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Dissecting and fusiform aneurysms of vertebro-basilar systems

MR imaging

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Summary. The magnetic resonance (MR) findings of three cases with vertebro-basilar dissecting aneurysms (DA) were compared with those of two cases with vertebro-basilar fusiform aneurysms (FA). No abnormal findings, excepting a dilatation of a signal-void area corresponding to the arterial blood flow, were shown on the MR images in the patients with a FA. In contrast to the FA cases, various abnormalities were detected by the MR studies in all three DA cases. An intimal flap and a double lumen were demonstrated in one case. An intra-mural hematoma was shown in one case. A hematoma neighboring the parent artery was demonstrated in two cases. MR imaging was thought to be useful for detecting intracranial vascular lesions, such as a DA, and for discriminating between a DA and a FA.

Key words: Dissecting aneurysm – Fusiform aneurysm – MR imaging – Vertebro-basilar system

Dissecting aneurysms (DA) and fusiform aneurysms (FA) of the vertebro-basilar systems have been thought to be rare, but recently reports of these aneurysms have increased with the progress of technique in angiography [1, 2]. The differentiation between a dissecting and a fusiform aneurysms is requisite to deciding therapy and to estimating prognosis, but it is often difficult, even if angiographies are conducted [1, 3].

Although magnetic resonance (MR) imaging has been recognized to be one of the most useful modalities for detecting abnormalities in the central nervous systems, the utility of MR imaging for intracranial vascular diseases, such as a dissecting or a fusiform aneurysm has not yet been fully investigated [4–6]. The authors reviewed the MR findings of our 3 dissecting and 2 fusiform aneurysms in the vertebro-basilar systems.

Patients and methods

The authors have treated 80 cases with vertebro-basilar aneurysm at the Gifu University Hospital in the last 17 years. Among them, there were 6 fusiform and 5 dissecting aneurysm cases, and MR imagings were conducted on 2 fusiform and 3 dissecting aneurysm cases. These 5 cases were reviewed with special reference to those MR findings.

All MR images were obtained in an untriggered multislice mode by a SIGNA system (GE, 1.5 T). Spin-echo (SE) sequences with a repetition time (TR) of 400 ms and an echo delay time (TE) of 20 ms, with a TR of 2000 ms

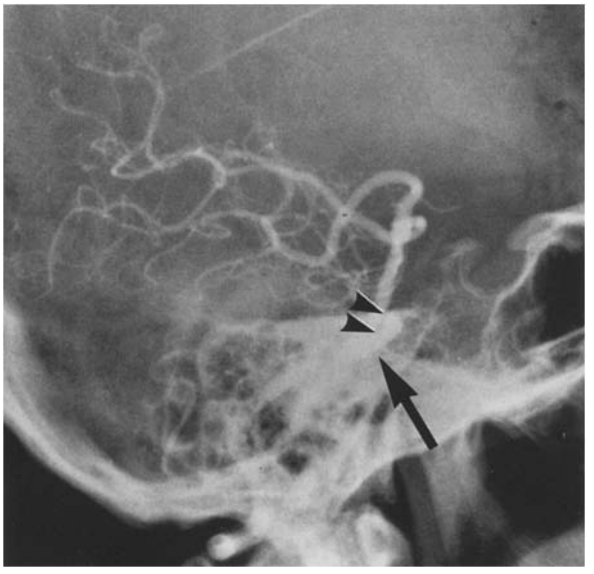


Fig. 1. Case 1. Dissecting aneurysm of the left vertebral artery. Lateral view of the left vertebral angiogram taken 3 months after the ictus demonstrating a fusiform arterial dilatation *(arrow)*. A linear defect *(arrowheads)*, suggested to be an intimal flap, is seen in the fusiform dilatation

