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Calcification of the Vertebral Artery

Kazuhiro Katada,[1] Tetsuo Kanno,[1] Hirotoshi Sano,[1] Yoichi Shinomiya,[1] and Sukehiko Koga[2]

A series of 3,648 computed tomographic (CT) scans was reviewed to determine the incidence of intracranial vertebral artery calcification. Calcification was identified in one or both vertebral arteries in 3.4% and was more frequent in the higher age groups. Skull radiographs demonstrated vertebral artery calcification in only one of 48 patients in whom CT studies showed it. A high correlation was observed between vertebral artery calcification on CT and vertebral artery stenosis on cerebral angiography.

Calcification of arterial walls demonstrated on plain radiographs is considered a reliable sign of atherosclerosis. Much has been written regarding the incidence and significance of calcification of the carotid siphon [1, 2], but no report has been published concerning the incidence of radiologic detection of intracranial vertebral artery calcification.

Computed tomography (CT) exceeds conventional skull radiography in the detection of calcified structures [3]. The purpose of this paper is to demonstrate the greater sensitivity of CT in the detection of vertebral artery calcification as compared with conventional skull radiography and to determine the incidence and the clinical significance of this finding.

Materials and Methods

Of 5,525 cranial CT scans obtained in a 32 month period, 3,648 met the following two criteria: (1) entire posterior fossa was examined, including the level of the foramen magnum, and (2) images were of good quality without motion artifact. Most of the scans were obtained using a Hitachi CT-HF unit (second-generation type) with a 256 × 256 matrix, 120 kVp/25 mA, 48 sec scan time, and 10 mm collimation. Hitachi CT-H (first-generation) and CT-W3 (third-generation) scanners were also used on some patients.

Calcification of the intracranial vertebral artery was identified on plain CT studies. The incidence of the calcification was evaluated in relation to age and gender of the patient. The shape and location of vertebral artery calcification were also studied. In patients with vertebral artery calcificaton on CT, plain skull films, complex motion tomograms, and vertebral angiograms were reviewed as were clinical signs and symptoms. Postmortem examination was performed in one patient.

Results

Vertebral artery calcification was identified in 123 patients (3.4%). There were 78 males and 45 females in this group, but there was no significant difference in incidence between males (3.6%) and females (3.1%) in the population of patients who had CT scans.

The relation between age and incidence of vertebral artery calcification is shown in table 1; high correlation was noted between these two factors. Vertebral artery calcification was not found in patients under 40 years of age. It began to appear in the fifth decade of life, and its incidence increased with age thereafter.

Most of the calcifications were found at the level of the foramen magnum, but a few were at craniocervical junction and a few were located more distally in the vertebral artery. In eight cases, the calcification extended upward to involve the basilar artery. The lesion was unilateral in 90 patients and bilateral in 33. The left vertebral artery (88 cases) was more frequently involved than the right (68 cases). The shape of the calicification varied widely; spotty, linear, nodular, circular, and tubular calcifications were noted.

Of the 123 patients with vertebral artery calcification, 48 had had plain skull films. These consisted of 47 straight anteroposterior, 46 lateral, five Towne, and two axial projections. Vertebral artery calcification was detected in only one patient who demonstrated massive calcification of the right vertebral artery on a Towne projection. Complex motion tomograms were obtained in three patients; none of these demonstrated the calcification.

Of the 123 patients with vertebral artery calcification, 19 vertebral angiograms were obtained in 17 patients. Stenosis or wall irregularity of the vertebral artery was identified in 14 arteries and occlusion in four. Only one artery appeared normal on the arteriogram.

From the clinical analysis of 123 patients, 41 were considered to have signs and symptoms related to the vertebrobasilar circulation. These included 10 patients with transient ischemic attacks, 20 with major strokes of the brainstem and cerebellum, and three with homonymous hemianopsias. Signs and symptoms not related to vertebrobasilar circulation were shown by 65. In another 14 pa-

TABLE 1: **Incidence of Vertebral Artery Calcification on CT**

Age Range (years)	No. of CT Scans	
	Totals	With Calcification (%)
40–49	586	4 (0.7)
50–59	666	17 (2.6)
60–69	546	43 (7.9)
70–79	357	52 (14.6)
80 +	42	7 (16.7)
Totals	3,648*	123 (3.4)

* Includes the 1,451 scans of patients 0–39 years of age in whom no calcifications were seen.

