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AJNR Am J Neuroradiol 1983, 4 (3) 796-799
http://www.ajnr.org/content/4/3/796

Percutaneous Transluminal Angioplasty of the External Carotid Artery

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Percutaneous transluminal angioplasty was used to treat stenotic lesions in 10 external carotid arteries in nine patients. Four representative cases are described. Nine arteries were successfully dilated. One attempt failed because the catheter could not be passed through the stenosis. Spasm of the distal external carotid artery due to guide wire-catheter manipulation was seen in six patients. No serious complications were encountered.

The increased acceptance of percutaneous transluminal angioplasty (PTA) over the past few years reflects its simplicity, cost-effectiveness, and low incidence of serious complications. The advantages of using PTA to dilate stenotic lesions at the origin of the external carotid artery (ECA) were pointed out in a preliminary report [1]. This technique can benefit the patient not only before superficial temporal artery–middle cerebral artery (STA–MCA) bypass but also, as Motarjeme et al. [2] emphasized, to increase the probability of establishing an efficient collateral blood supply to the intracranial circulation.

Subjects and Methods

Transluminal angioplasty of the ECA was attempted in nine patients, six men and three women, all in their sixth or seventh decade (table 1). All patients except one (case 5) had complete occlusion of the ipsilateral internal carotid artery with symptoms pointing to insufficient blood flow in the corresponding MCA. In seven patients (eight ECAs) the stenosis was atherosclerotic, and in two the result of an endarterectomy. In one patient (case 7) PTA was performed bilaterally in one setting. A complete angiographic assessment was made of the brachiocephalic and intracranial arteries before PTA procedures were undertaken.

The technique described in the preliminary report [1] was altered significantly on the basis of additional experience:

1. We previously recommended traversing the stenosis at the origin of the ECA with a small J guide wire. We now agree with Motarjeme et al. [2] that the best way of traversing the stenotic segment is with a soft straight wire. Taking advantage of the distal curve of the polyethylene catheter, a straight 0.035 inch (0.89 mm) guide wire with a "floppy" end segment (about 2 cm) is directed into the origin of the ECA and advanced through the stenotic segment distally. The procedure is closely monitored by fluoroscopy.
2. The size of the angioplasty balloon is based on the size of the artery to be dilated. The selected balloon is 1 mm larger than the expected normal size of the vessel.
3. After the balloon catheter has been introduced into the stenotic area, the 0.035 or 0.038 inch (0.89 or 0.97 mm) exchange wire is replaced by a 0.025 inch (0.64 mm) "anchor" guide wire, and the catheter is hooked by side arm to the continuous-pressure drip of heparinized saline. On completion of the PTA procedure, the tip of the anchor wire is left in the ECA; the angioplasty catheter is pulled proximally into the common carotid artery and control angiography is performed. If the results of the procedure are unsatisfactory, the angioplasty catheter can then be safely reintroduced into the stenotic area without danger of subintimal passage and additional dilatation can be performed.

Results

Nine ECAs, five on the left and four on the right, were successfully dilated in eight patients (table 1). The results of the procedure were judged as very good (eight ECAs in seven patients) if the dilated segment regained its normal size and as good (one ECA) if the vessel was dilated to less than its original size. The procedure failed in one patient (case 8) because the catheter could not be passed through the stenosis.

Representative Case Reports

Case 5

A 60-year-old man presenting with transient right arm weakness underwent bilateral carotid endarterectomy 4 years before admission. Arteriography showed stenosis near the origin of the ECA at the level of the endarterectomy and severe stenosis in the proximal part of the cavernous segment of the internal carotid artery (fig. 1). PTA was performed preparatory to STA–MCA bypass surgery.

Comment. PTA is useful for correcting postendarterectomy stenosis, as in this case and case 1 [1]. In certain cases, angioplasty of the ECA is indicated even if the internal carotid artery is patent.

Case 7

A 66-year-old woman presented at another institution with a right-sided transient ischemic attack and bilateral amaurosis fugax. Arteriography showed occlusion of the internal carotid arteries with bilateral stenoses, more severe on the right, at the origin of the ECA. The patient was transferred to our institution. It was decided to perform bilateral STA–MCA bypass surgery in stages, first on the left, then on the right. PTA was performed bilaterally, using the PTA catheter to simultaneously catheterize the carotid arteries. The

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AJNR **4:796–799, May/June 1983** 0195-6108/83/0403-0796 $00.00 © American Roentgen Ray Society

TABLE 1: **PTA of the Stenotic External Carotid Artery: Summary of Nine Cases**

Case No. (Age, Gender)	Side of ECA Dilated	Type of Catheter Used	Result of PTA
1 (50,M)	L	7-100-2-6-2	Very good
2 (59,M)	L	7-100-4-4-1	Very good
3 (66,M)	R	7-100-2-6-1	Good
4 (57,M)	R	7-75-2-6-1	Very good
5 (60,M)	L	7-75-2-5-1	Very good
6 (66,F)	R	7-100-2-6-1	Very good
7 (66,F)	L + R	7-120-2-5-1	Very good
8 (68,F)	R	7-75-2-6-1 7-120-2-4-1	Unsuccessful
9 (63,M)	L	7-100-2-5-1	Very good

Note.—All patients except one (case 5) had complete occlusion of the ipsilateral internal carotid artery. PTA = percutaneous transluminal angioplasty; ECA = external carotid artery; L = left; R = right.

catheter was shaped with a double curve. The left ECA was dilated first, followed by the right (fig. 2).

