Original Article

Sixty-four multi-slice cerebral CT angiographic findings in early non-traumatic subarachnoid hemorrhage

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Summary:

Background: spontaneous subarachnoid hemorrhage (SAH) is subtype of hemorrhagic stroke with extremely poor prognosis. It's a medical emergency and can lead to death or severe disability even when recognized and treated at an early stage. Computed tomographic angiography (CTA) is frequently become the initial step in detecting intracranial aneurysms and planning therapeutic interventions.

Objectives: to analyze the findings of non traumatic SAH in cerebral CTA and characterization of the underlying causes, emphasizing the importance of CTA as a new advent investigation in Iraq.

Patients and methods: This cross sectional study performed on 62 patients with non-traumatic SAH who underwent CTA in Baghdad Teaching Hospital at medical city-Baghdad from August 2012–August 2013 of patients with highly clinical suspicion of SAH or those who were diagnosed by native computed tomography (CT) or magnetic resonance imaging (MRI), the sample of the study was consist of 37 males and 25 females, age of patients ranged from 1-70 years; all patients examined by CTA using 64 multi-slice CT.

Results: From 62 patients in our study, 10 patients have negative finding, 38 have aneurysm, 7 have AVM, 5 have cavernoma and 2 patients have venous angioma. 81.6 % of the aneurysms were saccular and 18.4% were fusiform in shape and mostly (89.5%) supratentorial in location and 10.5% infratentorially, which is single in 84.2% and more than one in 15.8% of patients. The most frequent types of arteriovenous malformation (AVM) were parenchymal (71.4%), from which the size 3-6 cm was most frequent (60%), while the Dural AVM identified in 28.6% of patients; from which, the size 3 cm most frequent size (66.6%) and no cases reported with mixed types.

Conclusion: CTA can provide rapid, minimally-invasive evaluation of broad spectrum of cerebrovascular disorders and CTA adequate for detecting aneurysms in symptomatic SAH patients especially when conjoined with native CT, also CTA is helpful in intervention planning.

Key words: subarachnoid hemorrhage, aneurysm, CT angiography.

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Introduction:

Spontaneous SAH is a subtype of hemorrhagic stroke with an extremely poor prognosis. 85% of non-traumatic SAH are caused by ruptured intracranial aneurysms, 10% fit into the non- aneurismal perimesencephalic hemorrhage pattern, whose etiology remains debated. The final 5% usually due to various rare causes such as arteriovenous malformation (AVM).[1] The annual incidence of non-traumatic SAH is believed to range from approximately 11 to 25 per 100,000 population in the United States and results in at least 25,000 cases annually. Early detection is critical because as many as 25% of patients may die within 24 hours, and the three-month mortality rate has been estimated to be as high as 50% without early definitive treatment.[2] Fast and accurate evaluation of the patients is very important in the management and planning of the therapeutic interventions. Digitalsubtraction angiography (DSA) is currently the accepted gold standard method for the detection and characterization of intracranial aneurysms. DSA is an invasive test; however, results from studies of patients who had SAH and underwent cerebral DSA indicate a 0.07%-0.5% risk of permanent neurological complications.[3] besides, this method is time consuming and expensive.[4] DSA has high sensitivity and specificity values in the detection of cerebral aneurysms while false negative results range from 5% to 10%.[5] One leading cause to false negative results is the impossibility to know which specific projection will render an aneurysm visible.[6,7] Furthermore, accurate detection and measurement of the aneurysm neck and its relationship to the parent artery may be difficult or impossible which impair the suitable treatment method.[8] Multi-slices CT angiography is a non-invasive imaging method. Images can be relatively safely obtained and there is no need for arterial puncture or catheter insertion. Cerebral CT angiography has been widely used in the

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diagnosis of intracranial aneurysms and this method does not carry the neurological risks of DSA. Furthermore, it is less expensive and quicker than DSA.[9, 10] Multi-section CT Scanners are better than single section CT scanners due to faster speed, longer distance and better section thickness.[11, 12] The major goal of this study was to study the findings of non traumatic SAH on CTA and characterization of the underlying causes, emphasizing the importance of CTA as a new advent investigation in Iraq.

