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Internal Carotid Artery Occlusion by DSA: "Diagnostic Trap" Relearned

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There is wide acceptance and use of digital subtraction angiography (DSA) for the evaluation of extracranial carotid vascular disease. Investigation of high-grade stenotic lesions of the carotid bifurcation by arch aortography and noninvasive techniques can be misinterpreted as complete occlusion. Recent communications have implied that intravenous DSA is sufficient to distinguish internal carotid artery occlusion from high-grade stenosis [1, 2]. We report two patients with DSA diagnosis of "complete" internal carotid artery occlusion in which angiography showed the distal segment of the artery to be patent. This differential diagnosis carries therapeutic consequences. Therefore, we would like to emphasize that angiographic verification of DSA-determined occlusion is probably justified at this time.

Technique

An ADAC DPS 4100 digital vascular imaging system was used. Serial imaging of the neck region is at two frames/sec. Radiographic techniques generally are 70–80 kVp and 300 mA at 0.063 sec. The system contains a trimode image intensifier of 4.5, 6, and 9 inch (11.4, 15.2, and 22.9 cm) with a lead oxide Vidicon camera. There is immediate conversion and processing with 512 × 512 matrix. Contrast resolution is 1% with a signal-to-noise ratio of 1000:1.

DAS is done using the Seldinger technique. An antecubital vein is catheterized using a 5.8 French multiholed catheter. The catheter is positioned in the superior vena cava under fluoroscopic control. Thirty ml of diatrizoate meglumine (MD-76, Mallinckrodt) is injected at 12 ml/sec using a concentration of 370 mg I/ml. Arteriography is performed with a Philips Polydiagnostic N with biplane Puck changers and a ×2 magnification.

Case Reports

Case 1

A 79-year-old diabetic right-handed man with well controlled essential hypertension and stable angina had two transient ischemic attacks (TIAs). The TIA episodes were manifested as expressive-receptive aphasia. After the first episode, the patient was free of symptoms for 3 years. He then developed transient episodes of left hemiparesis and hemiparesthesia lasting for several minutes. A digital venous angiogram was interpreted as showing right internal carotid artery and left vertebral artery occlusion (figs. 1A and 1B). Since the TIAs persisted while on aspirin and Persantine treatment, he was referred for possible superficial temporal artery–middle cerebral artery anastomosis.

A computed tomographic (CT) scan documented a small left cerebral hemisphere infarct consistent with his history of transient aphasia. The neurologic examination was entirely normal. A retrograde femoral arteriogram demonstrated a small, nonstenotic plaque at the bifurcation of the left cartoid artery, an occluded left vertebral artery, and a highly stenotic, but not occluded, right internal carotid artery (figs. 1C and 1D).

At endarterectomy he was found to have severe stenosis of the right internal carotid orifice measuring 1.2–2 mm. Stenosis was caused by friable ulcerated plaque, which was excised, and a distal soft thrombus was extricated. There was excellent back-bleeding from the distal carotid. He had no neurologic deficits in the postoperative period and remained free of symptoms.

Case 2

A 69-year-old woman had a 20 year history of treated essential hypertension without other cardiovascular or neurologic symptoms until 2 months before surgery. At that time she developed daily TIA episodes referable to the left carotid circulation with primary blurring of vision in the left eye. Some spells lasted up to 1 hr. Ophthalmologic evaluation was normal except for ophthalmodynamometry which measured a pressure of 15 mm Hg in the left eye versus 55 mm Hg in the right. Neurologic examination was normal. There were no carotid bruits, and the left supraorbital artery Doppler signal was obliterated by left superficial temporal artery occlusion.

A retrograde femoral cerebral arteriogram demonstrated normal right internal carotid artery caliber circulation with good cross-communication to the left anterior cerebral artery. A left vertebral injection was normal; however, the patient experienced immediate onset of amaurosis in her left eye; therefore, the procedure was terminated. A digital venous angiogram was interpreted as showing left internal carotid artery occlusion (figs. 2A and 2B). The next day a left internal

