TECHNIQUES

Microneurosurgical Management of Anterior Choroid Artery Aneurysms

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OBJECTIVE: **Anterior choroid artery aneurysms (AChAAs) constitute 2%-5% of all intracranial aneurysms. They are usually small, thin walled with one or several arteries originating at their base, and often associated with multiple aneurysms. In this article, we review the practical microsurgical anatomy, the preoperative imaging, surgical planning, and the microneurosurgical steps in the dissection and the clipping of AChAAs.**

METHODS: **This review, and the whole series on intracranial aneurysms (IAs), are mainly based on the personal microneurosurgical experience of the senior author (J.H.) in two Finnish centers (Helsinki and Kuopio) that serve, without patient selection, the catchment area in Southern and Eastern Finland.**

RESULTS: **These two centers have treated more than 10,000 patients with IAs since 1951. In the Kuopio Cerebral Aneurysm Database of 3005 patients with 4253 IAs, 831 patients (28%) had altogether 980 internal carotid artery (ICA) aneurysms, of whom 95 patients had 99 (2%) AChAAs. Ruptured AChAAs, found in 39 patients (41%), with median size of 6 mm (range = 2-19 mm), were associated with intracerebral hematoma (ICH) in only 1 (3%) patient. Multiple aneurysms were seen in 58 (61%) patients.**

CONCLUSIONS: **The main difficulty in microneurosurgical management of AChAAs is to preserve flow in the anterior choroid artery originating at the base and often attached to the aneurysm dome. This necessitates perfect surgical strategy based on preoperative knowledge of 3 dimensional angioarchitecture and proper orientation during the microsurgical dissection.**

INTRODUCTION

We classify the internal carotid artery (ICA) aneurysms into seven groups based on their site of origin, wall morphology, and clinical or surgical behavior: (a) extracranial ICA aneurysms (ICAextraAs); (b) intracranial extradural ICA aneurysms (ICAintraAs) subdividing them into petrosal aneurysms (ICApetrAs) and intracavernous aneurysms (ICAcavAs); (c) paraophthalmic (clinoid-ophthalmic) ICA aneurysms (ICAophtAs); (d) ICA trunk aneurysms (ICAtrunkAs) subdividing them into nonbranching sites of the ICA trunk wall (ICAwallAs) and blister-like (malignant) ICA aneurysms (ICAmalignantAs); (e) ICA–posterior communicating artery aneurysms (PCoAAs); (f) ICA–anterior choroid artery aneurysms (AChAAs); and (g) ICA bifurcation aneurysms (ICAbifAs) (**Table 1**).

Key words
- Aneurysm
- Anterior choroid artery
- Clipping
- Internal carotid artery
- Microanatomy
- Microsurgical technique
- Subarachnoid hemorrhage

Abbreviations and Acronyms
3D: Three-dimensional
A1: Proximal segment of anterior cerebral artery
ACA: Anterior cerebral artery
AChA: Anterior choroid artery
AChAA: Anterior choroid artery aneurysm
ACP: Anterior clinoid process
CSF: Cerebrospinal fluid
CT: Computed tomography
CTA: CT angiography
DSA: Digital subtraction angiography
IA: Intracranial aneurysm
ICA: Internal carotid artery
ICAbifA: Internal carotid artery bifurcation aneurysm
ICG: Indocyanine green
ICH: Intracerebral hematoma
IVH: Intraventricular hemorrhage
LSO: Lateral supraorbital approach
M1: Proximal segment of middle cerebral artery
MCA: Middle cerebral artery
MRI: Magnetic resonance imaging
PCoA: Posterior communicating artery
PCoAA: Posterior communicating artery aneurysm
SAH: Subarachnoid hemorrhage

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Table 1. Categories of ICA Aneurysms

Category	Location
ICAextraA	Extracranial ICA aneurysm
ICAintraA	Intracranial extradural ICA aneurysm
ICApetrA	Petrous segment ICA aneurysm
ICAcavA	Intracavernous segment ICA aneurysm
ICAophtA	Paraophthalmic ICA aneurysm
ICAtrunkA	Medial, superior, and inferior wall of ICA trunk aneurysm
ICAwallA	Nonbranching sites of the ICA trunk wall aneurysm
ICAmalignantA	Blister-like (malignant) of the ICA trunk aneurysm
PCoAA	Origin of posterior communicating artery aneurysm
AChAA	Origin of anterior choroidal artery aneurysm
ICAbifA	ICA bifurcation aneurysm

ICA, internal carotid artery.

