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J H Pexman, C H Wriedt and T C Richard

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The Significance of Internal Carotid Artery Occlusion Shown by IV Digital Subtraction Angiography

J. H. W. Pexman[1]
C. H. R. Wriedt
T. C. Richard

A retrospective review of 493 IV digital subtraction angiography examinations performed for cervicocerebral vascular disease revealed 27 apparent occlusions of the internal carotid artery. We identified 20 patients whose occlusions did not warrant further investigation. Fourteen occlusions were on the asymptomatic side, two were in patients who preferred medical treatment, two were in patients unsuitable for carotid endarterectomy, and two patients with bihemispheric transient ischemic attacks were treated for the contralateral carotid. Four very tight stenoses were found in the other seven patients, one of whom refused endarterectomy. As the signs of a very tight stenosis are subtle, and the number of such stenoses that are treatable is low (three in 493), cerebral angiography is justified in doubtful cases to avoid missing potentially treatable lesions.

IV digital subtraction angiography (IV-DSA) is a screening procedure for evaluating patients with transient ischemic attacks (TIAs) and amaurosis fugax [1–6]. Some reports suggest that IV-DSA can distinguish internal carotid artery occlusion from very tight stenosis [4, 7, 8], but others regard it as a diagnostic trap [9]. As the diagnosis carries therapeutic consequences, we conducted a retrospective review to determine the magnitude of the problem, whether potentially treatable lesions were being missed, and the role of cerebral angiography.

Materials and Methods

During a 2-year period, 493 patients were evaluated for cervicocerebral disease using a Philips DVI-2 digital vascular imaging system attached to a conventional fluoroscopy unit. Most studies were performed with right atrial injections of 34 ml of Renografin 76 from an antecubital approach with a 5-French multihole hockey stick catheter (Meditech) introduced through a 5-French Cordis sheath or with a pigtail catheter (Cook).

Oblique views of the neck and a posteroanterior image of the neck and siphon were obtained. The imaging sequence was cardiac gated until contrast material reached the jugular vein. A 10-inch or 6-inch field size in conjunction with a 512 × 512 pixel matrix was used. Postprocessing with pixel shift was performed. The radiographic techniques were usually 60–90 kV at 200 msec, producing 245 kW. Twenty-seven patients who had suffered TIAs, minor strokes, or amaurosis fugax had reports indicating an occlusion or possible occlusion of the origin of the internal carotid artery (ICA). The charts, IV-DSAs, and cerebral angiograms on these patients were reviewed.

Results

IV-DSA showed occlusion at the origin of the ICA on the symptomatic side in seven patients (Table 1). We performed cerebral angiography on six of these patients because we were uncertain of our ability to distinguish a very tight stenosis from a complete occlusion of the ICA using IV-DSA. Cerebral angiography confirmed the occlusion in two patients, and occlusion of the ICA was found at external carotid angioplasty (performed for persistent visual symptoms) in the seventh

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[1] All authors: Department of Diagnostic Radiology, University of Western Ontario, Victoria Hospital, Box 5375, London, Ontario N6A 4G5, Canada. Address reprint requests to W. Pexman.

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patient. In the other four patients, cerebral angiography with conventional subtraction over 7 sec demonstrated a very tight stenosis at the origin of the ICA. Three of these underwent successful endarterectomy, and the fourth, a severe diabetic, refused surgery.

TABLE 1: Important ICA "Occlusions"

Case No	IV-DSA	Cerebral Angiography		Surgery
		Catheter	DP or RRBP	
1	Occluded	Stenosed	—	Stenosed
2	Occluded	Stenosed	—	Stenosed
3	? Occluded	Failed	Stenosed	Stenosed
4	? Occluded	Failed	Stenosed	Refused
5	Occluded	Occluded	—	—
6	Occluded	Unsuitable	Occluded	—
7	Occluded	Unsuitable	—	Occluded

Note.—ICA = internal carotid artery origin; DP = direct puncture; RRBP = right retrograde brachial puncture.

A retrospective review of the IV-DSA in the four patients with very tight stenoses revealed that the correct diagnosis might have been made in three, while one had a suboptimal study on account of movement. Two showed an apparent occlusion of the ICA origin with an unconnected artery appearing 1–1½ cm above it—the gap sign (Figs. 1 and 2). In one patient, the mid portion of the ICA filled slowly and this could be seen on the anteroposterior projection when the radiographs were carefully scrutinized (Fig. 2). One very tight stenosis of the origin of the ICA was called an occlusion when we mistook the ICA for a branch of the external carotid artery (Fig. 3).

The other 20 patients who had occlusion of one ICA origin shown by IV-DSA were not considered to be potential ipsilateral surgical candidates (Table 2). Either the occlusion was on the asymptomatic side, the patients had bihemispheric symptoms with a surgical lesion on the contralateral side, they preferred medical treatment, or they were unsuitable candidates for surgery.

