Duplex Scanning in Extracranial Vertebral Artery Dissection

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Ultrasonic (duplex scanning and continuous-wave Doppler) and angiographic findings in three patients with bilateral extracranial vertebral artery dissection are reported. A pattern of ultrasonic anomalies diagnostic of dissection is described, including association of a localized increase in diameter of the artery with hemodynamic signs of a stenosis or occlusion at the same level and decreased pulsatility and presence of intravascular echoes in the enlarged segment. (Stroke 1987;18:116–121)

Though classically rare, dissections of extracranial vertebral arteries are increasingly reported.1–3 Their diagnosis relies mainly on suggestive angiographic anomalies (such as long and irregular stenosis or double lumen4–7) that usually disappear in a few weeks, thus a posteriori confirming the diagnosis. Repeated arterial assessment is therefore important in this condition but cannot easily be performed with conventional angiography; therefore, digitized intravenous angiography was found useful in this respect.8 This study discusses the value of ultrasonic examination in both the diagnosis and follow-up of extracranial vertebral artery dissections.

Subjects and Methods

Three patients with bilateral extracranial vertebral artery dissections were studied. Since clinical and angiographic findings have been fully reported in a previous paper7 (Cases 6, 7, and 8), only a brief summary will be given. Ultrasonic examination was performed using both continuous-wave Doppler and duplex scanning. Continuous-wave Doppler was conducted with a 4-MHz probe; velocity curves were recorded at the suboccipital segment. Duplex scanning equipment (Biosound, Indianapolis, Indiana) includes a system for imaging arterial walls and their contents (B-mode echo) and a pulsed Doppler with a 1-mm² sample volume for analysis of flow velocity wherever blood vessels are visualized. This equipment has previously been extensively described8 together with the examination procedure for vertebral arteries, and such an examination has been shown to assess reliably normal extracranial vertebral arteries.8–10

In the present study, the following four parameters were systematically recorded for both vertebral arteries in their pretransverse (from origin to C6) and C6–C5 and C5–C4 intertransverse segments: diameter in mm, pulsatility (systolic expansion), presence or absence of intravascular echoes, and pulsed Doppler signal. Ultrasonic findings were compared with angiographic data obtained at the time of dissection in all patients and during follow-up in two. The interval between angiographic and ultrasonic study was <2 weeks in all cases.

Results

Patient 1

A 32-year-old woman had a left lateral medullary syndrome preceded by neck pain on March 25, 1983. Bilateral brachial angiography on March 30, 1983, showed an irregular stenosis of the second and third segments of the right vertebral artery with an aneurysmal dilatation at the C1 level (Figure 1, right). The distal intracranial vertebral artery and the basilar artery were not filled by the right vertebral artery. The left vertebral artery was irregularly stenosed in its second and third segments; its intracranial segment and the basilar artery were thin but their walls were regular (Figure 1, left). On the digitized intra-arterial angiography performed on December 12, 1983, the left vertebral artery was normal, but the right one was not opacified with certainty.

The first ultrasonic study was performed 2 weeks after the onset of ischemic symptoms, 10 days after angiography. On continuous-wave Doppler, no signal was recorded on the right side and only a weak one was present on the left. On duplex scanning, the right vertebral artery appeared normal from its origin to a few millimeters below its entry into the transverse foramen of C6, but immediately above and in its C6–C5 and C5–C4 portions, the diameter of this vessel was increased to 5.5 mm (Figure 2), its pulsatility was decreased, and intravascular echoes were observed. Pulsed Doppler was audible in the first segment but its amplitude was low, without diastolic component; it was not audible in the C6–C5 and C5–C4 segments. B-mode and pulsed Doppler findings were absolutely identical for the left vertebral artery.

The second ultrasonic study was performed 4 weeks later. No change was observed on the right side, whereas the left side had returned to normal.

The third ultrasonic study was performed 7 months later, 2 days after the control angiography. The right...
vertebral artery showed signs of occlusion: no pulsatility and no audible signal on pulsed Doppler. Furthermore, the diameter of the artery was reduced to 2 mm, and the intravascular echoes had a higher echogenicity and were also noted in the pretransverse portion (Figure 3). The left vertebral artery was normal, thus confirming angiographic findings.

