Carotid paraclinoid aneurysms with intradural origin and intracavernous location

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Five cases of a congenital berry aneurysm of the internal carotid artery with origin partially intradural and fundus mainly intracavernous are presented. Angiography does not allow a precise definition of the amount of aneurysm that is intradural, a fact of importance when planning treatment of these cases. However, the angiographic features are characteristic of the type and suggest that these aneurysms be grouped together as a separate entity.

KEY WORDS • internal carotid artery aneurysm • intradural aneurysm • intracavernous aneurysm

Carotid artery berry aneurysms are usually classified into either intracavernous or intradural types. Some fusiform aneurysms may bridge these two regions, or a giant intracavernous aneurysm may extend intradurally. However, small saccular aneurysms that occupy space in both regions have not been recognized as an entity. The present paper documents the existence of a group of aneurysms with these characteristics.

Clinical Material

Five cases demonstrating six examples of this type of aneurysm serve as the basis for this paper. In Case 3, the aneurysm occurred bilaterally. Four of the patients were cared for by other surgeons who have kindly allowed the analysis and publishing of their cases.

Tracings of the angiographic outlines of the aneurysms are presented in Fig. 1. All the aneurysms had a similar appearance on lateral view, originating from the inferior surface of the internal carotid artery and pointing downward in the region just distal to where the artery makes its curve in the anterior cavernous sinus to enter the intradural cavity. Four of the six aneurysms could be seen on the anteroposterior view, but their exact site of origin from the carotid artery was not evident in that projection. That view confirmed the fact that they were directed straight downward, or downward and very slightly medially. In all examples, a part of the sac lay beside an uneroded anterior clinoid process. Therefore, for convenience they will be referred to as paraclinoid aneurysms.

The relationship between the anterior clinoid process and the aneurysm can be described only imprecisely because of the complex form of these structures and difficulty in differentiating the right and left clinoids. However, in most cases part of the aneurysmal dilatation lay above, and in all cases part lay below the level of the anterior
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Fig. 1. Tracings of lateral (left) and anteroposterior (right) angiograms of the five cases in this series. The carotid artery and its branches are represented by heavy lines and the aneurysm is stippled. The lighter lines in the lateral view represent the overlying bone. Both anterior clinoid processes are shown because of difficulties differentiating the right from the left.

clinoid process. This argues for a partially intradural and partially intracavernous location, respectively.

Other radiographic features suggested the dual location of the aneurysms. The origin of the ophthalmic artery is known to be intradural in about 90% of cases. In most of the present cases, the ophthalmic artery arose more proximally on the carotid than the most proximal part of the aneurysm. Another feature that indicated an intracavernous location was that in many of the cases the fundus of the aneurysm superimposed on the intracavernous carotid artery on the lateral angiogram. Since the aneurysms were seen to be pointing straight down rather than medially into the sella turcica on the anteroposterior view, this feature argues that the fundus was within the cavernous sinus.

Table 1 gives a summary of the features localizing the aneurysms to the intradural and intracavernous site that were noted on angiography and observed at surgery or autopsy. Table 2 summarizes the clinical data of the five cases, which are presented in detail below.

Case Reports

Case 1

This 68-year-old man was admitted to hospital 4 hours after a subarachnoid hemorrhage (SAH).

Examination. He had neck stiffness, a mild left upper motor neuron facial weakness, and a left Babinski sign. Cerebral panarteriography performed on the second hospital day revealed a right paraclinoid aneurysm. During the first week of hospitalization, the patient became somnolent with an increasing left hemiparesis. However, 2 weeks posthemorrhage he was asymptomatic with a normal neurological examination.

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### TABLE 1
*Summary of anatomical localizing features*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Intracavernous Aneurysms</th>
<th>Intradural Aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Angiography</td>
<td>Infraclinoid</td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>right</td>
<td>3</td>
<td>+</td>
</tr>
<tr>
<td>left</td>
<td>4</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*A “+” or “-” refers to an observation that showed that the feature did or did not exist, respectively. A “0” indicates that uncertainty arose because of an incomplete observation or no inspection of the feature. Cav. = cavernous; A. = artery.

