Dissecting aneurysm of the vertebral artery

Report of seven cases and angiographic findings

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Seven cases of dissecting aneurysm of the vertebral artery, all appearing to be of fusiform type, are reported. Clinically, all seven cases initially showed symptoms of subarachnoid hemorrhage; however, three of these were associated with Wallenberg’s syndrome. The characteristic angiographic findings in these cases were: 1) retention of contrast medium in the aneurysm; 2) the presence of a true (vertebral artery) and false (arterial wall) lumen in the late arterial and/or venous phase; and 3) irregular arterial narrowing proximal and/or distal to the aneurysm. Autopsy findings of one patient supported the angiographic findings. Recently, reports of fusiform aneurysms associated with subarachnoid hemorrhage have been increasing. As dissecting aneurysms are found in the fusiform group, it is very important to analyze serial angiograms in order to choose a method of surgical treatment.

KEY WORDS • dissecting aneurysm • fusiform aneurysm • Wallenberg’s syndrome • subarachnoid hemorrhage

Case Reports

A clinical summary of the seven cases reported here is presented in Table 1.

Case 1

This 48-year-old man suddenly felt dizzy and fell when he was about to go to bed on October 11, 1981. He also had a headache and vomited. He felt dizzy again the next day and deviated to the right when he tried to walk. He visited our outpatient clinic on October 17 after consulting his family doctor. Moderate confusion, and cerebellar ataxia and Horner’s sign on the right side were observed on neurological examination. On October 21, a lumbar puncture revealed slightly xanthochromic cerebrospinal fluid (CSF), with a protein content of 101 mg/dl, and a cell count of 118/cu mm. No abnormalities were observed on computerized tomography (CT). A fusiform aneurysm was detected on right vertebral angiography in the portion distal to the posterior inferior cerebellar artery (PICA).

Suboccipital craniectomy was performed on November 26, and the right vertebral artery was clipped distal to the PICA and proximal to the aneurysm. The postoperative course was uneventful. Rehabilitation was...
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## TABLE 1

Clinical summary of seven cases of dissecting aneurysm

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Symptoms &amp; Signs</th>
<th>Proof of SAH*</th>
<th>Surgical Treatment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48, M</td>
<td>confusion, headache, vomiting, Horner's sign disturbance, Wallenberg's syndrome</td>
<td>LP: xanthochromic CSF</td>
<td>proximal clipping</td>
<td>excellent</td>
</tr>
<tr>
<td>2</td>
<td>48, M</td>
<td>headache, vomiting, vertigo, ataxia, gait disturbance, Wallenberg's syndrome</td>
<td>LP: bloody CSF</td>
<td>proximal clipping</td>
<td>good, it hypalgesia</td>
</tr>
<tr>
<td>3</td>
<td>48, M</td>
<td>dizziness, vomiting, nystagmus, Wallenberg's syndrome</td>
<td>LP: bloody CSF</td>
<td>not done</td>
<td>good, it hypalgesia</td>
</tr>
<tr>
<td>4</td>
<td>43, M</td>
<td>severe headache, nausea, vomiting, ret vitreous hemorrhage</td>
<td>LP: bloody CSF</td>
<td>not done</td>
<td>excellent</td>
</tr>
<tr>
<td>5</td>
<td>39, M</td>
<td>severe headache</td>
<td>LP: xanthochromic CSF</td>
<td>trapping</td>
<td>excellent</td>
</tr>
<tr>
<td>6</td>
<td>58, F</td>
<td>confusion, headache, stiff neck, bilat vitreous hemorrhages</td>
<td>CT</td>
<td>proximal clipping</td>
<td>excellent</td>
</tr>
<tr>
<td>7</td>
<td>58, M</td>
<td>severe headache, vomiting, initial loss of consciousness, stiff neck</td>
<td>CT</td>
<td>not done</td>
<td>died after second rupture</td>
</tr>
</tbody>
</table>

* SAH = subarachnoid hemorrhage; LP = lumbar puncture; CT = computed tomography; CSF = cerebrospinal fluid.

started on the 8th postoperative day. The preoperative symptoms, including Horner's sign and ataxia, gradually improved and had almost disappeared within 4 weeks after the operation. The patient was discharged on December 26. He is presently asymptomatic and is engaged in religious activity.

