

## Anterior Communicating Artery Aneurysm Clipping: Experience at a Tertiary Care Center with Respect to Intraoperative Rupture

### Abstract

**Context:** The incidence of anterior communicating artery (Acomm) aneurysm is high and it is associated with high risk of rupture. **Aims:** The aim is to evaluate various factors (size, wall morphology, and fundus direction) associated with intraoperative rupture (IOR) of Acomm aneurysm. **Settings and Design:** Retrospective cohort study. **Subjects and Methods:** Our study includes 25 operated patients diagnosed to have ruptured Acomm aneurysm in the Department of Neurosurgery of Institute of Medical Sciences, Banaras Hindu University, Varanasi, India, between January 2016 and July 2020. Our study included all patients with ruptured Acomm aneurysm who received clipping as method of treatment. **Statistical Analysis:** Chi-square test was used for analysis. Values with  $P < 0.05$  were considered statistically significant. Statistical tests were done using GraphPad Prism version 8.3.0 software. **Results:** None of the patients with  $<4$  mm, 6 patients of  $>4$ – $10$  mm, and 2 patients of  $>10$  mm aneurysm size experienced IOR. IOR was seen in 2 patients with smooth wall and 6 in irregular aneurysm wall. All patients with posterior, 1 patient with inferior, 2 patients with anterior, and 1 patient with superior directing aneurysm experienced IOR. Patients with bilaterally clipped A1 experienced no IOR, while in unilaterally clipped aneurysm only 2 patients experienced IOR. Glasgow outcome score was better in patients with no IOR. **Conclusion:** The factors associated with high risk of IOR are: Aneurysm size  $>4$  mm, multilobulated or irregular aneurysm wall, posteriorly and inferiorly directed aneurysms. Patients in whom Both A1 was temporarily clipped, experienced no IOR and better outcome.

**Keywords:** Aneurysm fundus direction, anterior communicating artery aneurysm, Glasgow outcome score, intraoperative rupture, temporary clipping

### Introduction

The anterior communicating artery (Acomm) is one of the most common locations for intracranial aneurysm (IA). They account for approximately 10% of unruptured aneurysms,<sup>[1]</sup> and as high as 45% of ruptured aneurysms.<sup>[2]</sup> The Acomm aneurysm is considered to be at increased risk for rupture and therefore necessitates aggressive management.<sup>[3]</sup> Rupture of aneurysm results into subarachnoid hemorrhage (SAH) formation. Rupture of Acomm aneurysm may also produce basal frontal hematoma and intraventricular hemorrhage.

As per the Mayo Clinic (2009) recent research report, the incidence of un-ruptured aneurysms is nearly 2% and the yearly morbidity of SAH caused by rupture of IA is about 60–100/100 thousand people.

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The results of international study on unruptured IAs (ISUIA) revealed that Acomm aneurysms of size  $<7$  mm were not found readily as compared to aneurysms of other sites or of a larger size, thus posing the increased risk of rupturing. The data of ISUIA provide statistical corroboration that the Acomm aneurysms of even smaller diameters rupture as compared to aneurysms located elsewhere.<sup>[4-6]</sup>

Studies have shown that the anterior and posterior communicating (Pcomm) artery aneurysms have been associated with higher risk of rupture than the middle cerebral artery (MCA) aneurysms. In particular, even smaller ( $<7$  mm) Acomm aneurysms have been shown to have high rupture rate.<sup>[7,8]</sup> These results suggest that alternative factors-such as aneurysmal morphology-strongly correlate with the aneurysm rupture risk. There are the

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studies that suggest that the relationship between the size of an aneurysm and aneurysm rupture may not be correlated.<sup>[9-22]</sup> Pang *et al.* found that among all aneurysms, anterior communicating artery aneurysm demonstrates higher frequency of intraoperative rupture (IOR) (30%) as compared to Pcomm (26%) and MCA (18%) aneurysms.<sup>[23]</sup>

Technical advances in instrumentation and operative techniques have brought down the morbidity associated with IA surgery. However, aneurysmal rupture is still a main risk factor that can remarkably affect the patient's prospect for smooth recovery.

In the majority of earlier studies, the aneurysm size was considered the major risk for rupture of aneurysm, suggesting the possibility that other factors associated with aneurysm morphology may have been ignored.

