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Percutaneous Puncture of the External Carotid Artery or Its Branches After Surgical Ligation

Y. Pierre Gobin, Anne Pasco, Jean-Jacques Merland, Armand A. Aymard, Alfredo Casasco, and Emmanuel Houdart

PURPOSE: To describe the technique and results of percutaneous puncture of the external carotid artery or one of its branches distal to a surgical arterial ligation. **METHODS:** Forty-three patients underwent 64 embolization attempts by percutaneous arterial puncture distal to an external carotid artery ligation. The punctured arteries were the trunk of the external carotid artery in 31 patients, the internal maxillary artery in nine, the facial artery in nine, the lingual artery in eight, the occipital artery in four, and the superficial temporal artery in three. **RESULTS:** In 64 attempts 57 were successful in one session, six were successful in two sessions, and one failed. Puncture-related complications were eight spontaneously resolving hematomas and six asymptomatic punctures of the internal carotid artery. **CONCLUSION:** After surgical ligation of the external carotid artery or its branches, arterial puncture above the ligation allowed selective catheterization and endovascular occlusion of vascular lesions.

Index terms: Arteries, carotid (external); Arteries, therapeutic blockade; Arteries, surgery; Interventional neuroradiology; Arteriovenous malformation

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Endovascular occlusion of head and neck hypervascular lesions is a useful treatment. It can be curative for small arteriovenous malformations or for single-channel arteriovenous fistulas, and it can help curative surgery of large arteriovenous malformations or hypervascular tumors. In addition, performed in a palliative attempt, endovascular occlusion can stop the hemorrhages or improve the trophic troubles that can complicate the evolution of arteriovenous malformations (1–4). To be effective, the embolizing material must reach the proper arteries to the tumor or the shunts of the arteriovenous malformation; this requires selective catheterization. However, not infrequently in these patients a surgical ligation, sometimes bilateral, of the external carotid artery (ECA) has been previously performed, and selective catheterization is jeopardized. In order to solve this problem, we developed a technique of percutaneous puncture of the ECA or its

branches distal to a ligation. We report here the results in 64 cases. The advantages of this method and some technical points are discussed.

Methods

Patients

Since 1982, 43 patients (mean age 32 years), have undergone a total of 64 attempted embolization procedures by percutaneous puncture of the ECA or its branches. Indications for embolization were facial arteriovenous malformation (33 patients), direct-ECA arteriovenous fistulas (four), dural-arteriovenous fistulas (one), cavernous dural fistula (two), and juvenile angiofibroma (three).

All had undergone previous surgical ligation of the ECA trunk, a more distal arterial ligation, or a segmental arterial resection. In all cases, after transient improvement, there was recurrence of the symptomatology after ECA ligation.

Punctures were attempted on the trunk of the ECA in 31 patients, the internal maxillary artery in nine, the occipital artery in four, the superficial temporal artery in three, the facial artery in nine, and the lingual artery in eight.

Technique

Direct punctures were performed under neuroleptanalgesia and local anesthesia in 49 sessions and under general anesthesia in 21 sessions. The procedure began with an angiogram of the common carotid, vertebral, and subcla-

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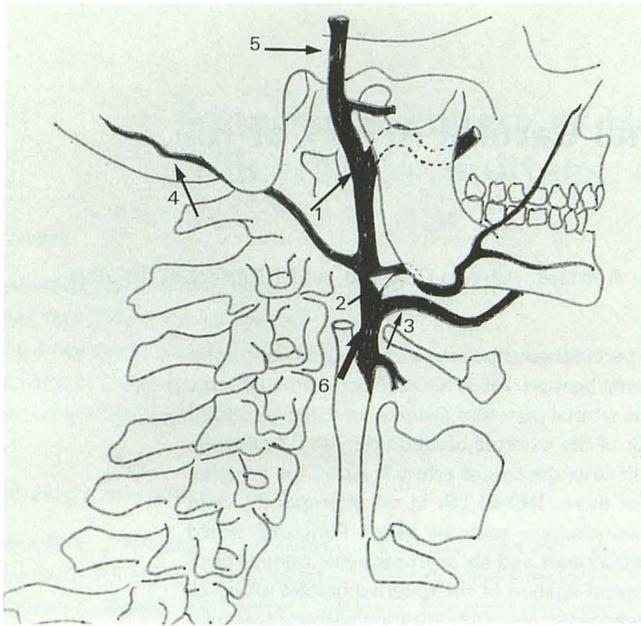


Fig. 1. Puncture sites of the ECA and its branches related to bone landmarks. 1 indicates the internal maxillary artery; 2, facial artery; 3, lingual artery; 4, occipital artery; 5, superficial temporal artery; and 6, trunk of the ECA.

vian arteries. This allowed the detection of the arterial anastomosis distal to the ligation. Depending on the site of ligation, the anastomosis could involve the contralateral ECA, the internal carotid artery (ICA), or the vertebral, cervical, or thyroid arteries.

