Aneurysms protruding from the dorsal wall of the internal carotid artery

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Saccular aneurysms arising at locations other than at arterial divisions are extremely rare. The authors describe eight such aneurysms that protruded from the dorsal wall of the internal carotid artery (ICA) and were unrelated to any arterial junction. Radical surgery was performed in all eight cases. The aneurysms were saccular with a fragile wide or semifusiform neck. Intraoperative rupture occurred in three cases. From this experience, it is emphasized that these unusual protruding aneurysms of the dorsal ICA should be clipped with the clip blade parallel to the parent artery. In addition to clipping, complete wrapping with fascia or Bemsheet (cellulose fabric) is often advisable to prevent slippage of clips or postoperative rupture of residual aneurysm.

KEY WORDS cerebral aneurysm □ internal carotid artery □ clipping

THE vast majority of saccular aneurysms are located at arterial divisions; those arising elsewhere are extremely rare. Ohara, et al., reported that the pathogenesis of intracranial aneurysms unrelated to arterial junctions was arteriosclerotic; they described a 1% incidence of such aneurysms (11 of 1116 cases) among cerebral aneurysms.

During a recent 5-year period, we found eight of these unusual aneurysms protruding from the dorsal wall of the internal carotid artery (ICA) among 460 cases operated on for aneurysm (Table 1). These eight aneurysms were located between the junction of the ICA and posterior communicating artery (PCoA) and the distal ICA bifurcation. Five patients with single aneurysms and one with multiple aneurysms suffered subarachnoid hemorrhage (SAH) from these unusual aneurysms. The other two patients had multiple aneurysms, and the SAH occurred from aneurysms other than those unrelated to arterial divisions. All eight patients had a history of mild hypertension and presented intraoperative findings of arteriosclerosis.

Three of the aneurysms ruptured intraoperatively and one rebled fatally after surgery. In our series, the incidence of intraoperative bleeding was far higher in aneurysms unrelated to arterial divisions than in usual aneurysms. Besides the unusual locations of these aneurysms, six of them had a wide fragile neck or were semifusiform in shape with no neck. Three cases are described in detail to illustrate the management and course of these unusual aneurysms.

Case Reports

Case 1

This 53-year-old woman suffered a sudden headache and repeated vomiting on December 5, 1980. On the following day she was admitted to our institution with a marked stiff neck but no other neurological deficits. There was no noteworthy medical history except for hypertension. Her father and one of her siblings had died from cerebral apoplexy. Computerized tomography (CT) demonstrated thin but diffuse cisternal clot. Because a right ICA aneurysm was strongly suggested by angiography (Fig. 1 upper left), surgical treatment was chosen.

Operation. Three days after onset of symptoms, a right frontotemporal craniotomy was performed. The right ICA was slightly elongated and sigmoid in form. A semifusiform aneurysm was found on the dorsal wall of the ICA attached to the basal surface of the frontal lobe by local clots (Fig. 1 lower left). It had no relation to any of the carotid divisions and its wall was very thin. An oblique-angled Sugita clip was placed parallel to the ICA (Fig. 1 lower right). Because the adjacent proximal wall of the ICA was pathologically thin, it was coated with a piece of muscle. Complete wrapping with fascia was difficult in this case as the proximal half of the ICA was too close to the right optic nerve.

Postoperative Course. Four days postoperatively the patient suddenly began vomiting and became unconscious, with left conjugate deviation and bilateral...
TABLE 1