Patients and Methods:

This is a cross sectional study carried out on 62 patients examined by brain CTA in Baghdad Teaching Hospital-Medical city (Baghdad, Iraq) from august 2012-August 2013. The inclusion criteria include patients with high clinical suspicion of SAH and those with SAH diagnosed by recent CT or MRI. The sample of this study consisted of 37 males and 25 females, the patients aged from 1-70 years. The exclusion criteria include patients with trauma, recent surgical intervention, bleeding tendency like hemophilia and sensitivity to intravenous contrast media; therefore, the renal indices are assessed and the patients are prepared prior to examination by usually holding food at least 6 hours prior to examination, all patients were examined by Multi-detector CT of the brain by 64 slices Philips 120KV, 200 MAS, slice thickness 5mm, on interval 5 mm, using brain (soft) algorithm. Then patients examined by CTA using Philips device KV=120kv, MA=300mAs, slice thickness 0.7 mm, interval 0.7 mm, using standard algorithm, the Automated bolus tracking, with ROI at the Aortic arch, threshold 100 HU. The amount of iv-contrast material 80-100cc, 350mg I/dl (omnipaque= Iohexol) using right antecubital venous line, catheter 18G (Green color coded), using power injector, single head, at rate of 3cc/second. A data collection sheet was specially designed for this study to collect information from each patient including the age, gender, clinical presentation, CT findings as size, site, shape, location and number of aneurysm and the AVM types, size, arterial supply and venous drainage and other types of vascular malformations. Data management and statistical analysis were performed by using the statistical package for social sciences (SPSS) software for windows version 10. Chi square statistical test was used to assess the significance of differences in frequencies. Student's t test was used to compare mean age in between both genders. Level of significance (P. value) of 0.05 or less was considered as significant. Results were presented in tables and figures with appropriate explanation for each table or figure.

Results:

Age and gender of the patients: In this study the patients aged from 1-70 years, males were 37 and females were 25. The age group 41-50 years (20.9%) was the highest risk groups; however, no statistically significant differences had been found in age and gender; p. value= 0.287 (>0.05).

CTA findings in non-traumatic SAH:

The CTA findings are demonstrated in table 1, Aneurysm was the most common finding, 38 (61.3%) of the total studied group, followed by normal finding in 10 patients (16.1%), AVM in 7 patients (11.3%), cavernoma in 5 patients (8.1%) and venous angioma in only 2 patients (3.2%), no statistically differences in distribution of CTA findings had been found in between both genders, P value= 0.50; Furthermore, the distribution of CTA findings according to age groups revealed, significantly, that the higher incidence of aneurysm was among those aged 41-50 years, P<0.01 , while the higher incidence of AVM was among those aged 21-30 years, P=0.021, other findings was shown in table 3, with no statistically significant differences among age groups, P>0.05, these findings were shown in table 2.

Table (1) CTA findings in non-traumatic SAH.

Findings	Male		Female		Total	
	No.	%	No.	%	No.	%
Normal	6	16.2	4	16.0	10	16.1
Aneurysm	23	62.2	15	60.0	38	61.3
AVM	4	10.8	3	12.0	7	11.3
Cavernoma	3	8.1	2	8.0	5	8.1
Venous angioma	1	2.7	1	4.0	2	3.2
Total	37	100.0	25	100.0	62	100.0
P-value = 0.47						

Table (2) CTA findings in non-traumatic SAH distributed by age groups.

Age (years)	Total No.	Normal		Aneurysm		AVM		Others	
		No.	%	No.	%	No.	%	No.	%
1-10	2	2	100.0	0	0.0	0	0.0	0	0.0
11-20	7	1	14.3	2	28.6	1	14.3	3	42.9
21-30	9	1	11.1	4	44.4	3	33.3	1	11.1
31-40	12	1	8.3	9	75.0	2	16.7	0	0.0
41-50	13	1	7.7	12	92.3	0	0.0	0	0.0
51-60	11	2	18.2	8	72.7	1	9.1	0	0.0
61-70	8	2	25.0	3	37.5	0	0.0	3	37.5
Total	62	10	16.1	38	61.3	7	11.3	7	11.3
P-value		0.34 non sig.		0.01 sig.		0.021 sig.		0.71 non sig.	

The characterization of aneurysms in CTA:
It had been significantly found that 92.1% of aneurysms in non-traumatic SAH had a size <2.5cm, P-value <0.001, saccular findings was the most frequent shape than the fusiform, 81.6% versus 18.4% respectively. Supratentorial site was the most common location than infratentorial, 89.5% versus 10.5% respectively (P-value <0.001), and single aneurysm was present in 32 patients (84.2%) as compared to multiple aneurysm in 6 patients (15.8%), P<0.05. These findings are shown in table (3).

