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PROJECT REPORT

Name	: *Easwer. H.V*
Programme	:*M.Ch. Neurosurgery*
Month and Year of submission	: *November-2002*

PROJECT REPORT

TITLE OF THE PROJECT

THREE DIMENSIONAL CT ANGIOGRAPHY IN THE EVALUATION OF CEREBRAL ANEURYSMS.

Name : ***Dr. Easwer H.V***

Programme : ***M.Ch. Neurosurgery***

Month and Year of Submission : ***November- 2002.***

CERTIFICATE

I, Dr. Easwer H.V hereby declare that I have actually performed/assisted all the procedures listed under report.

Place:Thiruvananthapuram Signature

Date: 7th November, 2002 ***Dr. EASWER H.V***

Forwarded. He has carried out the project titled "***Three Dimensional Ct Angiography In The Evaluation Of Cerebral Aneurysms.***"

Signature

Prof. R.N. Bhattacharya
Head of Department of Neurosurgery
SCTIMST, Thiruvananthapuram-11

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CONTENTS

INTRODUCTION

Subarachnoid hemorrhage due to aneurysms is one of the most alarming and catastrophic conditions known to mankind. It causes significant morbidity and mortality and poses a formidable challenge both in its diagnosis and management. The earliest reference about subarachnoid hemorrhage is found in Avicenna 's records (980-1037 AD) where he describes "apoplexy due to sanguineous tumor effusing suddenly about the ventricles". Morgagni (1682-1771) gave the first description of aneurysm as cause of subarachnoid hemorrhage. Thomas Willis (1621-1675) and Brunner (1653 –1727) described aneurysms as the possible etiology of apoplexy. The incidence of subarachnoid hemorrhage is reportedly 6-10.9 per 100,000[1]. In India though initially reportedly low[2], the numbers have been increasing steadily[3,4]. An autopsy series found 21%[5] of subarachnoid hemorrhage due to aneurysms in the cerebral vasculature.

While the clinical entity of SAH was known its cause remained an enigma for long, as diagnostic methods were not available. Quincke ushered in a new era in the diagnosis of subarachnoid hemorrhage with his lumbar puncture procedure in 1891. Egaz Moniz in 1927 developed the technique of cerebral angiography. In 1933, he demonstrated an aneurysm in a living patient. This anatomical localization of the cause of subarachnoid hemorrhage by angiography helped to move the treatment of subarachnoid hemorrhage from medical to surgical mode and presently the evolving field of endovascular therapy. The twentieth century saw the evolution of newer imaging modalities namely Computerised tomography and Magnetic Resonance Imaging. (It is worth recalling here that C.T won for its inventors Godsfrey Hounsfield and Alan Cormack the Nobel Prize in 1979)[6]. Refinement has occurred in both C.T and MRI and there has been an attempt to replace the invasive conventional angiography. This study attempts to use CT angiography (CTA) in the evaluation of cerebral aneurysms and compares with the gold standard digital subtraction angiography (DSA).

AIMS AND OBJECTIVES

1. To compare CT Angiography with cerebral DSA in the diagnosis of cerebral aneurysms.
2. To see whether CT Angiography can replace the more invasive Catheter angiography.
3. To assess the usefulness of CT Angiography in evaluating complex cerebral aneurysms.

MATERIALS AND METHODS

During the nineteen month period between January 2001 and Aug 2002 forty three patients underwent both 3 D – CTA and 4 - vessel cerebral DSA. These patients reported with sub arachnoid hemorrhage or had a high index of suspicion of harboring an aneurysm. All the patients were assessed clinically based on the Glasgow Coma Scale (GCS) and the World Federation Of Neuro Surgical Societies (WFNS) scale at the time of admission. Also their liver and renal function tests were done along with an echocardiogram in order to assess the cardiac status of the patients This was done as high loads of contrast was administered rapidly which requires good left ventricular function and liver and renal function to metabolize and excrete the contrast[7].

Three Dimensional C. T Angiography

The 3D CT angiography employs contrast enhanced helical C.T scans to create a computer generated three-dimensional depiction of cerebral blood vessels. It can provide reasonably detailed angiograms, which can be rotated freely in space on a computer workstation for viewing the vascular anatomy from any position.

Machinery in C.T Angiography:

This includes the following: [6]

Rotating Gantry: The spiral CT Angiography utilize rotating gantry consisting of X ray tubes, collimators, X ray detectors and a data acquisition system. The continuous rotation is made possible by the slip-ring design where multiple electrically conductive brushes on the stationary part contact a set of parallel rings on the moving part.

Front End Memory and Work Station: Data acquired from the machine needs to be removed from the rotating gantry to a computer where reconstruction is done. This study utilized the Advantage Windows work Station and the Windows 2.0 basic display software.

Principles and Techniques of 3D C.T Angiography:

3 D- C.T Angiography involves the following steps.

1. Injection of contrast.
2. Acquisition of images by the C.T Scanner and creation of angiogram.

The patients did not require any pre-medication with sedatives prior to the procedure. At the C.T suite using the intravenous access contrast was injected using the pressure injector. We utilized the pressure injector device (Medrad Envision C.T) to introduce the contrast with a capacity of 125 ml and a flow range of 0.9 –9.9 per minute. The rate of infusion was 3 ml per second with a pressure of 300 psi. The volume of contrast utilized was 125 ml. The contrast agent used is Iopamidol which is chemically N,n"bis 12 hydroxy-1-(hydro methyl)-ethyl 2-4-6 tri iodo-5-lactamido isophthalmide. It is a new generation contrast agent that is non ionic and water-soluble. Apart from severe renal and hepatic dysfunction it does not have any major contra indications to its use[7].

We obtained lateral scout films to decide the extent helical scanning, which was 30 mm below and 30 mm above the sellar floor. C.T technique utilized included 1mm slice thickness with table speed of 1mm per second, pitch of 1.3, 120 kV, 240 mA and a 12.5 cm field of view. While the actual scanning took only about few minutes the whole procedure required about thirty minutes. Contiguous axial C.T images were reconstructed without overlap. The reconstruction took an hour or two in most cases. The patient was observed following the procedure for any complications. We used the source images, Maximum Intensity Projection (MIP) and Shaded Surface Display (SSD) to study the cerebral vasculature.

Digital Subtraction Angiography

An experienced radiologist performed this procedure via the femoral arterial route using the Seldinger technique. Selective bilateral carotid and bilateral vertebral injections were done and images were obtained in the antero-posterior, lateral, and oblique directions in a two dimensional DSA machine. About 30 – 50 ml of the contrast is used during the study.

As we feared that the contrast load would be high if the two procedures were undertaken on the same day we staged the procedures on two separate days.

Interpretation

The images obtained by both methods were interpreted by a blinded observer with experience in neuroimaging. Prior to this the clinical details of the patient and the findings on the non-contrast CT scan were provided. The findings in 3D CTA including the presence of an aneurysm, its location projection and relation ship with adjacent blood vessels were noted followed by the same on DSA. The findings were compared and the results analyzed.

Computerized Tomography In SAH And Aneurysms:

The latter half of the twentieth century also saw the development of the computerized tomography technique by Sir G. Hounsfield. Paxton and Ambrose demonstrated the ability of computerized transverse axial tomography to detect intracerebral blood clot. Van Gijn et al, [8] in a series of 100 patients reported a sensitivity of 100% by computerized tomography in the first two days, while the same dropped to 85% after 5 days, 50% after one week, 30% after two weeks and almost nil after three weeks.

