

## Fundus Direction and Vascular Anomalies Associated With Anterior Communicating Artery Aneurysms

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**Abstract :** In 52 cases with 54 aneurysms of the anterior communicating artery (ACoA), the configurations of the ACoA complex and the aneurysm as observed during surgery were defined and the ability of pre-operative angiography to show the direction of fundus projection and the presence of anomalies was investigated. The aneurysms were either designated as being complex (9 %) or assigned to one of the primary positions: anterior (9 %), posterior (39 %), inferior (13 %), or superior (25 %). Marked

hypoplasia of the A1 segment (13 cases), fenestrated ACoA (7 cases), azygous A2 (1 case) and median callosal artery (1 case) were the anomalies that were observed. At angiography the anomalies could not be detected, but the direction of fundus projection could be determined correctly in 78 % of the cases.

**Key Words :** Anterior Cerebral Artery, Anterior Communicating Artery, Anomaly, Cerebral Angiography, Microsurgical Anatomy Saccular Aneurysm

### INTRODUCTION

Microsurgical techniques allow complete dissection of aneurysms and associated vessels, making obliteration and preservation of parent and perforating arteries possible with very low operative morbidity and mortality rates. Aneurysms of the anterior communicating artery (ACoA) present a special challenge to the surgeon because of the frequently associated variants of the normal anatomy of the ACoA complex and the multiple directions to which these aneurysms may project (1-9). Successful surgery of aneurysms of the ACoA requires a thorough knowledge of the often encountered variations of the ACoA complex and possible configurations and projection directions of the aneurysms. Difficulties in fully visualizing aneurysms of the ACoA complex and adjacent arteries on angiography usually preclude preoperative knowledge about the presence of anomalies and fundus direction. The purpose of this study was to define the configuration of the ACoA complex and the aneurysm as observed during surgery and to investigate the ability of pre-operative angiography to delineate the direction of fundus projection and presence of anomalies.

### MATERIAL AND METHODS

Fifty-two consecutive patients with ACoA aneurysms who underwent surgery between January 1990 and June 1991 comprise the clinical material. All patients underwent preoperative angiography, pterional craniotomy and clipping of the aneurysm neck. Proximal anterior cerebral arteries (A1), ACoA, distal anterior cerebral arteries (A2), recurrent arteries of Heubner, hypothalamic, frontopolar and frontoorbital arteries and any associated anomalies were identified before clip obliteration of the neck. Operative sketches of the ACoA complex and the aneurysm were drawn immediately after the procedure by the surgeon. The aneurysms were either designated as being complex or assigned to one of the primary positions: anterior (projecting forward over the optic nerves), posterior (projecting between the two A2 segments), inferior (projecting into the lamina terminalis), superior (projecting into the interhemispheric fissure) (Fig. 1). When the aneurysm seemed to lie in an intermediate position, the more prominent direction was taken into account.

Angiograms were performed in the standard antero-posterior (AP) and lateral views as well as

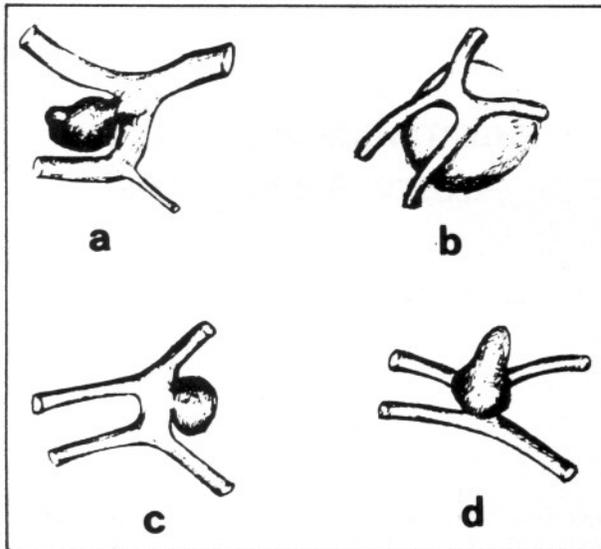


Fig. 1: Anterior communicating artery aneurysm projections:  
 A. Posterior (39 %), B. Inferior (13 %), C. Anterior (17%),  
 D. Superior (22 %).

