Role of Magnetic Resonance Angiography in Evaluation of Brain Pathologies

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ABSTRACT

Background: MR angiography is the latest technique for the evaluation of cerebrovascular diseases. It is now used commonly for the evaluation of brain pathologies. The advantage is it is a non-invasive method of brain vasculature. The present study aimed to evaluate the role of Magnetic Resonance Angiography in the detection of brain pathologies and to study the Role of Magnetic Resonance Angiography in Cerebral Arteriovenous Malformations, Aneurysms, and Cerebral infarctions.

Methods: Data for the study was collected from patients with clinically suspected cerebral lesions or from patients, in whom previous images depicted cerebral lesions, undergoing MRA for evaluation of cerebral lesions. Patients underwent MR imaging including TOF Magnetic resonance angiography according to the set protocols after obtaining informed consent. All these patients had undergone detailed clinical evaluation by the referring neurosurgery unit.

Results: In this study, a total of n=32 cases were included out of which n=6 (18.75%) were AVM, n=10 (31.25%) were Aneurysms, and n=16 (50%) were cases of infarcts. Of the total n=16 infarct cases n=8 (50%) were found in the middle cerebral artery (MCA) n=4 (25%) in ACOM and n=2 in PCOM, as well as internal carotid artery (ICA). Of the MCA cases n=5 (62.5%) were right-sided and n=3 (37.5%) were left-sided.

Conclusion: MRA is now in routine use as a non-invasive tool for imaging the cerebrovascular anatomy. In cerebrovascular disease, it is the investigation of choice for patients who are suspected of having disorders such as unruptured intracranial aneurysms, intracranial vascular diseases associated with acute cerebral infarction, or intracranial dissection of the carotid and/or vertebral arteries, and follow up cases of Cerebral AVMs.

Keywords: Arteriovenous malformations, Magnetic resonance angiography, aneurysms, cerebral infarcts

INTRODUCTION

Magnetic Resonance Angiography is a rapidly evolving technique for non-invasive vascular imaging. Since 1985, when it was first shown to be clinically feasible, the imaging techniques and hardware used for MR angiography have greatly improved.[1] MRA has become an essential component of MRI in the evaluation of many types of cerebrovascular diseases. In the cases of acute stroke, MRA is useful for determining the severity of stenosis, vascular occlusion, and collateral flow.[2] 3D TOF technique has a high sensitivity and specificity for differentiating surgical from nonsurgical carotid stenoses. Three-dimensional TOF MRA is quite sensitive and specific for the evaluation of intracranial proximal stenoses and occlusions.[3] Two-dimensional PC MRA is useful for determining collateral flow patterns in the circle of Willis. MRA can clearly define the circle of Willis sufficiently to allow detection of intracranial aneurysms as small as 3-4 mm. MRA holds promise as a truly non-invasive intracranial vasculature screening examination in patients at risk for aneurysms.[4] TOF-MRA which provides information about vascular patency and caliber, has shown value in the diagnosis, localization,
and follow-up of patients with moyamoya disease and other intracranial vasculopathies. TOF & PC techniques allow visualization of cerebral vasculature without administration of contrast therefore it plays a vital role in patients who are allergic to contrast and in patients with renal failure in whom contrast is contraindicated. Further advances in hardware and software in the future will result in improved resolution of smaller vessels. MRA is likely to replace angiography for a large number of clinical applications. The current study aims to determine the role of Magnetic Resonance Angiography in the evaluation of brain pathologies.

Materials and Methods:
This prospective study was conducted in the Department of Radiology & Imaging, Prathima Institute of Medical Sciences, Nagunoor, Karimnagar. Institutional ethical committee permission was obtained before the study. Written consent was obtained from all the participants of the study. Data for the study were collected from patients with clinically suspected cerebral lesions or from patients, in whom previous images depicted cerebral lesions, undergoing MRA for evaluation of cerebral lesions. Patients underwent MR imaging according to the set protocols after obtaining informed consent. All these patients had undergone detailed clinical evaluation by the referring neurosurgery unit.

Inclusion Criteria
1. Patients of age 12 years & above with clinical/ CT suspicion of cerebral vascular malformations.
2. Patients already diagnosed of having cerebral AVM, Aneurysms, and Infarcts on CT scan or CT angiography or DSA and requiring MR imaging evaluation before radiosurgery/ embolization.
3. Follow up patients of cerebral AVM, for assessing the adequacy of the treatment / residual AVM.