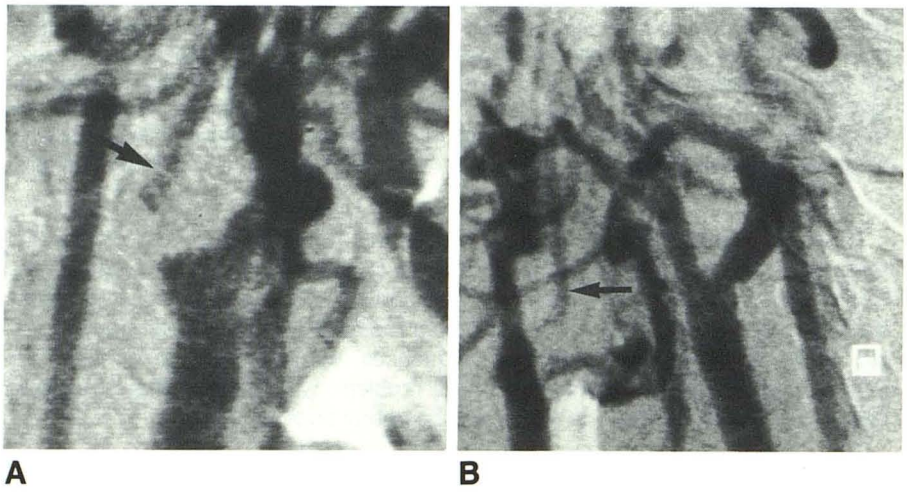

Fig. 1.—Case 4.
***A* and *B*, Oblique neck projections. An unconnected artery (*arrow*) is seen just above what appears to be the stump of an occluded internal carotid artery with a gap of 1–1½ cm (the gap sign).**

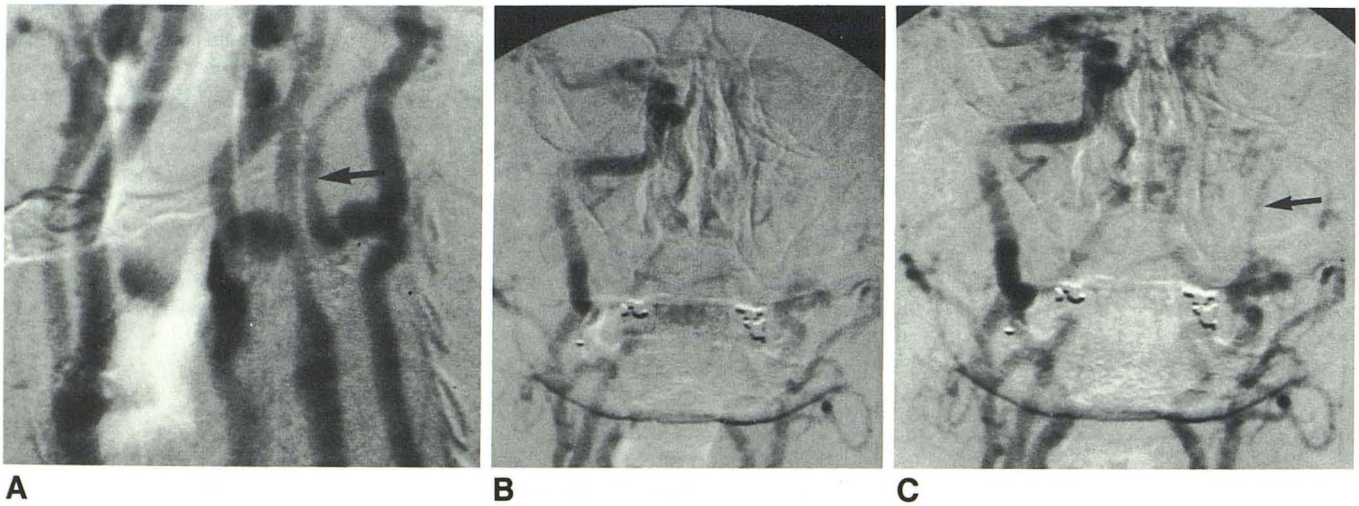

Fig. 2.—Case 3.
***A*, An unconnected artery (*arrow*) is seen above bifurcation, which only has an external carotid artery arising from it (the gap sign). (Other projections showed that this unconnected artery was not arising from the adjacent vertebral artery).**
***B*, Early anteroposterior projection.**
***C*, Anteroposterior projection 1.5 sec later showing delayed filling of left internal carotid artery (*arrow*) (the anteroposterior string sign).**

Fig. 3.—Case 2.
A thin artery (*arrow*) arises below first bifurcation of external carotid artery. The level of origin is where internal carotid should arise. (The internal carotids usually arise at same level but on oblique neck projections on our apparatus since we move the patient and not the tube, the bifurcation nearer the intensifier appears more cranial than the opposite side: see Figs. 1A, 1B, and 2A).