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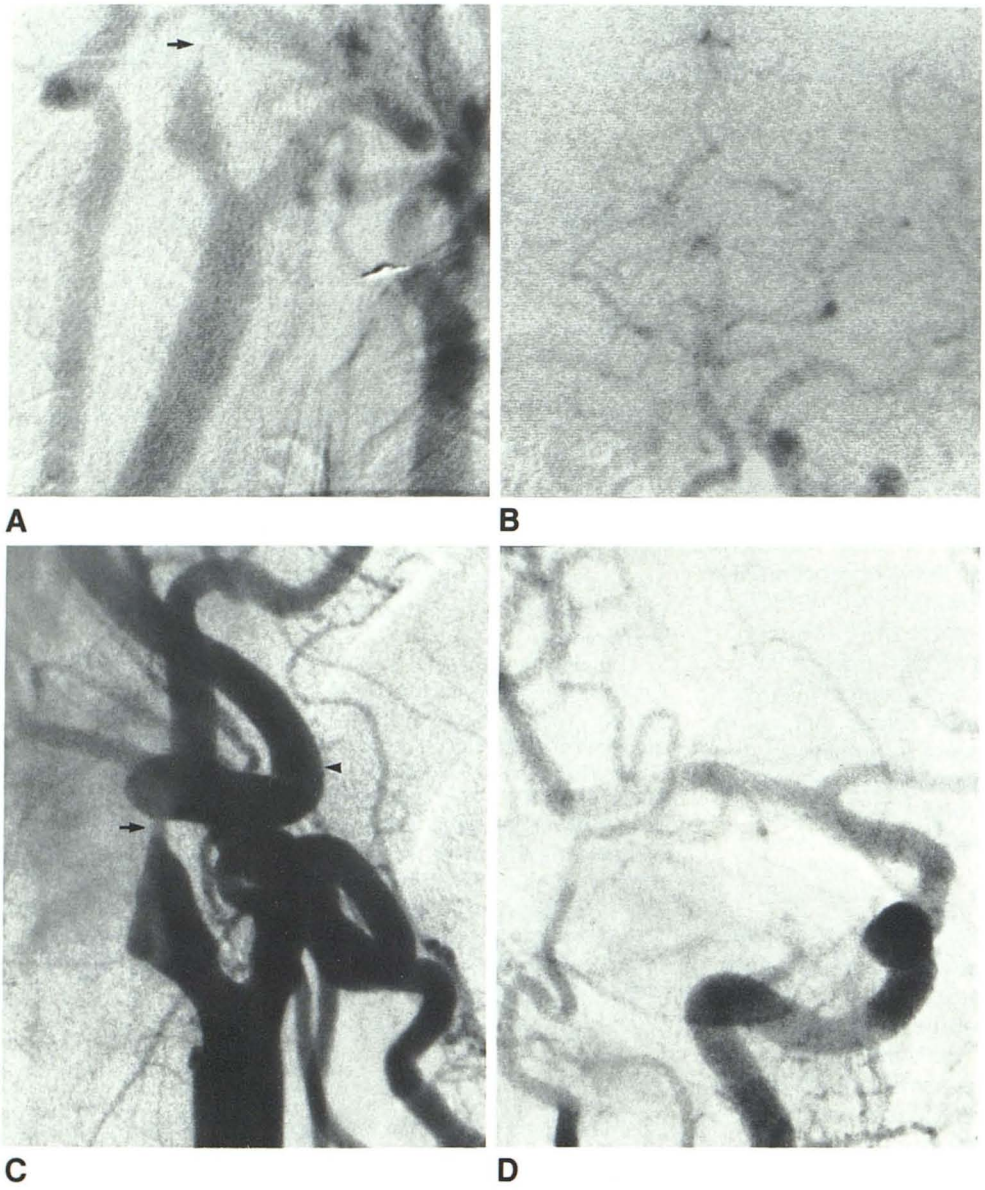

Fig. 1.—Case 1. **A,** Left posterior oblique DSA image of right carotid system. Complete occlusion of right internal carotid artery (*arrow*). **B,** Anteroposterior DSA image of intracranial circulation. Occlusion of right internal carotid artery. **C,** Left posterior oblique angiogram of right carotid bifurcation. High-grade occlusive lesion (*arrow*) of proximal right internal carotid artery. More distal internal carotid artery is patent (*arrowhead*). **D,** Anteroposterior angiogram of intracranial circulation. Patent right internal carotid artery.

carotid angiogram demonstrated a carotid "string" or "slim" sign, indicating high-grade but incomplete occlusion of the left internal carotid artery (figs. 2C and 2D). At endarterectomy the internal carotid artery was highly stenotic with a friable plaque occluding the orifice. A partly organized thrombus extended beyond this lesion and was extricated. The patient was free of TIA episodes after surgery.

Discussion

The need for meticulous selective angiography in diagnosing complete internal carotid artery occlusion has been stressed several times [3]. Angiographic workup for TIA can be technically demanding. Hence, each new noninvasive technique is embraced in the hope of obviating angiography. Arch aortography is limited by the overlap of vessels. Sonography has definite limitations. The ability of DSA to diagnose complete internal carotid artery occlusion has been reported recently [1].

Little et al. [4] stated that DSA "can clearly separate total from subtotal internal carotid occlusion." In their findings DSA had a sensitivity of 95%, specificity of 99%, and accuracy of of 97% (numeric data to support these statements were not presented). More often authors have accepted the findings of total occlusion on DSA as conclusive and without further angiographic or pathologic verification (e.g., case 1 in Seeger et al. [2]). Wood et al. [1] correlated DSA findings of internal carotid artery occlusion (14 cases) and 80%–99% occlusion (nine cases) with angiography and found an exact correlation. It is uncertain if any of their 23 cases included pseudoocclusion with the angiographic string sign.