Comment. Angioplasty can be performed bilaterally in a single setting. The PTA catheter can be used to catheterize both vessels to avoid double catheter exchanges and removal of the balloon catheters.

Case 8

A 68-year-old woman presented with left-sided hemiparesis. Arteriography showed complete occlusion of the right internal carotid artery with stenosis at the origin of the ECA (fig. 3). It was decided to perform angioplasty on the ECA before STA-MCA bypass. Using a 6.5 French (2.15 mm) polyethylene catheter, the right common carotid artery was easily catheterized and the 0.035 inch (0.89 mm) guide wire advanced into the ECA. Some spasm was elicited on the distal ECA. Despite several attempts, the polyethylene catheter could not be advanced through the stenosis into the ECA. A second polyethylene catheter with a different shape was tried without success. Then a 7 French (2.3 mm) PTA catheter was tried, again in vain. Although the guide wire easily passed at least 3 cm beyond the stenosis, all the catheters buckled in the aortic arch and never advanced through the stenotic segment. The procedure was discontinued.

Comment. The distance between the groin and the origin of the ECA is such that not enough pressure can be exerted on the tip of the catheter to overcome the resistance of "hard" arteriosclerotic narrowing (fig. 3). The tortuosity of the incoming route is also a hindrance. In addition, the tortuosity of the distal part of the ECA prevents the wire from being anchored deeply enough.

Case 9

A 63-year-old man presented with right-sided hemiparesis, confusion, and mixed dysphagia. Angiography showed complete occlusion of the left internal carotid artery and 95% stenosis at the origin of the left ECA (fig. 4A). The right carotid and vertebral arteries were unremarkable. The left MCA showed insufficient filling through the anterior communicating artery. The patient underwent ECA angioplasty before left STA-MCA bypass operation. During the procedure the guide wire had to be anchored in the facial artery. Immediate post-PTA arteriography showed excellent results but without filling of the facial artery (fig. 4B), presumably owing to spasm. Angiography 16 days after PTA again showed excellent results, but occlusion of the facial artery (fig. 4C).

A B C

Fig. 1.—Case 5. Left common carotid artery, oblique (**A** and **B**) and lateral (**C**) views. Postendarterectomy stenosis (*large solid arrow*) near origin of ECA where PTA was performed. Severe stenosis (*open arrow*) of internal carotid artery. **A**, Preangioplasty. **B**, Postangioplasty. Spasm of distal ECA (*small arrows*) caused by guide wire. **C**, 35 days post-PTA. In **B** and **C**, dilated segment of ECA has regained normal lumen (*large solid arrow*).

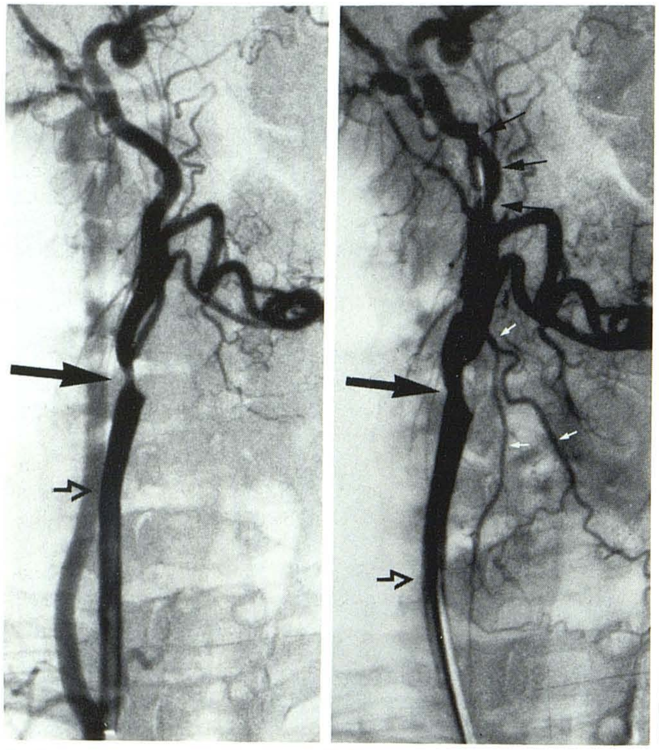
Comment. In a healthy ECA, the guide wire can be placed easily in the main stem of the vessel. If stenosis prevents guiding the wire, any branch of the ECA must suffice to anchor the exchange wire. However, the combination of spasm, lengthy stay of the guide wire, and eventually subintimal damage can cause thrombosis of the branch of the ECA that is used.

