AN ADDITIONAL APPROACH TO THE INTERNAL CAROTID ARTERY FOR CEREBRAL ANGIOGRAPHY

ARTHUR ECKER, M.D., AND RICHARD H. CHAMBERLAIN, M.D.
Department of Surgery, Syracuse University College of Medicine, Syracuse, New York, and Department of Radiology, University of Pennsylvania, Philadelphia

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SINCE the introduction of cerebral angiography in 1927 by Egas Moniz, studies of the cerebral circulation have been limited largely by technical difficulties. The purpose of this paper is to describe an additional site through which radiographic contrast medium may be introduced into the internal carotid artery. The site to be described is immediately below the carotid foramen at the base of the skull and, in our hands, has proven to be an advantageous method of approach in certain cases. With this method it is possible to obtain satisfactory angiograms, percutaneously, with 35 per cent diodrast.

CONSIDERATION OF REQUIREMENTS FOR COMPLETE CEREBRAL ANGIOGRAPHY

Technical considerations for complete cerebral angiography may be tabulated as follows:

1. Complete serial exposures during the passage of contrast medium through the cerebral circulation by means of mechanical facilities for changing the films rapidly. Thus, there are obtained capillary and venous phases as well as the arterial one.

2. Inclusion of both the right and left carotid circulations in the study unless the first lateral study is unequivocal. In certain instances the vertebral-basilar circulation should be included.

3. Inclusion of stereoscopic exposures, at least in the lateral projections of the carotid arterial phases.

4. Inclusion of anteroposterior projections as well as the lateral ones.

5. Repetition of the studies whenever physiological or morphological change is anticipated.

6. Choice of a suitable contrast medium. No perfect contrast medium is available at this time, but the choice between thorotrast and one of the organic iodides is influenced by the volume necessary for the above considerations and their relative merits in regard to:

a. General toxicity: both immediate and delayed (including residual radioactivity in the case of thorotrast).

b. Inflammatory reaction in the soft tissues of the neck and speed of resorption in the event of extravasation into those tissues.

c. Density of the radiographic image produced.

7. Disadvantages of the incisional approach. Although an open incision
gives better access to the carotid and may be employed either routinely or when it is felt to be expedient, percutaneous methods should be less troublesome procedures and, if perfected, avoid the psychological barriers to routine use of cerebral angiography.

8. Preference to injection of medium as high as possible in the circulation, i.e., into the internal rather than the common carotid. The inclusion of the external carotid circulation offers no appreciable disadvantage to interpretation, but it is our impression that it is possible to reduce the total volume or concentration of the contrast medium by confining the visualization to the internal carotid.

The discrepancies between the optimal considerations listed above and the performance obtainable with methods previously described have prompted us to report the method of high approach to the internal carotid. Although it suffers from limitations also, it has been useful in certain cases.

ANATOMICAL CONSIDERATIONS

An appreciation of the anatomical relationships is a necessity for this procedure. The internal carotid artery enters the base of the skull through the carotid foramen, which lies medial and slightly anterior to the base of the styloid process. As viewed laterally just below the base of the skull the carotid is framed by a triangular window formed by the styloid process posteriorly, the posterior edge of the mandibular ramus anteriorly, and the base of the skull superiorly. Posterior to the internal carotid, but usually separated from it by the styloid process, lie the internal jugular vein and the last four cranial nerves. Anterior to the internal carotid lies the Eustachian tube. At the level we are considering, the internal carotid is relatively fixed because of the proximity to its bony canal.

TECHNICAL METHOD

1. Sensitivity. Inasmuch as diodrast has been chosen as a contrast medium in this method some form of test for sensitivity seems to be advisable and we have considered the procedure contraindicated when one obtains a general history of allergy in the patient or if there is a positive response to an intradermal or conjunctival test. An oral test is also employed if the patient is conscious and cooperative.

2. Premedication and Anaesthesia. Premedication has been routinely employed, consisting of 0.2 gm. of nembutal, orally, 2 hours before the procedure, and hypodermic injection of 0.016 gm. of morphine with 0.0006 gm. of atropine an hour beforehand. The premedication is varied according to the size and condition of the patient. An ordinary shaving of the face is adequate; it is not necessary to shave the scalp. No further general anaesthesia is necessary.