[1] Department of Neurosurgery, Fujita-Gakuen University School of Medicine, Toyoake, Aichi 470-11, Japan. Address reprint requests to K. Katada.
[2] Department of Radiology, Fujita-Gakuen University School of Medicine, Toyoake, Aichi 470-11, Japan.

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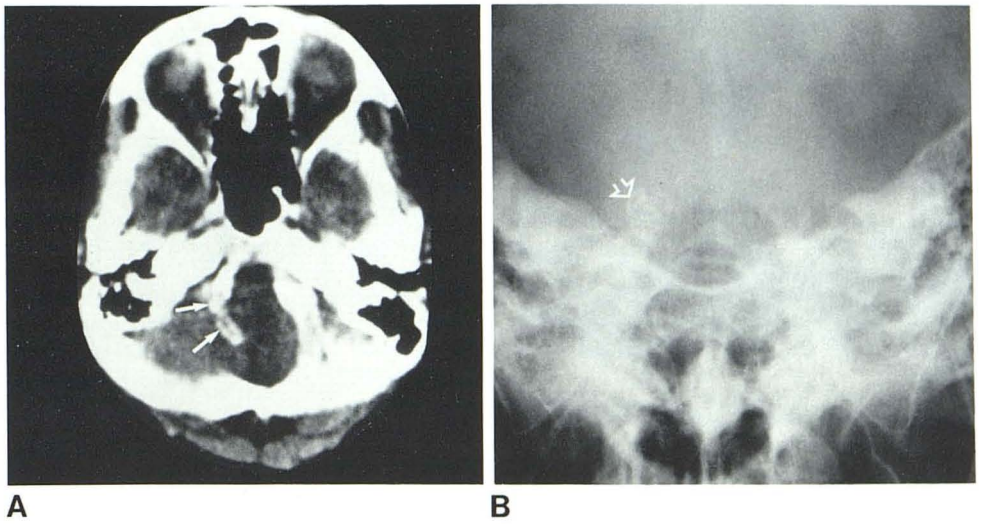


Fig. 1.—Case 1. **A**, Noncontrast CT. Tubular calcification of right vertebral artery (*arrows*). **B**, Towne projection. Nodular calcification at medial aspect of right petrous pyramid (*arrow*).

