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Teeba A. Al-Ageely,  
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Samer Hoz



# Management of brain aneurysm neck-avulsion during clipping surgery. Illustrative case and literature review

Teeba A. Al-Ageely<sup>1</sup>, Mustafa Ismail<sup>1</sup>, Salima B. Alsaadi<sup>2</sup>,  
Fatima F. Salim<sup>1</sup>, Zahraa M. Kareem<sup>1</sup>, Sura H.  
Talib<sup>3</sup>, Huda Jaafer<sup>1</sup>, Samer Hoz<sup>4</sup>

<sup>1</sup> College of Medicine, University of Baghdad, Baghdad, IRAQ

<sup>2</sup> Department of Radiology, Al-Hadi University College, Baghdad, IRAQ

<sup>3</sup> College of Medicine, Al-Mustansiriyah University, Baghdad, IRAQ

<sup>4</sup> Department of Neurosurgery, University of Cincinnati, Cincinnati, OH, USA

## ABSTRACT

**Background.** Intra-operative rupture (IOR) of intracranial aneurysms is a critical event affecting the operation course and the patient's outcome. However, A rupture induced by an avulsion in the aneurysmal neck is exceedingly challenging, as sealing the neck tear by clip application might result in ischemic injury due to parent vessel occlusion. Here we reviewed the literature regarding the intraoperative avulsion of the aneurysmal neck with an illustrative case to provide explanations of its surgical management intricacies.

**Methods.** A Midline PubMed literature review was performed using the following keywords; (Aneurysm) AND (neck) AND (surgery or clipping) AND (tear OR avulsion). Fifty-three results were found initially. After excluding non-human subject studies, and non-English studies, two independent researchers examined the title and the abstract for the cases of neck tear or avulsion with its management.

**Results.** Fourteen articles were found to be included in this study. The average age of the cases is around 57 years. The percentages of females in the review were 62% (8/13), and among the males, 38% (5/13). Regarding the locations, PcomA and AcomA were both 23% (3/13) of the cases; other locations include ACA, 15%, and MCA, 15%. The surgical techniques that opted from the literature include the cotton clip method, clip wrapping, parallel clipping and micro-suturing

**Conclusion.** IOR due to aneurysmal neck avulsion is a devastating surgical complication, and its management may differ according to the extent of the rupture. Choosing the most convenient technique depends on the surgeon's knowledge and experience.

## INTRODUCTION

Intra-operative rupture (IOR) of intracranial aneurysms is a catastrophic event that can adversely affect the course of the operation and the patient's outcome (3). Although there is a continuous decrease in the IOR due to microscope introduction in the neurosurgical field, the

## Keywords

aneurysmal neck tear,  
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Corresponding author:  
**Samer Hoz**

Department of Neurosurgery,  
University of Cincinnati, Cincinnati,  
OH, USA

hozsamer2055@gmail.com

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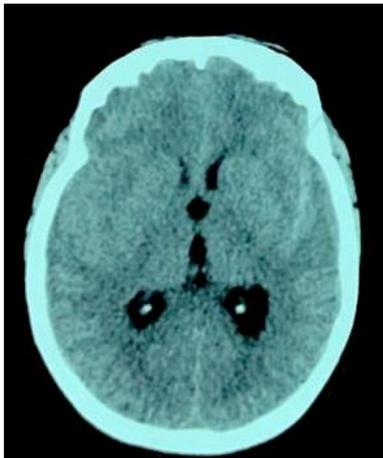


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incidence of aneurysmal IOR has reached approximately 20%, ranging from 5.5 to 40 % (7, 9, 16). It is commonly encountered in anterior communicating artery (AcomA) aneurysms which are estimated by 40 % of all IOR (20), and the risk is significantly increased in ruptured versus unruptured AcomA aneurysms (8). The dome of an aneurysm is the most common site for IOR, reaching up to 29% of the cases (20). In Surgery, a clip application to the neck of the aneurysm may cease the IOR of an aneurysmal dome origin (1). However, A rupture induced by a tear in the aneurysmal neck is far more challenging (10), as sealing the neck tear by clip application might result in ischemic injury due to parent vessel occlusion. IOR due to aneurysmal neck tear has been well stated in the literature, yet, there is scarcity regarding its operative management (1,4,10,11). Here we reviewed the literature regarding the intraoperative avulsion of the aneurysmal neck with an illustrative case, to provide explanations of its surgical management intricacies.

