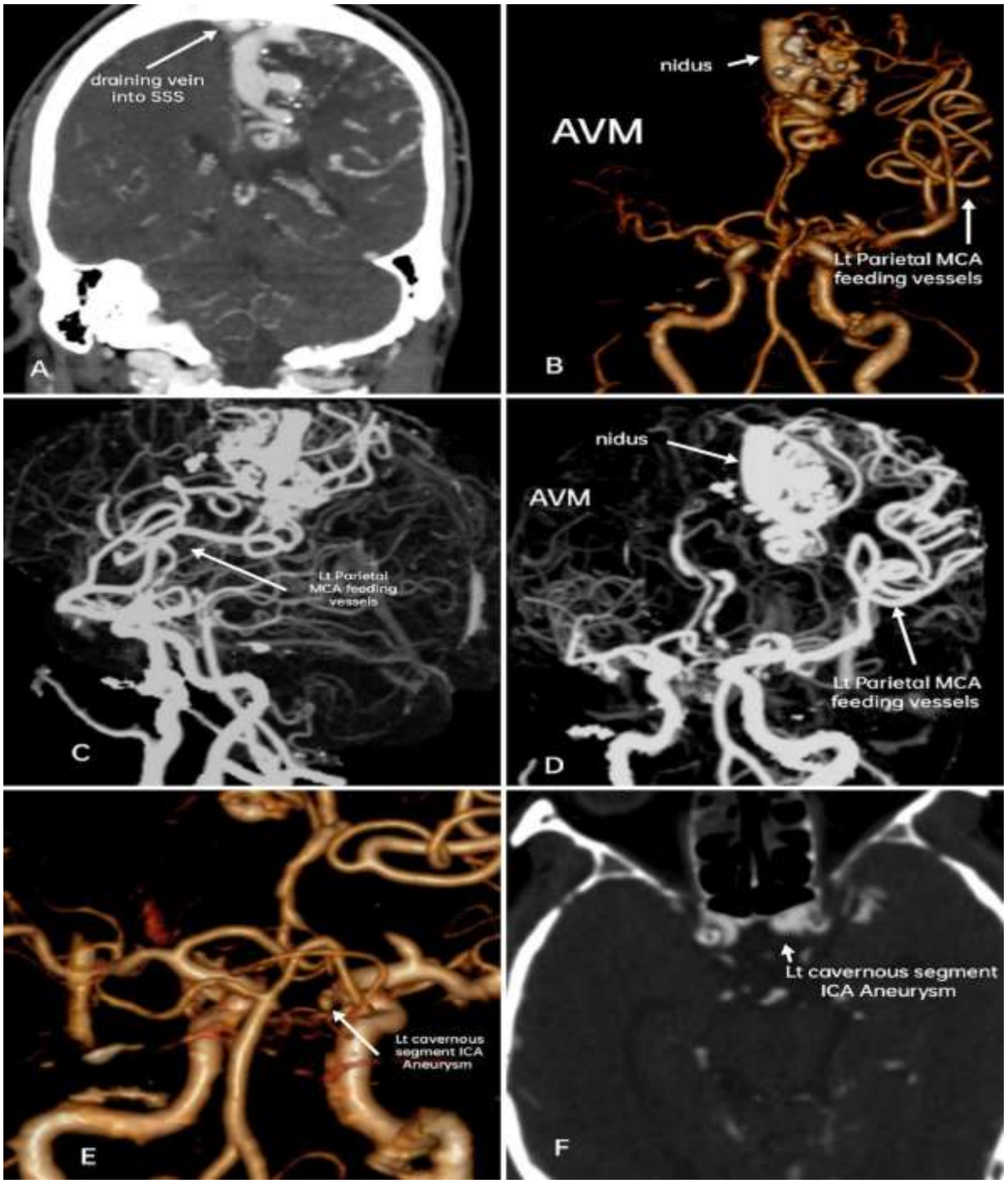
In this 3 participants had intraparenchymal hematoma where the hemorrhage extended into the sub arachnoid spaces.

