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Samer S. Hoz

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Hagar A. Algburi[1], Mustafa Ismail[2], Tabarek M. Al-Nuaimi[3], Zainab T. Alzeyadi[4], Jafar M. Sabbar[3], Ahmed K. Al-Kishawi[5], Rania H. Al-Taie[5], Mahmood F. Al-Zaidy[1], Mohammed A. Alrawi[2], Samer S. Hoz[6]

[1] College of Medicine, University of Baghdad, Iraq
[2] Department of Neurosurgery, Neurosurgery Teaching Hospital, Baghdad, Iraq
[3] University of Anbar, College of Medicine, Al-Anbar, Iraq
[4] University of Al Qadisiyah, College of Medicine, Ad Diwaniyah, Iraq
[5] Al-Mustansiriyah University College of Medicine, Baghdad, Iraq
[6] Department of Neurosurgery, University of Cincinnati, College of Medicine, Cincinnati, OH, USA

Keywords
intracranial aneurysm, pre-operative CTA, configurational changes

Abstract

Background: Ruptured intracranial aneurysms may face configurational changes in size and shape resulting from extreme weakness in their wall. These configurational changes are associated with an amplified risk of rupture and surgical challenges as these aneurysms have proven to be unstable. However, to our knowledge, no previous studies have addressed the issue of configurational aneurysmal changes between the patient's presentation (radiological images) and intraoperative findings. This paper aims to compare aneurysmal size and shape between pre-operative Computed tomography angiography and intraoperative lesion characteristics in a cohort of patients presented to our centre.

Methods: A retrospective analysis was performed on cases admitted to the Neurosurgery Teaching Hospital in Baghdad, Iraq, and underwent microsurgical clipping of ruptured aneurysms. Their records were checked for aneurysmal configurational changes by comparing pre-operative radiological images and intra-operative findings.

Results: Of the 275 patients, 5 cases were enrolled with aneurysmal configurational changes. Three of them were females, and two were males. The pre-operative aneurysmal shapes based on Computed tomography angiography were (3 unicyst and two conical shapes) and the range of aneurysmal size was (7-11 mm) with a mean of 9 mm. Compared to intra-operative findings, there were total aneurysmal shape changes (connected cyst in 4 patients and spherical aneurysm in one patient). The range of aneurysmal size was (7-11 mm) with a mean of 9 mm.

Corresponding author:
Mustafa Ismail

Neurosurgery Teaching Hospital, Baghdad, Iraq

mustafalorance2233@gmail.com

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Conclusion: Intracranial aneurysms may undergo configurational changes through the time between pre-op imaging and surgery; early detection of these changes may ensure optimal management of such cases.

Introduction

Intracranial aneurysm (ICA) is a common cerebrovascular disease with high morbidity and mortality in patients around 40–60 years old, characterized by abnormal focal dilation of cerebral arteries due to arterial wall weakness (13). Aneurysmal rupture is the most admissible cause of non-traumatic spontaneous subarachnoid hemorrhage (14). Despite advanced surgical techniques and peri-operative management, the morbidity and mortality associated with aneurysmal rupture are still very high, leading to an acute disability in 30% of cases and death in 30–50% of them (9,10). Ruptured intracranial aneurysms may face configurational changes in size and shape resulting from extreme weakness of the aneurysmal wall (6). It has been reported that approximately 10% of the aneurysms presented growth and changing size through follow-up imaging (5). These configurational changes are associated with an amplified risk of rupture and surgical challenges as these aneurysms have proven to be unstable (12).

Furthermore, this explains that the angiographic pathological finding is not correlated with the characteristics and nature of the aneurysm. Direct aneurysmal observation should be done accurately to detect if there are any abnormal configurational changes in the aneurysm. So, repeated regular follow-up computed tomography angiography (CTA) of an aneurysm is beneficial throughout the time between the first pre-operative (pre-op) CTA and the time of surgery. However, to our knowledge, no previous studies have addressed the issue of configurational aneurysmal changes between the patient's presentation (radiological images) and intraoperative findings. This paper aims to compare aneurysmal size and shape between pre-op CTA and intraoperative lesion characteristics in a cohort of patients presented to our center.