![Fig. 2. Case 1. Lateral x-ray films, preoperative (left), and postoperative (right).](image)

### TABLE 2
*Summary of clinical data in series*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, Sex</th>
<th>Clinical Presentation</th>
<th>Associated Aneurysms</th>
<th>Operation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68, M</td>
<td>SAH (Grade 3)</td>
<td>—</td>
<td>partial clipping</td>
<td>died: pulmonary embolus</td>
</tr>
<tr>
<td>2</td>
<td>49, M</td>
<td>SAH (Grade 3)</td>
<td>middle cerebral</td>
<td>clipping</td>
<td>died: cerebral ischemia</td>
</tr>
<tr>
<td>3</td>
<td>48, M</td>
<td>SAH (Grade 3)</td>
<td>bilat. paracclinoid, carotid cavernous, carotid post. comm.</td>
<td>partial clipping</td>
<td>died: myocardial infarct</td>
</tr>
<tr>
<td>4</td>
<td>36, F</td>
<td>dementia</td>
<td>pericallosal, middle cerebral, bilat. carotid-oph.</td>
<td>carotid ligation after rupture</td>
<td>died: cerebral infarct</td>
</tr>
<tr>
<td>5</td>
<td>37, F</td>
<td>seizures</td>
<td>—</td>
<td>exploration</td>
<td>unchanged</td>
</tr>
</tbody>
</table>

*Bilat. = bilateral; Grade = clinical grade; oph. = ophthalmic; post. comm. = posterior communicating; SAH = subarachnoid hemorrhage.*
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Fig. 3. Case 1. Autopsy specimen. A: The sella region is seen from above with the right carotid artery (1), right and left optic nerves (2 and 3), and opening in the diaphragma sellae (4) labeled for orientation. The medial attachment of the right carotid artery to the dura (broken arrow) has been cut revealing the aneurysm (solid arrow) which projects into the cavernous sinus. B: The medial aspect of the carotid siphon after removal from the rest of the specimen. The aneurysm (solid arrow) is seen to be mainly proximal to a ridge (open arrow) which represents the superior attachment of dura to the carotid artery. C: Sagittal section of the part of the artery containing the aneurysm and the attached dura oriented and labeled as in B. The relationship described above and the thin aneurysm wall are seen more clearly.

Operation. Surgery was performed on the 14th day after hemorrhage. The anterior clinoid process was removed for optimum exposure. The carotid artery seemed ectatic as it exited from the cavernous sinus and was thought to represent a part of the aneurysm. This segment was reenforced with a Sundt clip of which the anterior edge was placed as far proximal as the dura would allow. The postoperative angiogram (Fig. 2) helped clarify the anatomical relations: only the distal end of the aneurysm neck had been narrowed by the clip, indicating that it was mainly intracavernous.

Postoperatively, the patient had a low-grade fever and confusion which cleared in the first week. However, he died on the ninth postoperative day of a massive pulmonary embolus.

Postmortem Examination. Autopsy showed that the thinnest part of the aneurysm was intracavernous (Fig. 3). Histological examination of the aneurysm revealed absence of the internal elastic membrane and media consistent with the diagnosis of congenital berry aneurysm.

Case 2

This 49-year-old man was transferred from another hospital 48 hours after an SAH.

Examination. He was confused and agitated with moderate neck stiffness and a mild right hyperreflexia. Arteriography performed 2 days after admission revealed a left paraclinoid aneurysm with irregular outline and a right middle cerebral artery aneurysm of approximately the same size. Rupture of the paraclinoid aneurysm was suspected because of the contralateral hyperreflexia and the irregularities of its wall.

