Management of Proximal Anterior Cerebral Artery Aneurysms: Anatomical Variations and Technical Nuances

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■ OBJECTIVE: **The proximal segment of the anterior cerebral artery (A1) is among the most uncommon locations for occurrence of an intracranial aneurysm. These aneurysms may be missed if small or misinterpreted when they are near the internal cerebral artery bifurcation or Anterior Communicating Artery region. The association with congenital vascular anomalies and multiplicity makes them unique.**

■ METHODS: **Seventeen A1 aneurysms were diagnosed in sixteen patients between January 2000 and October 2014 in our institution. A retrospective review of the clinical, radiological, and management (microsurgical and endovascular) details of these patients was conducted.**

■ RESULTS: **The incidence of A1 aneurysm was 1.71% of all patients harboring aneurysms and 1.19% of all aneurysms. Half of these patients exhibited subarachnoid hemorrhage. Fourteen aneurysms underwent microsurgical or endovascular intervention. All patients recovered well, except for one patient who died in the postoperative period.**

■ CONCLUSIONS: **A1 aneurysms are rare, with wide anatomic variations. In this article, we discuss those variations in detail with illustrative cases and pictures. We also discussed the microsurgical and endovascular strategies to encounter them highlighting the technical challenges.**

INTRODUCTION

The part of the anterior cerebral artery (ACA) between its origin at bifurcation of the internal carotid artery (ICA) and the anterior communicating artery (ACOM) is designated as proximal segment or A1. It is considered as one of the rare locations for intracranial aneurysms, comprising approximately 1% of all aneurysms (10). Aneurysms in this location are characterized by small size at rupture, associated vascular anomaly, and multiplicity (3, 10, 18, 23). They are often bleb or fusiform in shape and intimately related to the perforating arteries around them. Microsurgical occlusion is challenging because of anatomic variability and the presence of perforators. In contrast, endovascular surgeons may also encounter difficulties at various steps of occlusion starting from successful negotiation of catheters.

In this study, we report our finding of wide anatomic variations and our microsurgical and endovascular experience with managing the aneurysms in this location. In addition, we discuss the strategies for successful management.

METHODOLOGY

Between January 2000 and October 2014, 938 patients with 1424 aneurysms were treated in our institution. A diagnosis of A1 aneurysm was made on the basis of angiographic or surgical finding in 16 patients. One of the patients had mirror aneurysms of A1, resulting in 17 aneurysms in those 16 patients. These 16 patients represented 1.71% of all patients with aneurysms and

Key words
- Aneurysm
- Clipping
- Coiling
- Proximal anterior cerebral artery
- Subarachnoid hemorrhage

Abbreviations and Acronyms

A1: Anterior cerebral artery proximal part (proximal to communicating part)
A1A: Aneurysm at proximal anterior cerebral artery
A2: Anterior cerebral artery between ACOM and genu of corpus callosum
ACA: Anterior cerebral artery
ACOM: Anterior communicating artery
ICA: Internal carotid artery
ICG: Indocyanine green angiography
ICH: Intracerebral hemorrhage
IVH: Intraventricular hemorrhage
MCA: Middle cerebral artery
OC: Optic chiasma
ON: Optic nerve
PCOM: Posterior communicating artery
PED: pipeline-embolization device
RAH: Recurrent artery of Heubner
SAH: Subarachnoid hemorrhage
SCA: Superior cerebellar artery

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1.19% of all aneurysms in the present study period. The clinical features, imaging, management of these 16 patients were reviewed retrospectively (Tables 1–4), after obtaining local institutional review board approval and in compliance with Health Insurance Portability and Accountability Act (HIPAA) regulations.

We further classified the aneurysms according to Bhaisora et al. (1). The aneurysms arising from the proximal, middle, and distal thirds of A1 have been designated as I, II, and III, respectively. Next, these aneurysms are subdivided based on the relationship of the origin of the aneurysms on the circumference of A1 and their direction (A, B, and C for anterior and anteroinferior; posterior, superior, and posterosuperior; and inferior and posteroinferior, respectively; Figure 1). Finally, we discussed the anatomic peculiarities and management strategies of these aneurysms based on this classification, and compared our results with available literature (Table 5).

RESULTS

In our study population, 10 patients were female (62.5%). Mean age at presentation was 52.50 years (range, 29–73 years). Ten of the aneurysms were located on the left side (58.82%). Information about risk factors was documented in thirteen cases. Ten (76.92%) of those were hypertensive, and 7 patients (53.85%) were long-term smokers. One patient had sickle cell anemia, and her mother harbored an aneurysm.