The punctures (Fig 1) were performed under fluoroscopy, using road mapping in 18 sessions.

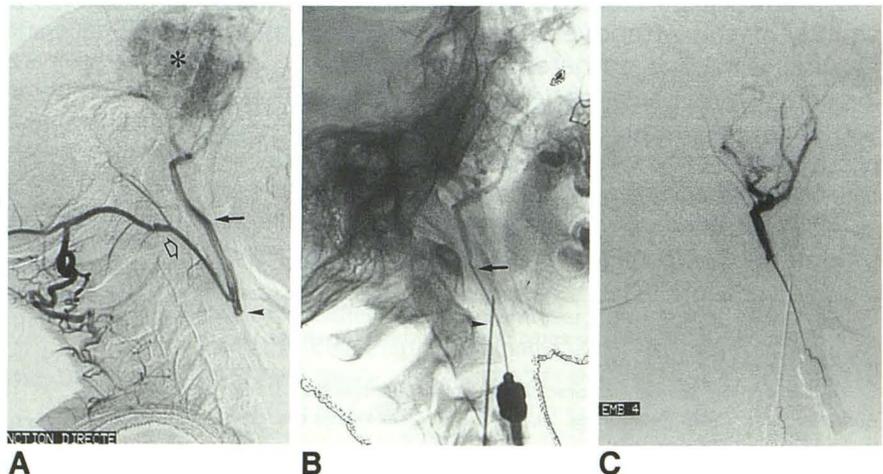
The trunk of the ECA was punctured laterally at its origin (Fig 2), avoiding puncture of the internal carotid artery (ICA). If inadvertent puncture of the ICA occurred, the needle was left in place to avoid a second puncture of the ICA, and a second more anterior puncture was attempted. In one case of incomplete ligation of the ECA,

Fig. 2. Direct puncture of the trunk of the external carotid artery. A 16-year-old boy presented with a recurrent nasopharyngeal angiofibroma. Previous surgical ligation of the ECA had been performed.

A, Deep cervical angiogram lateral view, showing the revascularization of the ECA (arrow) distal to ligation (arrowhead) via the occipital artery (open arrow). The tumor (asterisk) was fed by multiple branches of the internal maxillary artery.

B, Angiogram performed by percutaneous puncture of the ECA with a 16-gauge cathlon (arrow). A first puncture was too anterior; the cathlon (arrowhead) was left in place to guide the second one.

C, Angiogram performed after embolization with particles, introduced directly through the cathlon. Surgery was performed with minimal blood loss.



we were able to cross the ligation with a guide wire but not with the microcatheter. In this case, the guide wire was used to mark the artery under fluoroscopy, and the puncture was aimed at the guide.

The internal maxillary artery was punctured at its origin, behind the neck of the mandible (Fig 3). The entry point was under the lobe of the ear. The axis of the puncture had a triple obliquity of 45° medial, anterior, and superior.

The lingual artery (Fig 4) was punctured close to its origin, on its first curve with a superior convexity, above the superior edge of the great corn of the hyoid bone.

The facial artery was punctured at any of these three locations: its origin, on its submandibular course, or distally on its superficial jugal course.

The occipital artery was punctured at 4 cm behind the ear, where it lies superficially and is palpable.

The superficial temporal artery was punctured in front of the tragus.

The needles used were cathlons (Critikon, Chatenay, France) with different calibers (16, 18, or 20 gauge).

Embolization was performed directly through the cathlon, or using the cathlon as a sheath, through a microcatheter (Pursil, Balt-Co, Montmorency, France) or a Tracker microcatheter (Target Therapeutics, San Jose, Calif).

