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Original Article

Comparison of Computerized Tomographic Angiography (CTA) and Digital Subtraction Angiography (DSA) in patients with subarachnoid hemorrhage: A retrospective analysis

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Abstract

Aim: Aneurysmal subarachnoid hemorrhage (SAH) is one of the most complex conditions encountered in neurosurgery clinics. It is aimed to compare Computerized Tomographic Angiography (CTA) and Digital Subtraction Angiography (DSA) techniques for detecting aneurysms of anterior communicating artery (AcomA) and middle cerebral artery (MCA) in the present study.

Materials and Methods: The medical files of 20 patients with aneurysmal SAH who had both CTA and DSA scans were included in the study. Raw data of tomographic images was re-created as 3D reconstructions by using computer.

Results: Mean age of the patients was 55.5 years (min-max: 27-82 years). Nine of the patients were male (45%) and 11 were female (55%). Mostly, the results obtained by CTA imaging were confirmed by DSA. No significant differences were detected between CTA and DSA methods regarding to dome area and size of aneurysms of both AcomA and MCA ($p>0.05$).

Conclusion: Both methods can be implemented in clinical settings for detecting SAK.

Keywords: Aneurysm; imaging; subarachnoid hemorrhage

INTRODUCTION

Subarachnoid hemorrhage (SAH) is still a major concern for the neurosurgery clinics. It has a yearly prevalence of 10-16 in 100.000, and the prevalence increases with age. A history of trauma is the most frequent factor in the etiology. Aneurysms are the most encountered non-traumatic reasons (50-75%) followed by vascular malformations, hypertension, and atherosclerosis (1,2). Vascular variations are also accepted as the contributors of the aneurysms (3).

The aim for treatment of aneurysms is to obtain a reliable and rapid occlusion while protecting the major arterial structures. The success of the treatment is relied on many factors such as the patient's status at onset, choosing appropriate treatment method, timing, experience of the medical team, and the utilities of the center. However, evaluating aneurysm and surrounding tissues accurately is one of the most important determinants of the treatment success.

Digital subtraction angiography (DSA) is the gold standard for evaluating intracranial aneurysms both in pre-operative and post-operative periods (4). On the other hand, the advances in neuroradiologic imaging lead to frequent use of non-invasive imaging techniques such as computerized tomographic angiography (CTA) and magnetic resonance angiography especially in the preoperative period.

Generally, CTA is preferred in the preoperative imaging of SAH due to the advantages of being suitable for patients who need monitorization, being faster than magnetic resonance angiography, and demonstrating the calcifications in bones, in arteries, and in lesions better. Many centers continue using CTA routinely in the preoperative period due to positively reported studies and their own experiences (5-8). However, DSA is still accepted as the gold standard (7).

It is important to determine possible differences and similarities between CTA and DSA techniques to specify their advantages for diagnosis and treatment approaches, and to explain possible priorities for their use in the preoperative period of SAH. Therefore, comparison of these two techniques was investigated retrospectively in

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the present study.

MATERIALS and METHODS

The ethical approval was obtained from Ondokuz Mayis University Ethical Committee prior to the study. The files of the patients who consulted to our emergency service and who were diagnosed with SAH between 2010-2015 years were screened retrospectively. Twenty patients were included in the study who had both diagnostic CTA and DSA images. CTA thin-section axial images and 3D reconstruction images were re-created by using Apple iMAC® osx 10.12.2 2.7 Ghz 8 Gb RAM computer and OsiriX v.8.2 64-byte program. Then, 3D reconstruction images of DSA were created by using monoplane 3D rotational DSA device.

Both images were investigated and were compared regarding to configurations of vascular structures, and characteristics of aneurysms of anterior communicating artery (AcomA) and middle cerebral artery (MCA).

Statistical analysis

Statistical analysis was performed by using SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL, USA). Chi-square test was used for comparing descriptive characteristics. Mann–Whitney U test was employed to perform DSA vs. CTA comparisons. p-value of <0.05 was accepted as statistically significant.

RESULTS

Nine patients were male (45%), and 11 patients were female (55%). The mean age was 50.6±15.2 years (min-max: 27-82 years) for all patients, 53.7±17.1 years (min-max: 27-82 years) for females, and 46.7±11.2 years (min-max: 27-66 years) for males.

Table 1. Characteristics of aneurysms

	Anterior Communicating Artery (n: 10)	Middle Cerebral Artery (n: 10)	p*
Presence of Dome			
Yes	10	10	1.000
No	-	-	
Presence of Neck			
Yes	10	9	0.305
No	-	1	
Co-morbidities			
Yes	4	3	0.639
No	6	7	
Stage (According to Yasargil Classification)			
Grade1A	1	1	
Grade2A	8	9	0.589
Grade2B	1	-	
Type			
Fusiform	-	1	0.305
Saccular	**10**	**9**	

p<0.05

Ten patients were diagnosed with AcomA aneurysm. Only two patients were operated, while coilisation was applied for eight patients. Other ten patients were diagnosed with

Table 2. Comparison of imaging techniques

	AcomA		MCA	
	CTA	DSA	CTA	DSA
Site of Aneurysm				
No Aneurysm Detected	-	-	1	-
Anterior Communicating Artery	10	10	-	-
Right MCA Bifurcation	-	-	4	4
Originating from Right MCA M2 Superior Branch	-	-	1	-
Left MCA Bifurcation	-	-	2	3
Originating from Left MCA Bifurcation	-	-	2	1
Originating from M2 Superior Branch	-	-	-	2
Peripheral Branches				
No Aneurysm Detected	-	-	1	-
Focal Narrowing at Distal M1, Blister Aneurysm Proximally	-	-	1	1
Attenuation of M2 Superior Calibration	-	-	1	-
Not Clearly Being Detected	1	1	-	-
Normal Calibration	2	1	2	3
Right A1 Hypoplasia	2	3	-	-
Right A1 could not be Tracked. Right A2 hypoplasia	1	-	-	-
Arising from Right A2 Aneurism Neck	1	-	-	-
Decrease in Right M1 Calibration	-	-	1	1
Originating from Right MCA M2 Superior Branch	-	-	1	-