**Case 2**

This 48-year-old man had a severe headache of sudden onset in the occipital region once during the summer of 1979. He experienced a similar headache on July 17, 1980, which subsided in a short while. On July 19, he again had a sudden severe headache in the occipital region and vomited twice. He was admitted to our hospital on July 22.

Neurological findings on admission included vertigo, ataxia, unsteady gait, and Wallenberg's syndrome. No abnormality was detected on the CT scans. Lumbar puncture disclosed bloody CSF at an opening pressure of 130 mm HgO; CSF analysis showed a protein content of 74 mg/dl, and a cell count of 53/cu mm. Since SAH was suspected, cerebral angiography was performed. Right vertebral angiography showed narrowing and irregularity of the vertebral artery distal to the PICA (Fig. 1 left). The patient was treated with 600 mg aspirin and a drip infusion of Hespander (hydroxyethyl starch). He was discharged on December 12. The only sensory disturbances remaining were hypalgesia on the right side of the face and the left side of the body.

His condition was followed thereafter in the outpatient clinic, but no improvement in sensory disturbances was detected. He was readmitted, and right vertebral angiography on April 14, 1982, revealed a fusiform aneurysm at the site where narrowing was seen in the previous angiogram (Fig. 1 right). Suboccipital craniectomy was performed on April 19, and the vertebral artery was clipped distal to the PICA.

The patient temporarily complained of pain around the right eye after surgery, but it subsided gradually. The preoperative hypalgesia on the right side of the face was absent on neurological examination 10 days after surgery; however, the right side of his body was still hypalgesic. The patient was discharged on May 10, 1982, and is presently engaged in construction work, with no neurological symptoms except the unilateral hypalgesia.

**Case 3**

This 48-year-old man felt dizzy when he stood up briskly after a nap on March 6, 1982. The next morning he had severe vertigo and was unable to rise; later he vomited three times. On admission to another hospital the same day he was found to be hypertensive. Bloody CSF was obtained by lumbar puncture, and he was referred to our hospital for evaluation for SAH. Neurological examination revealed Wallenberg's syndrome with horizontal nystagmus, Horner's sign on the right, and hypalgesia on the right side of the face and the left side of the body. Cerebral angiography confirmed a fusiform aneurysm of the vertebral artery distal to the right PICA. Since the left vertebral artery was hypoplastic, clipping of the right vertebral artery was considered impossible. Drip infusion of glycerol was begun. Although Horner's sign disappeared and nystagmus improved, the sensory disturbance remained. He was discharged on May 15, 1982, and is now working with no signs of recurrence.

**Case 4**

This 43-year-old man complained of a sudden severe headache and blurring of right vision when he was about to go to bed on December 8, 1981, and vomited once during the night. The headache persisted the following day, and he consulted his family doctor, who identified retinal hemorrhage and bloody CSF, and referred him to our hospital. Observations on admission included vitreous hemorrhage in the right eye and reduced visual acuity. Although CT disclosed no signs of

* J. Neurosurg. / Volume 61 / December, 1984 1039
SAH, cerebral angiography revealed a fusiform aneurysm. Since the PICA bifurcated at the site of the aneurysm, clipping was impossible. The patient was kept at rest and treated conservatively. When he was discharged on January 24, 1982, the only remaining deficit was the visual disturbance of the right eye. He has since regained his vision and is presently working as a bank clerk.

Case 5

This 39-year-old man experienced the onset of a severe headache when he stood on his hands on July 18, 1982, and the headache persisted. No other neurological abnormalities were present, but xanthochromic CSF obtained by lumbar puncture suggested SAH. Cerebral angiography demonstrated a fusiform aneurysm of the left vertebral artery, and the patient was immediately hospitalized. Suboccipital craniectomy on August 2 confirmed a fusiform aneurysm proximal to the PICA, and trapping was performed. A hematoma was found at the same time under the adventitia; this was responsible for the aneurysm appearing smaller on angiography.