Discussion

Several authors have reported successful PTA of the brachiocephalic vessels [1–6]. All stress the advantages of PTA and the importance of proper selection of patients. The results have been uniformly excellent without complications. In the most recent report, Motarjeme et al. [2] reported dilatation of the stenotic segments of seven subclavian and 13 vertebral arteries. Dilatation of one ECA and one common carotid artery were performed intraoperatively.

In cases of occlusion of the internal carotid artery, the ECA attains special importance not only as a source of collateral circulation but also as the most convenient vessel for anastomotic bypass surgery. In either alternative, unhindered flow through the ECA is very important; for long-term patency of STA-MCA anastomosis, it is a prerequisite.

The potential hazard of PTA is the possibility of a distal ECA occlusion. In older patients the distal ECA is usually tortuous, and manipulation with guide wires and catheters can cause subintimal damage [7] or elicit spasm. For successful introduction of the PTA catheter, the exchange wire must be placed distally in the ECA. The same rule applies to the 0.025 inch (0.64 mm) anchor wire. Occa-



2A 2B

Fig. 2.—Case 7. Right common carotid artery, oblique view. **A**, Catheterization with PTA catheter (tip, *open arrow*). Internal carotid artery occluded. Stenosis at origin of ECA (*solid arrow*). Reflux into right subclavian and vertebral arteries caused by high resistance within common carotid artery. **B**, Postangioplasty. Origin of ECA is dilated (*large solid arrow*). Tip of PTA catheter (*open arrow*) in common carotid artery. Guide wire (shown protruding) causes spasm in distal segment of ECA (*small black arrows*). Superior thyroid artery (*white arrows*) is opacified.

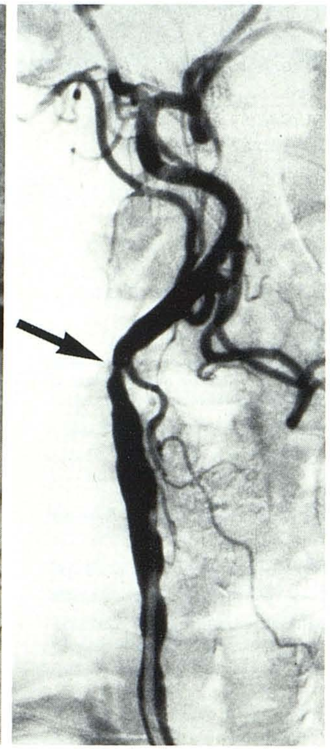


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Fig. 3.—Case 8. Right common carotid artery, oblique view. Internal carotid artery occluded. "Hard" stenotic lesion at origin of ECA (*arrow*) prevented successful angioplasty.

A B C

Fig. 4.—Case 9. **A**, Left ECA, lateral view. Nearly complete occlusion at origin of ECA (*large arrow*). Patent facial artery (*small arrows*). **B**, Postangioplasty. Left common carotid artery, lateral view. Excellent result of PTA (*large black arrow*). Guide wire in the facial artery (*small black arrows*). Previously nonopacified occipital artery (*white arrows*). **C**, 16 days post-PTA. Left common carotid artery, oblique view. Level of previous stenosis (*large arrow*). Facial artery occluded (*small arrows*).

sionally a larger wire has to be used as an anchor wire; the PTA catheter has a tendency to slide back into the common carotid artery, especially in elongated aortic arches. Mechanically induced spasm is frequently observed in small vessels during PTA of the popliteal artery. Sprayregen et al. [8] recommended injecting a vasodilator (60 mg papaverine or 25 mg tolazoline and 40 mg lidocaine) into the popliteal artery before passing the guide wire through the stenosis. This procedure reportedly greatly reduces the incidence of spasm. We never used spasmolytics to prevent spasm. Rather, when a spasm developed, we administered 30 mg papaverine diluted in 5 ml of saline solution at slow injection rate, mindful of collateral systems to the intracranial circulation. The spasm was relieved in almost every case. The distal ECA was always patent on the control (postbypass) arteriograms; in one case, however (case 9, fig. 4c) we iatrogenically occluded the facial artery. As mentioned in the case report, because of the stenosis and underlying arterial disease, the angiographer does not always have the liberty to maneuver the guide wire into the main stem of the ECA and is occasionally obliged to use smaller branches of the ECA to anchor the guide wire.

The mechanism of balloon angioplasty has been discussed [1, 9, 10]. Evidence from these studies indicates that some degree of laceration, the so-called controlled injury of the arterial wall, is necessary for successful transluminal angioplasty. The precise role and importance of anticoagulation therapy during angioplasty is still undetermined [3–5, 10]. The patients in our series were maintained on aspirin before, during, and after the procedure. Low-dose heparin therapy was initiated immediately after catheter withdrawal and continued for 4 days.

Close cooperation and communication with the vascular surgeon is of paramount importance in case of complication. Failure to achieve angioplasty is preferable to risking total occlusion of the vessel. Since PTA is a catheter procedure, not a surgical one, failure without complications has no adverse consequences, and follow-up vascular surgery can always be performed if the procedure is unsuccessful [11].

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