Our case 1 is an example of misinterpretation due to high-

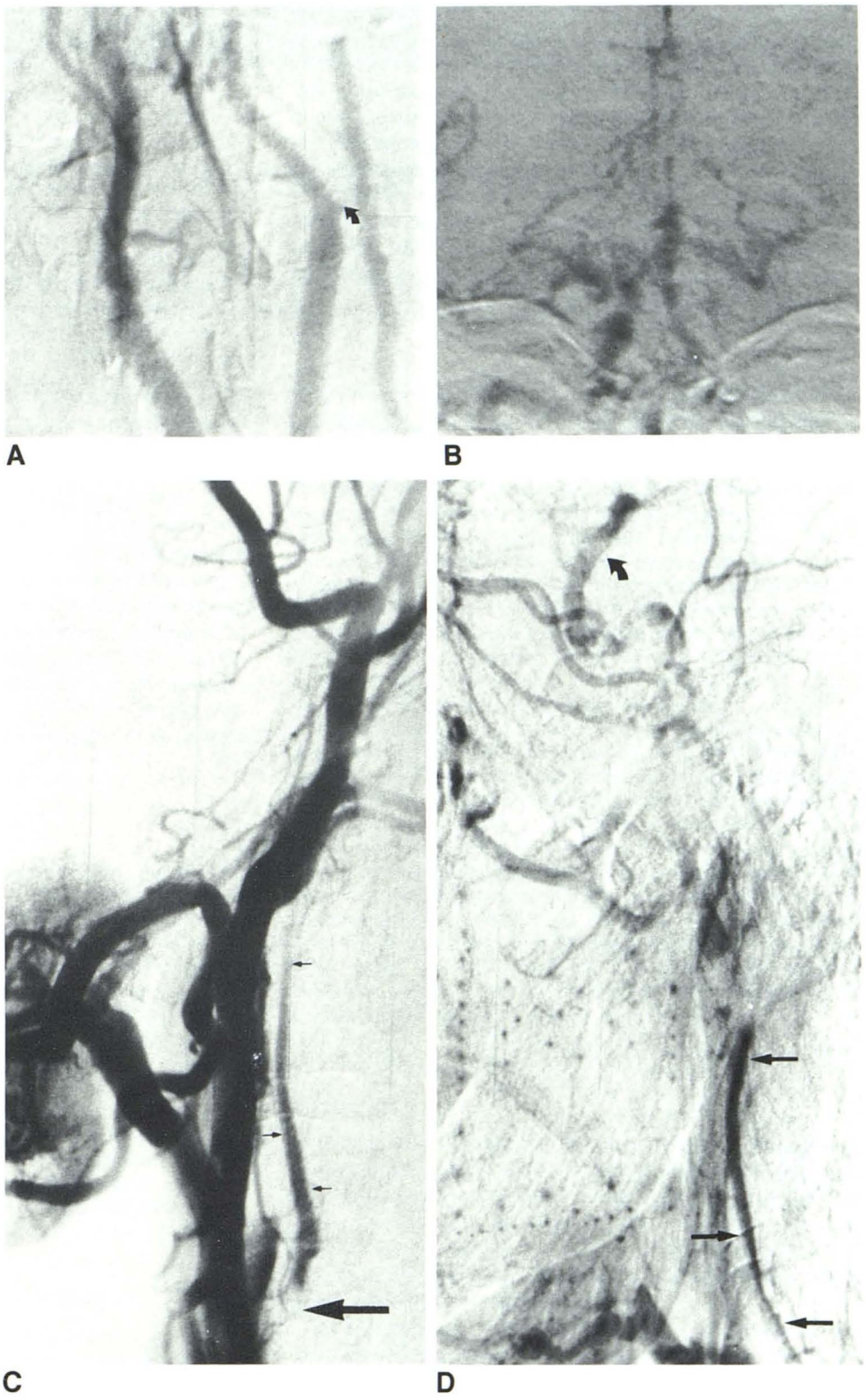

Fig. 2.—Case 2. **A,** Right posterior oblique DSA image of left carotid system. Complete occlusion of left internal carotid artery (*arrow*). **B,** Anteroposterior DSA image of intracranial circulation. Occlusion of left internal carotid artery. **C,** Right posterior oblique angiogram of left carotid bifurcation. Nearly total occlusion (*large arrow*) with poststenotic slim sign (*small arrows*). **D,** Right posterior oblique angiogram of left carotid system, late film. Slim sign (*straight arrows*) and patency (*curved arrow*) of left internal carotid artery siphon.

grade internal carotid artery stenosis, ectatic course of the internal carotid artery, and overlapping vessels on DSA. These limiting factors are acknowledged by most authors [1, 2, 4, 6]. In case 2 the small string of contrast material in the internal carotid artery was simply below the limits of resolution of the DSA technique.

Yonas and Meyer [5] reviewed prior experience with extreme pseudoocclusion of the internal carotid artery. They

carefully documented the results of angiography and surgical treatment. Our two cases confirm their findings, and we agree with the importance of distinguishing internal carotid artery pseudoocclusion from true occlusion. In true occlusion, external–internal carotid artery bypass may be appropriate. In pseudoocclusion treatment seems more appropriately directed toward removing a source of emboli and reestablishing a high-volume flow through the largest possible vessel.

Perhaps false-positive studies can be reduced by performing intraarterial DSA. In patients with recurrent TIAs, we would caution against sole reliance on intravenous DSA in establishing internal carotid artery occlusion.

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