In 1978, Yasargil[9] elucidated the correlation between favored location of intracerebral hematomas and location of aneurysms as shown below in the table.

Site Of Aneurysm	**Cisternal Hematoma**	**IntraCerebral Hematoma**
MCA	Sylvian cistern	Superior and middle temporal gyrus occasionally insula and frontal lobe
ACOM	Lamina terminals	Medial fronto-orbital lobes
PERI CALLOSSAL	Callossal cistern	Cingulate gyrus
INTERNAL CAROTID	Basal cisterns	Lateral fronto-orbital lobes
BASILAR	Interpeduncular	

Intraventricular hematomas secondary to aneurysm rupture were known with ACOM artery aneurysm into the third ventricle and MCA & PCOM artery aneurysms into the temporal horn and PICA aneurysms into the fourth ventricle

Siyoji Asari et al (1982) [10] used a high-resolution C.T. machine, with slice thickness of 10mm parallel to and at 60°, to cantho-meatal line in 14 patients with unruptured aneurysms. Unruptured aneurysms showed up as well demarcated round iso-dense mass which forms a defect in the basal cisterns or sylvian fissure on a plain C.T. image and are highly and homogenously enhanced by contrast. The limiting factors in the detection of aneurysms included aneurysm size below 5 mm diameter and location near skull base.

The site of aneurysm also counted in angio-tomography with Ghoshhajra [11] reporting a 76% detection rate for aneurysms of middle cerebral artery while the same falls to 36% in the internal carotid artery location.

Ravi Mandalam[12] in 1985 used rapid scanning techniques, thin section slices and bolus contrast injection for detecting 16 of the 26 aneurysms seen on DSA. The aneurysms that could not be visualized included three at PCOM artery origin, four at ACOM artery and one each at MCA bifurcation and pre-cavernous ICA. They contended "C.T. localization is decidedly advantageous in planning angiographic workup of the patient helping the vessel to be studied first and reducing contrast dosage and duration of study".

Spiral computerized Tomography found mention in literature in the early nineties, when Kalender et al[13], used this technique to image complete organ volumes and sub-volumes, using a single breath hold technique, with the patient being continuously transported through the scanner gantry.

There have been several reports in medical literature regarding the complications of catheter angiography. Reviewing eight series of cerebral angiography in patients awaiting carotid endarterectomy, Hankey et al[14]concluded a neurological complication rate of 4% and permanent deficit of 1% and the mortality rate of < 0.1%. Lefers and Wagner[15], reviewed their series of 277 angiograms performed with the indication of aneurysm/AVM, (which formed 57.3% of the 483 angiograms performed between 1993 and 1995) and reported a complication rate (neurological) of 2.5%. Non-neurological complications were seen in 14.7% of their patients (71/483). The major part of these non-neurological complications was hematomas in the groin that were considered minor by the authors.

In 1991, Shigeki Aoki [16] studied intracerebral aneurysms and reported that all the aneurysms could be seen well on 3D - C.T. angiography. They reported that the reconstructed views from different directions were helpful in determining the main direction of aneurysm, its actual shape, the size of neck and its relationship with parent arteries and vessels. Operative views were helpful in planning surgery and during the operation. In giant aneurysms, they found C.T. angiograms superior to conventional angiography as in the latter dense opacification of the aneurysm superimposed on adjacent vessels made identification of the neck of aneurysm difficult. 3 D - C.T angiography afforded several different angles to visualize the neck. Also 3D - C.T angiography is useful in this situation to help determine a suitable angle on conventional angiography to demonstrate the neck and small vessels. The drawbacks of CTA quoted in the study-included difficulty in demonstrating small vessels. Patient movement also interfered with the quality of images. Hence they recommended CTA as a compliment to DSA rather than as a replacement.

In 1992, Sandy Napel et al[17] argued that C.T.A has advantages of shorter duration of scan time and lower radiation dose. Besides the region of interest and projection angles could be retrospectively chosen to demonstrate anatomic features to the best advantage. They predicted CTA had the potential to become a minimally invasive screening tool and would obviate the need for conventional angiography in some patients.

In 1992 Robert E. Harbaugh et al[18], published a series of 20 CTA. Eleven of them also underwent 4 vessel DSA. Seven aneurysms (in 4 patients) and 1 AVM (1 patient) were found, correlating with DSA studies, six patients yielded negative results by both techniques. In the remaining 9 patients, they used only CTA as intra-arterial angiography was contraindicated with 8 revealing no intracranial vascular pathology and one yielding a venous angioma. They concluded that C.T. angiography is a safe and reliable alternative to intraarterial angiography in many clinical circumstances. It avoids potential complications of arterial injury and embolisation attached to the latter. They did not encounter any complications due to C.T. angiography.

Further, the limitations of C.T. angiography included small size of lesion, difficult separation of arterial and venous phases, when both enhance and poor delineation of a vascular anomaly in the presence of a clot. Evan Dillon et al (1993)[19] after performing 100 C.T. angiographic studies (both cerebral and extracerebral) found good tolerance of the same. However, they were apprehensive about the bolus I.V. contrast material in patients with hypersentivity reactions and poor cardiac function.

Richard B Schwartz et al[20] (1994) applied helical C.T. angiography technique on 21 patients with 30 aneurysms. Twenty-six aneurysm measuring 3mm or above were seen, while none below 3mm were seen in any C.T. images. While aneurysms measuring 3.5mm located near the skull base were not seen on reconstructed images but seen well on axial source images. Calcification was demonstrated in six of the 30 aneurysms. The advantages that were noted in C.T. angiography (Vs MR Angiography) included rapid acquisition of films even in uncooperative patients (due to anxiety, claustrophobia absence of motion artifacts). The radiation dosage (4.2 cGy) was less than the conventional C.T. (4.6 cGy).

One of the best-known comparisons between C.T. angiography and Digital subtraction Angiography was by Piedro Vieco et al [21]. In this study 30 patients, underwent both studies with 22 of them found to harbor 30 aneurysms. The best results (reviewed by two neuroradiologists) obtained by C.T. angiography interpretation vis a vis DSA was 29 with no false positive and one false negative. The sensitivity was 0.97 and specificity 1.0. The aneurysm that was missed on C.T.A. but detected on DSA was a one at PiCA origin, measuring 4 mm.

The reasons for being unable to perceive the presence of aneurysm were technical; According to them large aneurysms were not difficult to identify regardless of the location while smaller ones may be missed if located near branching vessels. They advised review of source images to overcome these problems of non-visualization. Tortuosity of the vessels was another reason for error (false positivity and false negativity) in detecting an aneurysm.

The study did not reveal any major discrepancy on assessing the size of aneurysm compared to DSA.

Dorsch et al [22] in 1995 evaluated 16 patients with C.T. angiography, for cerebral aneurysms with the following indications –

1. Suspicion of aneurysm on conventional C.T. scan: Of the 4 studied one aneurysm confirmed angiographically, 2 showed arterial ectasia and no saccular aneurysm, the fourth appeared to have an aneurysm but negative by DSA.

2. Follow-up of previously detected aneurysms not planned for surgery: In 3 patients studied the CTA findings were same as DSA.

