Original Article

Magnetic resonance angiography of intracranial aneurysms: Comparison with intra-arterial digital subtraction angiography

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ABSTRACt

Background: The aim of this study is to determine sensitivity and specificity of 3D- Time-Of-Flight and Phase Contrast Magnetic resonance angiography (MRA) in comparison with intra-arterial digital subtraction angiography (IA- DSA) in detection of intracranial aneurysms.

Methods: 54 patients with 22 aneurysms underwent MRA and then IA-DSA prospectively from October 2002 till December 2003.

Results: MRA detected 20 aneurysm where as IA- DSA scored 22 (90.9%). false positive in MRA was 18.1% (4 cases) and no false positive was in IA- DSA. So sensitivity of MRA in detection of intracranial aneurysms is 90.9%, and specificity is 88.8%. Positive predictive value of 83.3% and negative predictive value of 94.1% is also calculated.

Conclusion: MRA is a valuable non- invasive technique in the detection of intracranial aneurysms that can be a proper screening test for this purpose.

Key words: MRA, IA- DSA, Aneurysm.

The term of aneurysm is derived from Greek word eurys which means wide and dilatation and aneurysm is local dilatation of a blood vessel which communicate directly with the lumen of the parent vessel [1] (Figure 1).Intracranial aneurysms have different etiologies like congenital, traumatic, neoplastic, dissecant, mycotic, and atherosclerotic but mostly are congenital. In development of these congenital aneurysms no congenital, developmental, or hereditary weakness in the wall of the vessel has been found and recently it is believed that hemodynamic stresses are the most probable cause [2].

Aneurysms have a prevalence of 1-14% in general population[2] and the commonest cause of non-traumatic subarachnoid hemorrhage (SAH) is rupture of intracranial aneurysm; in addition, the commonest presentation of aneurysm is SAH. Other presentations of aneurysms include: Compression effect on the adjacent structures, cranial nerve palsy, and visual defects.

Risk of rupture of an aneurysm is 2% in a year, so more than 50% of lesions rupture eventually and morbidity (20-25%) and mortality (50-60%) of rupture are highly common. In a recent study rupture risk of small aneurysm (diameter less than 10mm) in patient with no history of previous SAH was only 0.05% and for large aneurysms (diameter more than 10mm) and for all aneurysms in patients with previous SAH was about 0.5%. These results are less than which in previous studies [3].

The gold standard diagnostic method for detection of intracranial aneurysm is cerebral angiography which is invasive and needs hospitalization. this method has potential complications for catheterization, injection of contrast media,

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infection at the site of puncture, X-ray radiation,...[4]. It is also time-consuming (30-60 minute) and expensive. For all these reasons, it is not an ideal screening test.

On the other hand, due to very low morbidity (4%) and mortality (0%) of surgery of an unruptured aneurysm, presence of a non-invasive, accurate, cheap and available screening test is necessary[2].

Development of magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) have opened a wide and hopeful perspective in this way. In recent years many studies have been reported about the ability of MRA in the detection of intracranial aneurysms (Figure 2). Anzalone et al. reported that sensitivity of MRA in the detection of these lesions is 95%, specificity is 88%, and positive predictive value (PPV) and negative predictive value (NPV) are 95% and 89% respectively[5]. Falk et al. from Germany reported sensitivity 86.8% ,specificity 90% , PPV 97.1%, and NPV 84.8% for MRA[6] and Gasparotti et al. reported sensitivity and specificity of 95% in a study from Italy[7].In addition to proper sensitivity and specificity of MRA, multiple factors are present which emphasize that MRA is a suitable screening test: It is non-invasiveness, can be performed as out - patient, needs no puncture and catheterization, is cheaper than angiography, has no irradiation hazards, its imaging time is shorter (7-10 minute), and multiplanar and 3-dimmensional imaging is possible[2].Efficacy and cost- benefit factor are other important factors in a screening test. Yoshimoto and Wakai calculated the cost- effectiveness of screening asymptomatic unruptured aneurysms with a mathematical formula according to variables factors such as rupture risk, screening costs, and treatment risks. Cost versus quality - adjusted life- year with rupture risk of 1-2% in a year was favorable [8].

Due to these reasons Webers and Torres, Rugieri et al., and Huston et al. reported that MRA may be a suitable non- invasive technique for detection of asymptomatic intracranial aneurysms[9] and Nakagava and Hushi have substituted MRA instead of angiography as a screening test in their recent protocol [10].

Materials and Methods

After initial evaluation, study began from October 2002. The inclusion criteria were patients with headache, convulsion, or cranial nerve compression in which brain CT was normal or suspicious signs of vascular aneuryrsms was present and in clinical examination such lesion was expected. And also patients with non-traumatic sudden SAH enter the study. Then patients referred to MRI centers and brain MRA was performed for them. The MR machines which used in this study were Philips with 1 Tessla magnet and Simens with 1.5 Tessla magnet. An obtained sequence was 2D/3D phase contrast and time- of-flight for all patients. All the films were reported by trained neuroradiologrsts.