The postoperative course was uneventful. The patient was discharged on August 21, 1982. At present he is working, and has no neurological abnormalities.

Case 6

This 58-year-old woman was found lying unconscious at about 8:30 a.m. on December 18, 1982. Although consciousness returned 2 hours later, she was restless and confused. A diagnosis of SAH was made by CT, and she was referred to our hospital.

On admission, the patient was restless and confused. She had a vitreous hemorrhage in the optic fundi. Left retrograde vertebral angiography disclosed a fusiform aneurysm of the left vertebral artery distal to the PICA, along with irregular narrowing in the artery distal and proximal to the aneurysm (Fig. 2 left). These narrowed segments were considered to be due to spasms. A headache and bradycardia with a heart rate of about 40 beats/min occurred on December 26. A pacemaker was implanted on December 28, and the headache subsided. Left-sided hemiparesis was noted on January 4, 1983, caused by a spasm in the middle cerebral artery. A CT scan suggested hydrocephalus, and a ventriculoperitoneal shunt was implanted on January 6, whereupon her neurological symptoms as well as overall physical condition began to improve. The pacemaker was removed on January 17, and the left hemiparesis disappeared 3 days later. The narrowed segments proximal and distal to the fusiform aneurysm were completely absent on a
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Fig. 2. Case 6. Serial left retrograde vertebral angiograms performed (left to right) on December 18 and 22, 1982, and January 5 and 27, 1983. The first angiogram, on the day of subarachnoid hemorrhage, showed a fusiform aneurysm and irregular narrowing on the right vertebral artery (arrow). This irregular narrowing gradually disappeared and the aneurysm became slightly larger (arrows).

Fig. 3. Case 7. Left Pair: Vertebral angiograms, lateral (left) and anteroposterior (right) views, showing a fusiform aneurysm (arrows) on the right vertebral artery. Right Pair: At autopsy the aneurysm was surrounded by clots showing the apparent site of rupture.

vertebral angiogram obtained on January 27 (Fig. 2). On February 7, suboccipital craniectomy was performed with clipping of the vertebral artery distal to the PICA.

Postoperatively, the fourth ventricle gradually became dilated, and nystagmus and truncal ataxia developed. The patient fell while walking and fractured the neck of her femur on May 6, and was treated surgically. The fourth ventricle gradually became smaller and the truncal ataxia also subsided, but the nystagmus remained. At the time of her transfer to another hospital on December 3, 1983, for rehabilitation, nystagmus was the only remaining neurological defect.

Case 7

This 58-year-old man complained of a sudden headache at night on February 24, 1983, which had resolved by the following day. He was snoring abnormally and was found to be unconscious around 3:00 a.m. on February 26. He recovered consciousness in about 30 minutes, but had a severe headache and vomited. He was admitted to a hospital on the next morning and was referred to us because of continued vomiting.

On admission, his consciousness was clear, and he had no neurological abnormalities except a stiff neck. Evidence of SAH was detected by CT. Cerebral angiography revealed a fusiform aneurysm in the right vertebral artery along with irregular narrowed segments proximal and distal to the aneurysm (Fig. 3 left pair). A moderate dilation of the ventricles was observed by CT on February 28, and ventricular drainage was scheduled. A rupture of the aneurysm occurred while he was waiting for the treatment, resulting in respiratory and cardiac arrest. In spite of resuscitation attempts, the patient died on March 1.

A blood clot was found attached to the fusiform
aneurysm on the right vertebral artery, and aneurysm rupture was confirmed at autopsy (Fig. 3 right pair). A section of the aneurysm was cut at the same angle as the anteroposterior view of the vertebral angiogram. In the dilated portion, three layers of vessel walls were almost completely destroyed and replaced by fibrins mingled with fresh blood. In a portion proximal to the aneurysm, fresh blood was present in the vessel walls, apparently due to the damaged intima and the muscularis layer (Fig. 4 left). In a magnified view of the portion, only the adventitia of the muscularis layer (which had become necrotic) remained, and the inner tissue of the layer was completely absent. In a section further proximal, signs of degenerative change in the muscularis layer were seen, including the disappearance of muscle fibers. A small number of inflammatory cells were also present (Fig. 4 right). A diagnosis of dissecting aneurysm was made from the above observations.