Method

A retrospective chart analysis was performed on cases admitted to the Neurosurgery Teaching Hospital in Baghdad, Iraq, and underwent microsurgical clipping of ruptured aneurysms for the period of (September 2018- March 2022). Their records were checked for the presence or absence of aneurysmal configurational changes by comparing pre-op CTA and intra-op findings. Patients with the presence of aneurysmal size and shape changes were analyzed according to the following parameters:

1. Pre-operative data: (A) patient demographics (age, sex). (B) Aneurysmal characteristics: location/side, shape based on CTA, size based on CTA.
2. Intra-operative data: (C) intra-op findings through changes in (size or shape or together), the time between the pre-op CTA and surgery.
3. Post-operative data: final outcome and last follow-up.

Result

Of the total 275 patients, 5 cases were enrolled with aneurysmal configurational changes. Three of them were females, and two of them were males. The range of patients' age was 41-62 years with a mean of 50 years. Regarding aneurysmal location and side, 3 out of 5 patients had posterior communicating artery (Pcom) aneurysm (two of them on the left side and one on the right side), while one patient had anterior communicating artery aneurysm and the last one had a right middle cerebral artery (MCA) aneurysm. The pre-op aneurysmal shapes based on CTA were (3 unicyst and two conical shapes) and the range of aneurysmal size was (7-11 mm) with a mean 9 mm. Compared to intra-op findings, there were total aneurysmal shape changes (connected cyst in 4 patients and spherical aneurysm in the last one). The range of aneurysmal size was (7-11 mm) with a mean of 9 mm. The time range between the pre-op CTA and surgery that the configurational aneurysmal changes occurred was (10-21 days) with a mean of 16 days.

Regarding the outcome, two patients were good with no deficit, one patient had intra-op rupture (IOR) and right-sided weakness (grade 3-4) for two months then was good with left side grade 4+ when followed up, one patient had a left-sided weakness (grade 2) then was good with left side grade 4+ when followed up. The last patients had incomplete clipping, left-sided weakness (grade 3), redo surgery, and complete clipping that was good with no deficit when followed up. The range of the last follow-up of the

patients was (6-30 months) with a mean of 20 months. The included patient data is described in Table 1. In addition, examples of the included cases are depicted in figure1 and 2.

Table 1. Ruptured intracranial aneurysm cases with pre-operative configurational changes.

ID	Age	Sex	Aneurysmal location/Side	Pre-op Aneurysmal shape based on CTA	Pre-op Aneurysmal size based on CTA	Intra-op findings: change in size, and shape	Time between the pre-op CTA and surgery	Final Outcome	Last Follow up
1	45	F	L Pcom	unicyst	4 mm	Size 9 mm, shape 3 connected cysts	17 days	IOR, right side weakness (grade 3-4) for 2 months final outcome is Good with no deficit	24 months
2	58	F	AcomA	Conical shape dome	3 mm	Size 8 mm, shape 2 connected cysts	12 days	left side weakness (grade 2), final outcome is Good with left side grade 4+	6 months
3	47	M	R MCA	conical	4 mm	size 7 mm, spherical	21 days	incomplete clipping, left side weakness (grade 3), redo surgery and complete clipping, the final outcome is Good with normal	18 months
4	62	F	L Pcom	unicyst	5 mm	Size 10 mm, shape 2 connected cysts	10 days	Good with no deficit	24 months
5	41	M	R Pcom	unicyst	6 mm	Size 11 mm, shape 3 connected cysts	18 days	Good with no deficit	30 months

AcomA; Anterior communicating artery CTA; Computed tomography angiography, Pre-op; Pre-operative, Intra-op; Intra-operative Pcom; posterior communicating artery, A2; post-communicating anterior cerebral artery, MCA; middle cerebral artery.