3. Follow-up of aneurysmal remnants after surgery: findings correlated well with previous angiography. Further clips causing no artifact problems (3 cases)

4. Detection of ruptured aneurysms: in 2 cases, small aneurysms missed on angiography and in the third resolution of a doubt regarding the presence of aneurysm by CTA.

5. Past cases of treated aneurysms or first-degree relative of a patient with aneurysm: Of the three screened, the yield by CTA was one and this was confirmed by angiography.

The authors used the shaded surface display, which they claimed provide a much clearer depiction of vessel contour abnormalities, particularly when looking for smaller aneurysms (i.e. < 5mm).

The advantages of CTA according to the authors included shorter scan time avoidance of arterial cannulation and 360^0 rotation of images while reconstruction.

The authors found the following disadvantages, including large amount of contrast, dependence on the skill of the operator in the reconstruction of the images and the time taken for the same. The search for smaller aneurysms in the circle of Willis required more diligent examination. Thrombosed aneurysm not filling with contrast administration may not be demonstrated though source images may reveal the same.

Daved Piepgras [23] commented that the technique may fall short while assessing aneurysms outside the circle of Willis for eg:- proximal vertebral aneurysm or other distal sites. The speed of acquisition of the images lower cost and risk to the patient, he prophesized, may make CTA the imaging study of choice to identify and characterize both ruptured and unruptured aneurysms of the circle of Willis Marc Mayberg [24] recommended CTA in cases of negative angiography which forms 5-10% of all SAH cases.

Robert Solomon[25] held out the advantage of CTA in evaluating clipped aneurysms with residual neck without the risk of artifacts. He added that CTA could also be used to follow patients who have had coil (embolisation) of cerebral aneurysms.

Donatella Tampieri [26] (1995) et al evaluated 18 patients with aneurysms proven on DSA and discovered 18 aneurysms ranging in size 2mm to more than 25mm. There were 3 failures including one 3mm ophthalmic artery aneurysm obscured by genu of carotid siphon, another A3 segment anterior cerebral artery aneurysm obscured by the distal ACA and another aneurysm, which was not included in the field of view.

The authors found CTA a useful tool for visualizing complex aneurysms including giant aneurysms. In ophthalmic segment aneurysms the imaging offered good view of the relationship of neck of aneurysm to anterior clinoid process and cavernous sinus.

However, Kobayashi[27] commenting on this study, remarked that angiographic information regarding small perforating arteries surrounding aneurysms were found wanting in CTA.

Alberico [28] et al (1995) studied 68 cases of subarachnoid hemorrhage or an intracranial aneurysm. The sensitivity of CTA was 95% with specificity of 100% in one observer who was the most experienced while for the least experienced observer they were 85%

and 100% respectively. All the three observers missed one aneurysm and it measured less than 2mm and the contrast infusion in this patient was slowed down because of patient discomfort.

The size of aneurysm ranged from 2mm to 40mm with an average of 7.9mm. There were no statistical differences between C.T. angiography and DSA in defining the neck of aneurysm.

In this study the cisternal blood measuring between 80-120 H.U. did not interfere with the vessel delineation, as the level of contrast was adequate enough to isolate the vessels for reconstruction. Pcom aneurysm especially when they are small, were difficult to be demonstrated.

Among the aneurysms best-demonstrated MCA topped. There was no interference of the aneurysm being obscured by the surrounding veins.

In his commentary on this article Ralph Heinz [29] made this notable observation the CTA is ideal in an emergency setting with complaints like “worst headache of my life” hither to assessed only with Plain scan and exclude an aneurysm as true negative. He foresees CTA to be a definite part of our investigations of symptomatic patients and can be used also in those asymptomatic persons with systemic disease (eg. Polycystic Kidney disease) who are statistically at risk for cerebral aneurysms.

In 1995 Davidd Katz et al [30] used C.T. angiography to evaluate the circle of Willis and compared the results with MRA and conventional angiography and found both of them to have comparable (CTA – 88.5%, MRA – 85.5%) sensitivities. The authors recorded difficulty in identifying the posterior communicating artery and the anterior communicating artery.

In 1996, Ogawa et al [31] used CTA to examine 65 patients who had also undergone conventional DSA. 61 of 73(84%) of aneurysms were identified on CTA. The aneurysms not visualized on CTA were 3 outside the imaging volume (1 pericallossal and 2 ophthalmic) 4 aneurysms (all ophthalmic) obscured by bone and 5 aneurysms of 2-3mm in size. There was specificity of 100% though only 15 subjects had no aneurysms on both CTA and DSA.

Apart from good visualization of large aneurysms afforded by CTA especially its relationship with neighboring structures including arteries and skull base bones (which could be manually eliminated during reconstruction) the inner surface of vessels could observed by cutting through the aneurysms. The authors recommended MIP images as well as the surface rendering technique for better visualization of aneurysms.

John Hsiang [32] et al (1996) used CTA in 30 pts with suspected aneurysms and DSA in 25 of these cases and reported a sensitivity of 95% and specificity of 83% compared with conventional DSA. They recommended CTA (apart from the usual indications) for hematomas at unusual sites including external capsule, frontal pole to rule out an underlying aneurysms, which may be responsible for the hematoma.

The need for expert personnel and sophisticated workstation are factors, which could be held out against CTA according to the authors.

Pfeiffer et al [33] (1996) studied 9 aneurysms with diameter between 5-28mm and found that CTA helped in not only diagnosing the aneurysms, but also in giving a good assessment of size, location and its relation to the parent vessel.

In 1996, Hope et al [34] published a series of 80 cases of CTA and DSA and found a positive predictive value of 93.3%. The limitations in their study included motion artifacts and possibility of confusing high-density clot with contrast inside aneurysm. Of the 14 false positive cases, thirteen were less than 3mm. In the false negative group, 3 were missed as they were outside the screening volume. Also four aneurysms could not be seen as they were close to skull base and were difficult to identify against a bony background.

The study recommends, CTA as useful in a setting of patients with intracerebral hematomas and rapidly declining neurological status and also to look for aneurysm in a patient with oculomotor palsy. CTA, according to the authors is a good tool to plan surgery as it shows not only shape and direction of the aneurysm but also its relation with adjacent vessels. The authors recommended the technique to follow up incidental small aneurysms.

Michael I Harrison [35] et al in 1997 used MRA and CTA in 10 patients with unruptured aneurysms and reported better delineation of surgical anatomy in CTA compared to DSA and MRA. They reported 100% sensitivity of both CTA and MRA and recommended review of all source data in the assessment of aneurysm.

Robert Solomon [36] commented that the non invasive studies of cerebral vasculature lacked the dexterity of DSA viz, trial occlusions assessing collateral circulation and hence did not provide the vital inputs that surgeons wanted in the intra-operative decision making.

Glenn Anderson [37] et al, did a comparative study of CTA and DSA in 37 patients of acute SAH, and found similarity in their usefulness to detect and delineate cerebral aneurysms. They recommended that it is possible to forego DSA in a setting where non-augmented CT and CTA show a clear source of bleeding.

A. Zouauai et al [38] (1997) published a study involving 107 patients with CTA and DSA and found sensitivity comparable to DSA and specificity of 100%. They recommended CTA as replacement for the more invasive DSA. There were two aneurysms of middle cerebral artery not detected by DSA but by CTA. Apart from location, size and neck of aneurysms they also demonstrated vasospasm in 5 of their patients, which were later confirmed by DSA.