**Patient 2**

A 26-year-old woman had a minor basilar stroke preceded by neck pain on July 8, 1983. Bilateral brachial angiography on July 26, 1983, showed a severe and irregular stenosis of the second segment of the right vertebral artery and of the second and proximal third segments of the left vertebral artery with reinjection of the distal part of both vertebral arteries via muscular arteries.

The first ultrasonic study was performed 13 days after the onset of symptoms, 5 days before angiography. On continuous-wave Doppler, a weak signal was recorded on both sides. On duplex scanning, only the C6-C5 and C5-C4 portions could be visualized. The diameter of both vertebral arteries was 6 mm; pulsatility was decreased on the right side and absent on the left. Intravascular echoes were observed on both sides. Pulsed Doppler was weakly audible on the right side and not audible on the left.

On the second ultrasonic study, performed 2 months later, both vertebral arteries appeared normal.

**Patient 3**

A 27-year-old woman had a minor basilar stroke on December 31, 1983, 40 days after a chiropractic manipulation of her neck. On transfemoral angiography on January 6, 1984, the right vertebral artery was occluded from C6 to C2 and reinjected via anastomosis with muscular arteries. The left vertebral artery was moderately and irregularly stenosed from C6 to C2. Both vertebral arteries were normal on control digitized intra-arterial arteriography performed 5 months later.

The first ultrasonic study was performed 18 days after the onset of symptoms, 11 days after angiography. Continuous-wave Doppler was normal on both sides. On duplex scanning, the pretransverse right vertebral artery was normal except for pulsed Doppler,
FIGURE 2. Ultrasonic study of Patient 1, April 9, 1983. Top: Right vertebral artery, pretransverse segment; diameter = 5.5 mm (black arrows) just below entry into foramen of C6 (scale, 2 mm between vertical lines). Bottom: Right vertebral artery, C6–C5 intertransverse segment; diameter = 5.5 mm (black arrows), intravascular echoes (white arrows).
Figure 3. Ultrasonic study of Patient 1, December 14, 1983. Top: Right vertebral artery, ostium and pretransverse segment; diameter = 2 mm (arrows), intravascular echoes. Bottom: Left vertebral artery, C6-C5 intertransverse segment; diameter = 4 mm (arrows).
which was weakly audible. At the C6–C5 and C5–C4 levels the diameter was increased to 6 mm, the pulsatility was decreased, and pulsed Doppler was only weakly audible. On the left side, the pretransverse segment was normal, but at the C6–C5 and C5–C4 levels the diameter was increased to 5 mm, the pulsatility was decreased, and intravascular echoes were present; pulsed Doppler was normal, however.

The second ultrasonic study was performed 3 weeks later. The right vertebral artery was unchanged except for a decrease in diameter to 5 mm at the C6–C5 and C5–C4 levels; the left had returned to normal. Both vertebral arteries were normal on the third study 6 weeks later.

Summary

Ultrasonic and angiographic findings at the time of dissection are summarized in Table 1. Increased diameter and decreased pulsatility were observed in the six vertebral arteries. Intravascular echoes were observed in five and the pulsed Doppler signal was diminished or absent in five. Continuous-wave Doppler signal was decreased or absent in four and normal in two.

Control ultrasonic examination showed a return to normal in five vertebral arteries and an occlusion in one. This correlates well with angiographic data in the two patients who had control angiography, which showed a return to normal in three vertebral arteries and probable occlusion in one.

Discussion

The present study shows a distinctive ultrasonic pattern in extracranial vertebral artery dissection, namely, increased arterial diameter associated with decreased pulsatility, presence of intravascular echoes, and hemodynamic signs of stenosis or occlusion.

For the diameter to be described as "increased" implies knowledge that the artery is not simply large either physiologically or pathologically, as in dolicho-vertebral artery. This knowledge can be obtained in two ways: first, when the increase in diameter is localized, as occurred here with an abrupt increase in arterial caliber from 3 to 5 or 6 mm; and second, when it is reversible, again noted in the present study.

