Ruptured Aneurysm of the Distal Anterior Cerebral Artery: Clinical Features and Surgical Strategies

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Abstract

Ruptured aneurysms of the distal anterior cerebral artery (ACA) are relatively rare and surgical management provides some unique technical challenges. This retrospective analysis of 20 patients with distal ACA aneurysms evaluated the clinical features and surgical strategies. The characteristic findings were small and common concurrent aneurysms, and frequent intracerebral hematoma (ICH). Aneurysms were divided by location on the genu (n = 13), infracallosal (n = 5), and supracallosal portions (n = 2). All patients except one underwent surgery via an interhemispheric route. Unilateral craniotomy was performed for aneurysms on the genu portions without massive ICH. Bilateral craniotomies were selected for aneurysm located on the infracallosal portion or combined with massive ICH. No intraoperative rupture was observed. Favorable outcomes were achieved in 15 of 20 patients, and only one patient died. The preoperative Hunt and Kosnik grade was closely correlated with the outcome.

Key words: anterior cerebral artery, distal aneurysm, interhemispheric approach, surgical strategy

Introduction

Ruptured aneurysms of the distal anterior cerebral artery (ACA) and its associated branches are relatively uncommon, comprising approximately 5% of all intracranial aneurysms. Most of these aneurysms arise at the bifurcation formed by the origin of the callosomarginal artery from the pericallosal artery. Common characteristics of these aneurysms need to be identified, such as the coexistence of other aneurysms, clinical symptoms, and technical challenges.

This report presents our experience with 20 cases of ruptured distal ACA aneurysm, and describes the clinical features and surgical strategies.

Patients and Methods

I. Patient population

The medical records were reviewed of patients with ruptured distal ACA aneurysms who had undergone surgery at Fukuoka University Hospital between January 1999 and September 2005. Patients with unruptured or incidental distal ACA aneurysms were excluded. Twenty patients, 10 men and 10 women aged 43–83 years (mean 64.9 years), with ruptured distal ACA aneurysms underwent clipping under the operating microscope, accounting for 5.5% of all 365 patients with ruptured intracranial aneurysms treated surgically during that period (Table 1). Nine of the 20 patients had multiple aneurysms, two aneurysms in five patients and three aneurysms in four patients. The distal ACA aneurysms were directly responsible for the subarachnoid hemorrhage. The aneurysm location was classified based on our operative approach into the infracallosal portion (n = 5), genu portion (n = 13), and supracallosal portion (n = 2). The aneurysms were divided by diameter into small, 6 mm (n = 13); medium, 6–14 mm (n = 7); large, 15–24 mm (n = 0); and giant, ≥25 mm (n = 0). Associated intracerebral hematoma (ICH) was present in 10 patients on admission. All patients were clinically classified according to the Hunt and Kosnik grading scale.

II. Surgical management protocol

Our standard protocol requires early surgical management for patients in Hunt and Kosnik grades 1–4, but not in grade 5. However, surgical manage-
Table 1  Summary of 20 patients with distal anterior cerebral artery aneurysm

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)/Sex</th>
<th>Hunt and Kosnik grade</th>
<th>Size*</th>
<th>Location</th>
<th>ICH</th>
<th>Drainage</th>
<th>Approach</th>
<th>Multiple aneurysms</th>
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*The aneurysms were divided by diameter into small (S), <6 mm; medium (M), 6–14 mm; large, 15–24 mm; and giant, ≥25 mm. BA: basilar artery, bi: bilateral frontobasal craniotomies, D: dead, GOS: Glasgow Outcome Scale, GR: good recovery, hema: evacuation of hematoma, ICA: internal carotid artery, ICH: intracerebral hematoma, IC-PComA: internal carotid-posterior communicating artery, MCA: middle cerebral artery, MD: moderate disability, Pt: pterional approach, SD: severe disability, sp: spinal drainage, uni: unilateral paramedian craniotomy ipsilateral to the parent vessel, VA-PICA: vertebral artery-posterior inferior cerebellar artery, vent: intraventricular drainage.

...ment should be considered for some patients in poor preoperative condition, particularly with massive ICH or young age, because some improvement might be anticipated following surgery. Removal of the ICH or thick subarachnoid clot is necessary to prevent vasospasm and improve psychiatric conditions caused by dysfunction of the frontal lobe.

The approach was selected depending on the location or association with massive ICH. The aneurysm location was analyzed on the lateral projection of digital subtraction angiography (DSA) or three-dimensional computed tomography angiography (3D-CTA). For aneurysms located on the genu or supracallosal portions of the corpus callosum without massive ICH, unilateral paramedian craniotomy ipsilateral to the parent vessel was performed for an interhemispheric approach. For aneurysms on the infracallosal portion or combined with massive ICH, bilateral frontobasal craniotomies were performed.

