ACCURACY OF THE MRA FOR THE DETECTION OF INTRACRANIAL ANEURYSM AS COMPARED TO THE CATHETER ANGIOGRAM

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ABSTRACT

Purpose: To assess the role of MRA for detection of intracranial aneurysm as compared to catheter angiogram by using standard method of post processing (MIP) in blinded-reader study.

Material and Method: Two hundred vessels were examined with catheter angiogram and 3DTOF MRA in 50 patients with SAH (38 aneurysms ,1 DAVF and 13 patients with no aneurysm at DSA). MRA were interpreted by neuroradiologist blinded to the DSA results for presence, location, size and morphology of the aneurysm.

Results: Mean sensitivity for detection of aneurysm was 92.1% specificity 100%,positive predictive value 100%and negative predictive value 81.3%. 38 aneurysms were found; A-com 14, P-com 8, MCA 7, Basilar 4, ICA 3, SCA 1, vertebral 1, 1 DAVF and 13 no aneurysm. True positive 35, true negative 13,false positive 0 and false negative 3.

Conclusion : MRA with standard post processing can result in high sensitivity and specific studies for the diagnosis of intracranial aneurysm that are of sufficient size to be considered for surgical treatment. The positive predictive value is also very high but the negative predictive value is not high enough. Therefore, in negative study of MRA, cather angiogram is still recommended.

Key word : MRA, SAH, Aneurysm. **SAH** = Subarachnoid Haemorrhage, **SCA** = Superior Cerebellar Artery
3DTOF = 3 dimentional Time of Flight, **DAVF** = Dural AV Fistular, **MIP** = Maximum Intensity Projection

Cerebral aneurysms are found in 1 to14% of population[1] in USA, suggesting that more than 0.6 million people of Thai people have this serious lesion. Aneurysms, most commonly are discovered when they rupture and acute subarachnoid hemorrhage (SAH) ensues. Aneurysms are treatable lesions, with extremely high morbidity and mortality if left untreated.[1] Intracranial aneurysms represent a major public health problem in a population with increasing longevity, with considerable cost in terms of diagnostic work up, hospitalization, treatment, morbidity and mortality.[2] It has been long considered desirable 2 to have a noninvasive test to replace the invasive catheter angiogram, a procedure with documented morbidity and mortality.[3] Moreover at least in selected population such as 1st degree relative of a family member with aneurysm, it may be

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desirable to have a noninvasive screening examination for intracranial aneurysm because of the known very low morbidity (<5%) and mortality (0%) rates when an unruptured aneurysm is operated on.[7-9]

An improved Magnetic resonance angiogram (MRA) method might permit the early detection of intracranial aneurysm in patients and family members with a higher potential incidence of aneurysm and allow surgery before rupture of the aneurysm. An improved MRA post processing technique could directly reduce costs involved in diagnosis and follow up of the aneurysm by catheter angiogram, a higher cost, invasive procedure with known morbidity and mortality, a further source of high medical costs. To our knowledge, few blinded reader studies have been published on MRA for intracranial aneurysm proved by catheter angiogram, and most used the standard Maximum intensity projection (MIP) of post processing. In these studies,[12-15] the sensitivity of MRA for detection of aneurysms has ranged from 55.6 to 75% overall. These studies also showed a reduction in sensitivity for detection of smaller aneurysm. Two of these studies showed an increase in sensitivity in detection of aneurysm when conventional MRI was combined with MRA, a difference due mainly to the depiction of very large aneurysm known to be characterized by slow flow that often results in low signal intensity (SI) on MRA due to saturation effects. One shows very high sensitivity with advanced post processing The purpose of this study was to assess the accuracy of MRA in blinded-reader study for detection and characterization of angiographic proved aneurysm by using standard method of post processing. We hypothesized that the use of this technique would permit a high sensitivity and specificity for detection of intracranial aneurysm and would allow accurate characterization of aneurysm and morphology, an important indicator of prior rupture.

MATERIALS AND METHODS

SUBJECTS

All patients referred to our MR imaging suite for intracranial MRA during the previous 12 months (June 2000-2001) served as the initial data base for the study. Inclusion criterion was obtainment of both intracranial three dimensional time of flight (3DTOF) MRA and selective catheter angiograms. Subject was skewed toward those with a highly likelyhood of having vascular disease presenting with SAH. Exclusion criteria were the following : inability to recover the MRA data form optical disc for post processing, inability to recover catheter angiogram, failure to include the circle of Willis with the volume of MRA, severe motion.