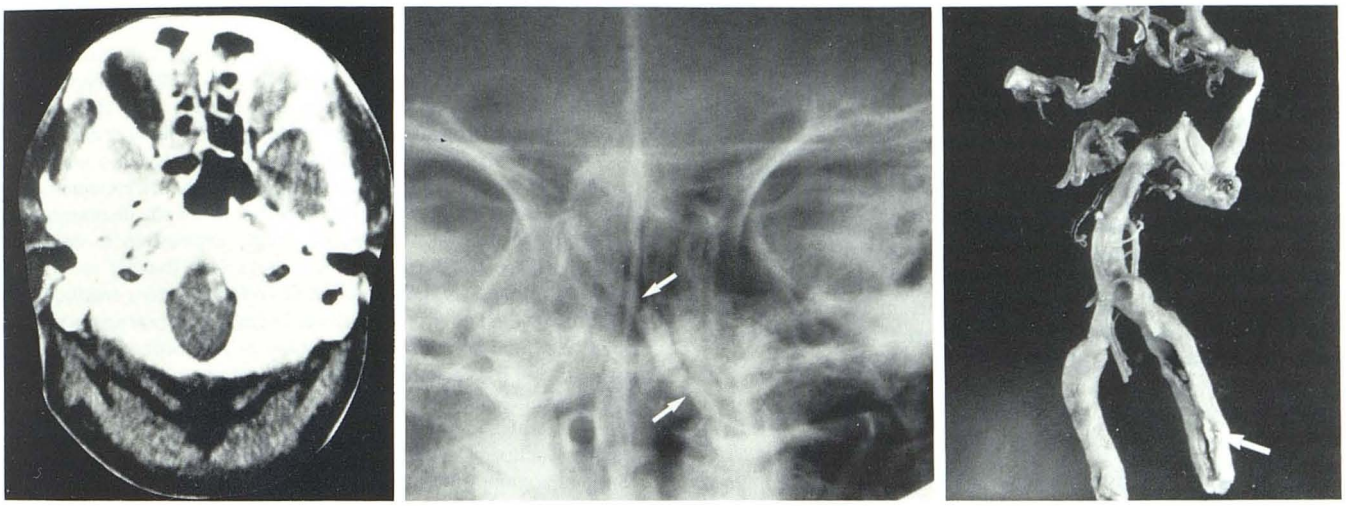


Fig. 2.—Case 2. **A**, Noncontrast CT. Tubular calcification of left vertebral artery. **B**, Left retrograde brachial angiogram, 7 sec after injection, anteroposterior projection. Multiple stenosis of terminal vertebral artery (*arrows*) with slowing of circulation. **C**, Autopsy specimen of basal cerebral arteries. Left vertebral artery was dissected. Massive deposit of lime in intima of artery (*arrow*).

tients, it was difficult to judge whether the signs and symptoms were related to the vertebrobasilar circulation or not. Of the 41 cases with vertebrobasilar symptoms, nine demonstrated infarcts in the brainstem and/or cerebellum on CT. Moderate to severe degrees of cerebellar and/or brainstem atrophy were identified on CT in nine patients, while 19 showed only mild atrophy and five appeared to have a normal posterior fossa on CT.

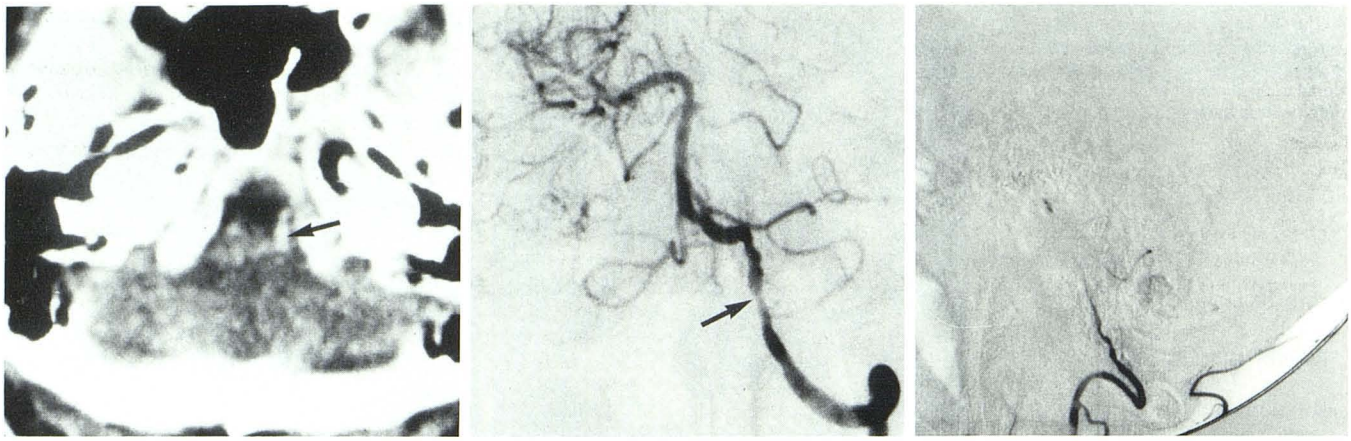
Representative Case Reports

Case 1

A 66-year-old woman had a gradual onset of vertigo and ataxia. CT of the posterior fossa revealed tubular calcification of the right vertebral artery (fig. 1A). Skull radiographs showed curvilinear calcification in both carotid siphons. A Towne projection revealed nodular calcification in the posterior fossa on the right (fig. 1B).

Case 2

A 71-year-old man with a history of recurrent transient attacks of left hemiparesis was admitted having lost consciousness and urinary continence. Physical examination revealed left hemiparesis, left mydriasis, skew deviation of the eyes, and absence of doll's-eye head movement. CT 3 hr after onset showed tubular calcification of the left vertebral artery (fig. 2A), but no abnormality was found in the brain parenchyma. Skull films were negative. The patient was treated conservatively, and follow-up CT 9 days after onset showed a large low-density area in the brainstem, predominantly on the left. Left transbrachial retrograde vertebral arteriography showed multiple areas of stenosis of the left vertebral artery in its terminal portion with marked slowing of the circulation (fig. 2B). The patient died, and postmortem examination confirmed massive calcification in the intima of the left vertebral artery as well as diffuse narrowing of the arterial lumen (fig. 2C).