Operation. The clinical status remained unchanged and surgery for the paraclinoid aneurysm was carried out 7 days after SAH. Adequate exposure required the removal of the anterior clinoid process. All but the most anterior extension of the aneurysm neck was definable, but most of the fundus was hidden within the dura of the cavernous sinus. During dissection, arterial bleeding occurred. This was controlled in about 4 minutes by clipping what was thought to be the aneurysm neck. The patient never awoke from surgery and died 6 hours later.
Postmortem Examination. Autopsy revealed a diffusely swollen brain with bilateral uncal herniation thought to be the result of diffuse cerebral ischemia. The exact position of the clip relative to the carotid artery and aneurysm was not defined. Histological sections of the aneurysm site confirmed its intradural and intracavernous location (Fig. 4). There was no evidence that the middle cerebral aneurysm had bled. Histological findings were those of a congenital berry aneurysm.

Case 3

This 48-year-old man was admitted after an SAH. He was stuporous and confused, but had no focal neurological signs.

Examination. Angiography was performed on the fifth day. The following aneurysms were identified: a small right intracavernous carotid aneurysm; a right paraclinoid aneurysm; a smaller left paraclinoid aneurysm; and a very small left internal carotid-posterior communicating artery aneurysm. The hemorrhage was thought to have occurred from the right paraclinoid aneurysm because it was the largest, had an irregular wall, and was associated with a small amount of local carotid artery spasm.

Operation. Surgery for the right paraclinoid aneurysm was performed 21 days after SAH, at which time the patient's status was normal. The anterior clinoid process was removed. Most of the aneurysm sac was noted to be encased within the cavernous sinus, but the surgeon believed that he had completely dissected its neck which he had clipped. However, the postoperative angiogram (Fig. 5) showed that the clip had not reached the most proximal end of the neck, which was probably within the dural wall of the cavernous sinus.

The postoperative course was characterized by progressive recovery with intermittent periods of confusion and focal cerebral seizures. However, on the 17th postoperative day he had an acute myocardial infarct and died.
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**Fig. 5.** Case 3. Lateral x-ray films of the right aneurysm, preoperative (left), and postoperative (right).

**Postmortem Examination.** Autopsy revealed that the treated aneurysm was thrombosed and shivered. Calcified atheroma within the aneurysm wall disturbed the histological architecture during sectioning, making adequate study impossible. The aneurysms on the left were not found.

**Case 4**

This 36-year-old woman was investigated because of a vague personality change and difficulty with memory and concentration of 6 months duration. One month before admission the symptoms had worsened following an episode of sudden headache and collapse.

**Examination.** The patient had slow mentation, poor remote and recent memory, and weakness of the left foot. Angiographic investigation revealed multiple intracranial aneurysms. These included a right paraclinoid aneurysm, bilateral carotid-ophthalmic aneurysms, a moderate sized right middle cerebral artery aneurysm, and a large pericallosal aneurysm projecting into the right frontal lobe. Recurrent bleeding from the latter aneurysm, which was documented at surgery, probably explained the clinical picture.

**Operation.** The aneurysms were approached from the right side. After successful occlusion of the pericallosal and middle cerebral artery aneurysms, attention was directed to those on the right internal carotid artery. Removal of the anterior clinoid process was necessary. There was an ectatic segment of the internal carotid artery about 5 mm long just after the artery became intradural. From this segment, there were two aneurysmal sacs originating at 180° to each other, a superiorly directed carotid-ophthalmic aneurysm and an inferiorly directed paraclinoid aneurysm. Dissection was carried completely around the neck of the paraclinoid aneurysm, but at that point the ectatic carotid artery ruptured, necessitating carotid ligation and making further precise anatomical observations impossible.

In the postoperative period, there was evidence of right cerebral ischemia with progressive cerebral swelling. The patient died 5 days postoperatively.

**Postmortem Examination.** Histological study of the aneurysms at autopsy was consistent with congenital berry aneurysms. A diagnosis of polycystic kidneys was also made.

**Case 5**

This 37-year-old woman presented soon after the occurrence of three focal motor seizures that affected the right face and arm.