Figure 1:



Positive CT angiogram in a female patient aged 50 yrs presented with accelerated HTN Plain CT(image A) shows SAH at left sylvian fissure and left temporal lobe cortical sulci . CTA axial miniMIP section (image B),CTA Coronal MIP section (image C)and VRT (image D) show large saccular left MCA Bifurcation Aneurysm as the culprit of SAH

Figure 2:



A 56 year old male patient presented with headache shows minimal SAH on plain CT head(Image not shown).

CTA miniMIP (Image A) ,VRT(Image B) and MIP (Image C & D) shows large diffuse superficial nidus in the left parietal lobe with feeding arteries from M3 parietal branches of left MCA. A large caliber draining vein arises from the nidus drainig into mid segment of superior sagittal sinus.

CTA VRT (Image E), and miniMIP(Image F) shows small aneurysm at cavernous segment of left ICA.

DISCUSSION

Subarachnoid hemorrhage is an infrequent and severe subtype of stroke affecting patients at a mean age of 50-60 years, leading to loss of many years of productive life. Rupture of an intracranial aneurysm is the most common cause in 85% of cases. Survival from aneurysmal subarachnoid hemorrhage has increased by 17% in the past few decades, mainly because of better and early diagnosis, swift aneurysm repair, prescription of nimodipine, and modern ICU support.However, the affected patients commonly have cognitive impairments, which in turn affect patients' daily functionality, working capacity, and quality of life. Also deficits frequently co-exist with mood disorders, fatigue, and sleep disturbances.

A “sentinel” or “warning” headache is a sudden, worst headache of life that is retrospectively identified to have occurred days to weeks before the SAH.
Aim of CTA in these patients is to delineate the cause of underlying hemorrhagic pathology, morphological evaluation of risk factors if present and for planning appropriate treatment regime.
In this study, there are 50 participants, ranged from 8 to 82 years with mean age of 51.86 SD of 17.59 with majority of the patients are in 6th decade accounting for 17 cases which is 34% , followed by 5th decade accounting for 11 cases which is 22% of total cases.
In this study, among these 50 participants, 24 participants were males and 26 participants were females.
I observed that spontaneous SAH is slightly more common among females compared to males, with females contributing about 52% of my study population and a female to male ratio of 1:0.9. The slight female preponderance of SAH in my study is similar to the recent study done by Sadasivam AS et al in parts of South India,even though previous studies in south india shows male predominance.
In this study, among 50 participants major diagnostic abnormality detected was isolated cerebral aneurysms in 30 participants followed by intra cerebral hematoma with no vascular abnormality in 3 participants, isolated cerebral venous sinus thrombosis in 2 participants, cerebral arteriovenous malformations in 1 participant and venous angioma in 1 participant.

A few study participants had multiple coexisting pathologies in which 1 participant had both aneurysm and AVM and 1 participant had aneurysm and CVST.

In this study all the 50 participants who had positive NECT with SAH underwent CTA and out of which CTA was positive in 16 male participants and 22 female participants and negative in 8 male participants and 4 female participants.

In my study Headache was the most common symptom reported by 88% of my study population. Thunderclap headache was reported to be experienced by around half of study participants and it was observed after CTA to be seen in participants with diffuse SAH and those with aneurysmal rupture. Less severe

headaches were seen in participants with perimesencephalic SAH where no pathology was identified.

Loss of consciousness at ictus was reported as a symptom by around 38% of our patients especially in patients with diffuse SAH and grade IV SAH with intraventricular extension which is comparable to the study done by Suwatcharangkoon S et al ,where loss of consciousness was reported in 40.4% of SAH patients. (1)

In this study, 30% of patients had complaints of weakness which are usually seen in participants with intraparenchymal hematoma with SAH extension. These types of patients were hypertensive and presented with headache which was less severe than thunderclap headache and they were suspected with SAH by the first contact physicians and referred to our department and the primary pathology was diagnosed to be intraparenchymal hematoma. Usually these participants had a sulcal type of SAH which is grade I severity.

Vomiting was the next most common complaint present among the participants contributing to 16% as it indicates elevated intracranial pressure and other signs like neck stiffness was also elicited by clinicians in these participants.