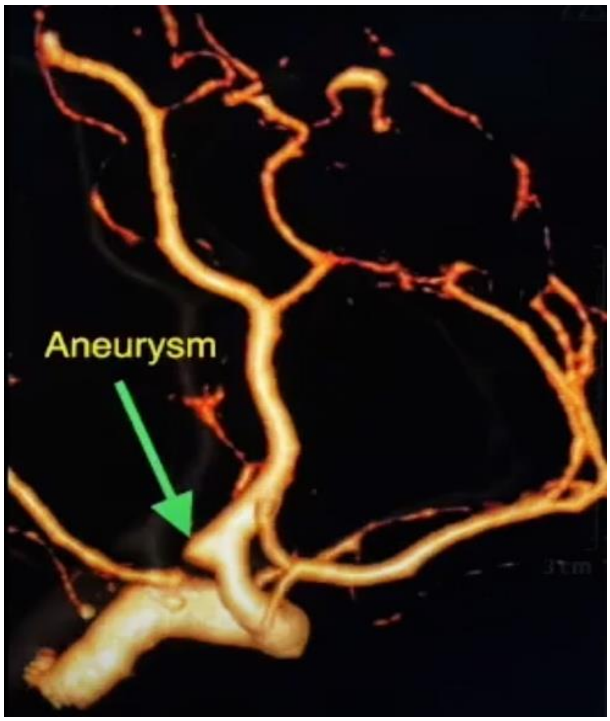

Figure 1. A. 45 yrs. female, presented with sudden severe headache and vomiting, CT showed SAH in basal cisterns (ID 1 in Table 1). Pre Op CTA showed a wide neck Left Pcom aneurysm measuring 4 mm.

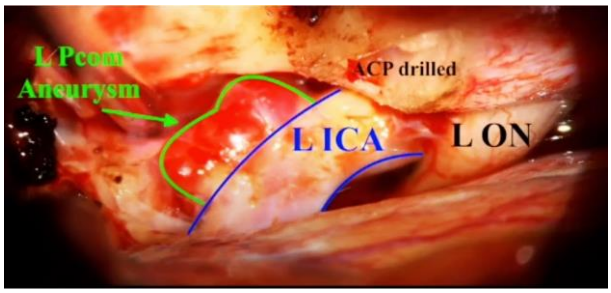

Figure 1. B. Intra-op view through Left pterional approach with the Pcom aneurysm and surrounding structures were dissected. 17 days after the rupture (CTA time), showed significant changes in the size and shape of the Pcom aneurysm. The intraoperative size was 9 mm, and the shape was 3 connected cysts.

Discussion

ICA, described as a pathological dilation of cerebral arteries found in the subarachnoid spaces, is considered the most challenging vascular lesion in the brain for clinicians (3). Aneurysmal formation is a multi-factorial disease that interferes with genetic and environmental factors and cerebral vessels. It is reported that ICA affects approximately 1-6% of the world's population and, specifically, 3–5% of the

adult population (4). ICA is classified according to its size (small < 5mm, medium 5-10mm, large 10-15mm, giant > 25mm) and shape as saccular (berry), fusiform and mycotic aneurysms (1). aSAH is a devastating medical event with high morbidity and mortality and can be found in approximately 0.7-1.9% of cases (2). Follow-up assessment of ruptured aneurysms is recommended because the aneurysm can change its size and shape over time, which may affect the surgical planning and patient's outcome (11). These configurational changes are slightly different as some grow wider, whereas others' growth ends with forming a bleb. The difference in change mechanisms might have different risks to the patient's surgical outcome as different pathological processes underlie the aneurysmal growth and size (8).

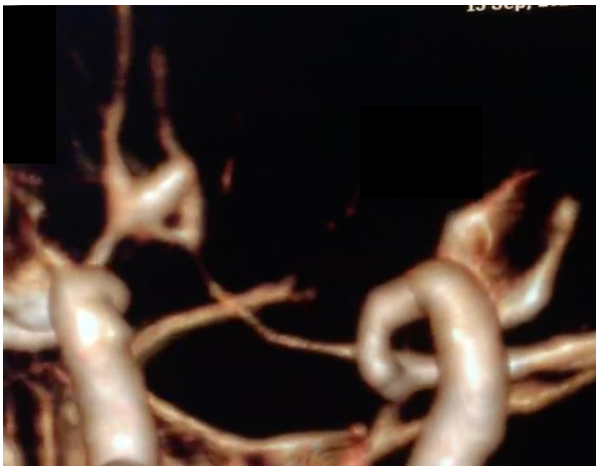

Figure 2. A. 58 yrs female, presented with sudden onset of severe headache, CT showed SAH in basal cisterns (ID 2 in Table 1). Pre-op CTA showed a conical shape aneurysm dome of an anterior communicating artery aneurysm measuring 3 mm.