In a pictorial essay, James Brown [39] et al (1997) concluded that CTA may aid not only screening of aneurysms of cerebral vasculature, but also should be considered as a useful option when other imaging techniques were inconclusive especially as a substitute for repeat catheter angiography. They recommend a second conventional DSA for these patients only if the CTA is also inconclusive.

In Satoshi Imakita [40] et al (1998) used the newly devised controlled orbital helical scanning technique and conventional DSA on 36 patients and found that subtraction techniques(by which bone structures obscuring the aneurysms could be removed) could be employed to delineate aneurysms close to the bone which was hitherto considered to handicap of CTA vis a vis conventional angiography.

T.K. Velthuis et al [41](1998) subjected 100 patients to a study with CTA and 80 of them with DSA. Their conclusions were similar to the many before them, with a sensitivity of 90%. They contended that CTA will not become superfluous even if endovascular treatment becomes widespread as it can be combined with an initial unaugmented C.T. study.

Korogi et al[42] (1999) studied 49 patients with CTA and the images were interpreted with by four blinded observers and categorized the aneurysms detected into four based on their size, large, greater than 13mm medium 5-12mm; small, 3-4mm and very small less than 3mm and found a sensitivity 100%, 95%, 83% and 64% respectively.

Hirayuki Hashimoto et al[43], studied 21 patients whose initial DSA were negative in a setting of SAH with CTA. If the CTA was also negative they were subjected to a second and third DSA at 2 weeks and 6 months respectively. The study yielded 5 cases of anterior communicating artery aneurysm and one middle cerebral artery aneurysm. Two were found to have vertebral dissection, one at autopsy and another at repeat DSA study. The remaining 13 (of 21 studies) were negative even after the second and third DSA.

Nakajima et al [44] used CTA in 42 patients with acute subarachnoid hemorrhage and aneurysms were detected in 93%. This study recommended the use of CTA as an alternative for DSA and magnetic resonance angiography.

Yoko Kato et al [45] used CTA not only in the diagnosis of cerebral aneurysms but also used it to determine aneurysm morphology, its relationship with cranial base bone structures and for preoperative simulation studies.

Gonzalez Darder [46] et al have ventured into aneurysm surgery without preoperative DSA utilizing CTA. They used post–operative DSA as control along with autopsy and found a sensitivity of 90.4%. This study recommends surgery for cerebral aneurysms without a preoperative angiogram.

To conclude computerized Tomography has evolved from merely diagnosing subarachnoid haemorrhage to establishing the cause of bleed. This less interventional mode of evaluation of Sub arachnoid haemorrhage and cerebral aneurysms will eventually lead to a quicker diagnosis there by facilitating earlier intervention.

RESULTS AND ANALYSIS

The data from this study has been analyzed under the following parameters, clinical presentation, findings on CT scan and comparison of CTA and DSA.

CLINICAL PRESENTATION:

Of the 43 patients who underwent both DSA and CTA 36 presented with history suggestive of subarachnoid hemorrhage. Focal deficits were seen in one patient, loss of consciousness in two patients and raised ICP in one patient. One patient each had long standing headache and headache with focal neurological deficit. One patient underwent evaluation for a fusiform vertebral artery aneurysm.

SUMMARY OF CT SCAN FINDINGS:

Of the 43 patients five patients were in Fisher grade 1, twenty in grade 2 and eleven in grade 3 and one in grade 4. Two patients had MRI; one showing MCA infarct with MCA aneurysm and in the other globular contrast enhancement in the supra sellar region. One patient had a cavernous sinus mass lesion, in another a large space occupying lesion. One patient had lumbar puncture suggestive of subarachnoid haemorrhage (CT data not available). One patient was being evaluated for a vertebral artery fusiform aneurysm.

ANALYSIS OF CTA AND DSA IMAGES

Of the 43 patients who underwent both DSA and CTA a total of 39 aneurysms were detected in 32 patients and the rest (11) did not have any aneurysms. DSA could detect 36 aneurysm and CTA 34 aneurysms. There were 5 aneurysms (one ACOM, one DACA, one ophthalmic and two cavernous segment), which were seen in DSA and not picked up by CTA. Similarly there were 3 aneurysms (2 ACOM and one DACA) seen in CTA and not revealed by DSA. Of the aneurysms detected the commonest was MCA (10) and the rest included ACOM (8), ophthalmic segment (7), DACA (4), PCOM (4), Cavernous segment (2), ICA bifurcation (1), basilar top (1), P2 –P3 aneurysm (1) and Vertebral (1).

All the ten MCA aneurysms were picked up by both the modalities in nine patients (one had two aneurysms). Eight of these aneurysms were located at MCA bifurcation, and 2 in the distal MCA. The CT findings of these patients included sylvian fissure bleed in four patients, infarct in one, anterior interhemispheric and sylvian fissure bleed in one, one patient there was no blood, one did not have CT scan (pt was evaluated with Lumbar puncture) and one patient with a mass lesion in frontal sub cortical region.

All the patients detected to have ACOM artery aneurysms had CT findings that included anterior interhemispheric fissure and suprasellar cisternal bleed. Of the six aneurysms detected by DSA, CTA missed one. Also CTA could detect two aneurysms, which was not evident on DSA. Three of the aneurysms seen in both DSA and CTA had hypoplasia of A1. The projection of these aneurysms matched in the two methods.

Of the four DACA aneurysms, three were seen in DSA and two by CT angiography. One patient had two aneurysms, one of which was missed by CTA. These two aneurysms were at the callosomarginal artery origin and distal pericallosal artery respectively. The latter was missed on CTA owing to its location outside the screening volume. One thrombosed aneurysm missed by DSA was picked up by CTA.

There were three posterior circulation aneurysms seen and all the three were picked up by both modalities. Among these was one Basilar artery aneurysm where CTA could reveal its projection and its relationship with the PCA, SEA & Dorsum sella. The CTA could reveal the projection, relation ship of the aneurysm with the PCA, SCA and dorsum sella and was considered superior to DSA in this respect. Here CTA images were superior to DSA.

Eleven patients were found to be negative for aneurysm by both the modalities. Of these apart from one all had evidence of blood in the subarachnoid cisterns by CT and the other patient had a positive lumbar puncture for subarachnoid blood. The classic perimesencepahlic bleed (which could be due to non aneurysmal causes was seen in two patients). Six patients had perimesencepahlic, anterior interhemispheric fissure suprasellar cisternal and sylvian fissure bleed (one of these had no sylvian fissure blood), one patient had a unilateral sylvian fissure bleed and another had blood in the interpeduncular cistern.

Six patients were found to harbor multiple aneurysms amounting to a total of 14 aneurysms. One had four aneurysms (Rt. PCOM, Rt. MCA bifurcation, Lt. P2- P3 and Lt. DACA) and the rest five had two aneurysms each. The CTA had missed 3 aneurysms in three patients. The left cavernous ICA aneurysm in a patient with ACOM and cavernous ICA aneurysms, the distal DACA in a case of two DACA aneurysms and the left ophthalmic aneurysm in a case of bilateral ophthalmic aneurysms were missed by CTA.