50 patients who ranged in age form 21 to 77 years met the inclusion cliterion and were included in the final study. A total 200 vessels were examined with MRA and catheter angiogram. 38 aneurysms were studied and categorized by location and size as depicted on DSA and MRA. Of these 38 aneurysms, 3 were 1.0-2.4 cm and 35 were 0.4- 0.9 cm. 14 aneurysms originated from Anterior communicating artery (A-com), 8 from Posterior communicating artery (P-com), 7 from middle cerebral artery (MCA), 3 from internal carotid artery (ICA) and 6 from the vertebrobasilar system.

MRA TECHNIQUE

We used three dimensional time of flight technique without injection of exogenous contrast agent for MRA. In all cases, we used a four-slabs excitation divided into 24x4 sections, 8 mm in thickness, TR 27 msec, TE 7.2 msec and flip angle 20 degree. The acquisition matrix is 200x512.

Key Word : SAH = Subarachnoid Haemorrhage, **MIP** = Maximum Intensity Projection, **SI** = Signal Intensity.

MRA POST PROCESSING TECHNIQUE

A standard post processing protocol performed off- line 30 minutes was followed in all cases. 3 operated selected manually drawn, rectangular volumes of interest were determined from the collapsed volume image of the axial image for post processing, so that selective segmentation of the data could be obtained in the projection image. For each case, one standard volume of interest was selected to included the vertebrobasilar artery (VBA) system and one standard volume of interest was selected to encompass each ICA, MCA bifurcation region, (each carotid segmentation was designed to include A-com artery,) A series of 12 projection images at every 15 degree around the cephalocaudal axis were generated from each of the 3 volumes of interest. The segmented projections derived from the 3 standard volumes of interest were post processed by using the standard MIP. All images were then obtained on hard copy films for review with a format that presented rotations of projection images of ICA,MCA and VBA

MRA AND CATHETER ANGIOGRAPHIC INTERPRETATION.

MRA and catheter angiogram were evaluated separately and blindly by neuroradiologist whose experience in DSA for more than 10 years and MRA at least 2 years. The presence and ollowing characteristics of aneurysms (location, size and morphology) were asked

RESULTS

PRESENCE OF ANEURYSM

The data of blinded reader are shown in tables 1-3. overall sensitivity is 92.1% and specificity is 100 %, positive predictive value 100 % and negative predictive value is 81.3%.

SIZE OF ANEURYSM

Table 3 illustrates the relationship between size estimates from MRA as compared with the true luminal diameter as depicted on DSA, for all correctly identified aneurysm on MRA. The data indicated that in an average of 75% of correctly identified aneurysm on MRA, the correct size was noted. 16% of identified aneurysm, the MRA estimate of aneurysm size was too large and in an average of 11% of correctly identified aneurysm the estimate size was too small.

MORPHOLOGY OF ANEURYSM LUMEN

All aneurysm of this study was noted to have irregular contour (the indicating of ruptured aneurysm). This is due to characteristic selection of patients in our study (all patients presented with SAH)

Key Word : A-com = Anterior Commucating artery,
MCA = Middle Cerebral Artery,
ICA = Internal Carotid Artery,
VBA = Vertebrobasilar Artery,
P-com = Posterior Commucating artery,
3DTOF = 3 dimensinal Time of Flight,
SAH = Subarachnoid Haemorrhage.

Table 1 Sensitivity for detection of aneurysm with MRA

No .of aneurysms detected(n=38)	Sensitivity(%)
35	92.1

Table 2 Detection of at least one aneurysm in 37 patients known to have 38 aneurysms

Sensitivity(%)	Specificity(%)	Positive predictive value(%)	Negative predictive value(%)
92.1	100	100	81.2

Table 3 Size estimates of correctly identified aneurysms on MRA

Size Estimate	% (n=35)
Correct	75 (26)
Overestimate	14 (5)
Underestimate	11 (4)

DISCUSSION

Although MRA is a relatively new technique in the array of diagnostic tools to define cerebrovascular disease, it has already become accepted in some clinical setting of suspected neurological disease as an effective method of delineating vascular anomalies. This is particular true in the evaluation of suspected extracranial carotid atherosclerotic diseases.[19-25] However, it is also generally acknowledged that MRA still suffers from very important limitations in the depiction of intracranial vascular anomalies,[26] despite its attractiveness as a noninvasive modality. In our study, we attempted to investigate the accuracy of MRA for the detection and characterization of intracranial aneurysm by using standard post processing technique shown to have several advantages.