oblique, axial and off lateral views as needed. Only AP and lateral views were examined for the purposes of this study. At the time of this examination the neuroradiologist was not aware of the surgical findings. The relative position of the aneurysm to the ACoA in the AP views (above or below) and to the origin of the A2 segments in the lateral projection (above or below) was recorded (Fig. 2).

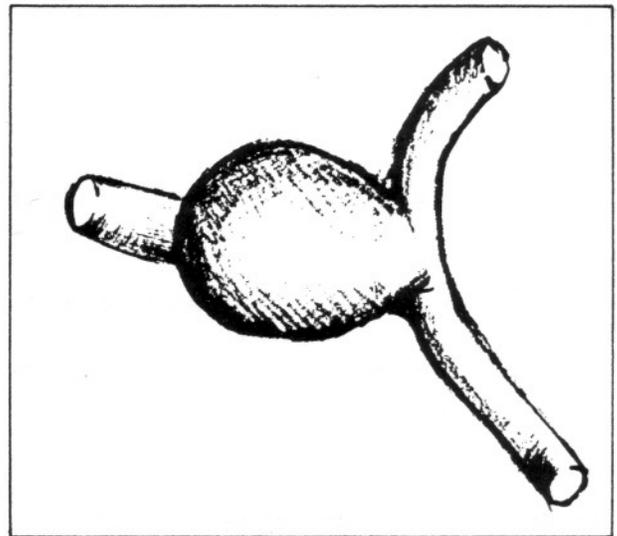


Fig. : 2A

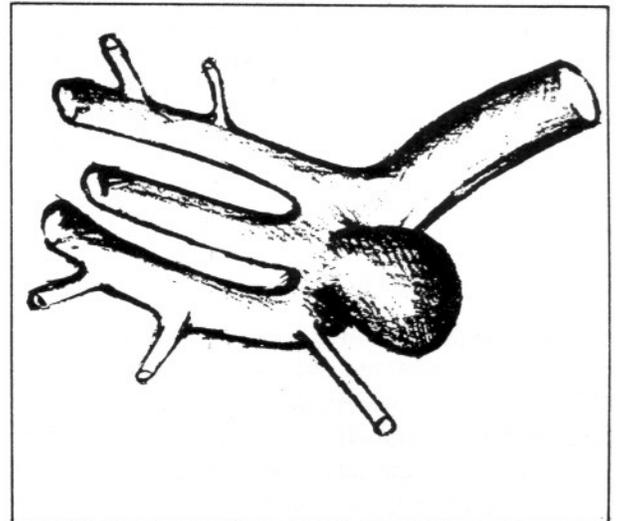


Fig. : 2B

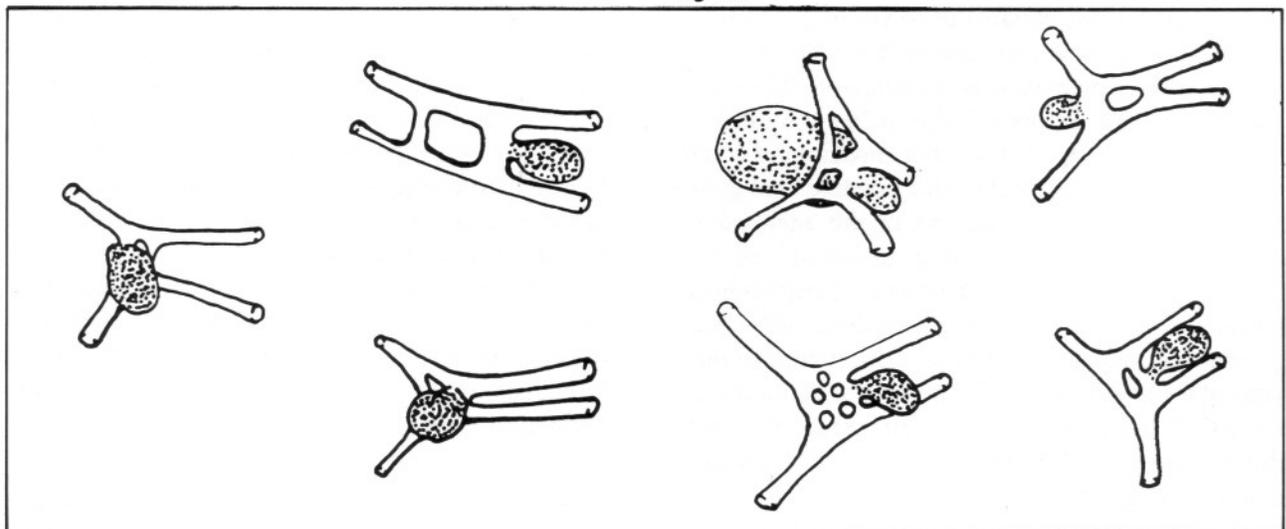


Fig. 2C: Anomalies of the anterior communicating artery complex associated with aneurysms: A. Azygos A2 (1 case), B. Median callosal artery (1 case), C. Fenestration (7 cases).

Surgical and angiographic findings were compared and statistical analyses of the results were made with Fisher's exact test.