**Summary of Angiographic Findings**

All the seven patients reported here exhibited a fusiform aneurysm in the vertebral artery (Fig. 5). Retention of the contrast medium in the aneurysm was observed even in the late arterial and venous angiographic phases in all seven patients (Fig. 6). In four patients (Cases 1, 2, 5, and 7), the aneurysmal and genuine vascular portions of the artery were clearly differentiated, representing double (true and false) lumina (Fig. 6). In addition, five patients (Cases 2, 3, 5, 6, and 7) showed irregular narrowed segments proximal and/or distal to the aneurysms (Fig. 6 and Table 2). In Case 2, the narrowing was observable only on the initial angiogram, but a fusiform aneurysm was detected and the narrowing was absent 21 months later (Fig. 1). In Case 6, a narrowed segment was seen the day that the patient developed SAH. Its complete disappearance was confirmed about 40 days later on the follow-up angiograms (Fig. 3). These fusiform aneurysms were identified as being dissecting aneurysms from our observations of double lumina and irregular narrowed segments as well as from the pathological findings in Case 7.

**Discussion**

Recent reports on fusiform aneurysms in the vertebral artery point out that these aneurysms frequently cause SAH. They fail to note, however, that these fusiform aneurysms may be dissecting lesions. All the fusiform aneurysms in our seven patients whose initial symptoms indicated SAH were radiologically diagnosed as dissecting.

Many authors have reported dissecting aneurysms in the extracranial internal carotid artery. The middle cerebral artery is a frequent intracranial site for this type of aneurysm, but the overall incidence is far less.

Most aneurysms were diagnosed histologically until 1959 when Wolman angiographically detected and

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**TABLE 2**

*Summary of angiographic findings in this series*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Side of Aneurysm</th>
<th>Retention of Contrast Media</th>
<th>Double Lumina</th>
<th>Narrowing or Irregularity of Artery</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>rt</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>rt</td>
<td>+</td>
<td>+</td>
<td>+ (first angio.)</td>
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<td>3</td>
<td>rt</td>
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<td>-</td>
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<td>rt</td>
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<td>7</td>
<td>rt</td>
<td>+</td>
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<td>+</td>
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</tbody>
</table>

* + = feature present; — = feature absent.*

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Fig. 4. Case 7. Photomicrographs of the autopsy specimens. *Left:* Section of the aneurysm showing that three layers of vessel were almost destroyed and replaced by newly formed fibrins mixed with blood. Proximal to this, intimal and muscle layers were destroyed, and blood entered the vessel wall (arrow). Elastica-van Gieson, × 22. *Right:* Higher magnification of the section shown left indicated by the arrow. In the outermost part of the destroyed vessel wall, only the degenerated muscle layer remained. Where the three layers were identified, the muscle layer appeared somewhat degenerated, and inflammatory cells were also seen. H & E, × 55.
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Fig. 5. Angiograms, lateral view (left) and anteroposterior view (right), showing the aneurysms (arrows) in each of the seven cases.

Fig. 6. Serial angiograms for each of the seven cases showing: 1) retention of contrast medium in the aneurysm, even in the venous phase in all cases; 2) double lumina in Cases 1, 2, 5, and 7; and 3) irregular narrowing in Cases 2, 3, 5, 6, and 7. Arrows indicate the aneurysms.
histologically confirmed three cases of occlusion of the internal carotid, middle cerebral, and basilar arteries. Anderson and Schechter\(^2\) reported retention of contrast medium at the origin of the left internal carotid artery, as shown by serial angiography 3 seconds after the initial picture.