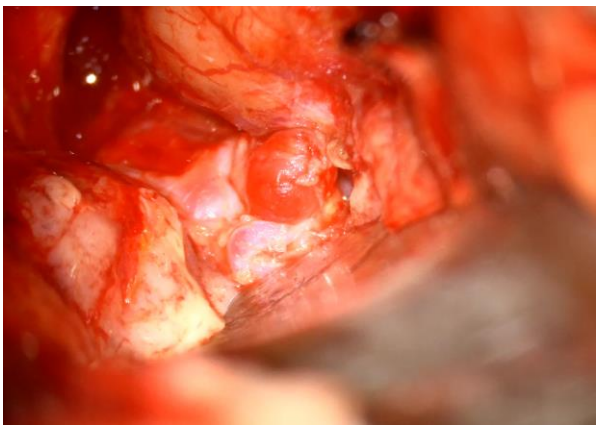

Figure 2. B. Intra-op view through Right pterional approach with the Acom aneurysm and surrounding structures dissected. of the aneurysm 12 days after the rupture, showed significant changes in the size of the Acom aneurysm with two connected cysts forming the dome and size 8 mm.

Moreover, the risk of aneurysmal configurational changes was found to depend on factors such as (age, sex, smoking, hypertension, history of a SAH, irregular shapes, multiple aneurysms, and anatomical site). However, the influence of individual risk factors on ICA growth is poorly understood. Ogwa et al. reported in their paper that the first aneurysmal angiogram of three patients revealed a tiny blister aneurysm. In contrast, in the second angiogram, there was an increase in aneurysmal sizes and shape change into the saccular aneurysm. During operation, these aneurysms faced extremely fragile walls with no firm aneurysms (7). This was reported in the literature; however, the description and impact of aneurysmal configurational changes in the period between the patient's presentation and surgical management are not addressed well. Our study will show the differences in aneurysmal growth and size between pre-op CTA and intra-op findings concerning possible factors and patient outcome assessment. Out of 5 patients who enrolled in our study, we noticed huge differences between the pre-op CTA aneurysmal characteristics and intra-op findings represented by configurational changes through size and shape, as shown in Table 1. The most commonly found aneurysm in those patients was PCOM aneurysm, whether it was right or left. The estimated aneurysmal size difference was 5 mm between pre- and post-aneurysmal changes.

Further, the time between CTA and surgery was 2-3 weeks which is a long period in which the configurational changes silently take place and lead to operative challenges regarding these changes. Fortunately, the patients were suitable after the operation, some with some complications resolved with time. So, the essential factor that can detect the aneurysmal change through its size and shape is the time between the last pre-op CTA and the time of surgery which should not be more than one week. As part of the Iraqi population, we faced many situations that obligate the surgeons to delay the operation, so this delay if it was more than one week; new CTA should be done to ensure that any configurational changes affect the patients and operation.

The small sample size of cases in our study is one of the limiting factors that may not render the

statistics definitely accurate. However, it has a significant impact on operative challenges and patients' outcome.

The potentials and advantages of our study are primarily better understanding the intra-op aneurysmal changes and how to deal with these circumstances. Also, possible future studies may make this study a severe issue in decreasing intra-op challenges and improving patient outcomes.

In summary, the presence of aneurysmal differences between pre-op CTA and intra-op findings may be attributed to configurational size and shape changes due to the enormous fragility of the aneurysmal wall.

Conclusion

Intracranial aneurysms can face configurational changes through the time between pre-op imaging and surgery; early detection of these changes may ensure optimal management of such cases.

Abbreviations:
ICA = Intracranial aneurysm
CTA = Computed tomography angiography
aSAH = Aneurysmal subarachnoid haemorrhage Pre-op = Pre-operative
Intra-op = Intra-operative
Pcom = posterior communicating artery
A2 = post-communicating anterior cerebral artery MCA = middle cerebral artery

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