**RESULTS**

Fifty-four ACoA aneurysms were encountered and clipped in 52 patients. Two patients died post-operatively. Two patients (4 %) had double aneurysms of the ACoA. Five aneurysms (9 %) were larger than 2.5 cm. Twenty-one (39 %) aneurysms were directed posteriorly, 12 (22 %) superiorly, 9 (17%) anteriorly and 7 (13 %) inferiorly. Five (9 %) had complex projections. (Table 1, Fig. 1)

**Table 1 : Anterior communicating artery aneurysm projections.**

Direction	No.	%
Posterior	21	(39)
Superior	12	(22)
Anterior	9	(17)
Inferior	7	(13)
Complex	5	(9)
<b>Total</b>	<b>54</b>	

Various anomalies were observed in 22 patients (42 %). Marked or severe hypoplasia of one of the A1 segments was found in 13 (25 %), seven patients had fenestrated ACoA (13 %). One patient each had azygos A2 and median callosal artery. (Table 2, Fig. 3)

**Table 2 : Anomalies of the anterior communicating artery complex associated with aneurysms.**

Anomalies	No	%
Hypoplasia of A1	13	25
Fenestration of ACoA	7	13
Azygos A2	1	2
Median callosal artery	1	2
<b>Total</b>	<b>22</b>	<b>42</b>



Fig. 3a(1)

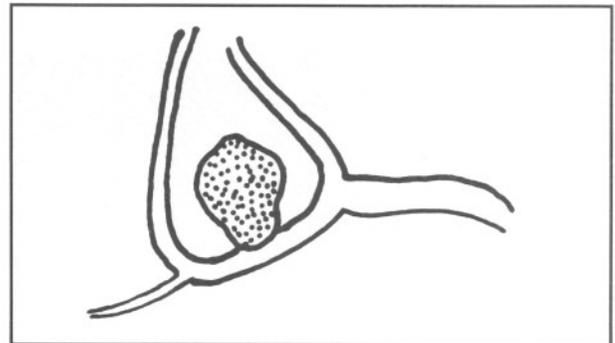


Fig. 3a(2)