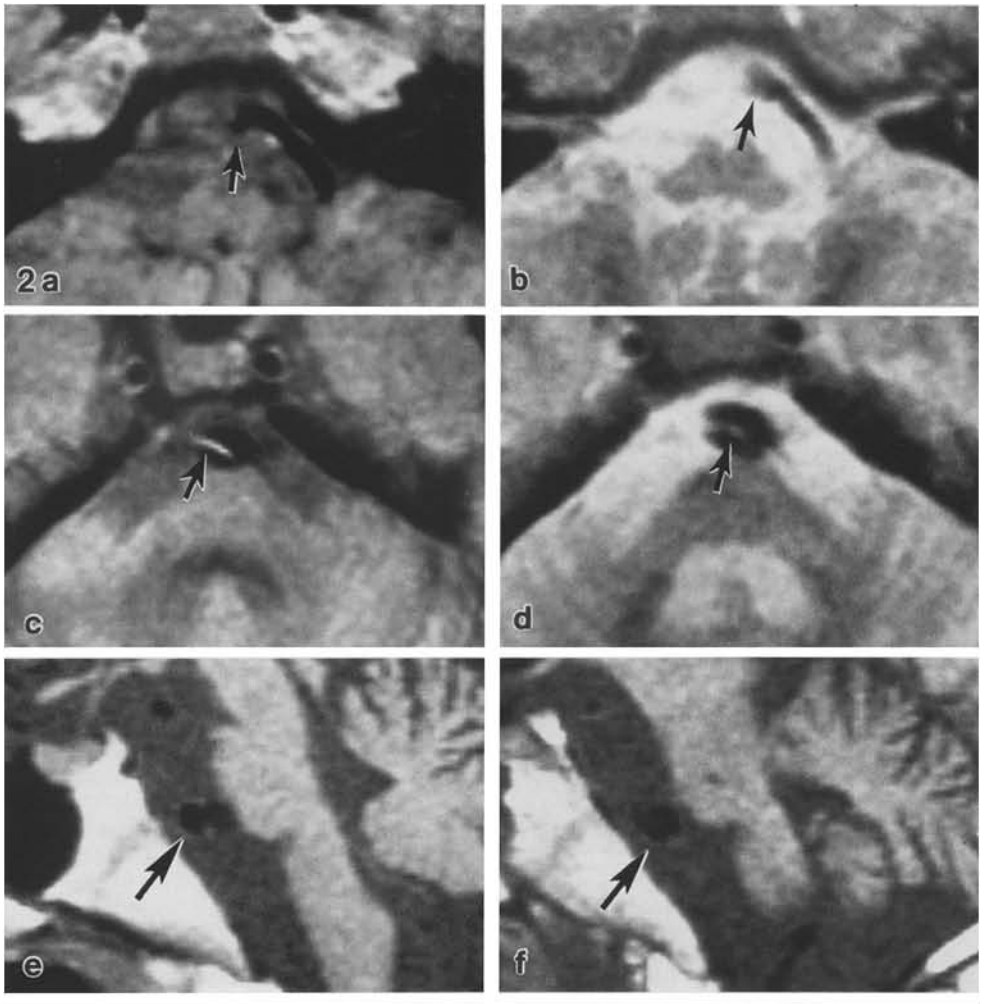


Fig. 2 a–f. Case 1. PD-weighted (**a**) and T2-weighted (**b**) axial images showing a terminal dilatation of the left vertebral artery, like a cudgel-shape, as a signal-void area *(arrows)*. A linear structure, corresponding to the linear defect demonstrated in the vertebral angiogram (**Fig. 1**), is depicted inside the dilated vessel on PD-weighted (**c**) and T2-weighted (**d**) axial images of the vertebro-basilar junction level *(arrows)*. Consecutive mid-sagittal T1-weighted images (**e, f**) demonstrate a double lumen *(arrows)*

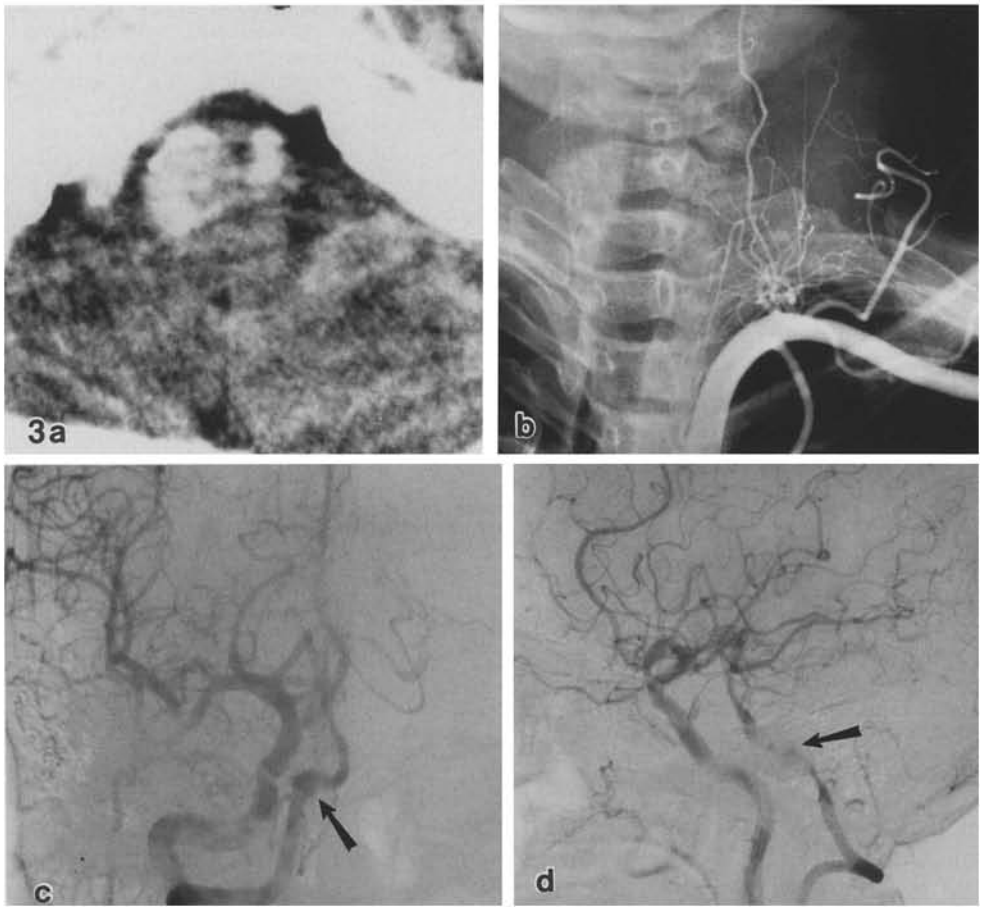


Fig. 3 a–d. Case 2. Contrast enhanced CT (**a**) depicts two hyperdense masses located ventral to the medulla oblongata. The left vertebral artery is not filled on the left vertebral angiography conducted using a trans-brachial artery method (**b**). Antero-posterior (**c**) and lateral (**d**) views of the right vertebral angiogram showing irregular narrowings accompanied by a dilatation of the right vertebral artery *(arrows)*