Then all the patients underwent 4-vessle intra arterial digital subtraction angiography (IA-DSA) with videofluroscopy recording and the interventional radiologists reported the results.

In a 15 month period of time (from Oct. 2002 till Dec. 2003) 65 patient entered the study of which 11 excluded for different reasons and the remainder 54 were evaluated. For prevention of any bias, the study was done in double – blinded method and all the patients underwent MRA at first.

Results

From 54 patients' 36 were female and 18 were male. The patients age ranged between18 and 77 with 46.3 as mean .In 22 patients, 22 aneurysms were detected with IA-DSA and commonest places were bifurcation of MCA in 10 cases (45.4%), intracavernosal and supraclinoid portion of ICA in 6 cases (27.2%), junction site of ACA and anterior communicating artery in 4 cases (18.1%), and basilar artery in 2 cases (9.3%). 15 aneurysms found in females and 7 in males (F/M ratio was equal to 2.14/1)

From 22 aneurysms detected by IA- DSA, MRA detected 20 and missed 2(false negative 9%). MRA demonstrated aneurysms in 4 patients in which in IA-DSA no lesion was found (false positive 18.1%). In 32 patients no aneurysm was found in IA- DSA and MRA. So MRA has a sensitivity of 90.9%, specificity of 88.8% ,PPV 83.8 %, and NPV of 94.1% in the detection of intracranial

aneurysms in comparison to IA- DSA as the gold standard technique .Of course in small aneurysms(less than 3 mm in diameter) these results may be lowered.

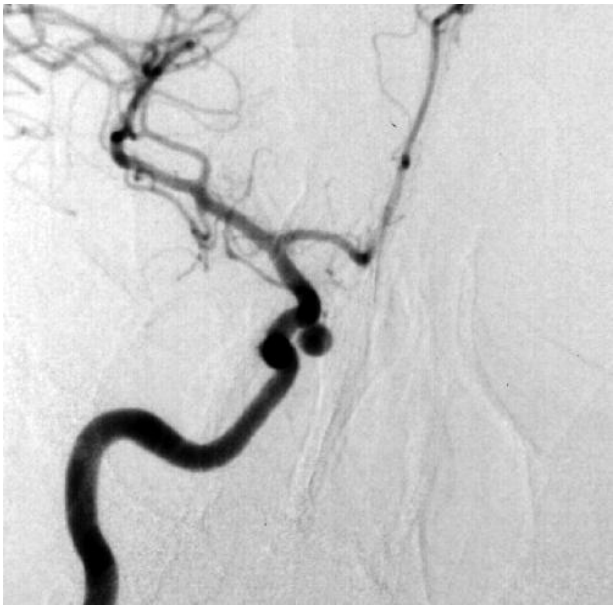

Figure 1. Aneurysm of ICA(supraclinoid portion) in IA-DSA

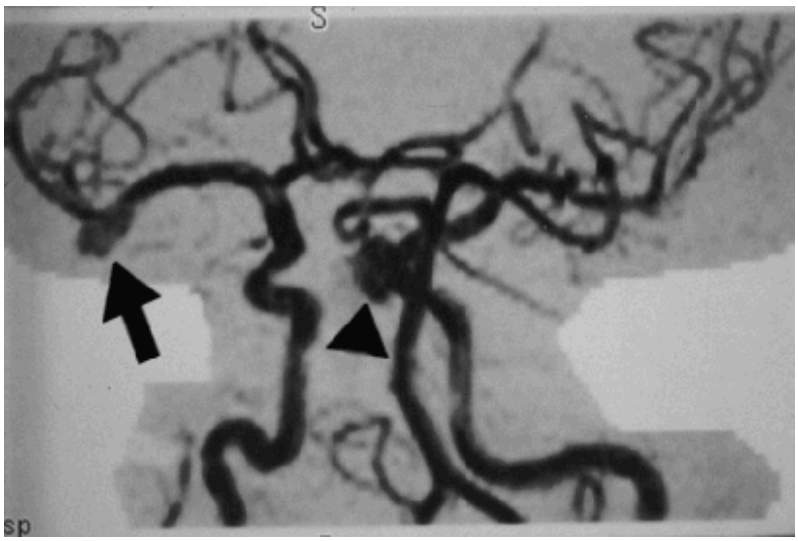

Figure 2. Bilateral aneurysm of right MCA and left ICA in MRA

Discussion

In various studies from different countries, sensitivity of MRA in detection of intracranial aneurysms was reported between 81-97%. For example, Falk et al from Germany, evaluated 30 patients with IA-DSA and MRA and reported a sensitivity and specificity of 86.8% and 90% respectively [6], or Spotti et al from USA report a sensitivity of 94.5 % with evaluation of 41 patients [11]. Chung et al from South Korea report sensitivity of 97% with evaluation 30 patient [12] and in a paper from UK, sensitivity of81% and specificity of 100% was reported [13]and finally Gasparotti et al. from Italy calculated the sensitivity and specificity of 95% for MRA [7].