In this study out of the 50 participants , 76% had hypertension predominantly seen in the female population indicating the importance of hypertension as risk factor for SAH.36% of the participants had a history of Diabetes mellitus co-existing with or without hypertension with equal distribution of males and females. Alcoholism was observed in around 26% of patients. Smoking is known to be a significant risk factor for the development of SAH, which has been emphasized in various studies previously.(2,3,4,5) However, unexpectedly smoking was observed in a comparatively lesser proportion of our study participants (30%) found only in the male participants which could be explained by the slight overall female preponderance in the study population and that the smoking and alcohol rate among the female population is nil in this study mainly due regional and cultural diferences.

MODIFIED FISHER GRADING OF SAH

To prognosticate cerebral vasospasm, the modified Fisher grading scale is used, which categorizes the plain CT scan appearance of SAH. The amount and position of hemorrhage seen on the initial head CT scan corresponds with the risk of developing vasospasm. The modified Fisher scale includes thick cisternal and ventricular blood, features that differentiate it from the previous Fisher scale.

The association of developing vasospasm with each progressing grade has been reported as follows:

- Grade 1 = 6%
- Grade 2 = 15%
- Grade 3 = 35%
- Grade 4 = 34%

This above grading has been previously followed and also analyzed in studies conducted by Frontera et al(6) and Kramer AH et al (7) and has proved to be better than the previous classification in predicting the complications in particular vasospasm.

MODIFIED FISHER SCALE

GRADES	CRITERIA
0	No SAH or IVH
1	Minimal SAH and no IVH
2	MInimal SAH and IVH
3	Large SAH* and no IVH
4	Large SAH* and IVH

*SAH completely fills at least 1 cistern or fissure.

In my study out of the 50 participants, Grade I SAH was seen in 28 participants ,Grade II SAH in 2 participants,Grade III SAH in 7 participants and Grade IV SAH in 13 participants. Grade I SAH is usually associated with good prognosis following surgical interventions, whereas grade IV SAH is usually associated with poor prognosis.

Out of 30 cases of aneurysms, 50% of cases are seen with grade I SAH and cases of isolated AVM, venous angiomas, CVST and intraparenchymal hematomas also associated with grade I SAH. Out of 13 cases of grade IV SAH, 9 cases are seen in isolated aneurysm and 1 case with CVST indicating clear association of aneurysmal SAH with grade IV severity and associated poor prognosis. Totally 11 cases of SAH do not have identifiable pathology where 6 cases(54%) are predominantly associated with grade I SAH, indicating good prognosis of nonaneurysmal perimesencephalic SAH.(8,9)

Out of 50 cases,10 cases had complications like infarct (8%), vasospasm (8%), infarct with cerebral edema (2%) and infarct with vasospasm (2%)(10).

In this study, out of 50 participants, 32 participants had intracranial aneurysms of which 13 were males and 19 were females. Compared with age and gender in our study females had higher incidence of intracranial aneurysms compared to males. Similar incidence was seen in other studies.

The 32 participants having aneurysms, ranged from 2 to 82 years with mean age of 51.31, with the majority of the patients in 6th decade accounting for 11 cases which is 34 .3 % , followed by 5th decade accounting for 7 cases which is 21.8 % of total cases

According to Gail L. Kongable(11),female gender is a recognized risk factor for the occurrence of aneurysmal SAH with female-to-male ratio of nearly 2:1. According to S. Claiborne Johnston(12), age related mortality rates of SAH were 62% greater in females than in males.

In this study, out of 50 patients, 30 patients had isolated intracranial aneurysms. One patient had coexisting AVM & aneurysm and another patient had aneurysm with CVST. The most common presenting complaints of these patients was headache seen in 87.5% of the cases, predominantly thunderclap headache. 43.7% of the participants presented with LOC to the ER department with initial complaints of headache, vomiting etc.28.1% of cases had weakness as a complaint and these types of cases were usually associated with complications of SAH like vasospasm and subsequent development of infarcts and cerebral edema. 21.8 % of the participants has vomiting which indicates raised intracranial pressure and 15.6% had giddiness and 3.1% presented with neck pain as their chief complaint.

This study demonstrated the importance of interrogating the patient and eliciting the signs of weakness as it may indicate the underlying focal neurological deficit due to vasospasm or infarct.