Left A1 Hypoplasia	2	3	-	-
Arising from Left A2 Aneurism Neck	1	1	-	-
Decrease in Left M1 Calibration	-	-	2	2
Originating from Left MCA Bifurcation	-	-	1	1
Originating from M2 Superior Branch	-	-	-	2
Right A1 Hypoplasia, Right A2 Normal Calibration	-	1	-	-
Presence of Pseudo-Aneurysm				
No	8	7	5	5
Yes	2	3	5	5
Branch from the Aneurysm				
No	8	8	9	9
Yes	2	2	1	1
Migration				
Anterior	6	5		
Anterior Right	1	1		
Anterior Inferior			3	2
Lateral			1	1
Lateral Inferior			1	1
Medial Inferior	1	1		1
Superior	1		1	1
Superior Anterior	1	3		
Superior Lateral			3	3
Posterior				1

AcomA: Anterior Communicating Artery, MCA: Middle Cerebral Artery, CTA: Computerized Tomographic Angiography, DSA: Digital Subtraction Angiography

MCA aneurysm. One patient was operated, six patients had coilisation, one patient was transferred due to his will, and one patient died.

Table 3. Comparison of dome area and size of aneurysms according to imaging techniques

	CTA (n: 20) Median (min-max)	DSA (n: 20) Median (min-max)	p*
AcomA (n: 10)			
Dome	30.4 (4.2-67.9)	27.7 (7.0-67.0)	0.508
Size	2.9 (1.6-5.2)	2.8 (1.9-4.5)	1.000
MCA (n:10)			
Dome	25.5 (6.8 – 53.4)	17.5 (3.9 – 57.3)	0.263
Size	3.0 (0.8 – 4.5)	2.3 (0.9 – 4.1)	0.069

AcomA: Anterior Communicating Artery, MCA: Middle Cerebral Artery, CTA: Computerized Tomographic Angiography, DSA: Digital Subtraction Angiography, min-max: Minimum-Maximum, *: Mann-Whitney U test

The comparison of the characteristics of aneurysms regarding to AcomA and MCA was presented at Table 1. Mostly, the results obtained by CTA were confirmed by DSA (Table 2). No significant differences were detected between CTA and DSA methods regarding to dome area and size of aneurysms of both AcomA and MCA ($p>0.05$, Table 3).

DISCUSSION

Cerebral aneurysms and their tears were described as the reasons of SAH in 18th century by Morgagni and Biumi. Numerous progresses have been achieved until today, however, the advances such as new surgery techniques and using computerized tomography angiography has changed the era for neurosurgery (9).

Computerized tomography (CT) is the one of the first assessments for a patient with suspected SAH. A well-performed CT detects nearly all patients with SAH in the first 12 hours (10). However, the ideal imaging method should be easily accessible and non-invasive, as well as with low complications (11). It should also allow determining adjacent structures, location of the aneurysm sack related to base of skull, and presence of the calcifications (12).

In this context, currently, the gold standard for diagnosing a vascular lesion responsible for SAH is DSA (13). DSA can detect the aneurysm, its location, and possible radiographic vasospasm at the level of 80-85%. However, the risk of DSA-related complications, including persistent neurologic deficits, is non-negligible and has been reported to be as high as 14% (14,15). Therefore, the use of non-invasive CTA and magnetic resonance angiography are increasing (16).

CTA and DSA methods were compared in the present study, and it was demonstrated that CTA correctly detecting aneurysms for AcomA (100%) and for MCA (90%) which were confirmed by using DSA. The location of the aneurysms which were detected by using CTA was also confirmed by DSA (100% for both AcomA and MCA).

No significant differences were detected between CTA and DSA imaging techniques for detecting the dome area and size for both AcomA and MCA in the present study. Moreover, some authors advocated that CTA images are enough to detect MCA and AcomA aneurysms before planning a surgery (12,17-19). Although, the DSA is the gold standard for detecting intracranial aneurisms, it may provide limited information due to superposition of vascular structures, tortuosity, small aneurysms, and complex aneurysms. Thus, rotational angiography was suggested for overcoming these limitations (12,20). On the other hand, CTA is easier and less-time consuming (interpreting is less than 1 minute) than DSA. It also allows to perform a multi-sectional CT in a very same setting following a non-contrast CT.

Both CTA and DSA uses ionizing radiation. However, the radiation exposure is lower in CTA compared to DSA (21). On the other hand, CTA has a disadvantage of being unable to show filling of artery and aneurysm in time. It is important to determine which side of the anterior cerebral artery is filled before planning the surgery. However, it is still possible to estimate the side by investigating the diameters of pre-communicating segments of the anterior cerebral artery and the direction of the aneurysm grow (22).

CONCLUSION

As similarities were detected between DSA and CTA substantially, both methods can be implemented in clinical settings for detecting SAK. Although, the DSA is the gold standard, clinics who have limited facilities might benefit from CTA imaging. CTA also has advantages as being easier and faster, and allows to perform detailed evaluations following a CT in a SAH suspected patient without transferring the patient into another setting. However, the retrospective nature of our study may limit our conclusion.

Conflict of interest : The authors declare that they have no competing interest.
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