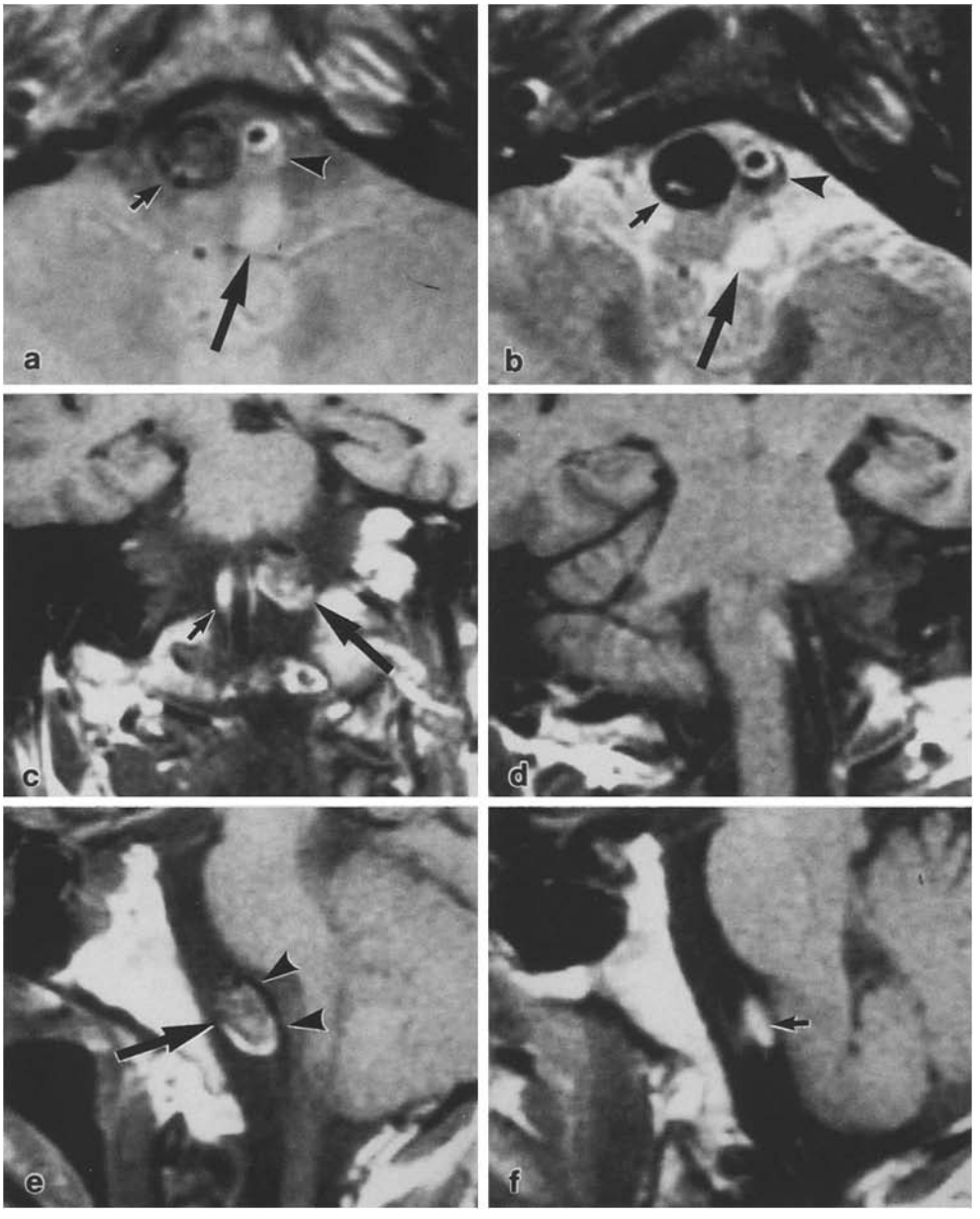


Fig. 4 a–f. Case 2. PD-weighted (**a**) and T2-weighted (**b**) axial images demonstrating two lesions in the premedullary cistern. The left lesion is seen to consist of a circle and a crescent-shaped part *(arrowheads)*. The circle is relatively thick and demonstrated as an increased intensity on both PD-weighted and T2-weighted images. The crescent-shaped part is demonstrated as being isointense on the PD-weighted image and as being hypointense on the T2-weighted image. The right lesion is larger than the left, and depicted as being hypointense with an inside vague isointensity on the PD-weighted image and an inner hyperintense spot on the T2-weighted image *(small arrows)*. Pontine infarction is seen as a hyperintense area *(large arrows)*. T1-weighted coronal (**c**) and sagittal (**f**) images at the plane including the left vertebral artery showing a thickening of the arterial wall as being hyperintense *(small arrows)*. T1-weighted coronal (**c, d**) and sagittal (**e**) images at the plane including the right vertebral artery depicting an oval mixed-intense mass *(large arrows)* located ventral to the arterial lumen *(arrowheads)*

and a TE of 30 ms and with a TR of 2000 ms and a TE of 80 ms were used for a T1-weighted image, a proton density (PD) weighted image and a T2-weighted image, respectively. Five mm thick sections with 2.5 mm spacing between adjacent sections were obtained routinely in an axial plane, and additional coronal or sagittal views were obtained when indicated.

Case reports

Case 1

A 34-year-old female with a past history of hypertension had a sudden severe headache and became unconscious. On admission to hospital, left hemiparesis and left hypoglossal nerve paresis were detected. A hypodense area was depicted in the pons on CT, and left vertebral angiogram demonstrated a fusiform dilatation with distal narrowing of the left vertebral artery. The arterial dilatation was reexamined by repeated left vertebral angiography after conservative therapy for 3 months. A linear defect, thought to be an intimal flap, was demonstrated in the aneurysmal outpouching (Fig. 1). She was diagnosed as having a dissecting aneurysm.