Among the 50 total participants, 30 participants had isolated single aneurysm ,1 participant had 2 aneurysms and another1 participant had 3 aneurysms.so totally 35 aneurysms were present in 32 participants. 91.4 % of the aneurysms were located in anterior circulation and 8.5% in posterior circulation.According to Takahshi (13) approximately 90% of aneurysms arise from the anterior circulation and similar observations were seen in this study.

Overall, ACOM with 13 cases accounting for 37 % is the most commonly involved site, followed by MCA aneurysm in 22% cases followed by ICA and ACA in 11% of aneurysmal SAH patients and 8.5% cases had PCOM aneurysms in the anterior circulation.

There were 3 participants with posterior circulation aneurysms with 2.8% at basilar artery, 2.8% at vertebral artery and 2.8% at Posterior inferior cerebellar artery.Aneurysms were not observed at the arteries like PCA, AICA,SCA in my study.The distribution of site of aneurysm is similar to the study conducted by Brisman JL et al.(14) Among 32 participants who had aneurysms on CTA, 26 participants had aneurysms with size <7 mm and 6 participants had aneurysms >7mm. (Two participants had multiple aneurysms in which case the size of the ruptured aneurysms are considered for the purpose of correlation with grading of SAH). In participants with aneurysms size < 7mm, 50% had grade I, 3.8% had grade II, 15.4% had grade III and 30.7% had grade IV severity SAH. In participants with aneurysms size >7mm, 50% had grade I, 16.6% had grade II, 0% had grade III and 33.4% had grade IV severity SAH.

Normal arterial wall contains three layers i.e, Tunica intima, tunica media and tunica adventitia.Intracranial aneurysms are classified according to their shape. Saccular/ berry aneurysms are the most common type of aneurysms.They develop at the point where the tunica media is congenitally thin or absent .These usually occur at the branching points of the main cerebral arteries and expand over time due to high hemodynamic stress at the bifurcation areas..

Blood blister-like aneurysms (BBAs) are special types of aneurysms that are recently recognized in the neurosurgical literature. BBAs are eccentric hemispherical arterial outpouchings that are covered by only a thin layer of adventitia. These lesions are vulnerable and are difficult to detect as well as to treat. They have a tendency to rupture at a much smaller size and much earlier as compared with SAs. Although BBAs can be found anywhere, they have a higher incidence to occur along the supraclinoid internal carotid artery.

Fusiform aneurysms (FAs) are focal dilations that involve the entire circumference of a vessel and extend for relatively short distances. FAs are more common on the vertebrobasilar ("posterior") circulation. FAs can be atherosclerotic (more common) or nonatherosclerotic type which is often associated with collagen-vascular disorders, like Marfan or Ehlers-Danlos type IV.(15) seudoaneurysms otherwise called "false" aneurysms are focal arterial dilations where all layers of normal arterial wall are absent .They are usually irregular in shape and typically consist of a cavity containing hematoma that communicates with the adjacent parent vessel lumen and usually arise from mid-sized arteries distal to the circle of Willis.

PAmong 35 aneurysms detected in 32 patients on CTA, 33 aneurysms were saccular in (94.3%) patients, 1 aneurysm was fusiform (2.85 %) and 1 aneurysm was a blood blister (2.85%).According to Takayashi (16), saccular cerebral aneurysms, also called as berry aneurysms are intracranial aneurysms which account for the majority of intracranial aneurysms. Similar distribution is noted in this study.

Among 35 aneurysms encountered in 32 patients in our study, total no of patients with single aneurysm were 30 (93%) and with multiple (>1) were 2 (7%). According to Takahashi (16),multiple aneurysms also constitute about 15-30% overall but a lesser prevalence (7%) is seen in my study.D.O.Wiebers (17) stated that patients with multiple aneurysms are at higher risk of rupture with severe SAH (Grade III-IV). In this study also the two patients with multiple (>1) aneurysms showed a higher grade of SAH.