Anterior choroid artery aneurysms

The AChAAs arise from the posterolateral wall of the supraclinoid ICA at the origin of the anterior choroid artery (AChA) (10, 13, 66, 68). AChAAs are rare, representing 2%-5% of all intracranial aneurysms (IAs), and there are few reports on their microneurosurgical treatment (10, 13, 44, 61, 66, 68). Ruptured AChAAs usually present with blood in the lateral suprasellar and ambient cisterns. Intracerebral or subdural hematomas are rare despite of the close relationship between the aneurysm and the temporal lobe. Intraventricular hemorrhage is usually more pronounced in the temporal horn. AChAAs are located well above the tentorium with their dome sometimes attached to the uncus or medial temporal lobe. Cranial nerve deficits are infrequent (13, 66, 68).

The treatment of AChAAs is challenging. Infarction in the territory of the anterior choroid artery may complicate the results of both microneurosurgical and endovascular procedures (10, 13, 25, 28, 45, 61, 68). The point of origin of the AChA is frequently incorporated in the base of the aneurysm and may be distorted or hidden by the dome (see below) (13, 68). Furthermore, anatomical variations of AChA are frequent. Occlusion of the AChA may result in ischemic stroke particularly in the posterior limb of the internal capsule (13, 58, 68), but the clinical consequences of such stroke are rather unpredictable because of frequent anatomical variations of the AChA and its collateral circulation (43). Hemiparesis or hemiplegia, dysarthria, lethargy, hemisensory loss, homonymous hemianopsia, and cognitive dysfunctions are reported findings (13, 52). Distal AChAAs, the true AChAAs, are exceptionally uncommon, often fusiform, and may present with a higher risk of postoperative ischemic injury (1, 13, 22, 23, 41, 69, 70).

AChAAs can be treated both by microneurosurgical and endovascular means. For both treatment methods, the biggest challenge is to occlude the aneurysm completely while leaving the origin of AChA free (25, 28, 45).

Purpose of the review

Even nowadays, when increasing number of aneurysms are coiled, there are still many countries and centers around the world where endovascular treatment is not available or too expensive to be used routinely. This review, and the whole series on IAs (4-6, 8, 19, 31-34), is intended for the neurosurgeons who are subspecializing in neurovascular surgery. The purpose is to review the practical anatomy, the preoperative planning, and the avoidance of complications in the microsurgical dissection and clipping of AChAAs.

Authors

The microneurosurgical technique in this review is mainly based on the personal experience of the senior author (J.H.) in two Finnish centers (Helsinki and Kuopio) that serve, without selection, the catchment area in Southern and Eastern Finland. These two centers have treated more than 10,000 patients with IAs since 1951 and more than 9000 patients during the microsurgical era since the mid-1970s. The data presented in our series of articles represents 3005 consecutive patients harboring 4253 IAs from the Kuopio Cerebral Aneurysm Database (1977-2005). The aim is to present a consecutive, nonselected population-based series of IAs. This database is not reflective of the personal series of the senior author (J.H.) alone and it does not include any of the 6123 patients from Helsinki Aneurysm Database as this database is not yet fully completed.

OCCURRENCE OF AChAAs

The incidence of AChAAs is reported to be 2%-5% of all IAs (13, 36, 66, 68). **Tables 2-5** present the clinical data on the 95 AChAA patients in the consecutive and population-based series of 3005 patients with 4253 intracranial aneurysms from 1977 to 2005 in the Kuopio Cerebral Aneurysm Database. All the radiologic data were evaluated by dedicated neuroradiologists. Of the 3005 patients, 831 (28%) had 980 ICA aneurysms (**Table 2**). There were 95 patients with 99 AChAAs, 2% of all the 4253 IAs, 10% of all the 980 ICA aneurysms. The right side ($n = 53$, 54%) slightly dominated over the left side ($n = 46$, 46%). There were only two fusiform AChAAs. We had no giant AChAAs in our series, and there were only three (3%) large (15-to 24-mm) ones (**Table 3**).

Ruptured and unruptured AChAAs

In our series, 498 (51%) of the 980 ICA aneurysms presented with subarachnoid hemorrhage (SAH), of which 39 (8%) were AChAAs (**Table 2**). Of our 99 AChAAs, 39 (39%) were ruptured and 60 (61%) unruptured (**Table 3**). Their size distribution showing the maximum diameter is presented in **Table 3**. Of the 39 ruptured AChAAs, 25 (64%) were smaller than 7 mm, suggesting that even small unruptured AChAAs would require occlusive therapy.

Intracerebral hematoma and intraventricular hemorrhage

Of the 39 patients with ruptured AChAA, intracerebral hematoma (ICH) was present on the initial CT scan in only one (3%) patient but