3. Apparatus. The apparatus prepared consists of 3 spinal puncture needles, 19 gauge, with a side arm attachment (Fleischer needles); 3 strong syringes of 10 or 20 cc. capacity; 60 cc. of 35 per cent diodrast. Before these materials are sterilized, a 35 cm. length of strong rubber tubing, 4.5 mm. in diameter, is tied firmly to the side arm of the needle and an adapter which will accept the locking device of the syringe is tied to the opposite end of the length of rubber tubing. It is desirable to insert a short length of glass tubing, for visualization, near the attachment of the rubber tubing to the needle. The rubber tubing tends to prevent jarring of the needle and keeps the operator’s hands out of the primary beam of roentgen rays. A rubber-covered clamp is used to prevent the needle from descending deeper into the tissues from its own weight, after the tip is in place in the internal carotid artery.
4. **Positioning of the Patient.** The entire examination may be carried out on a conventional radiographic table, although a special apparatus makes positioning and transfer of cassettes much easier. The definition obtained with high-speed Potter-Bucky diaphragm and rotating anode tube is especially desirable. When a conventional radiographic table is used, the patient is placed in the supine position; the head is rotated laterally and fixed with a clamp. Sand bags are placed under the shoulder and hip to allow a full lateral position of the head;

![Diagram](https://example.com/diagram.png)

**Fig. 1.** Relation of needle to carotid artery and skull. (1) Tympanic plate. (2) Styloid process. (3) Internal carotid artery. (4) Common carotid artery. (5) Needle.

it is usually necessary to tilt the tube toward the feet in order to correct for the vertical tilt of the head.

5. **Procedure.** The skin around the margin of the jaw is painted with an antiseptic and a sterile towel is placed around the neck. Approximately 8 cc. of 2 per cent novocaine is injected with a 22 gauge needle 6 cm. in length, along the course to be followed by the spinal puncture needle. This injection is made only after ensuring that the needle's tip is not in a blood vessel. It is important for the patient to keep the mouth closed during the procedure in order to avoid altering surface landmarks and disturbing the position of the needle.

The point of entry of the spinal needle is chosen on the skin 3 mm. anterior to the posterior edge of the ascending ramus of the mandible at the point where the latter is most concave; this is at about the level of the tip of the mastoid process. The needle is directed upward and medially in relation to the skull and backward in line with the center of the external auditory canal (auricular point). The cephalad angulation is so nearly compensated by the tilt of the patient's head as to bring the needle almost perpendicular in relation to the table. It must pass through a triangle of bone bounded by the styloid process below, the ascending ramus of the mandible in front and the tympanic plate above (Fig. 1). If it strikes bone within 3 or
4 mm. after penetrating the skin, it has struck the ascending ramus of the mandible and must be directed slightly more posteriorly. If it strikes the tip of the styloid process, it should be directed slightly more superiorly. If it strikes bone a few mm. after clearing the tip of the styloid process, it has probably struck the vaginal process of the tympanic plate and should be directed less superiorly and more medially. When the needle passes through the wall of the artery, a definite "give" may be felt. On the other hand, it is frequently necessary to strike the medial wall of the carotid foramen and then, after removing the stylet, to withdraw the needle very slowly until the arterial blood gushes forth. The internal carotid artery is usually

Fig. 2. Lateral angiogram indicating arterial aneurysm arising at bifurcation of internal carotid artery into the anterior and middle cerebral arteries. Note that both anterior cerebral arteries are being supplied by the internal carotid on the injected side.

entered at a depth of 2 or 2 1/2 inches (5.0 to 6.5 cm.) from the surface of the skin in this approach. If the needle penetrates 3 inches (7.5 cm.) its tip is in the pharynx and it should be withdrawn and redirected more cephalad. If the patient complains of pain in the ear, the point of the needle is in the Eustachian tube and the needle should be redirected slightly more posteriorly.

When the stylet is removed from the needle, dark or venous blood issuing from the hub indicates that the tip is in the jugular bulb and that the needle point should be redirected more anteriorly. If a clear, colorless fluid flows from the needle, it is cerebrospinal fluid from the anterior portion of the posterior lacerated foramen and the needle should be redirected more superiorly and slightly more anteriorly. (Incidentally, this site is the cerebellopontine angle and this method of injection may prove useful some day for the injection of a contrast medium; for example, in cases of suspected acoustic nerve tumor.) If bright red arterial blood issues from the needle at the rate of about one drop per second or faster, the needle tip is in
the proper position in the internal carotid artery. The rubber-covered clamp is now applied. After the needle has been thus clamped, the stopcock in the hub of the needle is turned gently so that the bore of the needle is continuous with the rubber tubing. Before injecting the diodrast, we aspirate some blood into the piece of glass tubing near the needle in order to be sure the tip of the needle is still in position.