Results

Results are summarized in Table 1. Sixty-four attempts at embolization were performed in 43 patients, because some of the patients required repeated embolization at various intervals.

Fifty-seven attempts at embolization out of 64 (89%) were successful (ie, allowed embolization) in one session. Seven attempts out of 64 (11%) were unsuccessful at the first session. In these cases, a second session was performed 1 to 3 days later under general anesthesia. This allowed successful puncture of the artery and subsequent

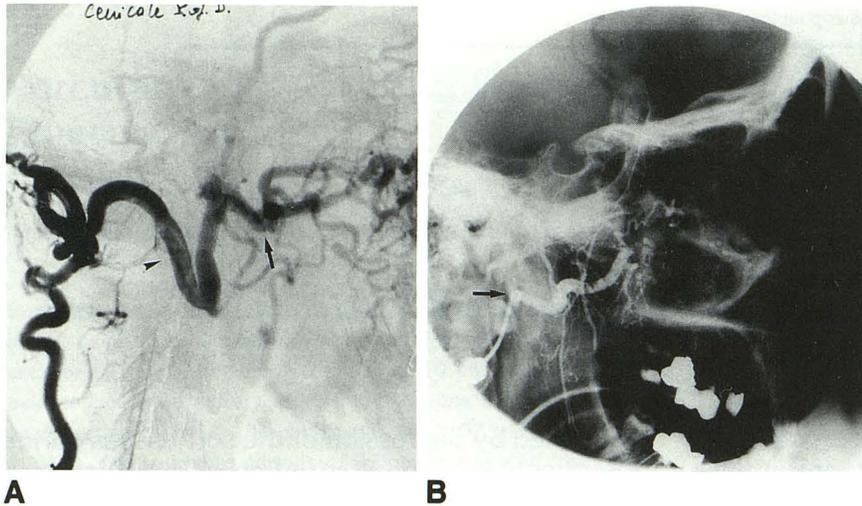


Fig. 3. Direct puncture of the internal maxillary artery. This 23-year-old woman presented a facial arteriovenous malformation with skin ulcerations and pain. Multiple arterial ligations (bilateral ECA) had been performed previously.

A, Deep cervical angiogram lateral view, demonstrated revascularization of the right-internal maxillary artery (arrow) by the occipital artery (arrowhead).

B, Angiogram performed by direct puncture of the right-internal maxillary artery, lateral view, after embolization with particles.

embolization in six of the seven cases (total success rate: 98%).

The superficial and palpable arteries (trunk of the external carotid artery in 31 cases, the occipital artery in four, and the superficial temporal artery in three) were all punctured in one session.

Punctures of deep arteries (internal maxillary artery in nine cases, facial artery in nine, and lingual artery in eight) were most difficult. The

first session was unsuccessful in seven cases. These involved the internal maxillary artery in three, the facial artery in two, and the lingual artery in two. The second session was successful in all but one case, which was a direct puncture attempt of the internal maxillary artery. In this case, a partial embolization was performed through the arterial anastomosis.

Puncture-related complications were hematoma at the site of the puncture in eight of the 64 attempts (12.5%), all of which resolved spontaneously. Inadvertent punctures of the ICA occurred in six of the 31 (19%) cases of punctures of the trunk of the ECA, with no consequences.

Discussion

It is now accepted that surgical ligation of the ECA to treat hypervascular lesions must be avoided, because collateral circulation and revascularization always occur (5, 6). When arterial ligation has been performed, any clinical improvement is often temporary, and further treatment, particularly endovascular occlusion, is necessary. Because direct endovascular access to the lesion by the femoral route is impossible, other accesses must be found.

Accesses that can be used are as follows:

1) The first possibility is to use the anastomotic arteries selectively to reach the lesion. However, navigation through the arterial anastomoses is a difficult procedure and rarely possible.