Table (3) Aneurysm findings in CTA in non-traumatic SAH.

Findings		No.	%	P-value
Size	< 2.5 cm	35	92.1	< 0.001
	>= 2.5 cm	3	7.9	
Total		38	100.0	
Shape	Saccular	31	81.6	0.0021
	Fusiform	7	18.4	
Total		38	100.0	
Site	Supratentorial	34	89.5	< 0.001
	Infratentorial	4	10.5	
Total		38	100.0	
Number	Single	32	84.2	< 0.001
	Multiple	6	15.8	
Total		38	100.0	

AVM findings in CTA:
It had been found that the largest proportion of AVM was pial type, it represented 71.4%, from which, the size 3-6 cm most frequent size (60%). Dural type was present in 2 patients, represented 28.6% of all types, in one of them the size was < 3cm and in the other patient the size was >6cm. No mixed type had been reported. Findings are shown in table (4).

Table (4) AVM findings in CTA in non-traumatic SAH.

Findings	size	No.	%	Total	
				No.	%
Parenchymal (pial) AVM	<3 cm	1	30.0	5	71.4
	3-6 cm	3	60.0		
	> 6 cm	1	10.0		
Dural AVM and fistulas	<3 cm	1	50.0	2	28.6
	3-6 cm	1	50.0		
	> 6 cm	-	-		
Mixed (dural and pial) AVM	-	-	-	-	-
Total				7	100.0

Arterial supply and venous drainage of AVM:
It had been found that the largest proportion of AVM was supplied by anterior cerebral artery (42.8%) while the middle cerebral artery and posterior cerebral artery have the same proportion (28.6%). The venous drainage in most of AVM was into superficial veins (71.4%) versus (30.7%) into deep veins as shown in table (5).

Table (5) Arterial supply and venous drainage of AVM.

Blood supply of AVM		No.	%
Arterial supply	ACA	3	42.8
	MCA	2	28.6
	PCA	2	28.6
	Total	7	100.0
Venous drainage	Superficial veins	5	71.4
	Deep veins	2	28.6
	Total	7	100.0

ACA, anterior cerebral artery. MCA, middle cerebral artery. PCA, posterior cerebral artery.

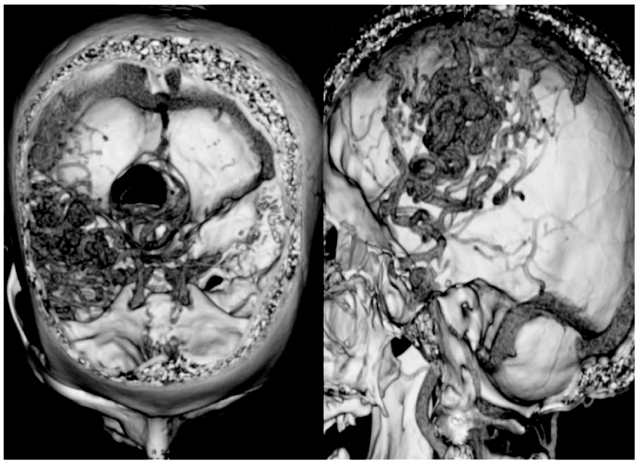

Figure 1. Case (1) 50 years old man presented with headache. CT brain done for him which shown a large cerebral AVM in right parietal region. CTA (volume rendering technique) revealed multiple avidly enhanced dilated primarily intracerebral AVM, which supplied by middle cerebral artery and drained into posterior aspect of the middle part of superior sagittal sinus.

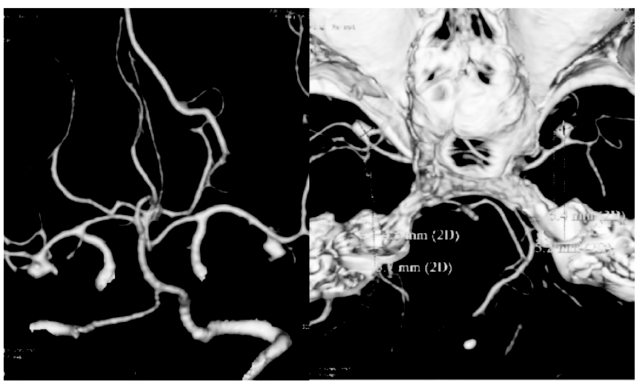

Figure 2. Case (2) 51 years old lady presented with focal deficits. Brain CT was normal but CTA (volume rendering technique) shown bilateral saccular aneurysms involved middle cerebral artery at its bifurcation into opercular branch (distal M1segment) into right and left temporal region; the right one measure 5.5x4.5mm and the left one measure 5.5x5mm.