Exclusion Criteria
1. Patients were excluded if contraindications to MR imaging (claustrophobia, pacemaker, potentially magnetic implants, etc) were present.
2. Patients requiring emergency vascular intervention.
3. Patients with severely impaired renal function, heart failure, and poor physical conditions which precluded contrast administration.
4. Patients who were pregnant.

MR Imaging Protocol: MR imaging examinations were performed with a 16 channel 1.5 T whole-body imager (Achieva 1.5 Tesla, Philips Medical System, Netherlands). Jequipped with a high-performance gradient system. A commercially available 16 channel head and neck coil was used for imaging. All the patients were positioned supine on a scanner table and head immobilization was achieved. First, routine MR imaging of the brain including T1WI, T2WI, and FLAIR sequences was done. Following this, 3D Multi Chunk Inflow Sequence was used for Time of Flight angiography (TOF). Time of Flight MRA: 3D Multi Chunk inflow sequence was used for TOF angiography. The scan was done by selecting a section thickness of 0.8-1 mm, over a 200-250-mm FOV (the upper thorax to the cranial vertex). Acquisition parameters of the sequence as follows: TR/TE, 23/6.5 ms, flip angle, 20 degrees; Slice Orientation Transverse, with 20 mm thickness of single Saturation band, Image Matrix 512x512 with a scan duration of 5 minutes. Maximum intensity projection (MIP) reconstruction was performed in-line. Post-processing and Image Analysis: After the acquisition of data, image post-processing was performed on a 3D workstation (Philips Medical System), with standard commercial software by using the MIP algorithm. Overlapping thin MIP subvolumes (10 mm, with 9 mm overlap) in the coronal, sagittal, and axial planes (or any desired obliquity) were reconstructed for all source images. Image Evaluation: Two neuroradiologists independently reviewed the TOF/MR Angiography results using source and MIP images for image quality and characteristics of (Arteriovenous Malformation) AVM and Aneurysms.

Results
In this study a total of n=32 cases were included out of which n=6 (18.75%) were AVM, n=10 (31.25%) were Aneurysms, and n=16 (50%) were cases of infarcts. Out of the total n=32 cases, n=18 (56.25%) were males and n=14 (43.75%) were females. Among the Arteriovenous Malformations (AVM) cases n=4 (66.67%) were males and n=2 (33.33%) were females male to female ratio of 2:1. N=3 50% of AVM’s were found in the Second Decade and 33.33% seen in the Third decade of life. In this study AVM’s are most observed in Supratentorial location, only one AVM observed in infratentorial location. 33.33% AVM’s are observed in the Right frontal region, 16.66% observed in the Left frontal region. 16.66% of AVM’s are seen in the Parietal region on each side.

Table 1: Distribution of AVM According to anatomical location

<table>
<thead>
<tr>
<th>Side</th>
<th>Frontal</th>
<th>Parietal</th>
<th>Infratentorial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>2(33.33%)</td>
<td>1(16.66%)</td>
<td>1(16.66%)</td>
</tr>
<tr>
<td>Left</td>
<td>1(16.66%)</td>
<td>1(16.66%)</td>
<td>-</td>
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</table>
Of the total n=10 cases of Aneurysms were commonly seen in n=4(40%) in 40 – 49 years n=3(30%) in 50 – 59 years and n=2(20%) in 60 – 69 years and n=1(10%) in 30 - 39 years. In this study aneurysms are most seen in Acom followed by MCA - Middle Cerebral Artery(MCA) 40% are seen in Anterior communicating Artery (Acom) and 30% are seen in MCA. In Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean size(mm)</th>
<th>Frequency of Aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACOM</td>
<td>6.23</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>MCA</td>
<td>7.03</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>PCOM</td>
<td>6.1</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>ICA (Cavernous)</td>
<td>9</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>A1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A2</td>
<td>5.4</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Basilar Tip</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>10(100%)</td>
</tr>
</tbody>
</table>

According to this study, the total number of infarcts cases was n=16. Males were n=10 and females were n=6 the male to female ratio was 1: 0.6. The most common age group for infarct is 7th Decade accounting for 37.5% of total infarcts followed by 6th decade, 25% of infarcts are observed in this age group depicted in figure 1. Infarcts are more commonly observed in males compared to females With, Male to female ratio of 1.63.

Of the total n=16 infarct cases n=8(50%) were found in the middle cerebral artery (MCA) n=4(25%) in ACOM and n=2 in PCOM, as well as Internal carotid artery (ICA). Of the MCA cases n=5(62.5%) were right sided and n=3(37.5%) were left-sided.