At MR imaging, conducted 5 years after the ictus, PD weighted and T2-weighted axial images demonstrated a curved linear structure in the dilated vertebral/basilar artery (Fig. 2 a–d). T1-weighted sagittal images depicted a double lumen (Fig. 2 e, f).

Case 2

A 49-year-old male felt dizziness and developed dyspnea and right sensory disturbance. When he was admitted to our hospital 5 days after the onset, left 7th, 9th and 10th

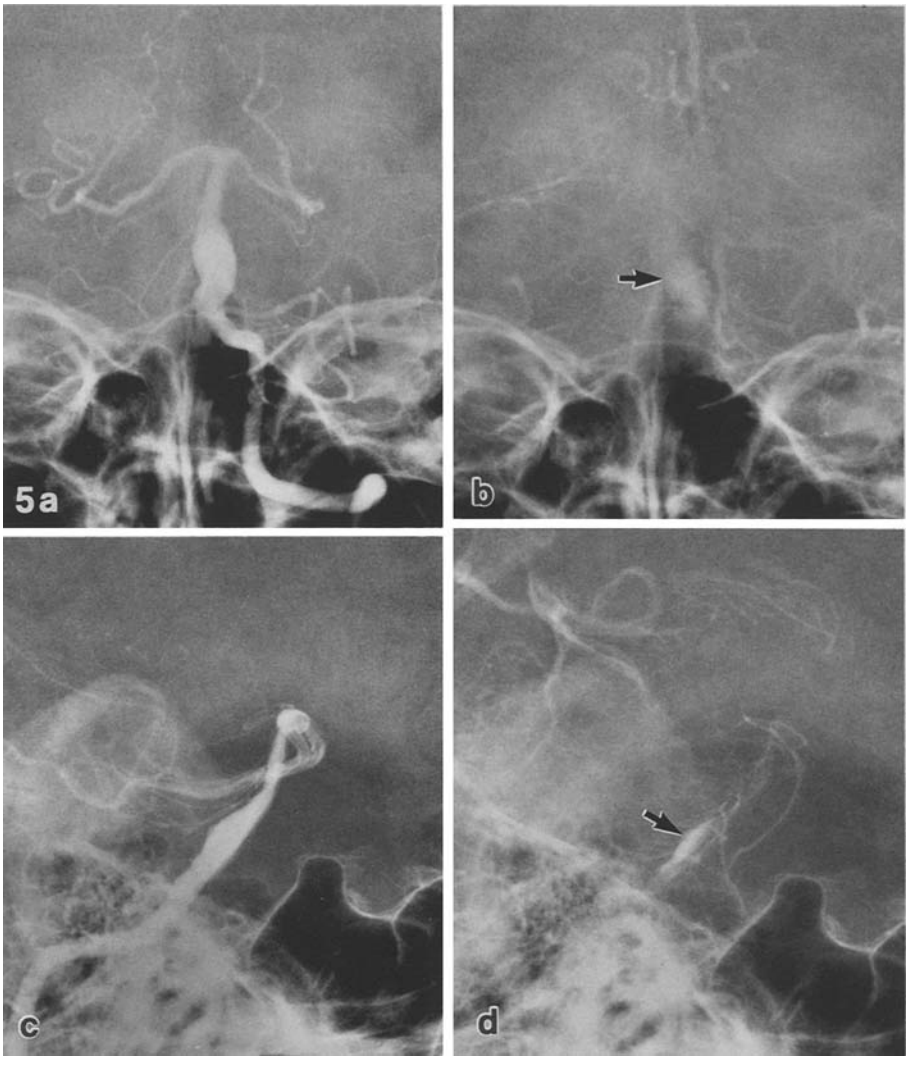
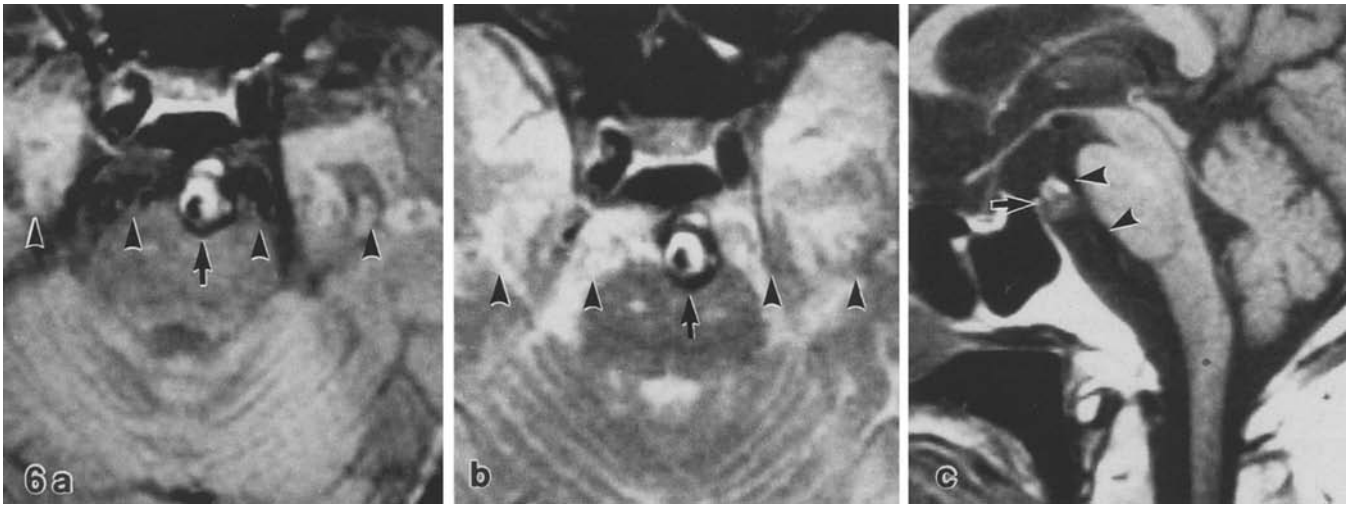