Decreased pulsatility in the enlarged segment contrasting with normal pulsatility in the predissected segment again might help to differentiate vertebral artery dissection from other conditions with large vertebral arteries but normal pulsatility, such as dolicho-vertebral arteries. However, this is a judgmental decision in the test and requires an experienced technician.

Intravascular echoes are not observed in normal arteries. They indicate the presence of an abnormal structure either in the arterial lumen or in the vessel wall. Progress in ultrasonic technology will probably allow differentiation between these two possibilities.

While the previous factors are all determined by B-mode scanning, continuous-wave Doppler and pulsed Doppler are necessary to detect hemodynamic signs of stenosis, which classically consist of a decreased Doppler signal proximal to the stenosis, an increased signal in the residual lumen, and a decreased signal distal to the stenosis. In the present study, an increased signal in the enlarged segment was never observed either because of the impossibility of detecting a small residual lumen or because of the actual characteristics of stenosis in dissections, namely, its tightness and

| Table 1. Summary of Ultrasonic and Angiographic Findings at Time of Dissection |
|---------------------------------|----------|----------|----------|
|                                 | RVA      | LVA      | RVA      | LVA      | RVA      | LVA      |
| Continuous-wave Doppler (suboccipital recording) |          |          |          |          |          |          |
| B-mode                          |          |          |          |          |          |          |
| Diameter (mm)                   |          |          |          |          |          |          |
| Origin to C6                    | 3        | 3        | 3        | 3        |          |          |
| C6–C5                           | 5.5      | 6        | 6        | 6        | 6        | 5        |
| Pulsatility                     |          |          |          |          |          |          |
| Origin to C6                    | N        | N        | —        | —        | N        | N        |
| C6–C5                           | ↓        | ↓        | ↓        | 0        | ↓        | ↓        |
| Intravascular echo              |          |          |          |          |          |          |
| Origin to C6                    | No       | No       | —        | —        | No       | No       |
| C6–C5                           | Yes      | Yes      | Yes      | Yes      | No       | Yes      |
| Pulsed Doppler                  |          |          |          |          |          |          |
| Origin to C6                    | ↓        | ↓        | —        | —        | ↓        | N        |
| C6–C5                           | 0        | 0        | ↓        | 0        | ↓        | N        |
| Angiography                     |          |          |          |          |          |          |
| C6 to C1 stenosis               |          |          |          |          |          |          |
| C6 to C1 stenosis               |          |          |          |          |          |          |
| C6 to C2 stenosis               |          |          |          |          |          |          |
| C6 to C1 stenosis               |          |          |          |          |          |          |
| C6 to C2 occlusion              |          |          |          |          |          |          |
| C6 to C2 stenosis               |          |          |          |          |          |          |

RVA, right vertebral artery; LVA, left vertebral artery; 0, absent; N, normal; ↓, decreased.
extent. Pulsed Doppler signal proximal to the stenosis and continuous-wave Doppler distal to it were not decreased in one patient. As suggested by angiography, this was probably due to the presence of only moderate stenosis on one side and to the development of a rich collateral circulation on the other. Hemodynamic signs can therefore be absent in extracranial vertebral artery dissections.

As illustrated in the present study, ultrasonic examination is an excellent tool with which to appreciate the evolution of dissection. The examination was performed before the end of the first month in two patients and already showed improvement or return to normal, which was later confirmed by angiography. How early improvement starts and normalization is achieved remains unknown, although it is well established that the majority of dissected vertebral arteries return to normal within 3 months.7

To conclude, the present study describes for the first time a pattern of ultrasonic anomalies diagnostic of extracranial vertebral artery dissection, namely, the association of a localized increase in arterial diameter with hemodynamic signs of stenosis or occlusion and/or decreased pulsatility and intravascular echoes at the same level. Furthermore, it outlines the utility of repeated ultrasonic examination in the follow-up of arterial changes in dissections.

References

Key Words • ultrasonic diagnosis • vertebral artery • angiography
Duplex scanning in extracranial vertebral artery dissection.

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Stroke. 1988;19:116-121
doi: 10.1161/01.STR.19.1.116

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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http://stroke.ahajournals.org/content/19/1/116

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