Summary of aneurysms protruding from the dorsal wall of the ICA

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Preop Grade*</th>
<th>Interval SAH to Op (days)</th>
<th>Size &amp; Shape of Aneurysm</th>
<th>Intraop Rupture</th>
<th>Aneurysm Management</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53, F</td>
<td>II</td>
<td>3</td>
<td>semifusiform</td>
<td>no</td>
<td>clipping, supplementary coating (muscle)</td>
<td>died (rebleeding)</td>
</tr>
<tr>
<td>2</td>
<td>44, F</td>
<td>II</td>
<td>10</td>
<td>3.5 mm, saccular</td>
<td>yes</td>
<td>clipping, supplementary wrapping (fascia)</td>
<td>excellent</td>
</tr>
<tr>
<td>3</td>
<td>45, M</td>
<td>III</td>
<td>2</td>
<td>4 mm, saccular</td>
<td>yes</td>
<td>clipping</td>
<td>died (spasm)</td>
</tr>
<tr>
<td>4</td>
<td>47, F</td>
<td>II</td>
<td>0</td>
<td>2.5 mm, saccular</td>
<td>no</td>
<td>clipping</td>
<td>excellent</td>
</tr>
<tr>
<td>5</td>
<td>42, F</td>
<td>II</td>
<td>0</td>
<td>4 mm, saccular</td>
<td>yes</td>
<td>clipping, supplementary coating (Bemsheet &amp; fibrin glue)</td>
<td>excellent</td>
</tr>
<tr>
<td>6</td>
<td>52, M</td>
<td>II</td>
<td>0</td>
<td>8 mm, saccular</td>
<td>no</td>
<td>clipping</td>
<td>poor (spasm)</td>
</tr>
<tr>
<td>7§</td>
<td>60, M</td>
<td>II</td>
<td>2</td>
<td>1: 4 mm, saccular</td>
<td>no</td>
<td>clipping</td>
<td>died (spasm)</td>
</tr>
<tr>
<td>8§</td>
<td>63, M</td>
<td>Ia</td>
<td>42</td>
<td>2: semifusiform</td>
<td>no</td>
<td>clipping</td>
<td>excellent</td>
</tr>
</tbody>
</table>

† The largest diameter of aneurysmal neck or dome as seen on the angiogram.
‡ This patient had two dorsal internal carotid artery (ICA) aneurysms (unruptured) and an aneurysm (ruptured) at the ICA-posterior communicating artery junction in the left carotid system.
§ This patient had a left dorsal ICA aneurysm (unruptured) and aneurysms arising from the right middle cerebral artery (ruptured) and from the ICA-anterior choroidal artery junction (unruptured).

positive extensor response. After recovery of consciousness, left hemiparesis was transiently observed. She did not complain of headache. A CT scan was normal. Immediate angiography showed that the aneurysm was only partially obliterated, suggesting postoperative slippage of the clip (Fig. 1 upper right). She recovered completely within several hours. On January 3, 1981, 26 days after the operation, she had a sudden attack of vomiting and lost consciousness on her way to the lavatory. She recovered consciousness transiently but then became comatosed. A CT scan showed a massive intracerebral hematoma just above the aneurysm clip. She deteriorated rapidly and died on the 28th postoperative day.

Case 2

This 44-year-old woman developed a sudden headache and repeated vomiting while driving an automobile on August 31, 1981. She was admitted to our hospital 4 hours later. On admission, a mildly stiff neck was observed. A CT scan revealed localized cisternal clots, more prominent on the right side than the left. Immediate cerebral angiography showed no definite aneurysm, presumably because the dome of the aneurysm had collapsed or the parent artery had contracted soon after bleeding. On the 7th day after onset she again suffered a sudden headache, vomiting, and transient unconsciousness. A repeat CT scan showed no remarkable change. On the 10th day after the first attack, right carotid angiography revealed a small saccular aneurysm in the dorsal wall of the right ICA, just proximal to the junction of the ICA and the anterior choroidal artery (AChA) (Fig. 2 left).

Operation. A right frontotemporal craniotomy was performed on September 14, 2 weeks after the initial attack. An aneurysm was found on the dorsal and slightly medial wall of the ICA. Because the dome adhered to the basal surface of the frontal lobe, neck clipping was performed from a direction anterolateral to the ICA. Just before complete closure of the blades, profuse bleeding occurred from the compressed aneurysmal neck. The proximal segment of the ICA was temporarily clipped for 3 minutes, and neck clipping was successfully accomplished with a Sugita clip (bayonet type) placed parallel to the ICA. On further exploration, an aneurysm was found to have arisen at some distance from both the ICA-PcoA and the ICA-AChA junctions. The clipped aneurysm was reinforced, together with the parent artery, by supplemental wrapping with a piece of fascia. Another small unruptured aneurysm on the right middle cerebral artery was clipped without difficulty.

Postoperative Course. Transient left hemiparesis was observed during the first 24 hours after surgery. Postoperative angiography revealed successful clipping of both aneurysms (Fig. 2 right). The patient recovered fully.