Due to the following factors such as:

A) Rupture risk of aneurysm which is 1-2 % per year,

B) Prevalence of aneurysms in general population (1-14%),

C) High morbidity (20-25%) and mortality (50-60%) rate in rupture,

D) Low morbidity (4%) and mortality (0%) rate in surgical repair of unruptured aneurysms, and

E) Proper cost - benefit for screening of asymptomatic unruptrued aneurysms,

Presence of an accurate and suitable screening test seems to be essential and MRA with high sensitivity and specificity and advantages such as: being noninvasive, out-patient performance, relatively cheap, no ionising radiation, short time of acquisition, and possibility of multi planar imaging is a perfect screening test for intracranial aneurysms. Several studies have emphasized on the role of MRA in the evaluation of high risk and suspicious patients such as polycystic kidney disease, coarectation of aorta, fibromuscular dysplasia, familial history of sacular aneurysm, Marfan syndrome, and Ehlers-Danlos syndrome. However it should he noted that in highly suspicious patients with normal MRA, more evaluation with IA-DSA is recommended.

Recently CT angiography has made an increasingly role in the detection of cerebral aneurysms and complementary studies should be designed for the comparison of MRA ,IA-DSA, and CT angiography in order to find the best screening method.

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References

1. Hensyl WR. Stedman's medical dictionary.25th ed. Baltimore: William & Wilkins; 1990.p. 77.
2. Intracranial vascular malformation and aneurysms In: Atlas SW. Magnatic Resonance imaging of the brain and spine.3rd ed. Philadelphia: Lippincott: William & Wilkins; 2002.p. 833-919.
3. International Study of Unruptured Intracranial aneurysms Investigators.Unruptured intracranial aneurysms: risk of rupture and risks of surgical intervention .N Engl J MED 1998; 339:1725-1733.
4. Taveras JM. Neuroradiology.3rd ed. New York: Williams & Wilkins; 1996.p.401-565.
5. Anzalone N, Triulzi F, Scotti G. Acute subarachnoid haemorrhage: 3D time-of-flight MR angiography versus intra-arterial digital angiography.Neuroradiology 1995 May; 37(4):257-61.
6. Falk A, Schmieder K, Hentsch A, Harders A, Heuser L. [3-D-TONE magnetic resonance angiography in the detection of intracranial aneurysms compared with digital subtraction angiography. A prospective study]Rofo 1996 Jan; 164(1):31-7. German.
7. Gasparotti R, Bonetti M, Crispino M, Pavia M, Chiesa A, Galli G. [Subarachnoid hemorrhage: assessment in the acute phase with angiography, with high-resolution magnetic resonance (angio-MR)]Radiol Med (Torino) 1994 Mar; 87(3):219-28. Italian.
8. Yoshimoto Y, Wakai S.Cost-effectiveness analysis of screening for asymptomatic, unruptured intracranial aneurysms. A mathematical model. Stroke 1999 Aug; 30(8):1621-7.
9. Huston J 3rd, Torres VE, Sulivan PP, Offord KP, Wiebers DO.Value of magnetic resonance angiography for the detection of intracranial aneurysms in autosomal dominant polycystic kidney disease. J Am Soc Nephrol 1993 Jun; 3(12):1871-7.
10. Nakagawa T, Hashi K.The incidence and treatment of asymptomatic, unruptured cerebral aneurysms. J Neurosurg 1994 Feb; 80(2):217-23.

11. Spotti AR, Lima EG, Santos ML, Magalhaes AC. [Magnetic resonance angiography of intracranial aneurysms: comparative study with cerebral angiography]Arq Neuropsiquiatr 2001 Jun; 59(2-B):384-9. Portuguese.
12. Chung TS, Joo JY, Lee SK, Chien D, Laub G.Evaluation of cerebral aneurysms with high-resolution MR angiography using a section-interpolation technique: correlation with digital subtraction angiography. AJNR Am J Neuroradiol 1999 Feb; 20(2):229-35.
13. Sankhla SK, Gunawardena WJ, Coutinho CM, Jones AP, Keogh AJ. Magnetic resonance angiography in the management of aneurysmal subarachnoid haemorrhage: a study of 51 cases.Neuroradiology 1996 Nov; 38(8):724-9 .