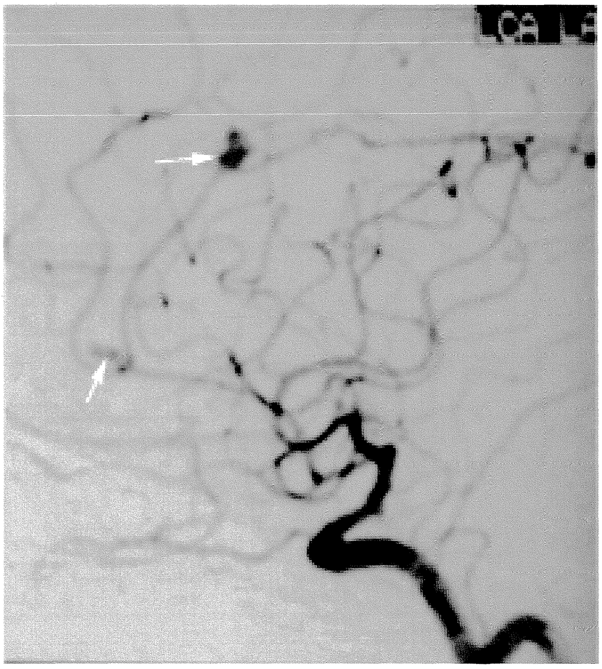

Fig 1a

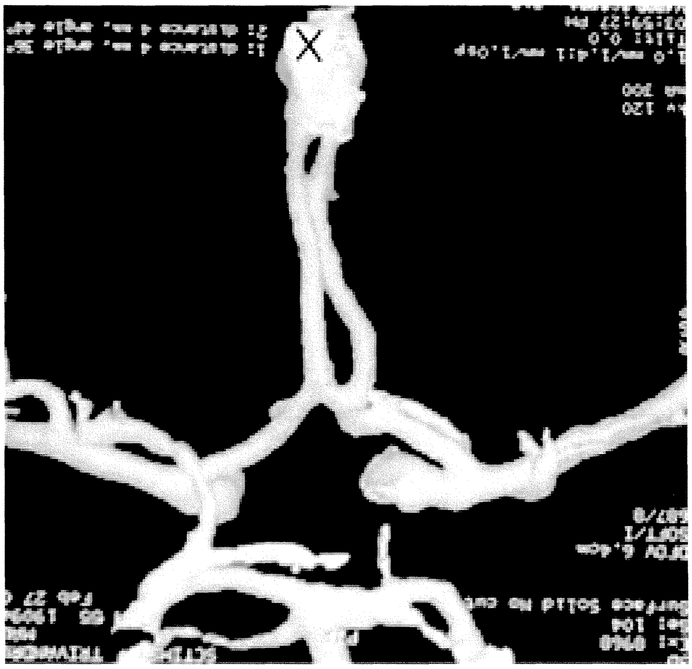

Fig 1b

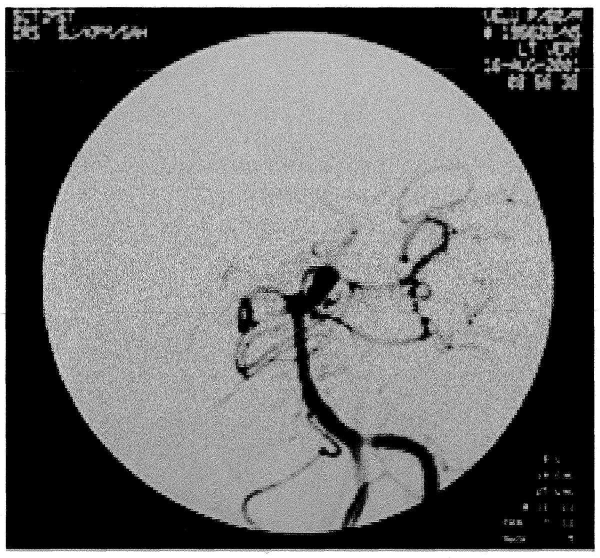

Fig 2a

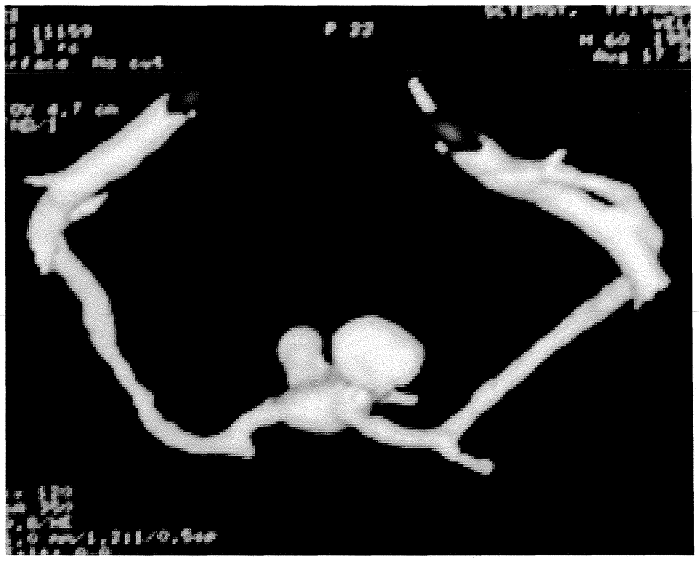

Fig 2b

Fig 3a & 3c. 49 year old lady with a giant middle cerebral artery MCA aneurysm on DSA.

Fig 3b& 3d. CTA images showing the narrow neck and projection of the aneurysm

CTA images provided a more realistic impression of the aneurysm.