Discussion:

Subarachnoid hemorrhage is a frequent condition and comprising 1-7% of all strokes and can lead to death or sever disability even when recognized and treated at an early stage.[1] The diagnosis and early management of SAH represent challenge to neurologists, neurosurgeons and interventional radiologists. Native CT scanning is the first investigation if SAH is suspected, therefore, CTA has very important role in detecting and characterization of the underlying cause for optimum selection of treatment (coiling or clipping), and it can provide rapid minimally invasive evaluation of broad spectrum of cerebral vascular disorders. Most of available data from researches are concerned about the evaluation of the role of DSA or try to compare between 16- row multislice CTA with conventional angiography, so it is some time difficult to compare the result of these studies because the methodology and goals are different for each study. In our research, the patients sample consisted of those patient who were suffering from SAH and we try to get benefit from the comprehensive valuation of underlying causes that achieved by CTA , so we try to evaluate the use of CTA aiming to avoid potential risk of any invasive technique, with subsequent risk of permanent neurological complication of underlying cause, so CTA allows for optimum diagnosis and early management of SAH. The demographic characteristics of the patients in our study revealed the predominance of male gender and age group 41-50 years, although no statistically significant difference in gender found in the current study, which is consistent with results of Jinsong W et al.[13]In the present study the common cause of subarachnoid hemorrhage detected by CTA was the aneurysm (61.3%) followed by, AVM (11.3%), cavernoma (8.1%) and venous angioma (3.2%), while normal findings of CTA were (16.1%), this finding is close to results of Kokkinis et al.[14] Another study by Kirk Patrick PJ et al [15] was previously reported similar findings to our results and the Kokkinis study.[14] No significant difference was observed regarding in between both genders of the patients concerning the causes of SAH that was agreed results of Carstair SD et al.[16] Morphological characterization of intracranial aneurysms is important as volume and shape characteristics have been shown to be associated with rupture risk. For investigating intracranial aneurysms, CTA is the most widely used imaging modality. In this study 92.1% of aneurysms had a size of less than 2.5 cm ($p < 0.001$). This finding is in agreement with results of Firouzian M et al.[17] The saccular findings among aneurysms was the most frequent shape recognized (81.6%), supra-tentorial was the most common location identified (89.5%, $p < 0.001$) and single aneurysm was the commonest (84.2%, $p < 0.05$). These morphological findings are close to results obtained by Ramachandran M et al.[18] Our study revealed that the most prevalent age group for aneurysm among SAH patients was 30-50 years and for AVM was 21-40 years. This finding is consistent with results of Wang YC et al. [19] The most common type of AVM in CTA findings in our study was pial type (71.4%) followed by dural (28.6%) and no mixed type was reported. This finding is close to results

reported by Gross BA et al. [20]Knowledge of the location and general features of AVM would facilitate resection of AVM during emergent hematoma evacuation and avoid the scenario in which AVM is unexpectedly entered.[21] In our study the common arterial supply of AVM was anterior cerebral artery (42.8%) and the common venous drainage of AVM was into superficial cortical vein, then superior sagittal sinus (71.4%).

Conclusion:

CTA has been widely used abroad in the diagnosis of intracranial aneurysms worldwide but in Iraq had entered the clinical practice in last 3 years, which is very important in detecting small aneurysms and vascular malformation. The importance of CTA also crucial in patients with negative CTA study because those patients in most cases need no further investigations or follow-up (i.e. better prognosis), so CTA can predict future outcome in patients with SAH. The rapid advances in neurosurgical techniques and the tremendous successes of interventional procedures in SAH put a new burden on neuroradiologist by demanding an accurate etiological diagnosis and precise anatomical localization of vascular malformations.

Recommendation:

The minimal invasive diagnostic procedures should be accompanied by minimal invasive therapeutic procedures, so we recommended the health authorities to start the intervention procedures training programs in Iraq and enhance the awareness about SAH and look for the treatable cause.

Auther's contribution:

Dr. Abdullateef Aliasghar and Dr. Basima Kadhim

Authors make substantial contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data.

Dr. Mudhaffar B. Mahdi: Author participates in drafting the article or revising it critically for important intellectual content; authors give final approval of the version to be submitted.

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