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Original Article

The comparative study on diagnostic validity of cerebral aneurysm by computed tomography angiography versus digital subtraction angiography after subarachnoid hemorrhage *

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Abstract

BACKGROUND: In order to declare the preoperative diagnostic value of brain aneurysms, two radiological modalities, computed tomographic angiography and digital subtraction angiography were compared.

METHODS: In this descriptive analytic study, diagnostic value of computed tomographic angiography (CTA) was compared with digital subtraction angiography (DSA). Sensitivity, specificity, positive and negative predictive values were calculated and compared between the two modalities. All data were analyzed with SPSS software, version 16.

RESULTS: Mean age of patients was 49.5 ± 9.13 years. 57.9 % of subjects were female. CTA showed 89% sensitivity and 100% specificity whereas DSA demonstrated 74% sensitivity and 100% specificity. Positive predictive value of both methods was 100%, but negative predictive value of CTA and DSA was 85% and 69%, respectively.

CONCLUSIONS: Based on our data, CTA is a valuable diagnostic modality for detection of brain aneurysm and subarachnoid hemorrhage.

KEYWORDS: CT scan angiography, digital subtraction angiography, cerebral aneurysm, subarachnoid hemorrhage.

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The incidence of subarachnoid hemorrhage (SAH) is 6-8 cases out of a hundred thousands in a year, mostly occurring in the sixth decade of life.[1] The main cause of this kind of hemorrhage is cerebral aneurysms so that 1/3–1/4 of cerebrovascular accidents are led to death because of rupturing of these aneurysms.[2] In spite of rational diagnosis and treatment of these events, 25-50% of the suffered patients die due to hemorrhage and its primary complications.[3] Digital subtraction angiography (DSA) has been appreciated as an acceptable and elective method for evaluation of cerebral aneurysms and designing the treatment of the process before surgery among the patients with the above problem and the results gained from this diagnostic method were crucial, but we should mention that 12-20% of results gained from this method in patients with subarachnoid hemorrhage have

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been negative.[4,5] So, the researches have been done for other diagnostic methods, such as MRA, CTA and TCD (Transcranial Doppler). Pathirana et al. reported negative values of DSA in patients with SAH in up to 20.3% of cases while 30% were diagnosed with aneurysms in reangiography.[5]

Whereas similar researches showed that in 11.7% and 21% of patients with SAH, aneurysms had not been diagnosed with DSA, it was diagnosed by reangiography.[6, 7] The rate of finding the pathology by other diagnostic tools including DSA, CTS and MRI has been different.[6, 7]

On the other hand, comparing with other diagnostic methods such as aggressive nature of DSA, some factors restricted this method including time spending related complications (4%), permanent nervous complications (1%) and high costs depending on the operator's skill methods. In some cases, the image made by this method can not reflect morphologic aneurysms such as mural calcification, luminal thrombosis and diverted vessels originated from the sack while awareness of presence of these lesions has vital values to help the surgeon before operation.[8,9] As a result, researches have been driven to other imaging methods like MRA and TCD. CTA is an appropriate method due to its high quality, reaction time, patient's tolerance and low cost. Regarding the three facts that only 1/3 of SAH patients have aneurysm, 10-20% of them have false negative DSA and aneurysms smaller than 4 mm in diameter have no indication for surgery, this study has been done to determine diagnostic values of image obtained by DSA and CTA in diagnosis of cerebral aneurysms in patients with SAH.

Methods

This was a descriptive analytic study conducted on the patients with SAH in AL-Zahra Hospital in 2008-2009. The non–probability sampling was convenient with sample size of 30 patients.

All patients referring to emergency or neurosurgery wards of AL-Zahra Hospital with signs of SAH underwent routine CT scan and after SAH was firmly diagnosed, they were enrolled in the study. Then, the patients underwent CTA and DSA methods and the obtained images were checked by radiology and neurosurgery experts concerning the existence or lack of cerebral aneurysms, their locations and their numbers. The patients were operated but those who should not be operated (because of having relative or absolute contraindication of surgery and those who died) were excluded from our study. The blood pressures of the patients were within normal range.