#### CASE SCENARIO

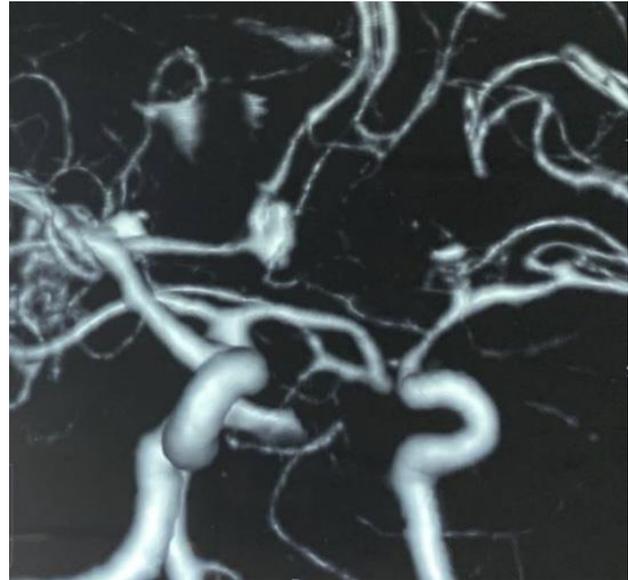
A 44-year-old female presented with behavioral changes, aphasia, headache, and right-sided weakness of grade 3 on the Medical Research Council of Canada (MRC) scale. Preoperative computed tomography (CT) scan (Figure.1) findings included left Sylvian subarachnoid hemorrhage (SAH) along with interhemispheric hemorrhage. Pre-operative CT Angiography (CTA) (Figure. 2) showed a right saccular superiorly-directing anterior communicating artery (AcomA) aneurysm.



**Figure 1.** Pre-operative CT scan, axial section revealing the left Sylvian SAH along with interhemispheric haemorrhage.

Intraoperatively, the right lateral supraorbital approach was performed following the typical steps of surgery. After meticulous dissection, IOR was

encountered during the initial clip application. It is caused by a tear (avulsion) in the aneurysmal neck; two suction devices were applied in the surgical field alongside attempts for micro-suturing of the rupture site were carried out but weren't successful as the neck tear was extending to the AcomA.



**Figure 2.** Pre-operative CTA showing a superiorly directed saccular aneurysm from the AcomA.



**Figure 3.** Post-operative CT scan, axial section, showing the location of AcomA clips as a metallic artifact.

Temporary clips were placed to regain haemostasis. Intra-operative neurophysiological monitoring (IONM), including somatosensory evoked potential (SEP) and motor evoked potential (MEP), revealed intact motor function in the right lower limbs and no findings of paresis that can be induced by the expected ischemia caused by the temporary clips. A final decision for permanently clipping the AcomA

aneurysm was made. A postoperative CT scan (Figure. 3) showed no complication of SAH or interventricular haemorrhage (IVH). Postoperatively, the patient's Glasgow Coma Scale (GCS) was 13 with the same preoperative weakness. The GCS improved over the next two weeks with the resolution of the right-sided weakness.

## DISCUSSION

IOR is considered one of the most challenging complications of the surgical management of cerebral aneurysms, with a major influence on patient morbidity and mortality (2,3). Similar to other surgical complications, numerous measures are taken to prevent the occurrence of IOR; this includes sufficient exposure to the aneurysm, sharp dissection, and the use of temporary clips (1, 6). Despite the advances in neurosurgical approaches, techniques, and instruments, aneurysmal IOR is still a well-known surgical complication that can impact the surgical procedure and the patient's prognosis (12).

The classification of IOR depends on the specific times within the surgery, which include: pre-dissection, initial microdissection, definitive microdissection, clipping, and post-clipping. (12) Pre-dissection IOR happens between induction of anesthesia and opening of the dura mater. IOR during initial microdissection is an aneurysmal rupture that happens while the parent vessels or branches are being defined. IOR during definitive microdissection is a rupture happening during exploration of the base or wall of the aneurysm or while the attempt to detach a branch vessel away from the aneurysm. IOR during clipping was an aneurysm rupture when the clip was applied to the neck, or it may occur when the clip is manipulated. Any change of the clip after its initial application is considered a "clip manipulation" (12). If bleeding occurs after the reopening, moving, or reapplying to the initial clip, the IOR is defined as occurring during a clip manipulation. Post-clipping IOR is defined as any IOR that occurs after placement of a permanent aneurysm clip (such as IOR caused by intentional puncture of an aneurysm that was incompletely clipped or placement of an additional permanent clip on the aneurysm) (12). In our case, IOR happened while the clip was being applied and caused a tear in the neck of the aneurysm, even though the tear extended to the parent artery.

