INTRODUCTION

Aneurysms of intracranial vessels are relatively common with a reported prevalence of 3-6% in the general population, predominantly in women. Cerebral aneurysms typically become symptomatic in people aged 40-60 years and are uncommon in children accounting for fewer than 2% of all cases. Rupture of an intracranial aneurysm is the commonest cause of non-traumatic subarachnoid haemorrhage (SAH), which constitutes 77% cases of spontaneous SAH. An approximate occurrence rate for aneurysmal rupture is 12/100,000 populations per year.

Initial bleeding impact accounts for most deaths in aneurysmal SAH and once rupture occurs, mortality increases by 50% with each subsequent bleed. One of the most important objectives in the management of aneurysmal SAH is to prevent aneurysmal re-bleeding and delayed cerebral ischemia caused by arterial vasospasm. Therefore, early detection and prompt localization of the aneurysm is critical for determining the appropriate neurosurgical or endovascular intervention.

CT scanning should be the first diagnostic study performed to evaluate the possibility of SAH. Cranial CT scan can also demonstrate intraparenchymal haematomas, hydrocephalus, and cerebral oedema and can help to predict the site of aneurysm rupture.

Intra-arterial digital subtraction angiography (IA-DSA) is considered the standard investigative tool for intracranial aneurysmal disease. It is central in the diagnosis, planning of treatment, and treatment of many central nervous system diseases. However, it is an invasive test with potentially severe complications and carries a 1% complication risk with a 0.5% rate of persistent neurological deficit. Cerebral embolism, dissection, rupture of cerebral arteries and haemorrhage, arterial vasospasm or systemic complaints have been described. Concerns over the small but potentially significant risk of permanent neurological complications associated with IA-DSA have generated growing interest in the use of alternative non-invasive techniques. Magnetic resonance angiography (MRA) has evolved as an attractive non-invasive and non-ionizing alternative for imaging intracranial vasculature. With the development of MRA, absolute reliance on IA-DSA for aneurysm detection and surgical planning is changing.

For the purpose of determining therapy accurate assessment of the presence of an aneurysm and
comprehensive visualization of the aneurysm location, orientation, size, morphology, neck and relationship to the parent vessel are crucial. The principle aim of this study was to evaluate the accuracy of MRA in the diagnosis of intracranial aneurysms and to compare MRA with IA-DSA, the reference standard, in detection and characterization of intracranial aneurysms.

METHODOLOGY

This comparative cross-sectional study was carried out at Department of Diagnostic Imaging, Lahore General Hospital and Postgraduate Medical Institute, Lahore, from January to June 2007. Patients of either gender and all ages presented with non-traumatic SAH, were included. Patients with traumatic SAH or those having contraindications to MRA were excluded.

The demographic information including name, age, gender and address was recorded and patients were further asked for history of illness regarding types of symptoms, severity and duration and physical examination was done. The diagnosis of SAH was made by either CT scan or lumber puncture. Three dimensional time of flight magnetic resonance angiography (3D-TOF MRA) and intra-arterial digital subtraction angiography (IA-DSA) was performed on all patients. All MR angiographic studies were performed using 1.5 T superconducting MR system (Philips Intera Achieva, Holland). A three dimensional time of flight magnetic resonance angiography (3D-TOF MRA) technique was used with imaging parameters of 30/6.4 and ramped pulse from 15 to 25 with a centre flip angle of 20. The whole volume was divided into 4 slabs with 38% overlap. Each slab consist of 48 partitions, resulting in total of 150 sections of 0.7 mm. The overall vessel coverage with this technique was 210 mm. It was placed to include the structures from foramen of magnum to A3 branch of ACA. Scan time was reduced to 8 minutes using SENSE factor II.

Diagnosis of aneurysm was performed after evaluating the maximum intensity projections (MIP) images and individual axial sections. When an aneurysm was detected, further information regarding the location, size, shape, neck of aneurysm, and relationship of aneurysmal neck to parent vessel were recorded.

Intra-arterial digital subtraction angiography (IA-DSA) was performed within 24 hours (n=25) to one week (n=5) of 3D-TOF MRA. Intra-arterial digital subtraction angiographic examinations were performed using digital subtraction system with standard transfemoral technique using 6F sheath and catheter systems. 8-10 ml of non-ionic contrast medium (Ultravist 300 mg I/mL) was injected at a rate of 3-4 ml per second. Calibrations and digital measurements of aneurysmal sac and neck were performed. Relationship of aneurysmal neck to parent vessel was evaluated.