Scott, et al.,\(^3\) and Nelson\(^27\) reported an opaque area resembling a rosette. Ojemann, et al.,\(^30\) observed lumenal narrowing of a vessel due to a subintimal hematoma, and termed it the “string sign.” Subsequently, dissecting aneurysms have been diagnosed on the basis of this sign.\(^8\)-\(^11,22\) These observations, however, are not definitely indicative of dissecting aneurysms.\(^21,23\) Angiographic identification of double lumina consisting of the true vessel lumen and the subintimal false lumen seems necessary for a decisive diagnosis. Such findings have been reported\(^2,4,19,28,34\) (Fig. 7). According to Anderson and Schechter,\(^2\) the retention of contrast medium seen in the late angiographic phase was due to its influx into the intramural lumina. In 1983, Aoki\(^3\) described the same phenomenon as an “intramural pooling sign” and defined it as a diagnostic indication of arterial dissection. Sekino, et al.,\(^34\) reporting cases in which contrast medium was retained in the venous phase, stated that a distinction between true and false lumina could be achieved with double subtraction films prepared by subtracting the image of retained contrast medium in the venous phase from the subtraction film of the arterial phase.

In 1971, Kunze and Schiefer\(^19\) diagnosed a dissecting aneurysm by the greater density of contrast material in the center of a dilated middle cerebral artery surrounded by less contrast material. Grosman, et al.,\(^14\) observed a similar difference in density of contrast material and ascribed it to a detached intima. Such intimal flaps are occasionally seen on angiography. New and Momose\(^28\) detected similar intimal flaps in two cases of traumatic dissection of the internal carotid artery, and reported them with diagrams. Several additional cases have been reported thereafter.\(^5,6,11,13,29\)

Such false lumina often resemble aneurysms. In 1967, Boström and Liliequist\(^4\) observed a “pea-sized oblong bulge” in the right internal carotid artery, which grew larger 1 month later. Autopsy revealed that the bulge was fed through a 2-mm orifice via the true lumen and was located in the media of the vessel wall. This aneurysm formation was also mentioned by other authors.\(^8,9,11,15,25\) Such aneurysms may develop into large masses, which may be perfused with contrast media in the late angiographic phase.\(^11,15,20\)

In the present series, all the fusiform aneurysms were considered to be dissecting lesions because of the retention of contrast medium in the venous phase, and the presence of double lumina with clearly identifiable aneurysmal and genuine vessel portions (Fig. 8). Only six fusiform dissecting aneurysms had been found in the vertebrobasilar system\(^1,24,34,40,42,46\) before Friedman and Drake\(^10\) reported 13 cases in 1984.

Yonas, et al.,\(^46\) Takita, et al.,\(^40\) and Adams, et al.,\(^1\) confirmed dissecting aneurysms at autopsy in patients presenting with SAH. Waga, et al.,\(^42\) observed angiographically a saccular aneurysm with proximally and distally narrowed sections. The aneurysm proved to be fusiform, and at surgery the artery proximal and distal to it was not found to be narrowed, but rather dilated, and a diagnosis of dissecting aneurysm was made. Miyazaki, et al.,\(^24\) obtained angiographic images of a fusiform aneurysm with arterial narrowing proximal and distal to it, but a diagnosis of dissecting aneurysm was also made only during surgery. Thirteen cases in the series of Friedman and Drake\(^10\) were of a fusiform type (their Case 7 exhibited only a narrowed basilar artery). They diagnosed these cases by the distal narrowing on angiography and/or the presence of subadventitial hematoma at surgery. One case was diagnosed at autopsy. Sekino, et al.,\(^34\) succeeded in diagnosing dissecting an-