There are generally two main obstacles surgeons encounter in the presence of IOR; the first is the continuous hemorrhage, which results in a limited field of vision, and the second is difficulty in localizing the aneurysm for clipping, which might endanger the parent vessel (20). Several variables might contribute to aneurysmal ruptures intraoperatively; this includes; The aneurysmal site, size, and configuration. Fundal adherence to the surrounding structures is also an essential factor associated with IOR (2).

In previous studies for analyzing the IOR rates according to the aneurysmal location, rupture rates in AcomA aneurysms reached approximately (48%) which was the highest rate among different aneurysmal sites. The surgical outcome of IOR is significantly affected by the bleeding position; Although the neck is the least common site constituting approximately 16% of all aneurysmal ruptures (20), IOR of the neck is one of the most severe and challenging complications encountered (1).

Multiple methods have been suggested and applied in managing different types of IOR. If the technique is accurately executed, the surgical outcome will mostly improve (20). Large-bore suction over the site of aneurysmal rupture (one in the surgeon's non-dominant hand and the other controlled by an assistant) helps reduce the bleeding and clear the visual field. Temporary clipping of the parent vessel is another form of proximal control to prevent blood loss but can be associated with ischemic complications (1,4). Clipping of the distal sac of the aneurysm can be applied in cases of IOR without neck involvement (3); the cotton-clip method is a widely suggested technique that can be useful for neck avulsion induced IOR, it is performed by a cotton placement over the bleeding site to prevent further blood extravasation, and after clearing the field, the neck of the aneurysm can be clipped. When performing this technique, it is considered that the clip and cotton must not compromise and affect the parent vessel (1, 10, 15). Numerous other practices and methods are reporting good results in neck tear IOR, such as micro-suturing of the ruptured neck, which has variable results, wrapping options, encircling clips placement, bypass, and endovascular trapping techniques (1, 17).

Although there are many methods for managing IOR, they cannot be considered standard

management of all types of aneurysmal neck tears. The cotton-clip method reported good outcomes in many cases of neck tear IOR when the tear is deemed to be minor and can be controlled by adding pressure and cotton placement (1,10, 15). However, this method is not always applicable for a neck tear that extends to the parent vessel, as there cannot be enough pressure applied over the avulsed segment and the bleeding is more profuse than in slight neck tears (20). Unconditional neck tears, larger avulsions arising at the aneurysmal neck with an extension to the parent vessel, are far more complex to manage. This is highly dependent on the neck tear degree, as well as the size, location, and shape of the aneurysm. Such as the longitudinal finger-like appearance of aneurysms can make them more liable for neck avulsions. The cotton-clip method can be applied successfully for partial neck tear ruptures (10).

In our case, initial clip placement over the aneurysmal neck induced IOR. Further dissection revealed a tear in the neck of the aneurysm extending to the AcomA. The modification of surgical steps while repairing the IOR due to an aneurysmal neck tear with extension to the parent vessel can be summarized in two points, 1) micro-suturing of the aneurysmal neck to seal the tear, which eventually didn't work in our case, 2) temporary clip placement over the AcomA to reestablish hemostasis with IONM which did not reveal any changes indicating hypoperfusion. As a result, a 3) final decision for permanently clipping the AcomA was made. The choice not to use the cottonoid clip is that the tear was extending to the parent artery, and there was no space to put the cottonoid patty around the parent artery. The forced decision to clipping the AcomA was the only choice left to cease the hemorrhage encountered intraoperatively.

A Midline PubMed literature review was conducted using the combinations of the following keywords; (Aneurysm) AND (neck) AND (surgery or clipping) AND (tear OR avulsion). Fifty-three results were found initially. After excluding non-human subject studies, and non-English studies, two independent researchers examined the title and the abstract for the cases of neck tear or avulsion with its management. Fourteen articles were found to be included in this study. The average age of the cases is around 57 years. The percentages of females in the review were 62% (8/13) and among the males 38% (5/13). Regarding the locations, PcomA and AcomA

were both 23% (3/13) of the cases, other locations include ACA 15%, and MCA 15%.

