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Diagnostic accuracy of angiographic computed tomography for detecting intracranial aneurysms in patients with spontaneous subarachnoid Hemmorhage taking digital subtraction angiography as gold standard-experience at liaquat national hospital, Karachi

Moinuddin Ahmed[1], Ameet Jesrani[2*], Muhammad Ali[3], Rehan Alamgir[4], Raja Sandeep[5]
[1, 3] Department of Radiology, Liaquat National Hospital, Karachi, Pakistan
[2, 4, 5] Department of Radiology, Sindh Institute of Urology and Transplantation, Karachi, Pakistan

Abstract
Objective: To determine diagnostic accuracy of angiographic computed tomography (CTA) for detecting intracranial aneurysms in patients with spontaneous subarachnoid hemorrhage (SAH) taking digital subtraction angiography (DSA) as gold standard
Design: Cross sectional study
Patients and Methods: A total of 195 patients with spontaneous subarachnoid hemorrhage were included in this study. Angiographic computed tomography was done and DSA was used as gold standard. The findings seen on CTA were documented with the help of Performa.
Results: The mean age of the patients was 49.01±10.86 years. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of Angiographic computed tomography in detection of intracranial aneurysms was 86.67, 93.33%, 95.41%, 81.4% and 89.23% respectively.
Conclusion: In conclusion, spiral CTA is a highly sensitive, specific, fast and non-invasive imaging method for diagnosis and evaluation of aneurysms in cases with acute SAH with suspected intracranial aneurysms.

Keywords: cerebral aneurysms, angiographic computed tomography, digital subtraction angiography, spontaneous subarachnoid hemorrhage

Introduction

Cerebral aneurysms, intracranial aneurysms or abnormal focal outpouching of cerebral arteries are transposable terminologies and are substantial degree of morbidity and mortality in community [1]. Rupture is the most common and fatal complication of intracranial aneurysm, resulting in subarachnoid hemorrhages (SAH) [1]. Women are more prone to develop subarachnoid hemorrhage secondary to ruptured cerebral aneurysm than men [1]. About 80% of non-traumatic SAH are due to rupture of an intracranial aneurysm [2].

Occurrence of aneurysmal subarachnoid hemorrhage (SAH) is around 20 per 100,000/ year in western population [3]. Unruptured aneurysm is an incidental finding may be asymptomatic or it may present with symptoms of mass effect resulting in cranial nerve palsies or compression over brainstem [1]. Ruptured intracranial aneurysms leads to death in 10% of patients before even getting to hospitals [1].

Conventional angiography [commonly stated as intra-arterial digital subtraction angiography (DSA)], is deliberated as gold-standard for the diagnosis of cerebral aneurysms for many years [4] [5] [6]. However DSA has some restrictions and shortcomings. This invasive time-consuming procedure requires expertise of an experienced interventional radiologist and usage of high radiation dose [6]. Additionally, it entails arterial puncture and handling and is also related with high false-negative rate of approximately 5-10% [4]. The sensitivity and specificity of DSA according to one study is 96.2% and 100% respectively. [7]

With the modern time imaging and rapid innovation of computed tomography (CT), multi-detector computed tomography angiography (CTA) has played a vibrant role in the detection of ICAs [8]. We can perform arterial phase angiography with or without contrast administration using the latest CT scanners. Some institutes uses angiographic computed tomography as the initial tool for detecting cerebral aneurysms because of better imagining of cerebral vessels [8].

According to one study, sensitivity and specificity of Computed tomography angiography for detecting cerebral aneurysms is 96.1% and 92.31% [9].

The aim of this study is to determine the diagnostic accuracy of CTA in detection of cerebral aneurysms in patients with aneurysmal SAH because as cited above CTA being non-invasive, requiring less radiation and expertise as compared to DSA. CTA will frequently be used as 1st line investigation for detecting cerebral aneurysms if results are found acceptable buying time for patient's management with less radiation, invasiveness, expenses and skill.

Material and Method

This cross-sectional study was conducted from October 2015 to March 2016 in Radiology department of Liaquat National hospital, Karachi, after approval from ethical committee. Total 195 patients with spontaneous Subarachnoid hemorrhage going for DSA within a week of CTA were selected with patient's age

ranging from 25 to 70 years. The mean age was 49.01±10.86 years of both genders. Cases were referred from Emergency and Neurological Departments who were suspected of having subarachnoid hemorrhage. The patients who were not giving consent for CTA and DSA, not going CTA before DSA, those with history of trauma, patients with poor renal function as assessed by serum creatinine level(> 1.5mg/dl) and those referred to other hospital without undergoing DSA were excluded from the study. Informed consent was taken from the research and ethical committee of the institution. Sample size was calculated considering both the sensitivity and specificity of CTA to diagnose subarachnoid hemorrhage. Nonprobability consecutive sampling technique was applied to collect the samples.