TABLE 2: Unimportant ICA Occlusions

Reason	IV-DSA	Catheter Angiography	
		Failed	Successful
Lesion on asymptomatic side	14	2	5
Bihemispheric symptoms	2	1	1
Desired medical treatment	2	1	0
Unsuitable for surgery	2	0	0
	20	4	6

Note.—ICA = internal carotid artery origin.

Twelve patients had symptoms referable to the contralateral anterior circulation and two had symptoms of vertebrobasilar insufficiency. Five of these patients had arterial angiographic confirmation of the occlusion.

Two patients in whom IV-DSA showed occlusion on the opposite side had 85% and 95% ICA stenosis, respectively. These patients had bihemispheric symptoms. Cerebral angiography was successful in one and failed in the other. Endarterectomy was performed on the known stenoses.

One patient preferred medical treatment. Another had IV-DSA after a failed femorocerebral angiogram and was assigned to medical treatment when he refused direct-puncture angiography.

An IV-DSA report stating ICA occlusion was taken at face value by the clinician. The patient had no further symptoms over several months, confirming the diagnosis. Another less fortunate patient suffered a devastating stroke while awaiting admission for cerebral angiography.

There were six unsuccessful femorocerebral angiograms because of aortoiliac arteriosclerosis and nine successful ones. Two showed very tight stenoses. Right retrograde brachial angiography confirmed one very tight stenosis and direct puncture cerebral angiography demonstrated occlusion in one case and a very tight stenosis in another.

Discussion

Several authors [4, 7, 8] claim to be able to separate subtotal from total ICA occlusion by IV-DSA. Seeger et al.[8] found three very tight stenoses of the ICA in 10 cases and thought that a nearly occluded ICA could at times be diagnosed safely and reliably by IV-DSA. We showed four very tight stenoses in approximately 500 cases by using angiographic confirmation in all doubtful cases. Nov et al. [9] describe two cases missed by IV-DSA, and one of our cases would have been completely missed had angiography not been requested by the clinician (Fig. 3). Had we not done angiography, we would have given inappropriate treatment to 0.6% (three of 493) patients. By not relying on IV-DSA for the diagnosis in the group for which the difference between occlusion and very tight stenosis had potential therapeutic consequences, six angiograms were performed and only two of them proved to be unnecessary because they showed complete occlusions. As one patient subsequently refused surgery, our IV-DSA diagnosis of an occluded ICA was wrong in 50% (three of six) of the suitable surgical candidates.

We identified 20 of 27 patients who did not need angiographic confirmation (Table 2). The symptoms were not in the territory of the "occluded" ICA in 14 patients. Some authors do not recommend carotid endarterectomy in asymptomatic carotid disease [10], and others believe that it should be carefully reappraised [11]. Patient treatment is not altered by separating occlusions from very tight stenoses in patients unsuitable for, or declining, surgery. Similarly, patients with bihemispheric ischemic symptoms may be managed on the basis of the findings in the other carotid artery.

Although we diagnosed none of our four very tight stenoses initially, it is possible in retrospect to diagnose two of them and to be suspicious of the third. The fourth came to angiography because the IV-DSA was unsatisfactory and did not show the vessel in question in two planes without movement or overlap [12].

Important observations are the gap sign, the anteroposterior string sign, and the same-level rule. Above the stump of the apparently occluded ICA there is a gap of approximately 1–1½ cm before an unattached artery is seen. We saw this in two cases (Figs. 1 and 2). One of Seeger's three cases exhibited this gap sign [8]. In one of those cases the anteroposterior projection of the head and upper neck provided a side-by-side comparison with the contralateral carotid, and partial and/or delayed filling of the string-like ipsilateral carotid could be seen. Although we looked carefully for this at the time of the examination, it was only in retrospect that we found it in one of two cases (Fig. 1) in whom this projection was obtained.

Both common carotid arteries usually bifurcate at the same level. Hence, the absence of a normal ICA and the presence of a narrower artery with or without a gap at the same level as the origin of the contralateral ICA should raise the possibility of a very tightly stenosed artery. Had we applied this

same-level rule we might have suggested angiography in the case we completely missed (Fig. 3).

Both patients with very tight stenoses described by Nov et al. [9] and two of three described by Seeger et al. [8] presented with recurrent TIAs. Three of our four cases had a single TIA or one episode of amaurosis fugax.

The frequency of symptoms is unhelpful. The signs of a very tight stenosis are subtle on IV-DSA, and the incidence of symptomatic very tight stenosis masquerading as occlusion is low. Therefore, careful angiographic confirmation [13–15] to separate the true ICA from the very tight stenosis is only recommended in patients who have symptoms on the appropriate side and who are suitable surgical candidates.

Duplex carotid sonography also cannot reliably differentiate very tight stenosis from occlusion [16–21]. Therefore, if noninvasive tests suggest an occlusion on the symptomatic side in a patient suitable for carotid endarterectomy, confirmation should be by carotid angiography and not by IV-DSA.

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