After surgery and detecting the existence of aneurysms and its location, the data were recorded in a checklist. At the end, with the use of a four box table, the diagnostic values were reported for each method considering numerical scale and then, were compared. All data were analyzed with SPSS software, version 16.

Results

The patients with diagnosis of cerebral aneurysm (CA) and SAH were operated and 63.3% (n=19) demonstrated cerebral aneurysm during operation.

Mean patients' age was 49.5±9.13 years (49 ± 8.26 years for those with CA within operation). About 57.9% (n=11) of the patients were female. About 36.8% (n=7) of the patients had past history of hypertension as the most prevalent background disease and one case had polycystic kidney disease. These patients had no ischemic heart disease (IHD) or diabetic disease. Regarding clinical grade, based on Hess & Hant hemorrhage signs in patients with CA and SAH, they were 6.5% grade I, 74% grade II, 13% grade III and 6.5% grade IV. In CTA, 56.7% (n=17) and in DSA, 56.7% (n=17) were indicators of CA. During surgery, 63.3% (n=19) of the patients had CA. Of that, 57.9% had aneurysm in middle cerebral artery, 20.8% in right middle cerebral artery (MCA), 10.6% in right anterior cerebral artery (ACA), 10.6% in internal carotid artery (ICA), 5.3% in left ACA and 5.3% in the form of supra-clinoid aneurysm. In CTA, 100% were true positive, 0% false positive, 69% true negative and 31% were false negative.

CTA showed 89% sensitivity and 100% specificity while DSA showed 74% sensitivity and 100% specificity.

Negative reporting value of 85% and positive reporting value of 100% were reported for CTA. The above values were reported 69% and 100% for DSA, respectively (Tables 1 and 2).

Discussion

In the past decade, special attention had been given to early treatment of ruptured CA. At the present time, the golden standard diagnostic method to detect cerebral aneurysms is intra-arterial digital subtraction angiography (IADSA).

There have already been 100 studies conducted to compare this method with other non–invasive methods since IADSA is an invasive, costly, time spending and complicating method. Most of these studies were done on CTA and MRA. There have also been some studies on TCD.[10-15] Sensitivity and specificity of CTA or MRA have been reported between 67-100% and 92-100%, respectively.[4, 13, 16]

The goal of the present study was to estimate success amount in aneurysm surgeries based on CTA findings before surgery compared to those after surgery. In all former studies, CTA has been used comparing with another diagnostic method especially IADSA to decide based on the type of surgery. Only in one study, CTA has been used as the mere diagnostic method before aneurysm surgery.

This study did not report a noticeable difference in success of CTA and DSA groups.[17]

In another study, some patients with aneurysm have been studied and IADSA and CTA were performed for each patient. Based on the findings, 74% of the patients could be operated just based on CTA pre–operation findings.[13] In the present study, we intended to know if CTA findings could merely be relied on to perform a successful operation on a ruptured aneurysm. In our patients, CTA reports had 89% sensitivity; and it means out of 19 patients with SAH due to aneurysm rupture, 17 cases had CTA positive predictive values. Meanwhile, another study had reported this ratio as 48% [11] CTA usually shows aneurysms over 4 mm located in common areas with high specificity. Furthermore, it can clearly report anatomic characteristics of aneurysms such as size, shape, form of neck, origin and side branches.[18] It seems that an ordinary CT together with CTA could be enough to conduct a safe surgery. The main problem of CTA is its inability to detect aneurysms less than 3-4 mm. So, if the patients undergo surgery just based on CTA results, this type of aneurysms will not be diagnosed and no treatment will be done for them. In fact, this type of aneurysms is accidentally diagnosed in post-operation with IADSA and does not often need emergency treatment. Recently, an international study of unruptured intracranial aneurysm has demonstrated the 0.5% possibility of rupture in aneurysms less than 10 mm for the patients with history of former SAH.[19] Therefore, pre-operation diagnosis of small unruptured aneurysms may not be so important.