Fig. 5 a–d. Case 3. Antero-posterior (**a**) and lateral (**c**) views of the left vertebral angiogram demonstrating an irregular dilatation of the basilar artery. Retention of the contrast medium is seen in the vanous phase of the angiogram (**b, d,** *arrows*)

Fig. 6 a–c. Case 3. PD-weighted (**a**) and T2-weighted (**b**) axial images showing a circular hyperintensity surrounded by a hypointense rim *(arrows)*. A crescent-shaped hyperintensity is located ventral to the lesion. Phase-encoding artifacts (flow artifacts, *arrowheads*) indicate that the central hypointensity is flowing blood, that is true lumen of the dissecting aneurysm. T1-weighted sagittal image (**c**) demonstrating a mixed-intense oval lesion *(arrow)* located ventral to the arterial lumen (signal-void linear structure, *arrowheads*)



cranial nerve palsies, right sensory disturbance, including the face, and left Horner's syndrome were revealed. He had no headache. Two hyperdense masses were demonstrated in the ponto-medullary cistern on CT (Fig. 3 a). In spite of conducting two left vertebral angiographies using a transbrachial method, the left vertebral artery was not depicted (Fig. 3 b). Irregular narrowings and dilatations of the right vertebral and basilar arteries, the so-called "pearl and string sign", were revealed by the right vertebral angiography (Fig. 3 c, d), but retention of the contrast medium was not observed in the venous phase.

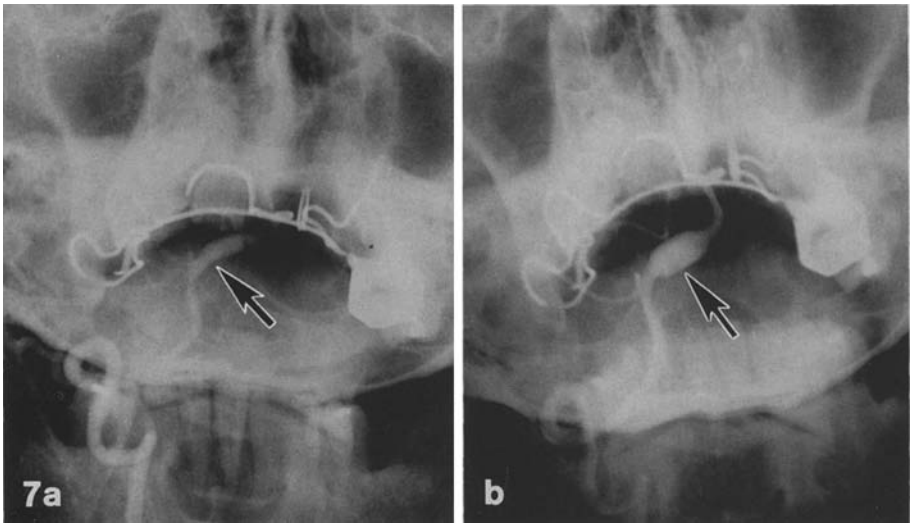
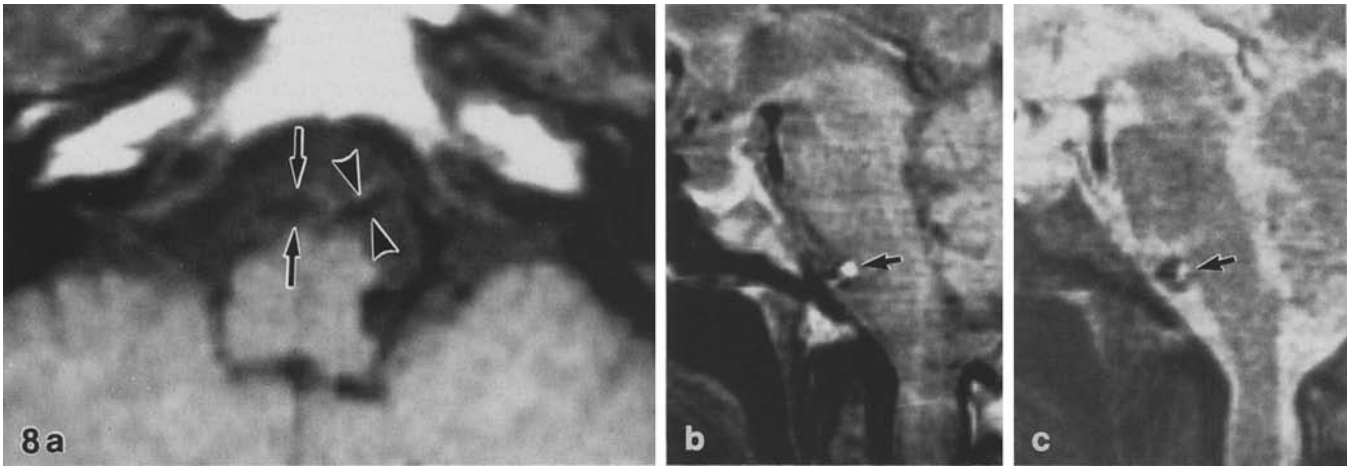