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**Fig. 7.** Diagnostic angiographic findings described by previous authors. a: Retention of contrast medium in the late angiographic phase (Anderson and Schechter\(^2\)). b: Flap of intimal layer (New and Momose\(^28\)). c: Outpouching of the artery (Boström and Liliequist\(^4\)). d: Double lumina as evidenced by different density of contrast material (Kunze and Schiefer\(^19\)). e: Double subtraction film technique demonstrating the distinction between true and false lumina (Sekino, et al.,\(^34\)).
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eurysms preoperatively by the double subtraction angiographic technique mentioned earlier. Our cases resembled those of Sekino, et al., in that contrast medium was retained in the aneurysm at the venous stage. If angiographic observations such as the distinction between the aneurysm and the genuine vessel, and the presence of proximal and distal narrowing of the artery (string sign) are considered in addition to the retention of contrast medium, dissecting aneurysms will be diagnosed angiographically with accuracy. These phenomena associated with dissecting aneurysms were supported histologically from the autopsy specimens in our Case 7. A fusiform aneurysm is mainly formed of fibrins mingled with fresh blood, explaining the retention of contrast medium in the venous phase of angiography. The presence in the vessel walls of blood from partially ruptured arterial intima proximal to the aneurysm may account for the narrowing observed in angiography, termed the “string sign” by Ojemann, et al.30 The identification of string signs requires special care, because they may be misdiagnosed as signs of spasm in patients with SAH.35,42,46 In our Case 6, narrowing of the artery proximal and distal to the aneurysm was observable on the day SAH developed. The irregularity of the vessel walls, which is absent in cases exhibiting spasm, was also evident. The string sign may be distinguished from ordinary vasospasm by the presence of the mural irregularity. The serial angiograms in our Case 6 (Fig. 3) and in Friedman and Drake’s Case 11 10 showed that the narrowing and irregularity of the vertebral artery gradually disappeared.

In our Case 2, narrowing of the vertebral artery was evidenced only on the first angiogram, but an aneurysm was found angiographically 21 months later (Fig. 1). Follow-up angiography is needed in such patients.

According to the review by Sekino, et al.,34 of 30 previously reported cases of dissecting aneurysm in the vertebrobasilar complex, onset of symptoms occurred at the mean age of 36.7 years, and the incidence was three times greater in men than in women. Headache was the commonest symptom in 17 patients, six of whom exhibited SAH. Disturbances of consciousness were observed in 15 patients, nine of whom died of occlusion of the basilar artery. Motor weakness was found in 10 patients, two of whom showed decerebrate rigidity. Nausea and vomiting were reported in eight. Vertigo, respiratory disturbance, double vision, and neuroparalysis were among the other symptoms. Twenty-five of the 30 aneurysms were found at autopsy to be severe. Our Cases 1, 2, and 3 demonstrated Wallenberg’s syndrome and Horner’s sign, which had not been observed in earlier studies of dissecting aneurysms. The severe narrowing observed on admission in Case 2, which was defined as the string sign, is reasonably considered to have resulted from vessel occlusion.

Friedman and Drake10 found 14 dissecting aneurysms in the vertebrobasilar system in patients presenting with SAH, as did ours. The occurrence of SAH may lead to death, as in our Case 7, and in patients presented by Takita, et al.,40 Yonas, et al.,46 and Friedman and Drake.10 To prevent rupture or dissection of aneurysms, several attempts at clipping of the artery proximal to the lesion have been reported.10,24,34,42,46 Proximal clipping in three of our patients and trapping in one proved to be effective in all cases. Although proximal clipping must be avoided if the contralateral vertebral artery is hypoplastic, wrapping with special attention to preserve the lower cranial nerve, as in the cases of Sugita, et al.,39 may be possible. Subadventitial hematomas are occasionally discovered in the aneurysmal sites during surgery.10,35,42 as in our Case 5.

Sugita, et al.,39 proposed the application of specially designed clips for fusiform aneurysms. However, because many fusiform aneurysms are of a dissecting nature, as shown in our cases, a surgical procedure for fusiform aneurysms must be determined after detailed angiographic examination.

Congenital medial defects,44 syphilitic arteritis,41 medial degeneration,10,26 cystic medial degeneration,43 arteriosclerosis,40 allergic arteritis,39 and variant periarteritis nodosa12 are among the known causative factors in the nontraumatic dissection of arterial walls. In Case 7, a degenerative change in the medial layer was observed at autopsy in the artery somewhat proximal to the fusiform aneurysm. Although the patient had been hypertensive, he was not found to be severely arteriosclerotic. The dissecting aneurysm is suspected to have developed from the degenerative changes in the medial layer.

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