Use of CTA in patients with low possibility of aneurysm (like post- trauma SAH or in patients with acute headache with hemorrhage or those who have positive family history of aneurysm) is suggested. Regarding high speed, availability and high quality of CTA images, use of CTA method has been accepted for screening craniofacial arteries.[20,21]

Table 1. Diagnostic value of CTA (Computed Tomographic Angiography) compared to surgery.

surgery / CTA	Negative	Positive
Positive	0	17
Negative	11	2

Table 2. Diagnostic value of DSA (digital subtraction angiography) compared to surgery.

Surgery / DSA	Negative	Positive
Positive	0	14
Negative	11	5

During the past 10-12 years, sensitivity and accuracy of CTA in diagnosis of intracranial aneurysms had increased day after day because the number of detectors has been increased from 1 to 4 to 16 and next 64 nowadays.

As a matter of fact, the studies conducted on CTA accuracy in diagnosis of cerebral aneurysms with one or four detector scanners have not had a very high sensitivity in diagnosis of aneurysms less than 4 mm.[22-23] With introducing 4 detector CT scanners, sensitivity of diagnosis of aneurysm over 4 mm was reported as 90% but its sensitivity for aneurysms less than 4 mm was controversial. As a whole, NPV (negative predictive value) of this method was reported about 90%. It was found out that aneurysms less than 4 mm may be missed by 4 detector CTA.[20-22] When 16 detector devices came to market, the level of their sensitivity and NPV to diagnose aneurysms were increased for aneurysm diagnosis but its inability to detect aneurysms less than 3-4 mm has not yet solved.[23-24]

Considering 64 detector devices, two new studies have been carried out to diagnose cerebral aneurysms reporting sensitivity of 92-98%, specificity of 100% and NPV of 82-99% compared to IADSA.[25,26] Our study also showed sensitivity of 89%, specificity of 100% and NPV of 85% for CTA which is consistent with former studies.

In another study, 3D (three-dimensional) CTA with 64 detectors was reported to have sensitivity of 92.3% to diagnose aneurysms less than 4 mm.[27]

In our study, CTA and DSA were performed and reported by an expert neuroradiologist who played a major role in the reliability of this study.

Based on the protocol in our center, the total amount of contrast injected to conduct CTA and IADSA was about 220-260 ml which is not very different from the one injected in former studies.[16, 28] No patient had history of renal failure and none of them had complication of contrast injection. The risk of nephropathy caused by contrast injection in patients with normal renal function is very low but in case of existence of renal disorders, appropriate care should be taken by the physician.[12, 29]

Although, the patients in the present study received intravenous contrast for both CTA and IADSA, there was also no risk in their injection. This study showed that CTA is almost always a simple, quick and safe method to aid operation and treatment of aneurysm.

This method shortens the delay in surgery and obviates the risk of pre- operation DSA in patients. If the surgery is carried out just based on CTA result, unruptured aneurysms less than 4 mm may be missed and not repaired during surgery. So, CTA can be used as the only pre-treatment diagnostic method instead of IADSA for some patients. But, IADSA should be performed for all patients undergone surgery. With improvement technology, CT devices may be able to detect small aneurysms not in far future. Use of 64 detector CT scanners and more advanced ones can decrease the time of scanning and the size of sections and make volume rendered images possible.

In this study, we revealed the quality and diagnostic value of CTA. Therefore, diagnosis of smaller aneurysms and description of their characteristics will be possible to decide on treatment with these scanners.

Conflict of Interests

Authors have no conflict of interests.

Authors' Contributions

A.H. has contributed in performing the radiological aspects of the study. M.S. has contributed in performing the neurosurgical aspect of the study. N.O. has contributed in the analysis aspect and editing the article. A. G has contributed in planning the study, writing and editing the article. F.H and R.B. have contributed in writing and reediting the article.

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