Fig. 7 a, b. Case 4. Antero-posterior view of the right vertebral angiogram taken on the 5th day after the ictus (**a**) depicting a dilatation and an irregular narrowing of the right vertebral artery *(arrow)*. Repeated angiography conducted 12 days after the ictus (**b**) reveals that the narrowing of the artery and the irregularity of the dilated arterial wall disappear and that the dilatation is enlarged *(arrow)*

Fig. 8 a–c. Case 4. T1-weighted axial image (**a**) demonstrating the inside diameter of the right vertebral artery *(arrows)* to be larger than that of the left *(arrowheads)*. PD-weighted (**b**) and T2-weighted (**c**) sagittal images, obtained in an untriggered mode using a spin-echo (SE) sequence, showing a dilatation of the right vertebral artery and hyperintense spots inside the arterial human *(arrows)*. These spots are thought to be flow-related enhancements (see text)



A MR study was conducted 7 days after the onset. PD-weighted and T2-weighted axial images demonstrated two round structures ventral to the medulla oblongata (Fig. 4 a, b). The left one was a hyperintense circle accompanied by a crescent-shaped isointense area on the PD-weighted image and a hypointense area on the T2-weighted image. The right one was a hypointense circle including an isointense part on the PD-weighted image and a hyperintense spot on the T2-weighted image. T1-weighted coronal and sagittal images revealed the left lesion as a hyperintense thickening of the left vertebral artery wall (Fig. 4 c, f). The right lesion was demonstrated as a mixed-intensity oval structure surrounded by a hyperintense rim (Fig. 4 d, e). These findings were thought to indicate that the left vertebral artery lesion was a subacute intra-mural hematoma and that that of the right vertebral artery was a chronic hematoma.

Case 3

A 74-year-old male developed left motor weakness, and was admitted to our hospital. On CT, a hyperdense mass was demonstrated in the prepontine cistern. Multiple lacunar infarctions were also revealed bilaterally in the cerebral hemispheres. A left vertebral angiography and MR imaging were conducted 3 months after the onset. The angiogram depicted a fusiform dilatation of the basilar artery (Fig. 5 a, c), and retention of the contrast medium was observed in the dorsal part of the dilatation in the venous phase (Fig. 5 b, d). A T1-weighted sagittal image demonstrated the basilar artery as a linear signal-void and an irregular hyperintense mass ventral to the basilar artery (Fig. 6 c). PD-weighted and T2-weighted axial images depicted a circular hyperintensity surrounded by a hypointense rim (Fig. 6 a, b). A hyperintense crescent-shaped lesion was seen next the rim and ventral to it. A central hypointense area surrounded by the circular hyperintensity was thought to be the true lumen, because of the existence of a phase-encoding artifact (flow artifact, arrowheads in Fig. 6 a, b). The dissecting lumen (false lumen) demonstrated by the left vertebral angiography was not visible on the MR images.

Case 4

A 45-year-old female had a sudden severe headache. She developed a consciousness disturbance and consulted a doctor. A subarachnoid hemorrhage (SAH) was demon-

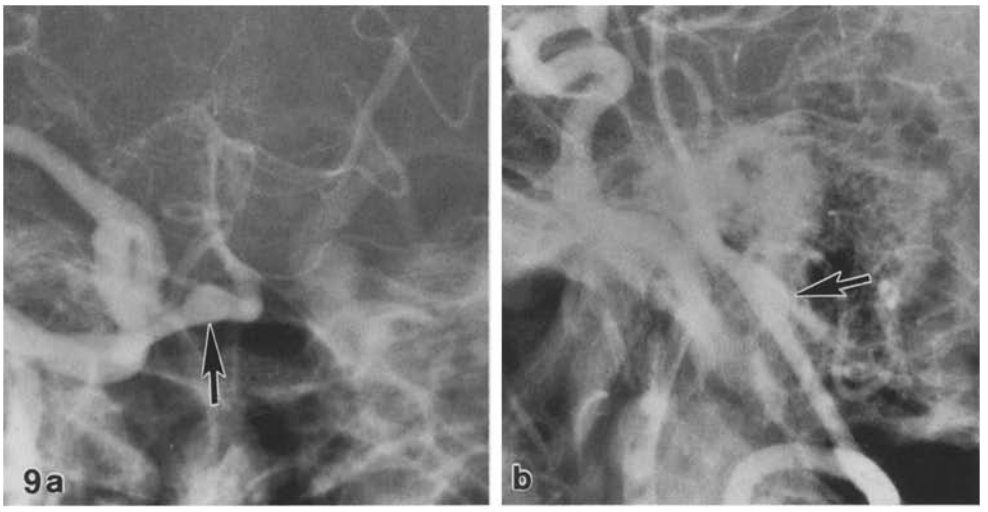


Fig. 9 a, b. Case 5. Antero-posterior (**a**) and lateral (**b**) views of the right vertebral angiogram demonstrating a smooth dilatation of the right vertebral artery *(arrows)*