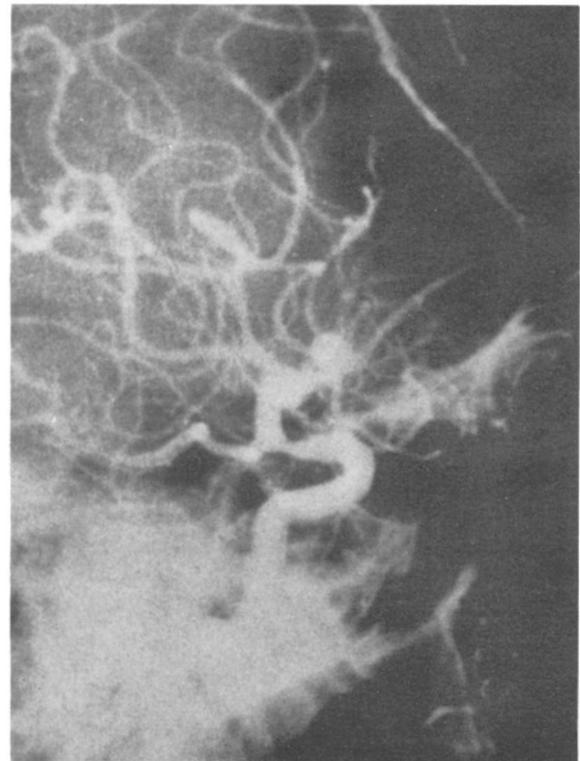


Fig. 3b(1)



Fig. 3b(2)

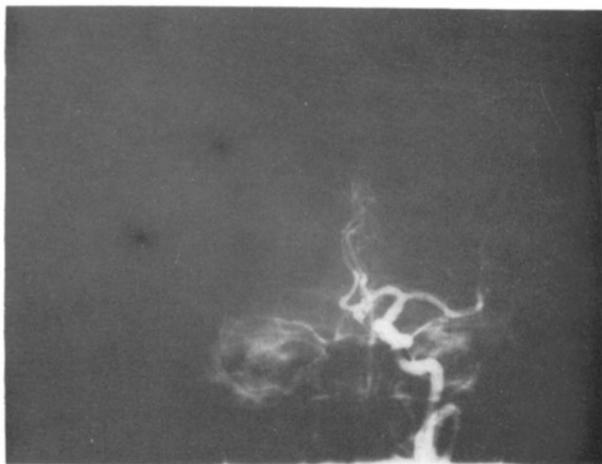


Fig. 3c(1)

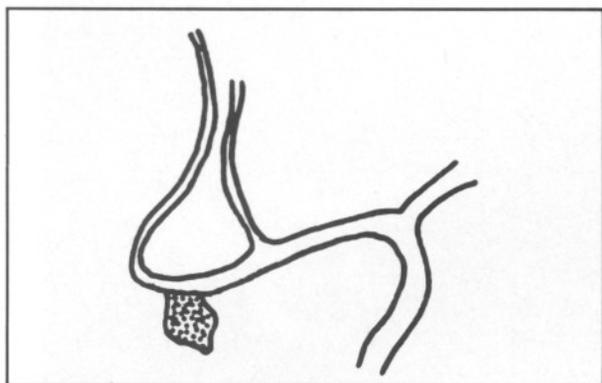


Fig. 3c(2)

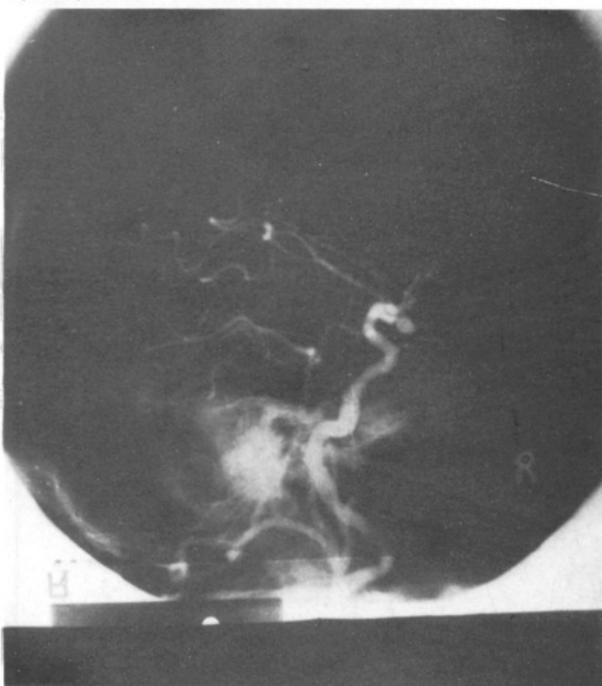


Fig. 3d(1)