Interpretation of 3D-TOF MRA and IA-DSA was performed independently by two radiologists. Findings on 3D-TOF MRA were compared with those on IA-DSA, taking IA-DSA as the gold standard.

All the data collected was entered in the SPSS version 10 and analyzed through its statistical program. Study variables included age in years, gender, presenting complaints, location of aneurysms, size of aneurysms, shape of aneurysms, neck of aneurysms, and relationship to the parent vessel. Mean was calculated for quantitative variables like age of patients and size of aneurysms.

Frequency and percentage was calculated for qualitative variables like gender of patients, presenting complaints and locations of aneurysms. The paired observation of 3D-TOF MRA and IA-DSA regarding size of aneurysms was analyzed by paired t-test.

The comparative data obtained through the two procedures regarding shape of aneurysms, neck of aneurysms and relationship of aneurysmal neck to parent vessel were tabulated in the form of 2 x 2 table. Sensitivity, specificity, diagnostic accuracy and predictive values for the positive and negative results of three dimensional time of flight magnetic resonance angiography (3D-TOF MRA) was calculated taking results of intra-arterial digital subtraction angiography (IA-DSA) as gold standard.

RESULTS

The study group was consisted of 30 patients. Most of the patients (40%) presented in 5th decade, youngest patient was of 12 years and oldest patient was of 70 years with mean age of 41±14.1 years.

Fourteen patients (46.7%) were males and 16 patients (53.3%) were females. Twenty two (73.3%) patients presented with subarachnoid haemorrhage, 5 (16.7%) patients with subarachnoid haemorrhage and focal neurological signs and 3 (10%) patients were having ICH along with SAH.

Three dimensional time of flight magnetic resonance angiography detected 29 of 30 aneurysmal lesions. In one case of 1.5 mm aneurysm of MCA at junction of M1 and M2 segment, MRA at first failed to detect the lesion, which was detected by intra-arterial digital subtraction angiography. Retrospective evaluation of MRA then revealed that aneurysm. Apart from that single case, magnetic resonance angiography successfully detected the rest of the lesions, and intra-arterial digital subtraction angiography confirmed them showing 96.7% sensitivity. Since no true negative or false positive results were produced, specificity could not be estimated.
Among 30 intracranial aneurysms, most of aneurysms were located on the anterior communicating artery (A Com A = 36.7%). Second most common location was middle cerebral artery (MCA = 20.0%) (Table I).

The smallest aneurysmal lesion was of 1.5 mm and the largest was of 12 mm. In 26 cases, the size was well matched among MRA and IA-DSA.

Mean size of aneurysms on intra-arterial digital subtraction angiography was 6.29 ± 2.87 mm and that on magnetic resonance angiography was 6.18 ± 3 mm.

In the evaluation of the shape of the aneurysms, the results from 25 cases matched in both procedures. In the remaining 5 cases magnetic resonance angiography revealed a smooth shape, whereas intra-arterial digital subtraction angiography indicated a daughter sac, with MRA sensitivity of 100% and accuracy of 83% in identification of daughter sacs as compared to DSA (Table II).

In confirmation of the neck of the aneurysms, the results from 25 cases matched in both procedures. In remaining 5 cases magnetic resonance angiography could not identify neck of aneurysms which could be identified by intra-arterial digital subtraction angiography, with 83% accuracy of magnetic resonance angiography in confirmation of aneurysmal neck (Table II).

For the analysis of the relationship of aneurysmal neck to the parent vessel, results were matched in 25 cases. In rest of the 5 cases relationship of aneurysmal neck to parent vessel was poorly identified by magnetic resonance angiography because of overlapping whereas relationship could be identified on intra-arterial digital subtraction angiography, with MRA accuracy of 83% in identification of relationship to parent vessel as compared to IA-DSA (Table II).

3D-TOF MRA provides good spatial resolution, an acceptable acquisition time and minimal signal loss caused by turbulent flow. It provides several advantages over IA-DSA including reduced cost, avoidance of arterial injury and stroke, rapid acquisition and retrospective manipulation of data.