The primary aim of our review is to deliver a comparative synopsis of the reported management techniques and outcomes for aneurysmal neck avulsions. The first case was reported in 1997 by Yasui et al. (19), who described two cases of intraoperative complications due to neck tears, both managed by the parallel clipping method. Since then, several similar cases have been identified in the literature. In 2002, Yanaka et al. (18) reported a thin-walled aneurysm on the C1 segment of the right ICA, which ruptured at the neck tear during dissection and was further fully separated from the parent vessel. This was managed by temporarily clipping the ICA proximally and distally to the avulsion, micro suturing the tear in the arterial wall, and then using an encircling clip on the rupture site. Despite postoperative hemiparesis, the outcome and recovery of the patient were good upon follow-up. In 2003, Lanzio et al. (10) reported using the clip wrapping method, which consisted of neck clipping preceded by wrapping a cotton swath around the avulsed aneurysmal neck in an AcomA aneurysm. The outcome was good during 1-year postoperative follow-up. The cotton-clip method was reported in 2011 by Barrow et al. (1) in three different cases of intracranial aneurysms in which clip placement induced a slight tear in the aneurysmal neck managed by the cotton clip method, which was preceded by temporary clipping in the second case (Table 1).

Although it is difficult to draw conclusions from this small number of cases, a few observations can be made. First, the scarcity of cases reported can be partially attributed to the inconsistency and different management methods of intraoperative neck tears, which are not always suitable due to multiple variables. The second observation is the lack of the post-operative outcome for a few of the management methods reported.

The main focus of neurosurgeons during microsurgical procedures should be the prevention of intraoperative complications. Various measurements for the management of IOR are reported; they differ according to the rupture site and the extent of the tear. Provisional knowledge of the suggested strategies with awareness of the convenience of each type of IOR can drastically improve the surgical procedure and outcome.

**Table 1.** The reviewed cases of aneurysmal neck tear

N	Authors	Age (years), Gender	Aneurysm location	Surgical Technique	Outcome
1	Yasui <i>et al.</i> 1997 (9)	50, Female	ACA (A1)	Parallel clipping	-
	Yasui <i>et al.</i> 1997 (9)	57, Female	IC-PC	Parallel clipping	-
2	Yanaka <i>et al.</i> 2002 (16)	46, Female	ICA	Suturing and encircling clip	Good
3	Lanzio <i>et al.</i> 2003 (10)	60, Female	AcomA	Clip wrapping	Good
4	Vashu R <i>et al.</i> (17)	14, Female	PcomA	Micro-suturing	Good
5	Park J <i>et al.</i> 2009 (14)	73, Female	ACA pericallosal	Occlusion of pericallosal artery along with A4-A5 in situ bypass with micro-suturing.	Good
6	Barrow <i>et al.</i> 2011 (71)	51, Male	AcomA	Cotton-clip method	-
7	Barrow <i>et al.</i> 2011 (1)	62, Female	MCA	Cotton-clip method	-
8	Barrow <i>et al.</i> 2011 (1)	52, Female	PcomA	Cotton-clip method	-
9	Feng YG <i>et al.</i> 2013 (5)	40, Male	PcomA	Dural Wrapping with clipping	Good
10	Feng YG <i>et al.</i> 2013 (5)	43, Female	Anteromedial wall of ICA	Dural Wrapping with clipping	Good
11	Feng YG <i>et al.</i> 2013 (5)	41, Male	Anteromedial wall of ICA	Dural Wrapping with clipping	Good
12	Safavi-Abbasi S <i>et al.</i> 2015 (15)	-	-	Cotton-clip method	-
13	Jiangang Liu <i>et al.</i> 2019 (13)	52, Male	Ophthalmic artery	Cotton-clip method	Good
14	Jiangang Liu <i>et al.</i> 2019 (13)	45, Male	MCA	Cotton-clip method	Good
15	Al Ageely <i>et al.</i> 2022	44, Female	AcomA	Parent artery clipping	Good

\*All the patients are presented with SAH

## CONCLUSION

IOR due to aneurysmal neck tears is a devastating surgical complication requiring prevention and management approaches, which can be unique to each case. Its management may differ according to the extent of the rupture. Several methods have been suggested to treat such cases and the choice of the most convenient technique depends on the surgeon's knowledge and experience for the best outcome possible.

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