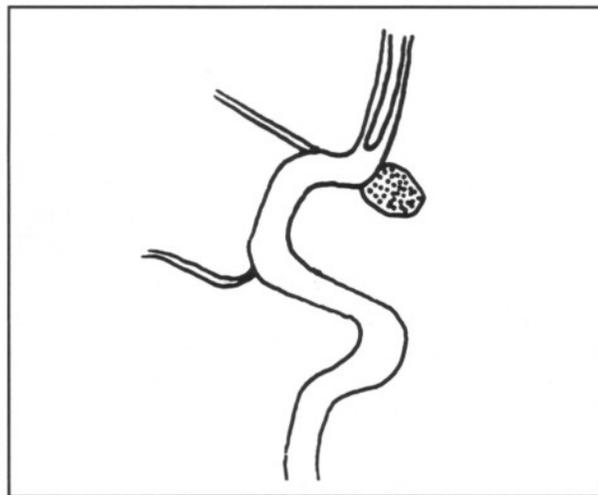


Fig. 3d(2)

Fig. 3 : Angiograms and artist's depiction showing the relative position of the anterior communicating artery aneurysm to the ACoA: A. AP view showing an aneurysm above the ACoA, B. Lateral view showing an aneurysm above the ACoA, C. AP view showing an aneurysm below the ACoA, and D. Lateral view showing an aneurysm below the ACoA. A and B indicate posteriorly or inferiorly directed aneurysms, and C and D indicate anteriorly or superiorly directed aneurysms.

An aneurysm of the ACoA was visualized in all 52 cases. The relative position of the aneurysm both to the ACoA in the AP views and to the A2 segments in the lateral views could be determined in 23 angiograms. The relative position of 22 aneurysms could be determined only in the AP views. There were no cases in which this relationship could be demonstrated in the lateral view but not in the AP view. In nine cases the relative position of the aneurysm could not be determined in either of the views (Table 3).

The angiographic finding of an aneurysm above the ACoA as determined in both views (10 cases), or only in the AP view (12 cases), correlated with a posteriorly or inferiorly directed aneurysm in every one of the 22 cases. Conversely, the finding of an aneurysm below the ACoA, as determined in both views (11 cases), or only in the AP view (10 cases), correlated with an anteriorly or superiorly directed aneurysm in 20 of the 21 cases ( $p < 0.00001$ ).

Of the nine aneurysms whose relative positions could not be ascertained angiographically in either one of the views, three were inferiorly, two posteriorly, one anteriorly directed and three were complex aneurysms. Four of these were giant aneurysms and

**Table 3 : Fundus projection of anterior communicating artery aneurysms as observed at surgery and as determined preoperatively at angiography.**

Projection of the aneurysms in relation to ACoA and the origin of the A2 segments as determined angiographically.	Projection of the aneurysm as observed at surgery				
	Pos Inf	Ant Sup	Co	Total	
Above ACoA in AP views and above A2 origin in lateral views	10	0	0	0	10
Above ACoA in AP views and position undetermined in lateral views	8	4	0	0	12
Below ACoA in AP views and below A2 origin in lateral views	1	0	4	6	11
Below ACoA in AP views and position undetermined in lateral views	0	0	4	6	10
Below ACoA in AP views and above A2 origin in lateral views	0	0	0	0	2
Position undetermined in both views	2	3	1	0	3
<b>Total</b>	<b>21</b>	<b>7</b>	<b>9</b>	<b>12</b>	<b>5</b>

two were the smaller aneurysms in the cases with double aneurysms, the presence of neither of which was suspected at angiography.