The injection should be made quickly so that 10 cc. of 35 per cent diodrast is placed within the artery in less than 3 seconds, preferably within 2 seconds. The first film, a lateral arteriogram, is made after about 7 cc. of the diodrast have been injected, while the injection is being completed. This film reveals primarily the internal carotid and the middle and anterior cerebral arteries (Fig. 2). The second film, a lateral phlebogram, is made as soon as cassettes can be changed, a period of time which is usually about 6 seconds after the first film is made and about 5 seconds after the injection is completed. While the phlebogram is being made, blood from the carotid artery is usually pushing the barrel of the syringe back and when preparations are made for the second injection, there are usually about 8 cc. of blood in the syringe, which is then changed for another syringe containing 10 cc. of diodrast. At this time, the tube is shifted for the other stereoscopic point. Again blood is aspirated into the syringe and injection made as for the first arteriogram.

It is possible then to make an anteroposterior projection of the arteriogram by carrying out the following steps: The sandbag is removed from under the shoulder, the head rotated so that it rests on the occiput and the shoulder depressed so that the needle can be approached.
without interference. If the flow of arterial blood into the syringe continues, anteroposterior (half axial or Towne projection) views of the arteriogram (Fig. 3) and phlebogram are made just as the lateral ones were made. The entire procedure may then be repeated on the other side of the neck. Carrying out this full procedure on both sides of the neck requires 60 cc. of 35 per cent diodrast. This amount is well within the quantity of diodrast usually considered to be safe (50 cc. of 70 per cent diodrast) for intravascular injection in a patient on one occasion. If there is any reason for performing a urogram, appropriate films of the genito-urinary tract can be exposed after the completion of the angiographic procedures.

If the diodrast is injected into the carotid sheath, it causes pain which is not excessive and the diodrast is absorbed in less than an hour. The procedure can be repeated a few days later. It is advisable to avoid unnecessary stimulation of the carotid sinus and to have epinephrine on hand in the event of a reaction of sensitivity to the injection; 1 cc. of 1:1000 epinephrine was injected subcutaneously in one patient in whom urticaaria developed a few minutes after the injection, with relief of symptoms and subsidence of the cutaneous wheals. No other complications have been encountered except an inconsequential hematoma in the neck in about half the cases.

DISCUSSION

Our present procedure for cerebral angiography is to attempt percutaneous injection of the common carotid artery first.\textsuperscript{1,4,9,10} If this procedure is unsuccessful, we feel that percutaneous injection of the internal carotid artery, as described in this paper, is the next procedure of choice. Should this method also be unsatisfactory, direct exposure of the carotid is then employed.\textsuperscript{2,3,5,6} We feel that it is obvious that the procedure that we have described offers some advantages and suffers some disadvantages as do other methods of technique but that it has a place in the choice of procedures as indicated. Among its disadvantages may be listed lack of visualization of the artery, probable contraindication of thorotrat as a contrast medium because of the dangers of extravasation, not infrequent inability to penetrate the artery and maintain the position of the needle in certain patients, and a possible disadvantage to working so close to other structures, such as the extension of the subarachnoid space, cranial nerves, and Eustachian tube communicating with the middle ear. There is also the remote possibility of production of arteriovenous fistula between the internal carotid artery and internal jugular vein. When one is seeking information concerning a possible meningioma which may have a double arterial blood supply; namely, one circulation from the internal carotid and one from the external carotid, it may be more desirable to inject the common carotid artery. On the other hand, the advantages of the method here described are use of a low-concentration contrast medium, with reduced total amount of medium employed, the direct injection into the internal carotid artery, the ease and accuracy of multiple injections when the technique is successful, the possibility of use in short-necked patients in whom lower percutaneous injection is difficult, especially where there is a low bifurcation of the common carotid artery, and the other advantages shared with percutaneous methods in general.

SUMMARY

There is reported a new method of performing cerebral angiography by
direct percutaneous injection of the internal carotid artery at the base of the skull with the use of local anaesthesia.

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