Among 32 patients with aneurysms on CTA, 28 patients(88%) have aneurysms with narrow necks (>4mm) and 4 patients(12%) have aneurysms with wide necks (=/> 4mm) .Neck width is classified as narrow (width <4mm) and wide (width =/>4mm). According to J. Thornton et al (18) in their study on detachable coiling for intracranial aneurysms in 2001, Neck width along with dome to neck ratio is an important predictor for identifying ideal candidates for use of coiling alone for aneurysms with Narrow neck (width<4mm) and adjunct techniques (balloon inflation or stent placement) for aneurysms with a wide neck

(width>4mm). These adjunct techniques prevent coil migration in wide neck aneurysm in to parent artery, therefore reduce the risk of thromboembolism.

Thus, neck width is an important factor determining the choice of technique to be employed in the management of aneurysms. Among 28 patients with narrow neck aneurysms(<4mm) on CTA, 15(54%) patients had grade I SAH, 1(3%) patient had Grade II SAH, 5 (18%)patients had grade III SAH and 7 (25%)patients had grade IV SAH. Among 4 patients with wide neck aneurysms(=/>4mm) on CTA, 1(25%) patient had grade I SAH, 0 patients had Grade II SAH, 0 patients had grade III SAH and 3(75%) patients had grade IV SAH.In this study the importance of CTA is demonstrated in the early detection of aneurysms with narrow necks to plan the necessary appropriate intervention depending on the size of aneurysmal neck and severity of SAH.Endovascular coiling being suitable for older patients and clipping for younger patients to prevent future SAH.Aneurysms located at the intercavernous ICA can be managed with balloon occlusion and coiling of the culprit vessel. Surgical therapy is better suited for ruptured aneurysms with mass effect as it enables the surgeon to clear the hematoma and thereby reduces the incidence of vasospasm.(19,20,21,22,23)

Among 35 aneurysms detected in32 patients on CTA, bifurcation type of parent artery configuration is seen in 26 (74.3%) aneurysms and side wall type of configuration in 09 (25.7 %). DaanBackes, MD et al (24) classified aneurysms based on location of aneurysm on the parent artery like bifurcation type or side wall type aneurysms from only one parent vessel visible on CTA.

Bifurcation type, are at higher risk of rupture compared to sidewall type.Bifurcation type of aneurysms was observed commonly among the nontraumatic SAH participants in our study implying that bifurcation type of aneurysms are more prone for rupture.

In this study, out of 50 participants, 02 participants had cerebral arteriovenous malformation in which 1 patient had a coexisting aneurysm which was the culprit of SAH . The participants presented with complaints of headache and no other significant complaints like seizures, LOC and vomiting etc which was expected.

In our study, 02 participants were diagnosed with AVM of which both were males 1 aged about 8 years who was a known follow up case and presented with SAH. The other participant was 51 years old who also presented with SAH but on CTA the main culprit was found to be an aneurysm at the cavernous segment of left ICA.The co-existence of an AVM and aneurysm was a rare finding. Age and gender distribution could not be analyzed in this study.

In our study 2 cases of AVM were detected out of 50 participants on CTA, both had AVM at the left fronto-parietal lobe was the commonly involved site. In study conducted by Abla et al (25), concluded that patients with posterior fossa AVMs are more likely to have severe outcomes than those with supratentorial AVMs and also concluded that age, sex and ethnicity were not associated with an increased risk of severe outcome after AVM rupture.Among 2 participants

with AVM, 2 of them had medium sized deep and compact type of nidus in eloquent area of brain, 1 had large superficial and diffuse type of nidus in eloquent area of brain

Table 2: showing Spetzler-Martin grading scale for AVM's.

CHARACTERISTIC	NUMBER OF POINTS ASSIGNED
SIZE OF AVM	
SMALL(< 3 CM)	1 point
MEDIUM (3-6 cm)	2 points
LARGE(>6CM)	3 points
LOCATION	
Non eloquent	0 point
Eloquent site*	1 point
PATTERN OF VENOUS DRAINAGE	
Superficial only	0 point
Deep component	1 point

Eloquent site – sensorimotor, language, visual cortex, hypothalamus, thalamus, internal capsule, brain stem, cerebellar peduncles and cerebellar nuclei.