Our literature search revealed only few blinded-reader studies of MRA for intracranial aneurysm have been published in the radiology literatures to date, and all have noted relatively low sensitivity for these highly morbid yet treatable lesions. Ross et al[12] studies 21 aneurysms in 19 patients by using 3DTOFMRA and MIP method. 17 of the aneurysms were greater than 5 mms in diameter. Overall sensitivity of MRA was 67%and when combined with imaging the sensitivity was 86%. Huston et al[3] used 3DTOFMRA and MIP method in a combined-reader study, in which 2of 3 positive readings were needed to indicate positive, in 16 patients with 27 aneurysms. 22of 27 aneurysms were larger than 3 mm. Overall sensitivity was 55.6 % which rose to 87.5% if considering only aneurysm 5 mms in diameter or larger. Korogi et al[14] reported on 61 patients with 78 aneurysms in a 3DTOFMRA study with MIP method, 60 aneurysms were 5 mms or smaller. They also included 65 control subjects. Overall sensitivity for detection of aneurysm was 63 % which dropped to 56% for those aneurysms 2-5 mms in size. Scott W Atlas et al[15] used 3DTOF and advanced post processing method in 44 patients with 63 aneurysms and 15 patients with no aneurysms. Overall sensitivity is 75% and rose to 95% when considered only aneurysm larger than 3 mms

To date, most potential improvement for intracranial MRA of aneurysm has been the subject of post processing. In this still relative early stage of clinical evaluation of MRA for clinical efficacy, most investigators have used MIP post processing, so that the MIP has been de facto standard method. This situation has probably evolved because of the computational simplicity of the MIP.

Important problems with the MIP method were noted by Anderson et al.[10]

In the diagnostic work-up of intracranial aneurysms, there are specific characteristics of the lesion and surrounding vessels that the radiologist must demonstrate with any angiographic technique. An MRA protocol should be directed toward achieving these objectives for the study to be of clinical value, particularly if it is intended to be used as a replacement for catheter angiogram. Aside from the essential detection of the aneurysm in question, one must be documented of other aneurysms, since approximately one fourth of patients with one aneurysm have multiple aneurysms. This fact under scored the need for the four vessels study routinely obtained in the angiographic suite. Once an aneurysm is discovered, specific characteristic must be delineated, including the vessel of origin, definition of the aneurysmal neck, and the relationship of the aneurysm to nearby small vessels. The morphologic characteristic of the aneurysm must be displayed since this is the key feature of the aneurysm, that allow one to deduce which of the aneurysms had in fact ruptured. Additionally, the definition of the luminal size of the circle of Willis vessels must be fairly accurate for normal versus spasm which is so highly influential on the outcome of the patients. Our results indicate that with the MIP post processing technique a high degree of sensitivity for clinical diagnosis of intracranial aneurysm can be achieved by using MRA (table 2).

The data are promising if one analyzes the data with perspective that MRA could be used as screening test for the presence of these lesions, so that the identification of at least one aneurysm would necessitate a conventional angiogram. We acknowledge that the ultimate role of screening patients for the intracranial aneurysm is largely uncertain and the subject of several recent investigator. We do note that, not withstanding the relatively high sensitivity, specificity and positive predictive value with our method for most aneurysms, there remain a fairly substantial number of false negative studies, making MRA still unacceptable as the final diagnostic study for such a serious and treatable disease.

This study showed fair success in the characterization of aneurysm size and morphology. On approximately 3 in 4 aneurysms were correctly categorized according to size. Size is an important predictor of aneurysm rupture, since the proportion of aneurysm that rupture increases according to size.[30] Interestingly, about equal frequency of the over estimates and under estimate of the aneurysm size were found similar to the study of scott WA et al[15] In conclusion, intracranial MRA by using MIP post processing can result in highly sensitivity and specificity for the diagnosis of intracranial aneurysm that are of sufficient size to prompt serious consideration of surgical treatment. The positive predictive value is also very high but the negative predictive value is not high enough. It still be necessary to perform catheter angiogram in negative study of MRA for detection of aneurysm. Moreover this method of MRA is also relative accurate for size determination. Although the data are promising, a better understanding of natural history of intacranial aneurysms, as well as risk-benefit and cost-benefit assessment, will determine to a great extent the ultimate clinical role of MRA as a screening tool.

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