Rotational obstruction of nondominant vertebral artery and ischemia

Case report

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A 70-year-old man presented with repeated vertebrobasilar insufficiency for 3 years. Four-vessel angiography revealed complete occlusion of the nondominant left vertebral artery on head turning to the right. Three-dimensional computerized tomography angiography demonstrated atlantoaxial joint dislocation when the head was turned to the right, in accordance with simultaneous occlusion of the left vertebral artery caused by stretching of the artery at C1–2. After posterior fixation of C1–2 by a Halifax interlaminar fixation system, the patient had no further episodes. Hemodynamic function associated with nondominant vertebral artery occlusion contributed to the symptoms in this case.

KEY WORDS • three-dimensional computerized tomography angiography • rotational vertebral artery occlusion • posterior fixation • atlantoaxial dislocation

Vertebral artery occlusion, or stenosis, may lead to brainstem ischemia or vertebrobasilar insufficiency requiring treatment. In the literature, most cases with angiographic evaluation have shown dominant vertebral artery occlusion or stenosis. The degree of head rotation giving rise to clinical symptoms, however, has not yet been quantitatively measured.

We report a case with repeated episodes of vertebrobasilar insufficiency produced by nondominant vertebral artery occlusion, which completely disappeared after posterior C1–2 fixation. The occlusion site and the degree of head rotation were clearly shown by three-dimensional computerized tomography (3D-CT) angiography, which provides forward subluxation of the atlas on the axis.

Case Report

This 70-year-old man was admitted to our clinic for evaluation of repeated episodes of vertebrobasilar insufficiency. Beginning in January 1993, the patient had suffered from vertigo and nausea when turning his head to the right with the neck hyperextended. The patient regained consciousness within a minute without any neurological deficit. Following his initial episode, the patient’s vertigo and unconsciousness increased to several times a day, interfering with his daily activities.

Examination. Routine roentgenographic examinations revealed a narrow cervical spinal canal without anomaly of the atlantoaxial joint, including the os odontoideum (Fig. 1). Arteriography demonstrated left vertebral artery occlusion on turning the head to the right at 70°, at which point vertigo regularly occurred (Fig. 2 left). Arteriography revealed that the right vertebral artery was larger in diameter than the left in the neutral position (Fig. 2 center). On turning the head to the left to the same degree, the vertebral artery showed no blood flow compromise (Fig. 2 right). Selective vertebral arteriography revealed that the left posterior inferior cerebellar artery was filled only from the left vertebral artery (Fig. 3).

Second Admission. The patient was followed as an outpatient until December 1993 when he was readmitted to our clinic with increased episodes of vertebrobasilar insufficiency associated with perioral and tongue numbness. A left vertebral arteriogram with a flow dynamics study in-
cluded a graded neck motion stability, ranging from 15° to 60°. At 15° neck rotation, no significant stenosis occurred (Fig. 4 left). Stenosis at the C1–2 junction became significant at 30° of neck rotation (Fig. 4 center). At 60°, complete obstruction was demonstrated at this junction (Fig. 4 right), and the patient complained of vertigo. Contrast-enhanced 3D-CT angiography was obtained by injecting the medium through the catheter placed at the origin of the left vertebral artery (Fig. 5). At 45° rotation to the right, the left vertebral artery became severely stenotic between the C-1 and C-2 segments with anterior displacement of the atlas over the axis (Fig. 5 center and right).

**Operation.** Because frequent vertebrobasilar insufficiency interfered with the patient’s daily living activities, he underwent posterior C1–2 fixation using a Halifax interlaminar clamp system. After the operation, the patient experienced no further attacks of vertigo or unconsciousness.

**Discussion**

Unilateral vertebral artery occlusion may lead to vertebrobasilar insufficiency when the contralateral vertebral artery blood flow is already compromised. A cervical anomaly such as os odontoideum may frequently be a contributing factor in these cases presenting with ischemic episodes induced by mechanical occlusion or stenosis of the vertebral artery. Studies on cadavers have demonstrated that head rotation causes narrowing of the contralateral vertebral artery at the C1–2 level. Husni and Storer reported a series of 23 patients with vertebrobasilar insufficiency induced by rotational occlusion of one vertebral artery, in whom the opposite vertebral artery was hypoplastic in 22 and narrowed at its origin in one. All previously reported surgically treated cases had the vascular compromise on the dominant vertebral artery. The present case, therefore, is the first in which the nondomi-
Rotational obstruction of the vertebral artery

Fig. 5. Three-dimensional computerized tomography angiography with contrast injection in the left vertebral artery. Left: Neutral position. Center: Head rotation to the right at 45°. The atlas displaced anteriorly over the axis on the left clearly demonstrating simultaneous stenosis of the vertebral artery at C1–2. Right: Head rotation at the same degree. Atlantoaxial articulation is seen from below, revealing slippage of the atlas over the axis more clearly.

nant vertebral artery is implicated as the cause of vertebrobasilar insufficiency.

Although head rotation is an important factor in the development of vascular compromise, little attention has been paid to the degree of head rotation. Grossmann and Davis reported a patient manifesting an embolic stroke after the head was replaced in a neutral position from a 60° turn to the right. In this particular case, the left vertebral artery was totally occluded at the C1–2 level when the head was turned approximately 60° to the right. When the head was placed in the neutral position, stagnant blood in the distal lumen of the occluded site migrated to the basilar system as an embolic source. In a radiographic study of the vertebral arteries in cadavers, complete occlusion of one vertebral artery was induced in five of 41 cases by setting the head position rotated 90° to one side with the neck extended.

Three-dimensional computerized tomography angiography demonstrates the bone structures and blood flow simultaneously. This technique has the additional advantage of presenting blood flow changes in accord with dynamic changes in the bone structures such as cervical vertebrae. The ipsilateral atlantoaxial articulation is fixed during rotation of the head, whereas the atlas moves both downward and forward in relation to the axis on the opposite side. In this case, such movement was clearly shown (Fig. 5). The hypothesis that stretching of the vertebral artery associated with this movement at the atlantoaxial joint may produce narrowing or occlusion of the artery has also been validated with this 3D-CT technique.

We would like to emphasize that nondominant vertebral artery occlusion may lead to ischemia, which contributes to clinical manifestations. Excessive head rotation, as reported by Sorensen, is not the only cause of occlusion of the vertebral artery; moderate rotation is also responsible for clinically significant vertebral artery stenosis or occlusion in some cases.

References

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