According to this scale, both the 2 participants are at greater risk of surgical morbidity and mortality.(26)

Thus, CTA is an inevitable imaging modality in a patient with cerebral AVMs and is immensely helpful in preoperative work up, patient management and assessing surgical morbidity and mortality.

In this study only 1 male participant was a known follow up case of venous angioma aged about 15 years who had come with complaints of headache.On CT he had mild SAH (gradeI) and CTA showed a venous angioma at the left frontal lobe with no obvious feeding artery made out. There were a cluster of compact and superficial draining veins giving it a characteristic “Head of Medusa” apperance.

In this 2 participants had cerebral venous sinus thrombosis with development of hemorrhagic infarct where the hemorrhage extended into the sub arachnoid spaces. In such participants the clinical presentation was headache with development of weakness due to hemorrhagic infarcts and the SAH usually was sulcal type i.e. of Grade I severity.

1 participant has aneurysm with CVST where the culprit of SAH was identified to be the aneurysm on CTA which was characterized under aneurysms.

In this 3 participants had intraparenchymal hematoma where the hemorrhage extended into the sub arachnoid spaces. In such participants the clinical presentation was headache with sudden onset of weakness and the SAH usually was sulcal type i.e. of Grade I severity(27,28)

CONCLUSION

The following conclusions can be drawn from the study:

1. Multi Detector Computed Tomography Brain Angiography helped us in describing morphology and imaging patterns of various vascular lesions and also non vascular causes as the source of SAH.

2. MDCTA also helped us in assessing the size, shape, location,neck and rupture status of a cerebral aneurysm and its specific imaging characteristics that may signify the higher risk of rupture and re-rupture thereby giving valid information for endovascular or surgical planning. Aneurysms were the most common etiology of non traumatic SAH and were commonly encountered in anterior circulation.

3. MDCTA also helped us in assessing the size, location, size and type of nidus with source of feeding vessels and draining veins of a cerebral arteriovenous malformation with specific imaging characteristics thereby giving valid information for endovascular or surgical intervention and also in follow-up.

4. MDCT with its various multi planar post processing techniques like MIP, VRT,SSD etc has increased the diagnostic confidence as well as serve as a decision making tool in our study.

REFERENCES

1. Suwatcharangkoon S, Meyers E, Falo C. Loss of consciousness at onset of subarachnoid hemorrhage as an important marker of early brain injury. JAMA Neurol. 2016;73(01):28–35.
2. Ohkuma H, Tabata H, Suzuki S, Islam M S. Risk factors for aneurysmal

subarachnoid hemorrhage in Aomori, Japan. Stroke. 2003;34(01):96–100.
3. Koshy L, Easwer H V, Premkumar S. Risk factors for aneurysmal subarachnoid hemorrhage in an Indian population. Cerebrovasc Dis. 2010;29(03):268–274
4. Chaturbedi A, Hossain A M, Hossain S S, Rahman Z, Barua K K. Clinical profile, risk factors and outcome assessment of aneurysmal subarachnoid hemorrhage (SAH) patients: a multicenter study in Bangladesh. Int J Neurosurg. 2019;2(02):43.
5. Feigin V L, Rinkel G J, Lawes C M. Risk factors for subarachnoid hemorrhage: an updated systematic review of epidemiological studies. Stroke. 2005;36(12):2773–2780.
6. Frontera, Jennifer A. M.D.; Claassen, Jan M.D.; Schmidt, J. Michael Ph.D.; Wartenberg, Katja E. M.D.; Temes, Richard M.D.; Connolly, E. Sander M.D.; Macdonald, R. Loch M.D., Ph.D.; Mayer, Stephan A. M.D.. PREDICTION OF SYMPTOMATIC VASOSPASM AFTER SUBARACHNOID HEMORRHAGE: THE MODIFIED FISHER SCALE. Neurosurgery 59(1):p 21-27, July 2006. | DOI: 10.1227/01.neu.0000243277.86222.6c
7. Kramer AH, Hehir M, Nathan B, et al. A comparison of 3 radiographic scales for the prediction of delayed ischemia and prognosis following subarachnoid hemorrhage. Journal of Neurosurgery JNS. 2008;109(2):199-207. doi:10.3171/JNS/2008/109/8/0199.
8. Macdonald R.L., Schweizer T.A. Spontaneous subarachnoid hemorrhage. Lancet. 2017;389:655–666. doi: 10.1016/S0140-6736(16)30668-7.
9. Geng B., Wu X., Brackett A., Malhotra A. Meta-analysis of recent literature on utility of follow-up imaging in isolated perimesencephalic hemorrhage. Clin. Neurol. Neurosurg. 2019;180:111–116. doi: 10.1016/j.clineuro.2019.03.006.