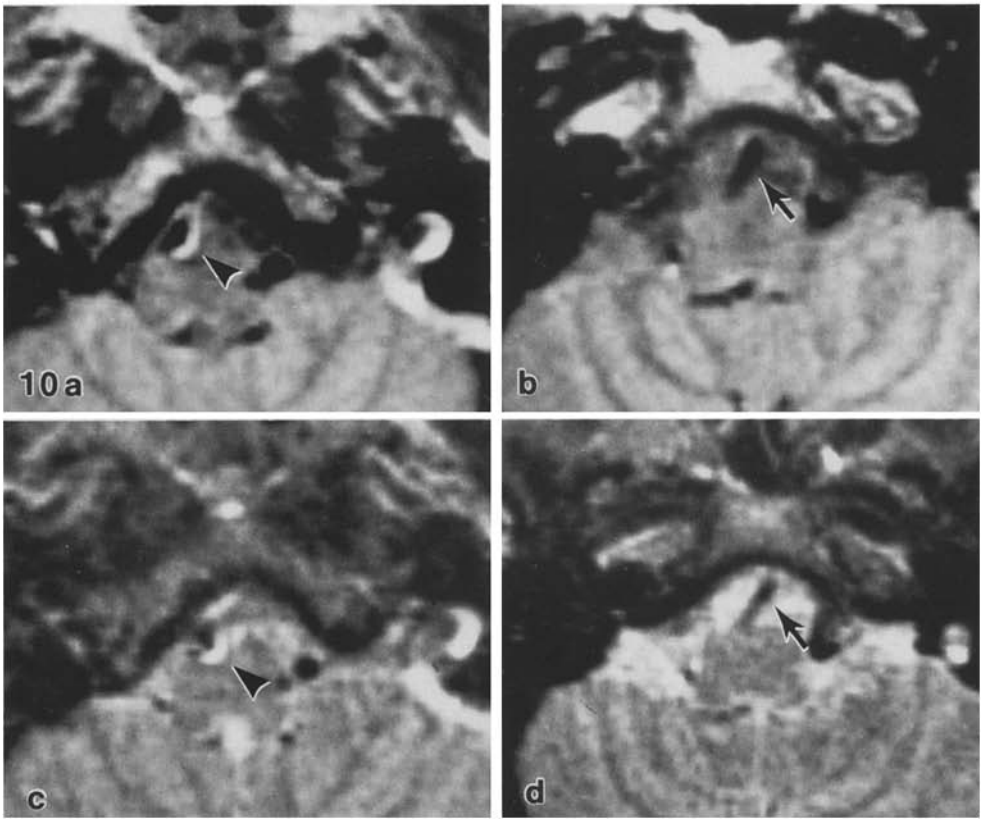


Fig. 10 a–d. Case 5. PD-weighted (**a, b**) and T2-weighted (**c, d**) axial images showing a dilatation of the right vertebral artery (**b, d,** *arrows*). Arcuate hyperintensities on the medial part of the right vertebral artery (**a, c,** *arrowheads*) are thought to be misregistrated flow-related enhancements (see text)

strated on a CT taken immediately after the consultation. A fusiform dilatation of the vertebral artery with distal and proximal irregular narrowing was revealed by a right vertebral angiography conducted on the 5th day after the ictus (Fig. 7 a). But retention of the contrast medium in the arterial dilatation was not observed in the venous phase. The narrowings and irregularity of the wall of the arterial dilatation disappeared on a right vertebral angiogram taken on the 12th day after the ictus (Fig. 7 b). The lesion was diagnosed as a fusiform aneurysm of the right vertebral artery. She was treated conservatively and has not suffered a rebleed for 4 years.

A MR image obtained 3.5 years after the ictus demonstrated the right vertebral dilatation as a widening of a signal-void area (Fig. 8). Hyperintensities shown inside the lumen on the sagittal images were thought to be flow-related enhancements caused by unsaturated blood protons entering the plane.

Case 5

A 55-year-old female had a sudden headache. A CT obtained on the 5th day after the onset revealed that there was a severe SAH in the posterior fossa. A right vertebral angiogram taken 9 days after the onset demonstrated a fusiform aneurysmal dilatation with a distal narrowing at the junction of the right

vertebral and posterior inferior cerebellar arteries, but retention of the contrast medium in the venous phase was not seen on the angiogram (Fig. 9). She was treated conservatively, and her symptoms disappeared within 4 weeks.

PD-weighted and T2-weighted axial images taken 4 years after the onset demonstrated a dilated arterial lumen (Fig. 10). Arcuate increased signals seen on the medial side of the artery were thought to be flow-related enhancements and misregistrations caused by obliquely flowing unsaturated blood protons within the plane (Fig. 10 a, c).

Summary of MR findings

Some abnormality was demonstrated on the MR images of each dissecting aneurysm. The curved linear structure, shown on the axial MR images of case 1, was thought to be an intimal flap upon consideration of the angiographic findings. A double lumen of the vertebral artery was also seen in the sagittal images in case 1. The lesions depicted on the MR images of cases 2 and 3 were thought, after consideration of the time between the ictus and the MR, and from the T1- and T2-weighted images, to be subacute or chronic hematomas.

In both fusiform aneurysms, dilatation of the signal-void area corresponding to arterial blood flow was seen on the MR images, but other abnormalities, such as hematomas, were not seen. Hyperintensities, seen in the arterial lumen on the MR images taken in the plane transverse to the blood flow, were thought to be flow-related enhancements.

Discussion

Recently, reports of dissecting and fusiform aneurysms of the vertebro-basilar systems have increased with the progress of angiographic technique [1, 2]. Although the symptoms and angiographic findings of dissecting and fusiform aneurysms have been described as being different in typical cases, discrimination between them is often difficult [1, 3, 7, 8]. The distinction is important, because their treatment is different.