If the ICH allows only limited exposure, partial removal of the hematoma should be performed to increase working space. In the presence of hydrocephalus or very tight brain, spinal or intraventricular cerebrospinal fluid (CSF) drainage can be helpful to achieve better exposure of the interhemispheric fissure. Although small bridging veins blocking access to the aneurysm need to be sacrificed on rare occasions, injury to bridging veins should be avoided or minimized. The site of the craniotomy was determined to secure adequate space, usually 15–20 mm long, between the bridging veins.

III. Postoperative care

Postoperatively, neurological condition was examined hourly and daily. Computed tomography was performed 1 day after surgery and after deterioration to identify ventricular dilation or ischemic damage. Postoperative angiography was performed when the patient’s condition stabilized, usually by 2–3 weeks after surgery except for aged patients. Surgical outcome was evaluated at discharge according to the Glasgow Outcome Scale, and classified as good recovery (GR), moderate disability (MD), severe disability (SD), or death (D).
GR and MD were considered to be favorable outcomes.

Results

I. Clinical characteristics

Table 1 summarizes the clinical characteristics of the patients. The most important characteristic was the presence of multiple aneurysms in nine of the 20 patients. The locations of associated aneurysms were the middle cerebral artery (n = 5), internal carotid artery (n = 3), vertebral artery-posterior inferior cerebellar artery (n = 3), and basilar tip (n = 1). Clinical status just before surgery was Hunt and Kosnik grade 1 in three patients, grade 2 in four, grade 3 in five, grade 4 in five, and grade 5 in three. Nine of the 13 patients with poor preoperative status (grades 3–5) had associated ICH on admission. In contrast, only one of the seven patients with good preoperative status (grades 1 and 2) had associated ICH. No clear correlations were noted between incidence of ICH and aneurysm size.

II. Surgical outcome

All 20 patients underwent early surgery within 48 hours of onset to avoid the risk of rebleeding. Standard microvascular techniques and the operating microscope were used in all cases.

Unilateral frontal craniotomy was performed for an interhemispheric approach in 12 patients with aneurysms located on the genu or supracallosal portion without ICH (Fig. 1). Bilateral frontobasal craniotomies were performed to minimize the surgical risks and facilitate retraction of the brain in four patients with aneurysms located on the genu or supracallosal portion combined with massive ICH (Fig. 2). Bilateral frontobasal craniotomies were initially performed in three of the five patients with aneurysms located on the infracallosal portion to secure the parent artery of the aneurysm (Fig. 3). A pterional approach was used in one patient because the aneurysm was located at the origin of the orbitofrontal artery. Spinal CSF drainage was inserted in eight patients, and intraventricular drainage following hematoma evacuation in seven patients at surgery. No patient suffered premature rupture during the dissecting procedure, but six patients required shunt operations for normal pressure hydrocephalus.

Outcomes at discharge were as follows: GR, n = 6; MD, n = 9; SD, n = 4; and D, n = 1. Favorable outcomes were obtained in 15 of the 20 patients. One patient died of cerebral infarction related to severe vasospasm, despite preoperative status of grade 3. The remaining four patients with unfavorable outcomes had poor preoperative status and severe bleeding with ICH. The preoperative Hunt and Kosnik grade and outcome had a close correlation.
Fig. 3 Case 16. A 71-year-old man transferred for disturbance of consciousness (Hunt and Kosnik grade 5). A: Computed tomography scan showing diffuse subarachnoid hemorrhage around the basal cistern. B: Right internal carotid arteriogram, lateral view, demonstrating a saccular aneurysm (arrow) located on the infracallosal portion of the genu arising between the pericallosal and callosomarginal arteries. The ruptured aneurysm was clipped without premature rupture during surgery through bilateral frontobasal craniotomies.

Discussion

The incidence of 5.5% in our series of distal ACA aneurysms agrees with the previous reports of 2.1–9.2% (average around 5%) of all intracranial aneurysms. Most studies have found higher incidences among women, but the male to female ratio was 1:1 in this study.

Multiple aneurysms are present in about 20% of all patients with aneurysm. However, distal ACA aneurysm is associated with an increased incidence of multiple aneurysms. The incidence was as high as 45% in our series. Although the reasons for this multiplicity remain unclear, the high frequency of congenital vascular anomalies may be a contributing factor in patients with distal ACA aneurysm.

Small aneurysm of ≤5 mm was found in 36 of 49 cases, whereas most aneurysms were <10 mm in another series. In our series, small aneurysms of <6 mm were found in 13 of 20 cases, whereas no aneurysms were ≥15 mm. The low incidence of giant aneurysms can be explained by the tendency of distal ACA aneurysm to rupture before reaching large or giant size. In addition, no clear differences in characteristics were noted between the size of the aneurysm and incidence of ICH. Therefore, distal ACA aneurysms must not be overlooked and require definitive treatment even if discovered incidentally in an unruptured state.