10. Street JS, Pandit AS, Toma AK. Predicting vasospasm risk using first presentation aneurysmal subarachnoid hemorrhage volume: A semi-automated CT image segmentation analysis using ITK-SNAP. PLoS One. 2023 Jun 1;18(6):e0286485. doi: 10.1371/journal.pone.0286485. PMID: 37262041; PMCID: PMC10234558.

11. Kongable GL, Lanzino G, Germanson TP, Truskowski LL, Alves WM, Torner JC, Kassell NF. Gender-related differences in aneurysmal subarachnoid hemorrhage. J Neurosurg. 1996 Jan;84(1):43-8. doi: 10.3171/jns.1996.84.1.0043. PMID: 8613834.

12. Johnston SC, Selvin S, Gress DR. The burden, trends, and demographics of mortality from subarachnoid hemorrhage. Neurology. 1998 May;50(5):1413-8. doi: 10.1212/wnl.50.5.1413. PMID: 9595997.

13. Kurihara, N. (2011). MR Imaging of Cerebral Aneurysms. In: Takahashi, S. (eds) Neurovascular Imaging. Springer, London..doi.org/10.1007/978-1-84882-134-7_12

14. Song JK, Newell DW. Cerebral aneurysms. N Engl J Med. 2006 Aug 31;355(9):928-39. doi: 10.1056/NEJMra052760. PMID: 16943405.

15. Chung DY, Abdalkader M, Nguyen TN. Aneurysmal Subarachnoid

Hemorrhage. Neurol Clin. 2021 May;39(2):419-442. doi: 10.1016/j.ncl.2021.02.006. Epub 2021 Mar 31. PMID: 33896527; PMCID: PMC8147706.

16. Kurihara, N. (2011). MR Imaging of Cerebral Aneurysms. In: Takahashi, S. (eds) Neurovascular Imaging. Springer, London. doi.org/10.1007/978-1-84882-134-7_12.

17. Wiebers DO, Whisnant JP, Huston J 3rd, Meissner I, Brown RD Jr, Piepgras DG, Forbes GS, Thielen K, Nichols D, O'Fallon WM, Peacock J, Jaeger L, Kassell NF, Kongable-Beckman GL, Torner JC; International Study of Unruptured Intracranial Aneurysms Investigators. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 2003 Jul 12;362(9378):103-10. doi: 10.1016/s0140-6736(03)13860-3. PMID: 12867109.

18. Thornton J, Dovey Z, Alazzaz A, Misra M, Aletich VA, Debrun GM, Ausman JI, Charbel FT. Surgery following endovascular coiling of intracranial aneurysms. Surg Neurol. 2000 Nov;54(5):352-60. doi: 10.1016/s0090-3019(00)00337-2. PMID: 11165609.

19. D'Souza S. Aneurysmal Subarachnoid Hemorrhage. J Neurosurg Anesthesiol. 2015 Jul;27(3):222-40. doi: 10.1097/ANA.0000000000000130. PMID: 25272066; PMCID: PMC4463029.

20. Higashida RT, Lahue BJ, Torbey MT, et al. Treatment of unruptured intracranial aneurysms: a nationwide assessment of effectiveness. Am J Neuroradiol. 2007;28:146–151.

21. Raymond J, Darsaut TE, Molyneux AJ. On behalf of the TEAM collaborative Group. A trial on unruptured intracranial aneurysms (the TEAM trial): results, lessons from a failure and the necessity for clinical care trials. Trials. 2011;12:64.