The mean size was 4.38 mm in the ruptured group and 6.23 mm in the unruptured group, which was due to the presence of large unruptured fusiform aneurysm in present series. Eight patients (50%) exhibited subarachnoid hemorrhage (SAH), and an A1 aneurysm was confirmed as causative after diagnostic angiogram in all but one patient. Half of these patients had at least one associated aneurysm. Five patients (31.25%) were diagnosed to have associated anatomic variations. One patient with SAH was found to have mirror aneurysms of A1 (13). She underwent embolization of both aneurysms in different sittings. Mirror aneurysms of A1 have been reported only once previously (22). Two patients had aneurysms at the proximal end of fenestrated A1, with one of them having associated contralateral A1 hypoplasia. The contralateral ICA was absent in one other case.

When we classified the aneurysms according to the location, 8 aneurysms (47.05%) were from the proximal third of A1, whereas 4 were located in middle third of A1 and 5 were located in distal third of A1 (Table 3). Eleven (64.7%) aneurysms were directed posterosuperiorly. Among the rest, 4 and 2 aneurysms were directed anteroinferiorly and posteroinferiorly, respectively (Table 3). In 8 patients, perforators were found at the neck of the aneurysms during preoperative angiogram. Two of those patients subsequently underwent surgical intervention, and the angiographic finding was confirmed at surgery. In one patient (Patient 3), the aneurysm was seen originating at the junction of perforator from parent artery at surgery; this was not revealed in preoperative angiogram. In 7 of those 8 cases (in which an aneurysm was originating from the junction of the parent artery and perforator on angiography), aneurysms were located at the proximal third of A1. However, a more pertinent classification from management point of view will probably be according to the morphology of the aneurysm. In the present series, 5 and 2 aneurysms were fusiform and bleb in shape, respectively. The remaining 10 were saccular in shape (1 of them was calcified). None of the fusiform aneurysms originated from proximal third of A1. Four of them originated from the middle third, and the last one was from the distal third. The bleb aneurysms were from the proximal third in both the cases. However, none of the saccular aneurysms originated from middle third of A1. Six of the aneurysms were from proximal third, and the other 4 were from the distal third. The saccular and bleb aneurysms were never found to be originating from middle third of A1 in the present series.

Fourteen aneurysms were secured by either surgical or endovascular intervention. Among the other 3 aneurysms, 2 patients were never treated for A1 aneurysm. Multiple aneurysms were diagnosed, and the causative aneurysm was treated in the first intervention. Patients refused any further intervention after that. The third patient with unruptured fusiform aneurysm did not agree to any intervention.

Craniotomy and clipping were performed in six cases. There were 2 each of fusiform and bleb aneurysms and 1 each of secular and calcified aneurysm in the surgical cohort. In contrast, 8 aneurysms in 7 patients were treated via endovascular approach. One patient required a second procedure for the regrowth of aneurysm, located in a fenestrated A1. Balloon-assisted coiling was performed in 2 patients. Stent-assisted coiling was performed in 2 patients. A Neuroform (Boston Scientific, Natick, Massachusetts) stent was used in 1 patient, and an Enterprise (Cordis, Miami Lakes, Florida) was used for the other patient. The Pipeline embolization device was used in one fusiform aneurysm.

The outcome did not differ from the aneurysms located in other anterior circulation aneurysms. For surgical cases, anatomic occlusion was achieved in all but one fusiform aneurysm. One patient (Patient 3) with poor clinical status at presentation (Hunt and Hess grade 4) died on postoperative day 2 after successful clipping. There was no residual aneurysm, fresh SAH, or infarct seen in that patient. Another patient had a right putaminal small infarct without much clinical deficit (Patient 5). In another patient (Patient 1), the follow-up angiogram showed occlusion of A1 distal to the clip, but a good cross circulation saved the patient from developing any deficit. Clinically, all patients except the said patient (Patient 3) are back to their normal daily activities. The mean follow-up duration was 52.25 months (range, 12–120 months).

Among the patients who underwent endovascular approach, two patients (Patients 12 and 13) had residual neck, one requiring an emergency second procedure for rebleeding. All patients had a good recovery. Four patients required cerebrospinal fluid diversion for ventricular dilatation. Two patients required a permanent ventriculoperitoneal shunt.

Illustrative Case 1: Surgical Reconstruction of Fusiform Aneurysm (Patient 4 in Tables 1, 2, and 4 and Figure 2J–N)

A1 aneurysm was diagnosed incidentally in a 56-year-old woman who was evaluated for headache. Angiography revealed a wide neck left A1 aneurysm measuring 7.8 × 4.7 mm with a neck width of 6 mm. The aneurysm was adherent to the left optic nerve. Two clips were put across the neck. However, the indocyanine green angiography (ICG) showed occlusion of parent vessel beyond the aneurysm; therefore, the clips were readjusted, and the aneurysm was reconstructed. Subsequently, the dome of the aneurysm was