ICH is associated more frequently with distal ACA aneurysms than with aneurysms at other sites, at 46.2%, 48%, and up to 73%, respectively. ICH was observed in 10 of our 20 cases on admission. Furthermore, nine of the 13 patients with poor preoperative status had massive ICH, but only one of the seven patients with good preoperative status had associated ICH. Therefore, association with ICH seems to have negative implications for the final surgical outcome, possibly due to the close apposition of the frontal lobe and corpus callosum to the aneurysms and the limited subarachnoid space adjacent to these aneurysms.

Distal ACA aneurysms present some unique challenges at surgery, including the narrowness of the interhemispheric fissure and callosal cistern, and the possibility of dense adherence between the cingulate gyri. A high frequency of broad-based aneurysms occurs in this location, particularly for those involving the origin of branching arteries. Another potential difficulty is that the dome of the aneurysm may adhere to the pial layer or even extend into the brain, making retraction of the frontal lobe dangerous, since this could cause premature rupture of the aneurysm before identification of the vascular anatomy.

Premature rupture during surgery is an important problem, with a frequency of 50% for distal ACA, compared to 13% for aneurysms at other sites. This propensity to intraoperative rupture is attributable to the projection of the dome of the aneurysm toward the surgeon, so that exposure can easily occur before the aneurysm neck is identified. If ICH with a mass effect is present, the hematoma should be removed early in dissection to provide additional working space. If hydrocephalus is also present, spinal drainage or intraventricular CSF catheterization following evacuation of the hematoma may be useful to gain additional space. On the other hand, if the dome of the ruptured aneurysm is embedded in the medial surface of one hemisphere, a contralateral approach will decrease the probability of intraoperative rupture.

We used two approaches to distal ACA aneurysms depending on the aneurysm location and association with massive ICH. Aneurysms on the genu or supracallosal portions were typically approached using unilateral paramedian craniotomy ipsilateral to the aneurysm, as these lesions are not as deep as the more proximal type. Aneurysms on the infracallosal portion were approached through bilateral frontobasal craniotomies, as the parent artery must be initially secured to minimize surgical risk and the possibility of brain damage caused by manipulation. Our series did not include any cases with premature rupture during surgery, as a result of our approach.
strategies. Favorable outcomes were obtained in 15 of 20 patients, which is satisfactory compared to other reports.

Distal ACA aneurysms are known to have poor clinical course and prognosis compared to other supratentorial aneurysms, as well as relatively high morbidity and mortality rates. We emphasize the importance of confirming the precise location of the aneurysm neck and rupture point using DSA and 3D-CTA, and selection of the appropriate surgical approach, based on the necessity for decompressive procedures to counter massive ICH or hydrocephalus.

References


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Commentary

The authors are congratulated to have added useful information about clinical features and surgical strategies along with their excellent results on ruptured distal anterior cerebral artery (ACA) aneurysms. We know that management and results of these aneurysms published to date have been unexpectedly difficult and unsatisfactory. We could confirm the incidence of aneurysms of this location in 3.7% of consecutive 1000 cases of ruptured aneurysms, although the detailed results are yet to be published. Further comments on the surgical strategy and the postoperative management are mentioned below.

Surgical strategy

1. Semicoronal incision followed by a right sided medial frontal craniotomy in which the posterior border is at the coronal suture and the medial border on the superior sagittal sinus, so that the size of bone flap is 4–5 cm anterior from the coronal suture and 3–4 cm from the midline. This craniotomy enables an interhemispheric approach, exposing the whole
stretch of the distal ACA from the anterior communicating artery to the paracentral artery originating from the pericallosal artery. One may expose branches of the left distal ACA along with aneurysms by incising the falx.

2. Aneurysms are accessed by the interhemispheric approach confirming first the pericallosal artery and the genu of corpus callosum. The genu locates always unexpectedly anteriorly. About 1.5 cm posterior from the genu, the corpus callosum is split to enter the ventricular system, this procedure enables CSF drainage (similar to the perforation of the lamina terminalis at the time of other anterior circulation aneurysms), so that the brain will become slack. This procedure requires neither spinal drainage nor ventricular drainage. At the end of surgery, one may place a ventricular catheter for ICP regulation and its monitoring in cases of grade IV, V.

3. Use of temporary clip to avoid and/or manage premature rupture so that small cingular gyrus suction or callosal suction is made to secure the ACA proximal to aneurysms. Usually 15 minutes of temporary clipping is enough for exposure and clipping of aneurysms.

4. The bone flap is replaced and skin flap is closed without any drainage except for above mentioned external drainage for ICP regulation and measurement in severe cases.

Postoperative management
We are performing intensive postoperative management including triple H therapy, endovascular spasmolysis, barbiturate coma and hypothermia in case of necessity according to our protocol. This has enabled good outcome in more than 30% of grade V cases.1)

Reference

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