Our study provides a more detailed statistical analysis of the individual and multiple factors affecting rupture of Acomm aneurysm during surgery. Although previously, studies have been conducted that individually examined issues such as aneurysm location, aneurysm morphology, timing of surgery relative to SAH, relationship between fundus direction and IOR, and use of temporary clipping of A1, our study is the first of its kind to elaborate all these components collectively.

Our study assessed the multiple risk factors which were intimately related to aneurysm rupture during surgery. The identification of these variables can be utilized to take preventive measures to decrease the events of IOR and thus better patient care. In our study, majority of IOR occurred during aneurysm dissection or clip application.

## Subjects and Methods

This was a retrospective study conducted at the Department of Neurosurgery, Banaras Hindu University, Varanasi. Data were collected from medical records of the department for January 2016 to July 2020. We reviewed the case of 25 operated patients diagnosed to have ruptured Acomm aneurysm.

Our study included all patients with ruptured Acomm aneurysm who received clipping as method of treatment. Exclusion criteria were: Patient with multiple aneurysms, patients who were hospitalized due to trauma, patients who were diagnosed with IA but did not receive surgical treatment.

We collected data on the following variables at the time of presentation: Age, gender, comorbidities (hypertension, diabetes mellitus, end-stage renal disease [ESRD], and cerebrovascular accident), Glasgow coma scale (GCS), Hunt and Hess Grade, Glasgow outcome score (GOS), and various factors related to Acomm aneurysm morphology.

Three-dimensional computed tomography angiography (CTA) was done in all patients in whom SAH was seen

on conventional computed tomography (CT) scan. The morphological details of the aneurysm and circle of Willis were depicted from CT angiography such as size, neck width, wall morphology, and fundus direction.

## Statistical analysis

The data were summarized using medians/mean for continuous variables, and counts and percentages for categorical variables. Differences of significance in categorical variables were evaluated using Chi-square test. The data collected were statistically analyzed using GraphPad Prism version 8.0.0 program  $P < 0.05$  was considered statistically significant.

## Results

### Patient characteristics

The characteristics of patient population are shown in Table 1. The mean age of patients was  $58.1 \pm 5.26$ . Of 25 patients, 10 (40%) were male and 15 (60%) were female. All the patients underwent surgical clipping of the ruptured Acomm aneurysm.

GCS at the time of presentation varied from 3 to 15 with mean of  $12.5 \pm 2.4$ . Patients with Hunt and Hess Grade 1, 2, and 3 consisted of 24%, 40%, and 24%, respectively, 8% were in grade 4 and 4% in grade 5. The presenting complaint was headache (76%), altered sensorium (52%), and seizures (16%).

Most of the patients (13) were operated after 14 days of presentation due to either poor Hunt and Hess grades or hemodynamic instability, unwillingness for surgery or some medical causes. Ten patients were operated within 3 days of presentation and only 2 patients were operated in 4–14 days duration, one on 5<sup>th</sup> and other on 12<sup>th</sup> day.

**Table 1: Patient characteristics (n=25)**

Patient characteristics	Number of patient/value, n (%)
Gender	
Male	10 (40)
Female	15 (60)
Hunt and Hess grade	
Grade 1	6 (24)
Grade 2	10 (40)
Grade 3	6 (24)
Grade 4	2 (8)
Grade 5	1 (4)
Symptoms	
Headache	19 (76)
Seizures	4 (16)
Altered sensorium	13 (52)
Surgical timing (days)	
0-3	10 (40)
4-14	2 (8)
>14	13 (52)

### Three-dimensional computed tomography angiography findings

CTA findings are summarized in Table 2. Patients in whom unilateral and bilateral A1 visualized were 8 and 17, respectively. A2 was visualized unilaterally in 1 patient and bilaterally in 24 patients. However, A1 and A2 of both sides were found intraoperatively in all cases. Unilateral nonvisualization of A1 or A2 in few cases in preoperative CTA may be due to vasospasm.

### Aneurysm morphology

Various morphological characteristics of Acomm aneurysm and its correlation with respect to rupture are depicted in Table 3.

Aneurysm neck width was classified into <4 mm or  $\geq$ 4 mm sizes. Only one patient with neck width <4 mm experienced IOR, while 7 patients experienced IOR with neck width  $\geq$ 4 mm and this difference was statistically not significant.