22. Clarke H, Nefale T, Mngomezulu V. Endovascular management of intracranial aneurysms at Chris Hani Baragwanath Academic Hospital. SA J Radiol. 2023 May 26;27(1):2634. doi: 10.4102/sajr.v27i1.2634. PMID: 37292418; PMCID: PMC10244967.

23. Mkhize NN, Mngomezulu V, Buthelezi TE. Accuracy of CT angiography for detecting ruptured intracranial aneurysms. SA J Radiol. 2023 May 30;27(1):2636. doi: 10.4102/sajr.v27i1.2636. PMID: 37292420; PMCID: PMC10244944.

24. Backes D, Vergouwen MDI, Velthuis BK, van der Schaaf IC, Bor ASE, Algra A, et al. Difference in aneurysm characteristics between ruptured and unruptured aneurysms in patients with multiple intracranial aneurysms. Stroke. 2014 May;45(5):1299–303.

25. Abla AA, Nelson J, Rutledge WC, Young WL, Kim H, Lawton MT. The natural history of AVM hemorrhage in the posterior fossa: comparison

hematoma volumes and neurological outcomes in patients with ruptured infra- and supratentorial AVMs. Neurosurgical focus. 2014 Sep;37(3):E6.

26. Fang, Y., Lu, J., Zheng, J. et al. Comparison of aneurysmal subarachnoid hemorrhage grading scores in patients with aneurysm clipping and coiling. Sci Rep 10, 9199 (2020). https://doi.org/10.1038/s41598-020-66160-0.

27. Raposo N, Charidimou A, Roongpiboonsopit D, Onyekaba M, Gurol ME, Rosand J, Greenberg SM, Goldstein JN, Viswanathan A. Convexity subarachnoid hemorrhage in lobar intracerebral hemorrhage: A prognostic marker. Neurology. 2020 Mar 3;94(9):e968-e977. doi: 10.1212/WNL.0000000000009036. Epub 2020 Feb 4. Erratum in: Neurology. 2021 Aug 10;97(6):300. PMID: 32019785; PMCID: PMC7238947.

28. Lindner A, Kunst S, Ianosi BA, Rass V, Schiefecker AJ, Kofler M, Limmert V, Grams AE, Pfausler B, Beer R, Thomé C, Helbok R. The location of intraparenchymal bleeding determines functional outcome after spontaneous subarachnoid hemorrhage. Eur J Neurol. 2023 Feb;30(2):372-379. doi: 10.1111/ene.15621. Epub 2022 Nov 21. PMID: 36318275; PMCID: PMC10100397.

KAMINENI ACADEMY OF MEDICAL SCIENCES AND RESEARCH CENTRE

Date: 28th February, 2023.

Dr. Safiyah Saba Fatima
DNB Student- 1st Year,
Department of Radiodiagnosis,
Kamineni Hospitals,
King Koti, Hyderabad - 500001.

IEC Provisional Registration No. EC/NEW/INST/2021/1676

Reference: 1. IEC Approval letter dated, 9th August, 2022.
2. Your letter dated, 27-02-2023.

Dear Safiyah Saba,

With reference to the above, the Institutional Ethics Committee (IEC) hereby approves to carry out your dissertation work titled, "Application of 128 Slice MDCT Angiography in Evaluation of Non Traumatic Subarachnoid Haemorrhage" under the guidance of new guide Dr. Shashidhar Sangineni, Professor & Head, Department of Radiodiagnosis at Kamineni Hospitals, King Koti, Hyderabad - 500001, India.

The rules and regulations of the IEC would remain the same.

The IEC expects to be informed about the progress of the study, any adverse events occurring in the course of the study, any changes in the protocol and participant information sheet/informed consent document and asks to be provided a copy of final report.

We appreciate your dedication to the ethical conduct of research at Kamineni Hospitals, King Koti, Hyderabad.

Yours faithfully,

28/02/2023

Dr. H.R.V. Raj Kumar
Member Secretary, IEC

INSTITUTIONAL ETHICS COMMITTEE
Kamineni Academy of Medical Sciences and Research Centre
L.B. Nagar, Hyderabad-68

L.B. Nagar, Hyderabad-500 068, T.S., India • Ph: 040-2411 0000, 2411 7777, • Email: info@kamsrc.com www.kamsrc.com