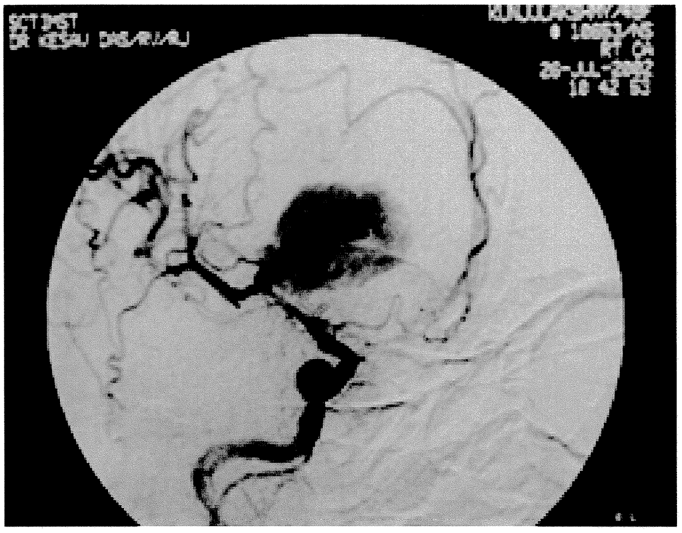

Fig 3a

Fig 3b

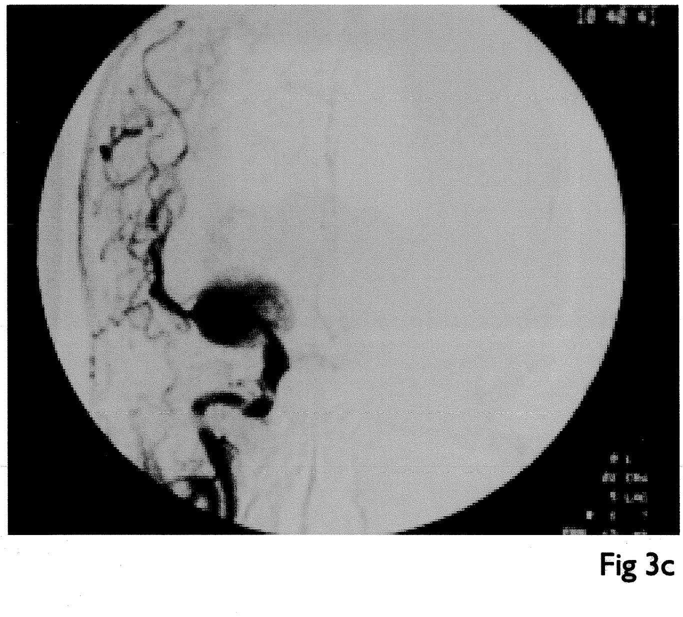

Fig 3c

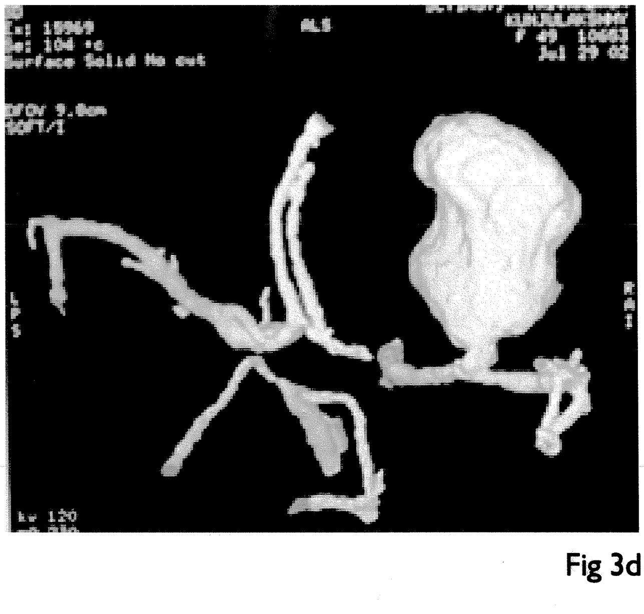

Fig 3d

Fig 4a. ICA Aneurysm projecting posteriorly on the lateral view images of DSA.(white arrow)

Fig 4b. CTA images showing the aneurysm origin, its projection. (white arrow)

Fig 5a. MCA bifurcation aneurysm (white arrow) projecting laterally on DSA images.

Fig 5b. MCA bifurcation seen on CTA (black arrow)

Note the two trunks of MCA at bifurcation straddling the aneurysm.

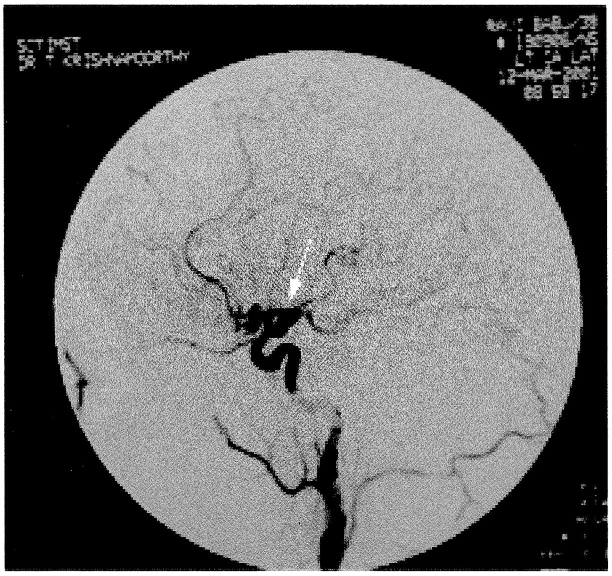

Fig 4a

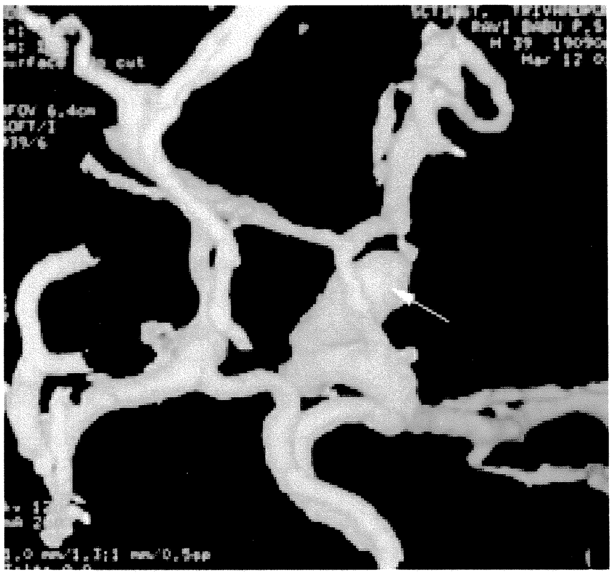

Fig 4b

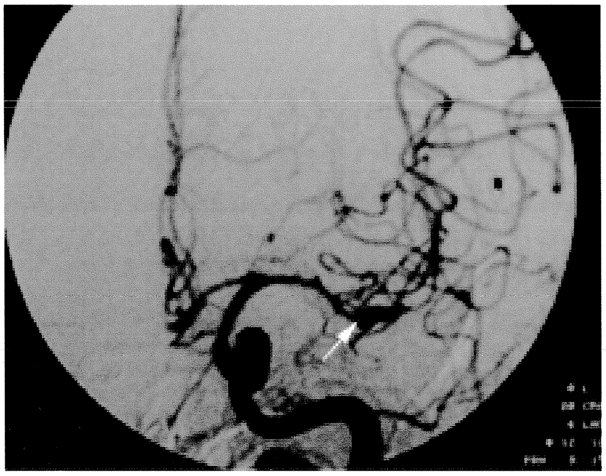

Fig 5a

Fig 5b

17-year-old boy who presented with headache, vomiting and transient loss of consciousness. Plain CT showed hyperdense lesion in the anterior inter hemispheric fissure.

Fig 6a&b. DSA AP & Lateral view did not reveal the aneurysm.

Fig 6c. CTA source images reveal a thrombosed aneurysm from DACA.

Fig 6d. CTA (SSD) images reveal DACA aneurysm.