Aneurysmal dome size was divided into three categories: <4 mm ( $n = 8$ ), >4–10 mm ( $n = 14$ ) and >10 mm ( $n = 3$ ). None of the patients of <4 mm size aneurysm experienced IOR, while 6 patients of >4–10 mm size category and 2 patients of >10 mm size category experienced IOR and this correlation came to be significant ( $P = 0.0455$ ).

**Table 2: Computed tomography angiography findings ( $n=25$ )**

	Unilateral (%)	Bilateral (%)	None (%)
A1 visualized	8 (32)	17 (68)	0
A2 visualized	1 (4)	24 (96)	0

Aneurysmal wall was simple or smooth in 17 patients and multilobed or irregular in 8 patients. IOR was seen in only 2 patients with smooth wall while 6 in irregular aneurysm wall and this difference was statistically significant ( $P = 0.0016$ ).

Aneurysm direction was classified into anterior, superior, posterior, and inferior based on CTA and intraoperative findings. In our study, 11 patients were having anterior projecting aneurysms, 8 patients had superior, 4 had posterior, and 2 patients had inferior projecting aneurysms. All patients with posterior and 1 patient with inferior directing aneurysms experienced IOR. While IOR was seen in 2 patients with anterior and only 1 patient with superior directing aneurysms, these differences in IOR were found to have statistical significance ( $P = 0.0008$ ).

In our study, proximal A1 was clipped bilaterally in 6 patients, unilaterally in 11 patients and no clipping was done in 8 patients. Patients with bilaterally clipped A1 experienced no IOR, while in unilaterally clipped aneurysm only 2 patients experienced IOR. In patients with no proximal clipping of A1, 6 out of 8 patients experienced IOR and these values were statistically significant ( $P = 0.0050$ ) on correlation.

### Risk of aneurysm rupture

Risk factors and comorbidities are enlisted in Table 4. In our study, 1 patient belonged to age group <20 years, 4 patients from  $\geq$ 20 to 39 years of age group, 10 patients from  $\geq$ 40 to 59 years of age group, and 10 patients from  $\geq$ 60 years of age group. Most of the IOR was seen in  $\geq$ 60 (4 patients) years of age group followed by  $\geq$ 40–59 (3 IOR) years of age group. IOR was seen in only 1 patient

**Table 3: Aneurysm characteristics (with respect to intraoperative rupture) ( $n=25$ )**

	Intraoperative rupture ( $n=8$ )	No intraoperative rupture ( $n=17$ )	<i>P</i>
Neck width			
<4 mm (7)	1	6	0.2364
$\geq$ 4 mm (18)	7	11	
Aneurysm size			
<4 mm (8)	0	8	0.0455
>4-10 mm (14)	6	8	
>10 mm (3)	2	1	
Aneurysm wall morphology			
Simple/smooth (17)	2	15	0.0016
Multilobed/irregular (8)	6	2	
Fundus direction			
Anterior (11)	2	9	0.0109
Superior (8)	1	7	
Posterior (4)	4	0	
Inferior (2)	1	1	
Proximal clipping of A1			
Not done (8)	6	2	0.0050
Unilateral (11)	2	9	
Bilateral (6)	0	6	

**Table 4: Risk of intraoperative aneurysm rupture (n=25)**

	Intraoperative rupture (n=8)	No intraoperative rupture (n=17)	P
Age (years)			
<20 (1)	0	1	0.8319
≥20-39 (4)	1	3	
≥40-59 (10)	3	7	
≥60 (10)	4	6	
Gender			
Male (10)	2	8	0.5073
Female (15)	6	13	
Comorbidity			
Hypertension (17)	5	12	0.6859
Diabetes (6)	2	4	0.9360
Previous history of CVA (3)	1	2	0.9579
ESRD (2)	1	1	0.5694
GOS			
5 (9)	0	9	0.0003
4 (9)	1	8	
3 (3)	3	0	
2 (2)	2	0	
1 (2)	2	0	

GOS – Glasgow Outcome Score; ESRD – End-stage renal disease; CVA – Cerebrovascular accident

from ≥20 to 39 years of age group. Although correlation these findings were not significant.

Intraoperative aneurysm rupture was seen in 2 male patients and 6 female patients out of 10 male and 15 female patients respectively but these data were found to be nonsignificant.

In our study, 17 (68%) patients were hypertensives, 6 (24%) were diabetic. Three (12%) patients had previous history of CVA and 2 (8%) had ESRD. IOR was seen in 5 patients with hypertension, 2 patients with diabetes, 1 patient with CVA, and 1 patient with ESRD, although these values were nonsignificant on correlation with respect to IOR.