**Examination.** Neurological examination was normal. A brain scan performed 24 hours after the seizures revealed an uptake in the left parietal region. Cerebral angiography showed a left paraclinoid aneurysm with irregular outline. The association of the positive scan and irregular aneurysm wall suggested that the seizures might have resulted from thromboembolism.
Operation. Direct obliteration of the aneurysm was planned. However, when the surgeon observed that it was partially intracavernous, he decided only to reinforce the visible intradural part with gauze. Further exposure by removal of the anterior clinoid process was not done.

The postoperative course was uneventful.

Discussion

The many similarities of these aneurysms are the reason for grouping them and suggesting that they be considered as a separate entity. The following list is a summary of these features, some of which will be discussed in more detail in the following paragraphs. They are small congenital berry aneurysms. Their overall angiographic appearance is strikingly similar. The site of origin from the carotid artery is at least partially intradural, and a large part of the sac is intracavernous. Aneurysms at that site are not defined in the existing classifications. If they are symptomatic, this is often the result of an SAH. Direct surgical treatment is difficult.

Several findings suggest that these cases are examples of congenital berry aneurysms. All except Case 1 had the radiological appearance of a sac with a well defined neck. Three of the cases had multiple aneurysms. The histological examination also supports the interpretation of a congenital origin. Although Cases 1 and 4 seemed to have an ectasia of the internal carotid artery in the region of the paraclinoid aneurysm, there was no fusiform dilatation. Furthermore, in Case 1, the only site of histological abnormality of the internal elastic lamina and media was at the site of aneurysmal outpouching. Although atherosclerosis was present in Cases 1 and 3, it was not of sufficient degree to explain the presence of the aneurysms. In this small series, the commonest symptom was SAH. The high incidence of SAH suggests that an important part of the aneurysm is intradural and subarachnoid. However, it is known that intracavernous aneurysms can bleed into the intracranial cavity. Dandy collected four cases in a series of 41 aneurysms presumably as a result of subarachnoid extension of the sac but the anatomical details of the cases were not given.

The fact that these aneurysms bleed demands an aggressive approach to their treatment. Clipping of an aneurysm neck is considered ideal, but is not always possible with these lesions. The results of attempted neck obliteration were poor in this series. The experience suggests that problems may be shearing of a fixed aneurysm from a mobile intradural carotid artery, compromise of the carotid lumen because of inability to expose enough of the aneurysm neck away from the carotid artery to accept the width of the clip, which possibly occurred in Case 2, and incomplete definition of the proximal end of the aneurysm neck (Cases 1 and 3). However, the findings do suggest that the direct approach is possible in some cases. This is indicated by the thrombosis of the aneurysm in Case 3, and the fact that the neck could be isolated in Case 4. Furthermore, the failure in Case 2 may have been related more to the timing of the operation than to the technical problems. Therefore, since it may be possible to clip some of these aneurysms but certain prediction of this cannot be made from the preoperative angiogram, direction exploration is justifiable. Alternative procedures must be planned in case the neck cannot be occluded. These might include reinforcement of the intradural component, especially if there has been no SAH or local nerve compression, proximal carotid ligation, or a trapping procedure.

These berry aneurysms do not fall into existing classifications, although examples can be found in the literature grouped with aneurysms originating in the neighboring regions. However, the present cases can be differentiated from the neighboring types such as carotid-ophthalmic and intracavernous aneurysms. Carotid-ophthalmic aneurysms are usually considered to arise from the superior or medial surface of the carotid artery in direct contact with the ophthalmic artery, although some authors give a broader definition. In contrast, the paraclinoid aneurysms presented here arise from the surface of the carotid artery opposite to the origin of the ophthalmic artery. Small aneurysms on the most distal intracavernous carotid artery originating at the site of McConnell's anterior capsular artery were described by Mishkin and Bull at the 11th International Congress of Radiology in Rome, 1965.
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ever, those aneurysms originate from the medial surface of the carotid artery proximal to the anterior clinoid process and ophthalmic artery rather than from the inferior surface of the carotid beside the clinoid process and distal to the ophthalmic artery, as described for the intradural-intracavernous paraclinoid aneurysms.

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