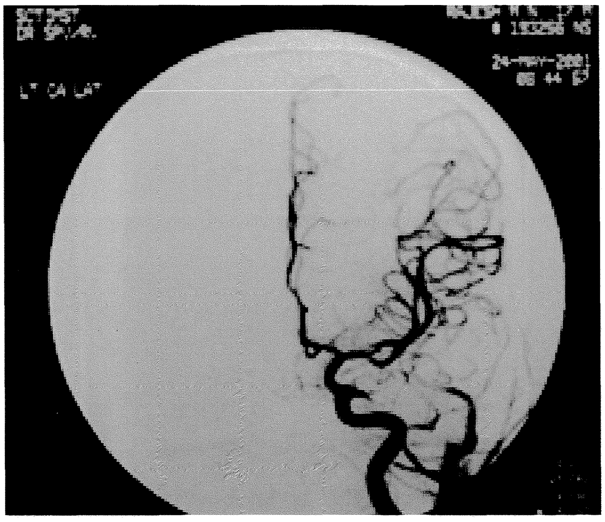

Fig 6a

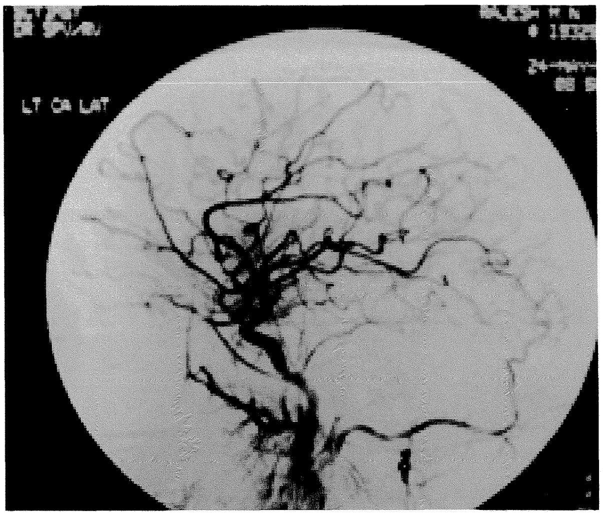

Fig 6b

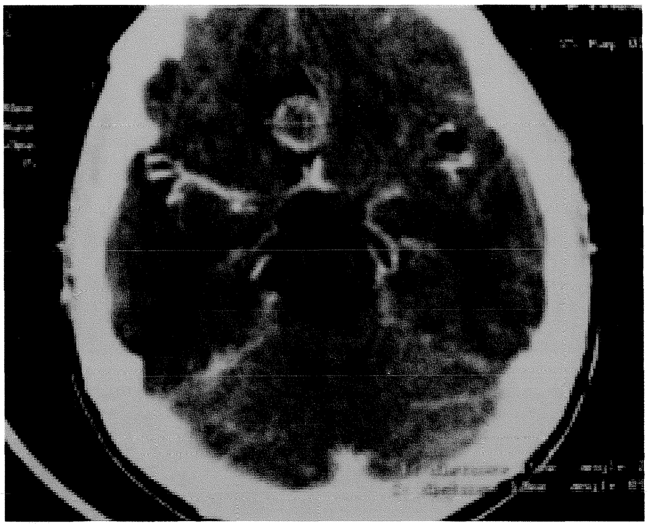

Fig 6c

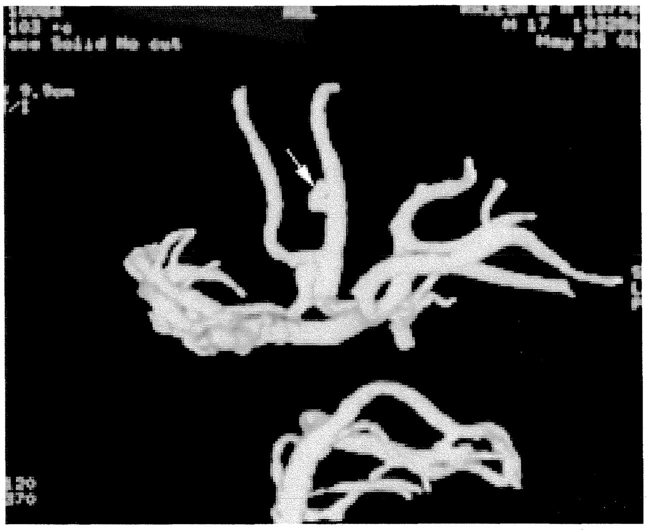

Fig 6d

55-year-old lady who presented with headache and vomiting. CT scan showing bleed into anterior inter hemispheric fissure, supra sellar cisterns and perimescencephalic regions.

Fig 7a & b. DSA- bilateral ICA injections did not reveal any aneurysm and the right A1segment was not seen.

Fig 7c. CTA images (SSD) revealed the aneurysm (grey arrow) between the two A2 segments projecting anterosuperiorly.

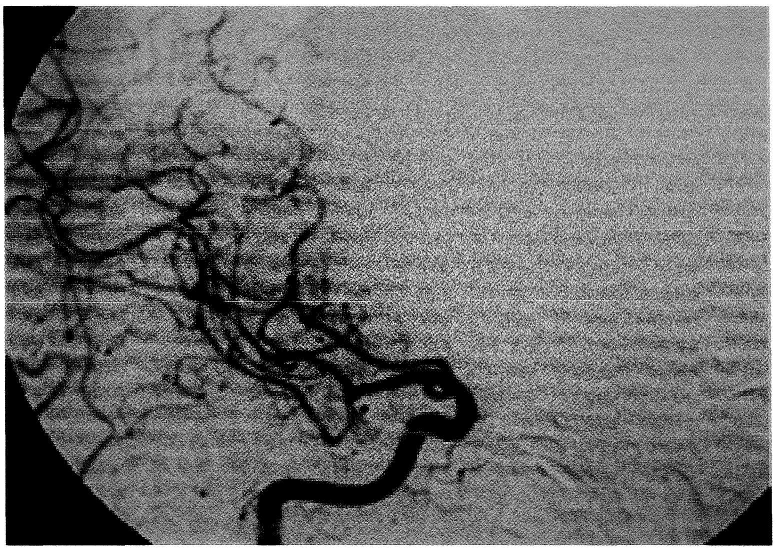

Fig 7a

Fig 7b

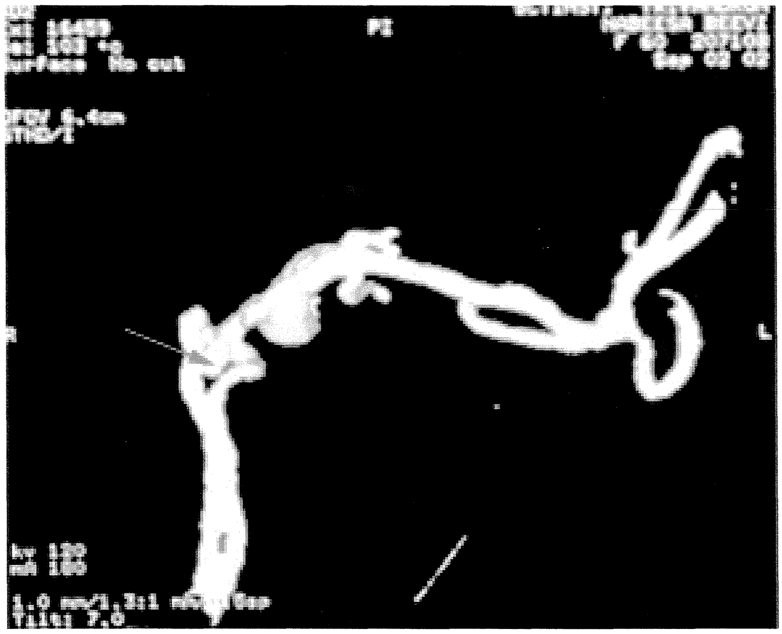

Fig 7c

65 year old lady who presented with transient loss of consciousness. Plain CT showing bleed in the anterior inter hemispheric fissure.

Fig 8 a& b. DSA images showing hypoplasia of left A1; aneurysm is not revealed.

Fig 8c. CTA images revealing Acom artery aneurysm (X) seen between the two A2 segments of ACA.