### Surgical outcome

Postsurgical outcome was measured in the form of GOS. GOS was better in patients in whom no IOR was seen. GOS 5 was seen in nine patients and all of them belonged to the group in which no IOR was seen. GOS 1 and 2 was seen in two patients and all of them (100%) belonged to IOR group. GOS 4 was seen in nine patients and eight of them (88.89%) belonged to group with no IOR. GOS 3 was seen in three patients and all of them (100%) had experienced IOR. These values were statistically significant ( $P = 0.0003$ ).

### Correlation between time of surgery and IOR

This correlation has been shown in Table 5. Only 2 patients (out of 10) experienced IOR, who were operated within 3 days of presentation. Only 2 patients were operated in 4–14 days' duration and none experienced IOR. Most of the patients were operated in >14 days' duration (13) and six of them had episodes of IOR. Although this correlation was not significant.

**Table 5: Correlation between time of surgery and intraoperative rupture**

Time of surgery	Intraoperative rupture	No intraoperative rupture	P
0-3 days (10)	2	8	0.2466
4-14 days (2)	0	2	
>14 days (13)	6	7	

## Discussion

In this study, we have emphasized on the multiple anatomical and structural features of Acomm aneurysms. We have attempted to extract the conclusive data to answer the pressing questions for the future and continued effort to improve clinical management of ruptured IAs.

In our study, male:female ratio was 2:3 with female preponderance and mean age was 58.1. Chee *et al.* found almost similar results with 42.9% males, 57.1% females and mean age  $51 \pm 11.82$  years.<sup>[24]</sup>

### Aneurysm morphological analysis

There is no doubt that the risk of aneurysm rupture is high for large sized aneurysms. Pang *et al.* found that the risk of rupture tended to increase as the size of the IA increased.<sup>[23]</sup>

Conservatively managed patients and those with no aneurysmal bleed were not included in this study. We have correlated various factors with respect to IOR in Acomm aneurysm with presentation as SAH and we found that most of IOR is seen in large sized aneurysm and with increasing size, incidence of IOR increased.

We also found that IOR was found to be significantly associated with aneurysm wall morphology. IOR was seen more in multilobulated as compared to simple and smooth walled aneurysm. No study on IOR could be retrieved in literature with regard to wall morphology. Myeong *et al.* found in his study that smooth aneurysm wall was observed in 38 aneurysms (44%) in the ruptured group and 25 aneurysms (57%) in the unruptured group. Patients with irregular walled aneurysm resulted into 48 (56%) ruptured and 19 (43%) unruptured cases; thus, it can be inferred that smooth wall was more frequently associated with unruptured than with ruptured aneurysms (57% vs. 44%).<sup>[25]</sup>

In our study, we observed that patients with aneurysm fundus directed posteriorly, experienced 100% IOR. Only 2 patients (out of 11) with anterior and 1 patient (out of 8) with superior directed fundus showed IOR. Although Matsukawa *et al.* found that an anterior direction of the aneurysm dome around the Acomm aneurysm was related to high rupture rate,<sup>[26]</sup> it is different from our study because our study includes aneurysm rupture while operating only.

In our study, we found that patients in whom proximal clipping of both A1 was done, none experienced IOR, while out of those who did not underwent proximal clipping many had IOR.

PKH Pang *et al.* also found that the use of elective temporary clipping is associated with a significant reduction of the IOR rate (from 25.86% to 7.89%) and a better patient outcome.<sup>[27]</sup>

We also found that patients who experienced IOR were undoubtedly associated with poor GOS when compared to aneurysm without IOR and this difference was statistically significant.

## Conclusion

From our study, we conclude that various factors remarkably associated with increased risk of IOR are: Aneurysm size >4 mm, multilobulated or irregular aneurysm wall, posteriorly and/or inferiorly directed aneurysms. We encourage temporary clipping of both A1 in Acomm aneurysms as there is less chance of IOR and better outcome.

Although the incidence of IOR may never be completely abolished by identifying the various risk factors responsible for IOR, the surgeon can anticipate and be better prepared to deal with it. We should be very generous while handling aneurysm to avoid rupture because IOR has poor outcome. Furthermore, a better comprehensive knowledge of the factors associated with IOR of Acomm aneurysm can allow us for a better approach in the surgical decision-making process.

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## Conflicts of interest

There are no conflicts of interest.

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