Discussion

In this study, Patients are having brain pathologies like AVM,s, Aneurysms, and Infarcts. Among n=32 Patients, n=6 (18.75%) patients had AVM, n=10(31.25%) patients had Acom, the mean size of the aneurysm is 6.23 mm and in MCA, the mean size was 7.03 mm. The most common size of the aneurysm is 6-7mm, accounting for 50% of Overall aneurysms. Among these 60% of aneurysms are observed in Acom (Table 2).

Table 2: Mean size and number of aneurysms according to Location

Aneurysms and 16(50%) patients are having Cerebral Infarcts. So, the majority of patients had cerebral infarcts in this study. Out of n=32 patients n=18 (56.25%) cases are male and 14(43.75%) cases are female patients. Arteriovenous malformations (AVMs) are defects of the circulatory system that are generally believed to arise during embryonic or fetal development or soon after birth. They are composed of a complex tangle of arteries and veins connected by one or more fistulas. The pathogenesis of arteriovenous malformations (AVMs) is not well understood. According to literature the common age at presentation is between 20 and 40 years. Most AVMs become symptomatic by 50 years of age. In this study, we had n=4 cases of AVM in males and n=2 in females. Similar findings have been reported by other studies. Headache with or without vomiting was the most common complaint and seizures was the second common complaint (60%) with which the patients had presented to the referring unit. Other associated complaints like loss of consciousness and weakness have also been described. Analysis of NCCT findings showed that intracranial hemorrhage was the most common finding and Intraventricular hemorrhage was also seen in some patients. SAH was not seen in our study which is the most common presentation in cerebral aneurysms. In this study, all patients had a single AVM nidus which is usually a common presentation as described in other studies. AVM with Multiple nidi is a less common presentation according to many studies. About 98% of AVMs are usually solitary. Although approximately 2% are multiple and they are usually associated with extracerebral cutaneous or vascular anomalies. Multiple AVMs are seen in Rendu-Osler-Weber
ROW) and Wyburn-Mason syndromes. Imaging that accurately defines the vascular anatomic features of AVMs is crucial for successful management. Yu S et al; Conducted a study to evaluate the clinical utility of anovel non-contrast four-dimensional (4D) dynamic MRA (dMRA) in the evaluation of intracranial AVMs. As a completely-non-invasive method, 4D dMRA offers hemodynamic information with atemporal resolution of 50-100 ms for the evaluation of AVMs and can complement existing methods such as DSA and TOF MRA. In our study out of 32 patients, 10 (31.25%) patients are women and 40% observed in males and females are more susceptible than men. Females are more prone to aneurysm rupture, with SAH 1.6 times more common in women. Aneurysms also run in families in the absence of an identified genetic disorder, with an prevalence of 7% to 20% in first- or second-degree relatives of patients who have suffered a SAH. Juan R. Cebrail et al; In their Report Stated that Hemodynamic factors are thought to play an important role in the initiation, growth, and rupture of cerebral aneurysms. In this study, 40% of aneurysms are seen in the 4th decade and 30% of aneurysms are observed in the 5th decade, which correlates with the literature. In our study, out of 10 aneurysms, 40% of aneurysms are observed at Acom, 30% are at MCA and 10% of each occurred at Pcom, ICA, and A2 segment of ACA. 50% of aneurysms had an average size of 6-7 mm, and 20% of aneurysms had an average size of 7-8 mm. Young-Gyun Jeong et al; Concluded that Ruptured aneurysms in the ACA were smaller than those in the MCA. Hemorrhage. In our study 60% of patients presented with Subarachnoid hemorrhage and 40% presented with headache. In our study, TOF MRA to diagnose all 10 aneurysms. However, in most of the cases, it failed to show the characteristics of the aneurysms like exact size and lobulations and origin of branch vessel arising from the intracranial aneurysmal sac and failed to demonstrate the sac contents.

Conclusion
MRA is now in routine use as a non-invasive tool for imaging the cerebrovascular. In cerebrovascular disease, it is the investigation of choice for patients who are suspected/ increased risk of having unruptured intracranial aneurysms, and intracranial vascular disease associated with acute infarction, intracranial dissection of the carotid and/or vertebral arteries, and follow up cases of Cerebral AVMs. It has got some limitations in detecting small aneurysms (<3 mm) and aneurysmal sac contents in case of giant aneurysms and venous drainage patterns in case of Cerebral AVMs and to show the complete nidus obliteration in follow up cases of cerebral AVMs. So, MRA should not be the sole imaging technique in all the above conditions; it should be supplemented with novel MRA techniques like CE-MRA, Time Resolving MRA, and MR DSA for adequate detection and characterization of lesions.

REFERENCES


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