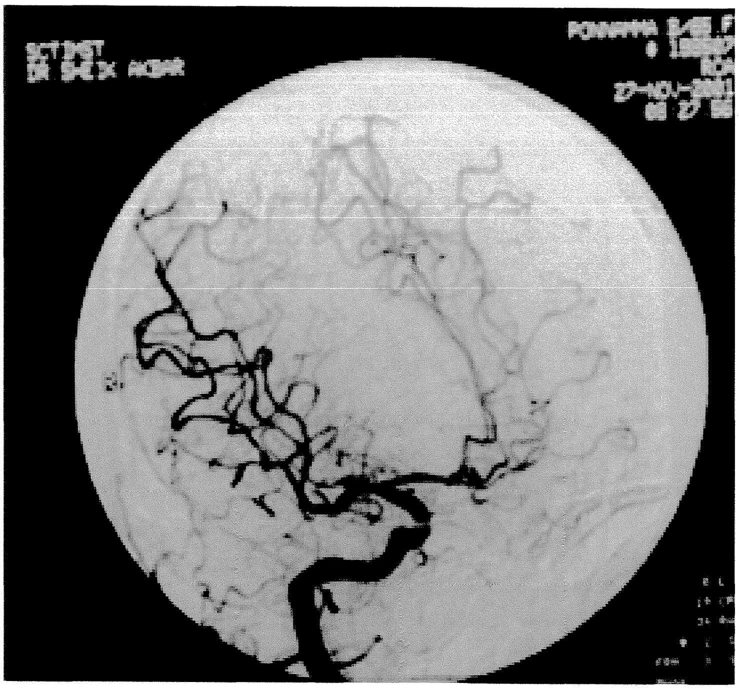

Fig 8a

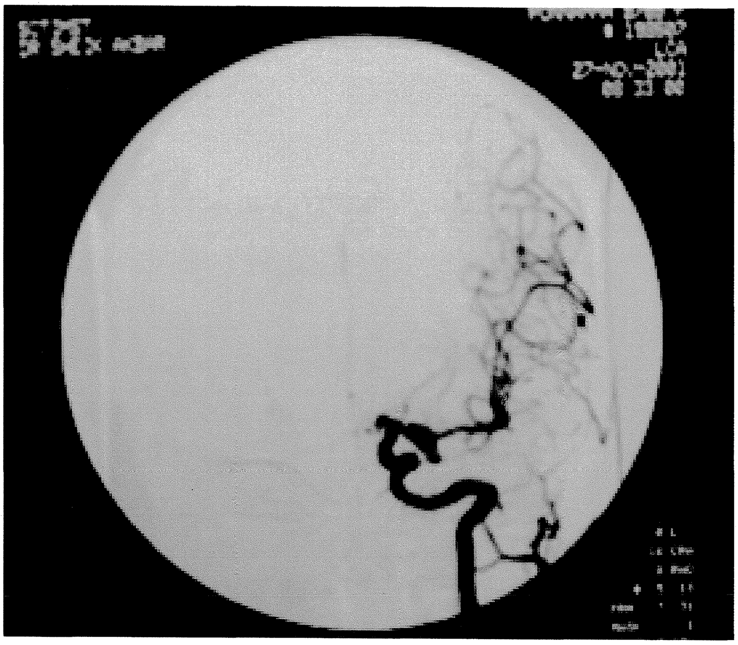

Fig 8b

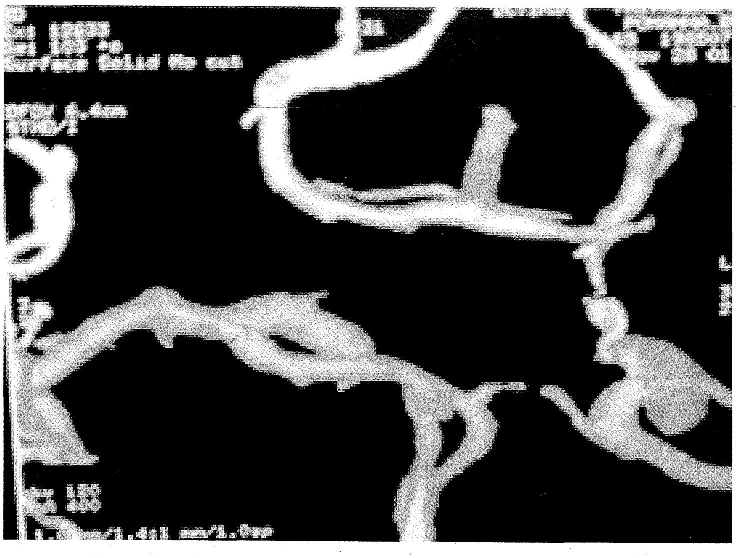

Fig 8c

DISCUSSION

This study assessed the utility of CTA in depicting and delineating aneurysms of the cerebral vasculature and compared them with the gold standard- DSA .The technique of CTA had the following advantages over DSA.

CTA[*]	DSA
Requires intravenous access only	Requires intra arterial access
Requires minimal physician supervision	Require expertise in cannulation of artery and conduct of the procedure
No procedure related complications[**]	Procedure related complications include hematoma at the arterial access site, incidence of loss of distal pulsation due to arterial obstruction and neurological deficits.
No post procedure observation required	Require observation for assessing neurological status and status of vessels distal to arterial access site and local hematoma formation [***].
Lower costs and lesser number of trained personnel required	Cost of procedure higher than CTA and require more number of trained personnel

*** 6, **44, *** 14,15.**

Of the forty-three patients who underwent both CTA and DSA, the former could identify 34 aneurysms including three, which could not be revealed in DSA[43]. At least in two of these missed aneurysm faulty angulation was to be blamed. Several studies have demonstrated the sensitivity of CT angiography of nearly ninety percent [28,30,34,41]while in this study the sensitivity was 83.78 %. Among the aneurysms MCA locations yielded excellent images of its projection and relationship with adjacent blood vessels, this is similar to the results described in literature[28]. The close proximity of cavernous and ophthalmic segment aneurysms to bony structures pose difficulty in their identification and such difficulties has been reported in literature[20, 31,34]. CTA missed one DACA aneurysm as its location was outside the screening volume[26, 34,31]. Also CTA missed one aneurysm at the ACOM artery, [30,44] the reason for which remains obscure. In this series one patient had an unruptured aneurysm (vertebral artery fusiform aneurysm) and the images of CTA matched with DSA in showing the extent of involvement of the vertebral artery by the aneurysm.[22, 34] CTA image of basilar artery aneurysms yielded excellent results as comparable to those of DSA with respect to dorsum sella and the adjacent vessels.

The specificity of this investigative modality was 78.57 % in our series, a figure close to other series hitherto published in medical literature.[32, 34] This could be held forth as a handicap inherent to this procedure when it is considered as an alternative to the more invasive DSA. Another feature of subarachnoid hemorrhage namely vasospasm is not evident on C.T angiography. In the characterization of complex large aneurysms CTA images were on par with DSA in revealing the location, projection and its relationship with adjacent arteries. (Two large MCA, one ACOM artery and one Basilar top aneurysms).

In the three patients where DSA failed to show the aneurysm CTA succeeded (2 ACOM and one DACA). This indicates a possible role for CTA in a setting where DSA is negative[43].

CONCLUSIONS

1. CTA is a good procedure with a sensitivity of 83.78% in the detection and delineation of cerebral aneurysms.
2. Owing to the lower specificity of CTA, DSA remains the gold standard in evaluating patients with cerebral aneurysms.
3. In documented subarachnoid haemorrhage CTA is a good adjunct when DSA is negative.
4. In complex aneurysms, CTA supplements DSA images in planning their management.

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