Angiographic computed tomography is performed on Toshiba Activion 16 slice CT scanner. Scanning protocol includes acquisition of axial helical CT sections after administration of intravenous contrast extending from the region of interest placed in the internal carotid artery at 120kVp & 300mA. At time of scanning intravenous contrast is to be administered using power injector at rate of 4 ml per sec. The collimation was 32x 0.6 mm with 0.75-mm section thickness. CT scanning was triggered by using a bolus-tracking technique, with the region of interest placed in the internal carotid artery. Image acquisition started 4 seconds after the attenuation reached the predefined threshold of 100 HU.

The information provided by CT scan was interpreted by consultant radiologist with minimum of five years of experience. DSA was used as gold standard. The findings seen on CTA were documented with the help of Performa by the researcher. Patient was referred back to the concerned department and followed after DSA.

Statistical analysis was performed by using Statistical Package for Social Sciences (SPSS 21.0) as to obtain sensitivity and specificity of angiographic computed tomography in the diagnosis of intracranial aneurysms and taken digital subtraction angiography as gold standard. Frequency and percentage was calculated for qualitative variables, i.e, presenting complains, detailed history of presenting complains; angiographic computed tomography findings and digital subtraction angiographic findings.

Mean ± SD was computed for quantitative variable, i.e. Age of the pateint. Taken digital subtraction angiography findings as gold standard, all statistical parameters, (sensitivity, specificity, positive predictive value, negative predictive value) were calculated to obtain diagnostic accuracy of angiographic computed tomography.

Results

A total of 195 patients with spontaneous subarachnoid hemorrhage were included in this study with age of the patients ranging from 25 to 70 years. The mean age of the patients was 49.01±10.86 years similarly mean BMI was 28.75±3.26 kg/m^2. There were 43.08% were male and 56.92% female.

Digital subtraction angiography confirmed diagnosed the intracranial aneurysms case that is 61.5% (120/195) while Angiographic computed tomography findings showed 55.9% (109/195) cases had intracranial aneurysms (table 2). Sensitivity, specificity, PPV, NPV and diagnostic accuracy and 95% confidence interval of Angiographic computed tomography in detection of intracranial aneurysms was 86.67%[95%CI: 79.44-91.62], 93.33% [95%CI: 85.35-97.12], 95.41% [95%CI: 89.71-98.02, 81.4% [95%CI: 71.89-88.21] and 89.23% [95%CI: 84.1-92.85] respectively as well as kappa statistics (k=0.78) was also showed the perfect agreement between findings as shown in table 2. Figure 1 and 2 showing bilobed aneurysm of posterior anterior cerebellar artery and its rupture with subarachnoid hemorrhage on CTA and DSA.

Table 1: Angiographic computed tomography and Digital subtraction angiography finding for detecting intracranial aneurysms in patients with spontaneous subarachnoid hemorrhage

Angiographic Computed Tomography	Digital Subtraction Angiography		Total
	Detected	Not detected	
Detected	104(TP)	5(FP)	109(55.9%)
Not detected	16(FN)	70(TN)	86(44.1%)
Total	120(61.5%)	75(38.5%)	195

Table 2: Diagnostic accuracy of angiographic computed tomography in the diagnosis of intracranial aneurysms in patients with spontaneous subarachnoid hemorrhage (p=0.0005).

Parameter	Estimate (%)	Lower – Upper 95% CIs (%)
Sensitivity	86.67	79.44-91.62
Specificity	93.33	85.35-97.12
Positive Predictive Value	95.41	89.71-98.02
Negative Predictive Value	81.4	71.89-88.21
Diagnostic Accuracy	89.23	84.1-92.85
Cohen's kappa	0.78	0.63-0.92

Fig 1: Axial image of computed tomography Angiography showing ruptured bilobed aneurysm of the poster anterior cerebellar artery with subarachnoid hemorrhage