Case 3

This 45-year-old man suffered the sudden onset of headache and vomiting on September 8, 1982. On the following day he had a second attack and became unconscious. On admission to our hospital he was stuporous with right hemiparesis and severe neck stiffness. A CT scan showed diffuse thick cisternal clot, and angiography revealed an aneurysm on the left ICA (Fig. 3 upper left). Because the patient’s neurological condition was judged too serious to allow immediate surgical treatment, he was treated conservatively with mannitol and steroids. He gradually improved to the extent of
Dorsal internal carotid artery aneurysm

Fig. 1. Case 1. Upper Left: Preoperative right carotid angiogram showing a semifusiform dilatation (arrow) on the dorsal wall of the internal carotid artery (ICA). Upper Right: Postoperative right carotid angiogram showing residual aneurysmal dilatation proximal to the applied clip, suggesting postoperative slippage of the clip. Lower Left: Drawing of the operative findings before clipping showing a tortuous ICA and a semifusiform aneurysm. Lower Right: Drawing of the operative view after clipping.

Fig. 2. Case 2. Left: Preoperative right carotid angiogram showing a saccular aneurysm (arrow) on the dorsal wall of the internal carotid artery (ICA). Right: Postoperative angiogram showing successful clipping of both the middle cerebral artery aneurysm and the dorsal ICA aneurysm.
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FIG. 3. Case 3. Upper Left: Preoperative left carotid angiogram showing a saccular aneurysm arising from the dorsal lateral wall of the internal carotid artery (ICA). Upper Right: Postoperative angiogram showing successful clipping and restored blood circulation. Lower Left: Drawing of the operative exposure before clipping. The ICA is curved and sclerotic and an aneurysm is seen arising from the dorsal lateral wall protruding dorsolaterally. Lower Right: Drawing of the operative view after final clipping. Two angled clips are catching the ICA wall beyond the torn part of the aneurysmal neck.

responding to verbal commands. Surgery was performed 2 days after onset of symptoms.

Operation. A left frontotemporal craniotomy was carried out. The aneurysm arose from the dorsal lateral carotid wall just proximal to the ICA-AChA junction. The dome was attached to both the temporal and frontal lobes by large localized clots; the medial part of the dome was carefully dissected subpially from the frontal lobe by suctioning a small portion of damaged surrounding brain (Fig. 3 lower left). Because further dissection between the temporal lobe and aneurysmal dome was considered dangerous, the aneurysm was clipped from the anteromedial direction. Just before the clip blades were closed completely, a major rupture occurred at the neck. Under temporary trapping of the ICA, which was performed twice (for 13 and 11 minutes, respectively), the neck was successfully clipped together with the adjacent part of the carotid artery wall. In this case also the origin of the aneurysm was distant from any arterial junction. Mannitol was infused during these procedures to reduce the risk of ischemic complications. During subsequent removal of the interhemispheric clots via the interhemispheric route, the clip slipped off spontaneously and blood pressure dropped to 40 mm Hg systolic. The aneurysm was exposed again and the neck was reclipped parallel to the ICA using two clips (one an angled clip and the other an angled ring clip) so as to catch the adjacent carotid artery wall with the aneurysmal neck (Fig. 3 lower right). Temporary trapping was necessary for another 10 minutes and unfortunately the systolic blood pressure dropped to 60 mm Hg for 15 minutes due to blood loss.

Postoperative Course. The patient’s condition deteriorated to a semicomatose state. He moved only the left upper limb on painful stimuli. Immediate postop-
Dorsal internal carotid artery aneurysm

operative angiography showed successful clipping and restored circulation in the left carotid system (Fig. 3 upper right). Intraoperative ischemia in addition to the patient's poor preoperative condition was suspected to be the cause of his neurological deterioration. Unfortunately, he did not survive the subsequent severe vasospasm and brain edema, and died 10 days after the operation.

Discussion

Intracranial saccular aneurysms are usually located at or very close to the junctions of arteries. Saccular aneurysms with no relation to arterial divisions are extremely rare. Ohara, et al.,8 reported 11 such aneurysms among 13 arteriosclerotic aneurysms in 11 patients. Six of the 11 aneurysms (five of which were operated on whereas the sixth was treated conservatively) were located on the ICA. The other two arteriosclerotic aneurysms were of the fusiform type. More recently, Yasargil15 reported three cases of this unusual type of aneurysm arising from the dorsal or medial wall of the distal ICA among a series of 319 cases of ICA aneurysm.