A B C

Fig. 3.—Case 3. **A**, Noncontrast CT. Linear calcification of left vertebral artery was identified (*arrow*). **B**, Left vertebral angiogram, anteroposterior projection. Focal stenosis of left vertebral artery (*arrow*). **C**, Left vertebral angiogram 3 years later, lateral projection. Terminal part of left vertebral artery is occluded.

Case 3

A 55-year-old man had gradual onset of left hemiparesis 1 month before admission. CT showed a low-density area in the right middle cerebral artery territory and linear calcification of the left vertebral artery (fig. 3A). Carotid angiography revealed occlusion of the right internal carotid artery. Localized stenosis of the left vertebral artery was identified on a vertebral angiogram (fig. 3B), but the patient had no signs and symptoms related to the vertebrobasilar circulation. The patient remained stable for the next 3 years but then suddenly developed vertigo, vomiting, and loss of consciousness, following which CT demonstrated a brainstem infarct. On angiography, the left vertebral artery, which was patent on previous examination, was found to be occluded (fig. 3C).

Discussion

It is generally accepted that atheromatous plaque in the intima or media of a cerebral artery is often associated with radiologically detectable calcification [1]. Calcification of the carotid siphon is readily recognized on skull radiographs [1, 2], but calcification of the intracranial vertebral artery is difficult to detect due to the overlap of dense petrous bones and air-filled sinuses.

CT can avoid the interference of overlying petrous bones by means of axial sections. Another advantage of CT is its superior sensitivity for detection of calcified structures. Norman et al. [3] reported that CT is five to 15 times more sensitive than skull radiography in the detection of intracranial calcification. For the above reasons, we believe that CT offers the potential for noninvasive detection of atheromatous calcification in the intracranial vertebral artery. This report is, to our knowledge, the first trial dealing with the incidence of radiological detection of vertebral artery calcification by CT.

It is evident that vertebral artery calcification can be readily detected by cranial CT. It was identified on plain CT as a high-density abnormality of varying size and shape located near the foramen magnum. The diagnosis is not difficult when the lesion is seen along the expected course of the vertebral artery, but when in doubt contrast enhancement is useful to determine the anatomic location.

Vertebral artery calcification was found not to be a rare occurrence on cranial CT, particularly in older patients. It was detected in more than 15% of patients over 70 years of age. A high degree of correlation between incidence and patient age supports the impression that the calcification is atherosclerotic in origin.

Since this study was performed retrospectively, the number of patients with concomitant skull radiography is small. However, even with our limited experience, it is clear that small calcifications in the intracranial vertebral arteries are nearly impossible to detect by means of skull radiographs. Thus, we believe that CT is the most effective method for the detection of vertebral artery calcification.

Although the importance of extracerebral vertebral artery involvement has been emphasized in studies of vertebrobasilar occlusive disease [4–7], involvement of the terminal segment of the vertebral artery by atherosclerosis is not rare. Thompson et al. [4] analyzed the vertebral angiograms of 22 patients with intradural vertebrobasilar occlusion and stressed the frequent involvement of the terminal segment of the vertebral artery. In our series with positive vertebral artery calcification on CT, 18 of 19 arteries examined by angiography showed local stenosis, wall irregularity, or complete occlusion of the terminal vertebral artery. It appears that the calcification may be an accurate sign of stenosis of the vertebral artery. Recently, microsurgical endarterectomy has been attempted for treatment of local stenosis of the terminal vertebral artery [8].

In this series, 41 cases out of 123 showed signs and symptoms related to the vertebrobasilar circulation. In such patients, detection of vertebral artery calcification on CT may be an important positive finding which supports the clinical signs, although it must be noted that in 65 patients there were no signs and symptoms related to the vertebrobasilar circulation in spite of the presence of vertebral artery calcification on the CT images. In such cases, it is probable that the vertebral artery calcification was asymptomatic in itself and may be regarded as an incidental finding. The clinical course of case 3, however, indicates the possibility of exacerbation in patients with initially asymptomatic vertebral artery calcification. We therefore suggest that the finding of vertebral artery calcification is clinically important in the aged patient and should not be overlooked.

All CT examinations in older patients should include images at the level of the foramen magnum. In patients with an appropriate

clinical history, CT demonstration of vertebral artery calcification should be regarded as an indication for vertebral angiography.

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