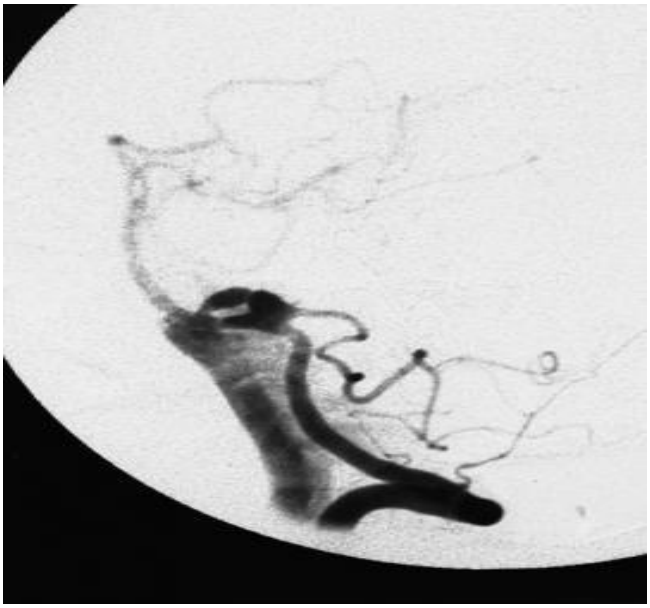

Fig 2: Digital subtraction angiography showing ruptured bilobed aneurysm of postero anterior cerebellar artery with subarachnoid hemorrhage

Discussion

Rupture of an intracranial aneurysm is the most common cause of non-traumatic SAH which accounts for approximately 85% of SAHs [10]. A subarachnoid hemorrhage (SAH) due to ruptured aneurysms has a high mortality. Most demises ensue due to the first bleed or repetitive bleeding [11, 12]. The primary culprit of this kind of hemorrhage is cerebral aneurysms. 1/3–1/4 of cerebrovascular accidents headed to demise because of ruptured aneurysms [13]. 25-50% of the suffered patients lead to death due to hemorrhage and its prime complications despite of prudent diagnosis and treatment of these events [14]. To ascertain the presence of cerebral aneurysm assortment of imaging modality is vital, when SAH is diagnosed [15]. CTA is the modality generally used for its logistic and diagnostic reasons. Due to its cost effectiveness and availability on 24 h basis [16].

The incidence of subarachnoid hemorrhage (SAH) is 6-8/100,000 cases in a year, mostly occurring in the sixth decade of life [17]. Mayberg *et al* reported the mean age of aneurysmal rupture is 55 years. The young children and the elderly can be affected; however most aneurysmal SAH occur between 40 and 60 years of age [18]. In our study a total of 195 patients with spontaneous subarachnoid hemorrhage were included with mean age of 49.01±10.86 years. Out of these 43.08% were male and 56.92% female, this female dominance for aneurysms ranging from 54 to 61 percent is also specified by other study [19]. Because of this gender incongruity hormonal influences have been suggested to play a part in the risk of SAH. In one case-control study, premenopausal women without smoking or hypertension history were at reduced risk of SAH in comparison with age-matched postmenopausal women (odds ratio 0.24) [20]. Demographic distribution of our patients was concordant with Van Gijn *et al*. who found that the peak presentation is between 40 and 60 years with female predilection [21].

The intracranial aneurysms diagnosed by Digital subtraction angiography (DSA) are 61.5% (120/195) while Angiographic computed tomography (CTA) diagnosed 55.9% (109/195) cases. In our study the diagnostic accuracy of CTA was found to be 89.23 % with sensitivity of 86.67%, specificity 93.3%, PPV 95.4% and NPV81.4%. By reviewing the different studies in the literature, it was stated that the sensitivity of CTA in diagnosing intracranial aneurysms ranges between 67% to 100% and specificity between 50% to 100% [22]. CTA sensitivity was reported to be 100% by Preda *et al*. in 1998 [23]. In their study Preda *et al*. testified that CTA had supplied adequate information in preoperative diagnosis and evaluation of cases with intracranial aneurysms. They compared CTA, DSA and surgical outcomes and stated that CTA was a promising method to substitute DSA [23]. Lenhart *et al*. stated in their study that CTA had supplied additional information to DSA and found to have the sensitivity of MIP angiograms as 98% [24]. In another research of 142 cases published in 2001 by White *et al,* found the sensitivity and specificity of CTA in detection of intracranial aneurysms to be 69% and 80% respectively [25].

The promising advantage of CTA is reconstruction of three dimensional angiography images in any preferred plane or angle. It is possible to evaluate the size, neck, orientation and relationship of the aneurysm better with surrounding structures by using multiple projections in CTA in comparison with DSA, where restricted numbers of projections are obtained [26]. The association between the aneurysm and neighboring bony structures like skull base, sella turcica or clinoid process is better evaluated by CTA which offers added information for surgical intervention [24]. CTA do has some limitations. Small arteries that has significant surgical importance like anterior choroidal artery or thalamoperforate arteries cannot be visualized because of low spatial resolution. In addition to this the collateral flow demonstrated by DSA cannot be evaluated by CTA.

Conclusion

In conclusion, spiral CTA is a highly sensitive, specific, fast and non-invasive imaging method for diagnosis and evaluation of aneurysms in cases with acute SAH with suspected intracranial aneurysms.

Conflicts of Interest: None

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