Magnetic resonance imaging has been recognized as having considerable ability to demonstrate intracranial and cardio-vascular lesions. Aortic dissections have been reported on MR images [9, 10]. MR images of a dissecting aneurysm arising from the extracranial carotid artery have been reported previously [4, 5], but reports of MR findings of intracranial dissecting and fusiform aneurysms have been rare [6].

The number of cases reviewed in this report is small, but some abnormality of the vessel was detected on the MR images of all dissecting aneurysm cases. On the other hand, no abnormal findings, excepting a dilatation of signal-void area corresponding to the arterial blood flow,- were shown on the MR images of the fusiform aneurysm cases. In the dissecting aneurysm cases, MR demonstrated a double lumen, an intimal flap, an intra-mural hematoma and a hematoma adjacent to the artery. A double lumen or an intimal flap is thought to be pathognostic of dissecting aneurysm. This, it is thought, being the first report of a demonstration of such by MR imaging. Waespe et al. reported that T1-weighted images revealed increased signal intensity in the wall of the internal carotid artery in which a dissecting aneurysm was demonstrated by angiography [4]. Rothrock et al. also reported that MR imaging demonstrated an intramural hematoma in a patient with an extracranial carotid dissection [5]. In case 2, although the repeated left vertebral angiographies did not depict the left vertebral artery or the arterial dissection, the lesion was suspected of being a dissecting aneurysm from the MR finding of an intra-mural hematoma. Intra-mural hematomas and thickening of the arterial wall are not pathognostic, but are thought to be important signs indicating the existence of an arterial dissection [5]. It was not possible to decide whether hematomas demonstrated to be adjacent to the parent arteries were intra-mural or extra-mural in cases 2 or 3. But we suggest that these hematomas were intra-mural, because their margins on the MR images were sharp. Future pathological studies may provide the knowledge that may enable us to confirm this, but, certainly a hematoma adjacent to the parent artery might be one of the indirect signs of a dissecting aneurysm.

Flow-related effects have been studied by several authors [11–13]. Both decreased and increased signal intensities caused by flow are seen on MR images [11–13]. When images are obtained in a multi-slice mode in the plane transverse to a vessel, a hyperintensity is often seen in or close to the vessel [11–13]. Especially, when the flow is oblique to the image plan, the flow effect is misregistered along the read-gradient axis and occasionally seen over the vessel wall [13]. It is always important to decide whether the hyperintensity is a lesion or a flow-related enhancement.

In conclusion, MR imaging is thought to be one of the most useful modalities for detection of an intracranial dissecting aneurysm and for distinction from a fusiform aneurysm. Small dissecting lumens are not demonstratable on MR images, but large dissections are to some degree depicted as double lumens and diagnosed only by MR imaging. Observation of an intimal flap is also thought to be a pathognostic sign. A thickening of the arterial wall or a hematoma adjacent to the parent artery might be a sign indicating a high probability that the lesion is a dissecting aneurysm. The MR findings of hematomas and flow-related effects, often seen in MR images of DA and FA cases, have to be carefully interpreted, because these findings change in accordance with the mode or a pulse sequence used for MR imaging and duration between the onset of the disease and the MR study [11–14].

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References

1. Yonas H, Agamanolis D, Takaoka Y, White RJ (1977) Dissecting intracranial aneurysm. Surg Neurol 8: 407–415
2. Berger MS, Wilson CB (1984) Intracranial dissecting aneurysms of the posterior circulation: report of six cases and review of the literature. J Neurosurg 61: 882–894
3. Miyazaki S, Yamaura A, Kamata K, Fukushima H (1984) A dissecting aneurysm of the vertebral artery. Surg Neurol 21: 171–174
4. Waespe W, Niesper J, Imhof H, Valavanis A (1988) Lower cranial nerve palsies due to internal carotid dissection. Stroke 19: 1561–1564
5. Rothrock JF, Lim V, Press G, Gosink B (1989) Serial magnetic resonance and carotid duplex examinations in the management of carotid dissection. Neurology 39: 686–692
6. Frank E, Brown BM, Wilson DF (1989) Asymptomatic fusiform aneurysm of the petrous carotid artery in a patient with von Recklinghausen's neurofibromatosis. Surg Neurol 32: 75–78
7. Shimoji T, Bando K, Nakajima K, Ito K (1984) Dissecting aneurysm of the vertebral artery: report of seven cases and angiographic findings. J Neurosurg 61: 1038–1046
8. Shokunbi MT, Vinters HV, Kaufman JCE (1988) Fusiform intracranial aneurysms: clinicopathologic features. Surg Neurol 29: 263–270
9. Akins EW, Hill JA, Carmichael MJ (1987) MR imaging of blood pool signal variation with cardiac phase in aortic dissection. J Comput Assist Tomogr 11: 543–545
10. Rumancik WM, Naidich DP, Chandra R, Kowalski HM, McCauley DI, Megibow AJ, Hernanz-Schulman M, Genieser NB (1988) Cardiovascular disease: evaluation with MR phase imaging. Radiology 166: 63–68
11. Bradley WG, Waluch V, Lai K, Fernandez EJ, Spalter C (1984) The appearance of rapidly flowing blood on magnetic resonance images. AJR 143: 1167–1174
12. Bradley WG, Waluch V (1985) Blood flow: magnetic resonance imaging. Radiology 154: 443–450
13. Von Schulthess GK, Higgins CB (1985) Blood flow imaging with MR: spin-phase phenomena. Radiology 157: 687–695
14. Gomori JM, Grossman RI, Goldberg HI, Zimmerman RA, Bilaniuk LT (1985) Intracranial hematomas: imaging by high-field MR. Radiology 157: 87–93

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