In two patients with complex aneurysms, the ACoA had assumed a vertical position in relation to the optic chiasm. In these patients the aneurysm was observed to be below the ACoA in AP views and above A2 origin in lateral views.

At angiography, the azygos A2 and one of the fenestrated ACoAs were the only anomalies that could be identified, and A1 segment spasm could not be differentiated from A1 hypoplasia.

### DISCUSSION

The "normal" ACoA complex is defined as a pair of A1 s of equal diameter (1-3 mm), an ACoA that is up to 3 mm long and 1 to 3 mm in diameter that unites the two A1 segments and provides for ade-

quate collateral flow, and a pair of A2 segments of equal diameter (6,9). This "normal" ACoA complex was found in only 20% of Yaşargil's cases (9). Reported anomalies of the ACoA complex include aplasia, hypoplasia and duplication of the A1 segments, hypoplasia, fenestration and trabeculation of the ACoA, and azygos, and median callosal arteries (2-7,9). The reported frequencies of anomalies of ACoA in surgical and postmortem series range between 8.8 and 80 % (2-9). It has been proposed that hemodynamic alterations caused by anomalies of the circle of Willis lead to aneurysm formation (6,8,9).

Unilateral hypoplasia of an A1 segment is the most frequently reported anomaly of the ACoA complex. The diameter below which an A1 is reported as hypoplastic is not given in most studies dealing with the subject. An inequality of the two A1 segments in association with ACoA aneurysm was found in 85 % of Wilson's (8), 76.5 % of Kwak and Suzuki's (4) and 80 % of Yaşargil's (9) series. The much lower rate of 25 % reported here stems from the fact that not inequality, but only marked difference in size was taken as indicative of hypoplasia in this study. The much lower incidence of A1 hypoplasia observed in postmortem series without aneurysms suggests a causal relationship between aneurysm formation and A1 hypoplasia. True aplasia of one of the A1 segments, reported to be extremely rare, was not observed in this series. Duplication of the A1 segment is also an extremely infrequent finding.

Fenestration (duplication or triplication) and trabeculation of the ACoA was observed in 13 % of our cases. These included one trabeculation and one triplication. Previously reported incidence of these anomalies ranges between 5.6 and 26 % in surgical series and 40 % in postmortem series (6,9). The higher incidence found in postmortem series suggests that there is no association between aneurysm formation and presence of fenestration. Hypoplasia of the ACoA is reported to be very infrequent and aplasia of the ACoA has not been reported.

Fusion of the two A2 segments to form a single artery has been called "the arteria termetica", "the unpaired A2", or "the arteria pericallosa azygos". Incidence in the literature varies from 0 to 5 % (3-6,9). Angiographic demonstration of this artery was possible in the single instance it occurred in this series. "The third A2", "the accessory distal cerebral artery", or "the median callosal artery" is met somewhat

more frequently (3–6,9). When present, this artery poses a particular threat to successful surgery as it can be left undissected and remain between the clips if not suspected (2). The possibility of its presence should be ruled out before clip application. Its presence may be suspected from angiograms, but can not usually be definitively demonstrated.

The direction of fundus projection of ACoA aneurysms in an important consideration in planning their microsurgical obliteration. While Vander Ark and Kempe (7) described 8 directions of fundus projection, Yaşargil (9) considered 4 primary directions, recognizing that many aneurysms lie in intermediate positions. When dealing with anteriorly projecting aneurysms, retraction of the frontal lobe must be avoided as adherence of the fundus to the optic nerves or the dura over the tuberculum sellae may lead to premature rupture during dissection. Posteriorly projecting aneurysms require excision of the gyrus rectus. Inferiorly projecting aneurysms are usually the most time-consuming to dissect and clip. Anticipation of the direction of fundus direction would help the surgeon considerably. In this study it was possible to determine it correctly at angiography in 78 % of the cases.

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