During a recent 5-year period, we encountered eight of these unusual cases among 460 patients operated on for aneurysm. Two of the aneurysms, including that in Case 1, were semifusiform and the rest were saccular. All were located on the dorsal wall of the ICA between the ICA-PCoA junction and ICA bifurcation and were thus unrelated to the main ICA junctions, although very fine branches such as those supplying the optic nerve might have been involved.7 They therefore differ from ophthalmic artery aneurysms or any of the usual types of ICA aneurysm classified by Pia.9

Some types of aneurysm, such as fusiform, dissecting, mycotic, or traumatic, usually show clear evidence of various etiological factors including congenital and acquired abnormalities, but the pathogenesis of saccular aneurysms, the majority of which occur at the apex of arterial divisions, has been controversial. A multicausal etiology was proposed by Jellinger,6 including a combination of a predisposing congenital medial defect in the arterial wall and acquired degenerative changes in the vessel walls, occasional arterial variations, and local hemodynamics as potentiating factors. Congenital medial defects and other congenital abnormalities do not seem to have been present as predisposing factors in the special aneurysms unrelated to arterial divisions. Siehens8 has noted that, pathologically, these saccular aneurysms unrelated to arterial divisions can be caused by arteriosclerosis. Ohara, et al.,5 also interpreted this type of aneurysm as sclerotic. In our cases, sclerotic changes of the ICA were most prominent in Case 1, in which the aneurysm was semifusiform, followed by Case 3. Sano8 suggested the importance of hemodynamic factors in the development of aneurysms at the abrupt curvature of the ICA in some cases. In three of our cases, including Cases 1 and 2, the aneurysms arose in such a location, which tends to confirm the importance of hemodynamic factors.

In surgical treatment of these unusual aneurysms, Ohara, et al.,8 stressed the need for completely different surgical management and special care because of the vulnerability of the arteriosclerotic parent arteries. Of their five surgical cases of sclerotic saccular aneurysms arising from the ICA, three were treated by clipping or ligation with supplementary muscle wrapping and two were managed with muscle wrapping alone. However, they made no other detailed comments about surgical techniques. In our cases, the aneurysms arose from the dorsal wall of the ICA. Their necks were wide and thin, and they had a greater tendency than usual aneurysms to rupture when the blades of a clip were applied from a direction oblique or perpendicular to the carotid axis. The most important point is that, in this kind of aneurysm, a clip should be placed on the neck parallel to the parent artery. If the neck is markedly thin at its carotid origin, induced hypotension or temporary clipping is helpful when attempting to include the parent artery and the vulnerable neck within the clip blades. The Sugita clip makes it possible to catch the parent arterial wall from the aneurysm side without causing substantial stenosis as it has a strong spring and narrow blades.13 When a clip is placed on a thin wide neck, care should be taken in positioning the clip head, which may slip and cause rupture of the aneurysm when brain retraction is released. Tying clip blades to the carotid trunk with a silk suture or complete wrapping with fascia or Bemsheet* (cellulose fabric) may be effective in preventing slippage of the clip or in reinforcing a vulnerable arterial wall.

There have been several papers on reinforcement of these vulnerable aneurysms with adhesive materials such as methyl methacrylate, methyl 2-cyanoacrylate, EDH adhesive (Biobond), or ethyl 2-cyanoacrylate (Aron Alpha A).1,4,5,11 In the past, we have often used synthetic adhesive materials such as Biobond in combination with muscle pieces to repair the sellar floor in transphenoidal surgery. In some of the cases in which reexploration was performed, these adhesives (especially Biobond) were not well attached to the surrounding tissues. Yodh and Wright16 also mentioned the same problem. While the use of muscle as wrapping material to reinforce the aneurysmal wall has been controversial, muslin gauze, gauze, and Bemsheet have been reported to be effective.2,7,14 At present we use Bemsheet for wrapping in such cases, with Weck clips used to fix it, and fibrin glue added.

References


* Cellulose fabric manufactured by Kawamoto Co., Osaka, Japan.

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