2) Another possibility is to infuse the embolization material through the arterial anastomosis. This is not very satisfactory because of the risk of occluding the anastomotic arteries. Such proximal occlusions are not efficient because other anastomotic channels will always develop and

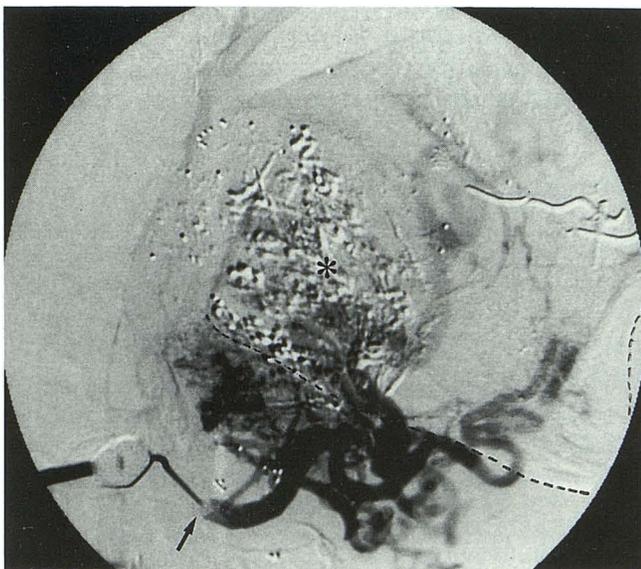


Fig. 4. Direct puncture of the lingual artery. This 34-year-old man presented with dysphagia and pain caused by a tongue arteriovenous malformation. Ligation of the right-facial and lingual arteries had been previously performed. The contralateral lingual artery supplied the arteriovenous malformation via transmedial anastomosis. Angiogram obtained by direct puncture of the right-lingual artery, oblique view, during embolization. The direct puncture of the right-lingual artery with a 16-gauge needle (arrow) allowed selective catheterization with a Tracker 18 microcatheter and embolization with N-butyl-cyanoacrylate (asterisk). Dotted lines indicate the edges of the mandibula.

TABLE 1: Results of percutaneous puncture of the ECA

| Artery | Attempts | Success at 1st Session | 2nd Session Needed | Success at 2nd Session | Total Success Rate |
|-------------|----------|------------------------|--------------------|------------------------|--------------------|
| ECA | 31 | 31 | 0 | | 31/31 |
| IMA | 9 | 6 | 3 | 2 | 8/9 |
| Facial A | 9 | 7 | 2 | 2 | 9/9 |
| Lingual A | 8 | 6 | 2 | 2 | 8/8 |
| Occipital A | 4 | 4 | 0 | | 4/4 |
| Sup Temp A | 3 | 3 | 0 | | 3/3 |
| Total | 64 | 57 | 7 | 6 | 63/64 |

Note.—ECA = external carotid artery; IMA = internal maxillary artery; Sup temp A = superficial temporal artery.

refill the lesion. Moreover, they compromise the vascularization of healthy territories around the lesion. Finally, such embolization carries a higher risk of aberrant emboli, which can have disastrous consequences if they reach the brain circulatory system.

3) Catheterization after surgical reanastomosis of the ECA also may be proposed, but this has some difficulties. The surgical anastomosis can be technically difficult because of the proximity of the hypervascular lesion and its dilated draining veins. In addition, there must be a few weeks delay between the surgical procedure and the catheterization through the bypass.

4) The final option is surgical exposure of the arterial feeders. This can give endovascular access to the lesion (7); however, this carries the inconveniences of a surgical intervention, and the quality of the fluoroscopy available in the operating room is seldom as good as that found in the angiographic room.

Because of the drawbacks in the options listed, we developed a technique of direct percutaneous puncture of the ECA and its branches. The difficulties we encountered were in puncturing the deeper arteries: lingual, facial, and internal maxillary. Nevertheless, superficial arteries (occipital, superficial temporal, and trunk of the ECA) were easy to puncture.

Neuroleptanalgesia and local anesthesia were generally sufficient to avoid pain and provide immobility of the patient. General anesthesia was necessary only in children and in an adult case of a second session after an initial puncture failure.

The first steps of the procedure were arterial palpation and marking of the artery in fluoroscopy. Road mapping was not of great assistance because of the modification of the landmarks

generated by depression of the soft tissues during the puncture. If the first puncture failed to reach the chosen artery, the technical trick was to leave the needle in place and to perform a new angiogram. Thus, this needle became a new landmark, more useful than bone marks or road mapping, because it was close to the chosen artery, and its anatomic relationships were not modified by the movements of soft tissues.

Using this technique, percutaneous puncture of the ECA or one of its branches was successful in almost all the cases. This technique is limited only when arterial ligations or resections have been performed very distally. In these cases, the endovascular route is definitively inaccessible, and embolization must be performed by direct puncture of the lesion, percutaneously or during surgery.

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