The study group was consisted of 30 patients. Regarding age of patients, the youngest patient was of 12 years while the oldest was of 70 years. Maximum cases were recorded in 5th decade of life. Several case reports denote the disease in early years of life but maximum cases are seen in 4th and 5th decade of life.

Gender distribution pattern of female pre-dominance has also been noted in other studies. In another study incidence of SAH in women was 1.24 times higher than in men starting at the age of 55 years and increased thereafter.

Gender is a recognized risk factor for occurrence of aneurysmal SAH along with other risk factors including age, smoking, hypertension, excessive alcohol intake and familial preponderance.

3D-TOF MRA using MIP as post-processing technique detected 29 out of 30 aneurysms in this study with sensitivity of about 96.7%. has reported the sensitivity of MRA in detection of intracranial aneurysms is 90.9% and specificity is 88.8%. Recent blinded reader studies have reported mean sensitivity of 63-93% for detection of intracranial aneurysms using 3D TOF MRA and / or MIP. When 3-5 mm was considered...
the critical size for detection, sensitivity increased to 86-100%.18

A potential risk exists for missing aneurysm with MR angiography especially 3 mm and smaller in size,19 owing to slow blood flow within them. Also loop formation and overlap of vessels have been described as main causes of false positive and false negative interpretations. The aneurysms most likely to be missed are those in carotid siphon, because of flow turbulence and complicated anatomy in this region. In the present study these diagnostic limitations of MRA led to one false negative interpretation and missed 1.5 mm aneurysm located on MCA.

Now 3D TOF MRA at new 3 Tesla MR scanners further increased its sensitivity and small aneurysms as small as 1 mm in size can be reliably detected without the use of intravenous contrast.3,20

MRA alone should reveal not only the aneurysm itself but also the vessel of origin, the definition of aneurysmal neck, and the relationship of the aneurysm to nearby small vessels. Also morphologic changes of the lesions must be discernable for rupture to be confirmed. Furthermore, normal vessels and spams should be differentiatated at circle of Willis. To satisfy these requirements, a high resolution MRA technique with careful post-processing may be essential.

Conventional MR angiography requires about 12-20 minutes of examination time. This scan time has to be reduced to as short as possible because most of the patients with ruptured intracranial aneurysms and SAH are in serious condition and irritable. Therefore, a section-interpolation technique using SENSE factor is proposed to reduce scan time as well as to achieve sub-millimeter resolution. Voxel size is kept small using this technique while measuring fewer data in K-space. In addition thinner partitions can be created in the 3D data set so that quality of MR angiography is improved without increasing scan-time. Using this section interpolation technique high-resolution MR angiography was obtained with a faster scan time of about 8 minutes.

In this study, most of the aneurysms (36.7%) were located on anterior communicating artery (A Com A) and second most common location was MCA (20%). In a local study most common location for aneurysmal lesions was A Com A.21 In another study most frequent location was A Com A (29.4%) followed by MCA bifurcation (21%).11

Slightly smaller size was detected in some aneurysms by means of MRA as compared to IA-DSA. MRA showed high sensitivity in detecting daughter sacs. For identification of aneurysmal neck and estimation of relationship between aneurysmal neck and parent vessel MRA also showed reasonable sensitivity. 3D-TOF MRA is equally good in detection and characterization of intracranial aneurysms as the IA-DSA and can be used as a non-invasive screening test for intracranial aneurysms and it can be a suitable alternative to IA-DSA as a primary examination for aneurysmal surgery.

There are certain limitations of this study for example sample size was small. Further studies can be carried out with larger sample size. In addition more studies comparing IA-DSA with other non-invasive alternative like CTA or comparing IA-DSA with both MRA and CTA can be carried out. CTA is having advantages of rapid acquisition of data and it is more sensitive in demonstrating mural calcifications and thrombosis; however, it carries risks related to contrast media injection and exposure to ionizing radiation. Moreover, it presents some difficulty in evaluation of aneurysms near bony structures.

**CONCLUSION**

Three dimensional time of flight magnetic resonance angiography (3D TOF MRA) technique showed a high sensitivity in the detection and characterization of intracranial aneurysms in this study, suggesting the possibility that this technique can be used as a non-invasive screening test for intracranial aneurysms and it can be a suitable alternative to intra-arterial digital subtraction angiography (IA-DSA) as a primary examination for aneurysmal surgery.

**REFERENCES**


