OPEN INDIRECT METHOD OF VERTEBRAL ANGIOGRAPHY

J. P. SCHEERER, M.D.

Department of Neurosurgery, Upstate Medical Center, Syracuse, New York

(Received for publication May 12, 1953)

SINCE the introduction of vertebral angiography by Moniz,11 Pinto and Alves, several methods of visualization of the intracranial vertebral system have been proposed and tried. Essentially they can be classified as open indirect, closed indirect, open direct and closed direct methods. Radner's14 catheterization method is in a class of its own.

Only two of these many methods are well documented in the literature as to results obtained in series large enough to be conclusive: Lindgren's "upper percutaneous technique"9 and Radner's catheterization method.14 (Sugar, Holden and Powell18 independently worked out a closed direct method practically identical to Lindgren's except for the use of general anesthesia instead of local anesthesia.)

Sjögren16 in a recent article stated that from a practical standpoint there are nowadays only two methods for contrast filling of the vertebral artery that need be discussed: the percutaneous and the catheter method.

Ameli2 in 1952 was the first, and to my knowledge the only one, to report a series of "over 20 cases" in which he used an open indirect method. This method had been described by Elvidge5 in 1938 and is a variation of the open indirect method of Moniz, Pinto and Alves. Elvidge exposed the right common carotid artery in a retrograde direction after the artery had been occluded distal to the point of puncture. At the moment of injection, the axillary artery was compressed manually. However, there is no evidence in Elvidge's paper that filling of the vertebral system was obtained in more than one case. In an editorial comment on Ameli's paper, Percival Bailey3 remarked: "When percutaneous vertebral arteriography is so easy, there seems little need to resort to this complicated technic."

It is the purpose of this paper to show that the principle of this open indirect method still deserves serious consideration and in certain settings may well be the method of choice.

METHOD

The patients are premedicated with atropine 1/150, Benadryl 50 mg., papaverine gr. 4, and tested for Diodrast: eye, skin, and intravenously.

Under general intratracheal anesthesia the right or both carotid arteries are exposed with small partial collar incisions, preferably placed in a natural crease in the skin of the neck at the level of the cricoid cartilage. Except for hemorrhage from small subcutaneous vessels this can be done practically without hemostasis being necessary. Two small bands of umbilical tape are slipped under the exposed common
carotid artery. These serve as reins to lift the artery to the surface and steady it for the introduction of the needle. A 16-gauge Tuohy needle is introduced into the right carotid artery, the point directed towards the heart. With a piece of plastic tubing, the needle is connected to a 3-way stopcock which in turn is connected to a drip of 5 per cent glucose in water with sodium citrate added. In between injections this drip is used to keep the system patent. For the actual injection, a 20 cc. syringe, containing the Diodrast, is attached to the 3-way stopcock. For indirect vertebral filling, an assistant occludes the common carotid cranial to the site of the needle puncture, again using the tape as a rein. A blood-pressure cuff is placed high on the right arm and inflated enough to suppress the arterial flow to the arm. Twenty cc. of 50 per cent Diodrast, obtained by mixing 35 per cent and 70 per cent Diodrast, are rapidly injected and the X-ray exposure is called for 1 second after the plunger has hit the bottom of the syringe. At this moment the vertebral system is usually visualized.

If carotid injections are to be made first, the direction of the needle can easily be changed during the procedure. We like to start with a Towne view. The patient is then turned on his left side and lateral views are taken. Because of the open method, the turning of the patient presents no problem. In certain situations (tumors of the pituitary e.g.) we take submentovertical views also. Again, the positioning of the patient with the needle in place can easily be done. We prefer to wait after each injection and to view the wet films before making the next injection. We agree fully with Sugar and Bucy that a rapid succession of injections is considerably more dangerous.

At the end of the procedure the needle is withdrawn, the puncture site is closed with a single fine arterial suture and the incision is closed in layers.

Rapid changing of cassettes permits taking a second shot about 5 seconds later, at which time the venous phase usually is visualized. If a seriograph is available, the problem of changing cassettes is, of course, not existent.

RESULTS

Between July 1952 and April 1955 we have used this indirect method of vertebral angiography in 52 instances. Excellent filling (Fig. 1) was obtained in 44 cases,* fair but useful pictures in 7 cases, and in 1 case the result was unsatisfactory.

Since the main purpose of this paper is to demonstrate the usefulness of a method, no detailed case histories are presented but merely a more or less random selection of pictures is reproduced, giving the pertinent diagnosis in the legends (Figs. 2–6).

DISCUSSION

A useful angiographic method should satisfy the following requirements:

1. Its technical difficulties should be minimal, enabling the surgeon to obtain good angiographic pictures even if he does only a limited number of angiograms per year, as is often the case in a small neurosurgical service. The rate of failure, therefore, should be low at the beginning as well as at the end of a series.

* In both frontal (Chamberlain-Towne) and lateral projections.
2. No additional potentially dangerous elements other than the well-known hazards of ordinary cerebral angiography should be introduced. Judged by these criteria the percutaneous as well as the catheter method appear inferior to the open indirect method.

The percutaneous techniques have been developed mainly in large centers where angiography is practically a daily routine. They seem to represent the result of the universal human desire to find short cuts, and simpler and faster ways of doing a given task. It shall not be denied that under the special conditions of a large center some individuals may become extremely efficient in percutaneous arterial puncture and obtain satisfactory results. On the other hand, there will always be elements of haste and tension with the percutaneous methods. Attempting to get as many pictures as possible before the “good position” of the needle is inadvertently lost, as so often happens, there will be a tendency for rapidly successive injections. That this may be dangerous has recently been pointed out by Sugar and Bucy\textsuperscript{17} who recommend a relatively long wait between injections. Even in the literature advocating the percutaneous method, we find many hints of real difficulties.\textsuperscript{10,13,19}

Radner’s method of catheterization is reported to be successful in over 90 per cent of cases. It is, however, to quote Lindgren, “considerably more complicated than the percutaneous method and not infallible either as we have found.” The method entails not only exposure but sacrifice of the radial artery. The latter is considered to be of little consequence in view of the rich collateral circulation at the elbow. Whether or not impaired circulation in the hand will result in an occasional case remains to be seen. There is an obvious discrepancy in the statistical figures regarding the comparative successfulness of the percutaneous and the catheter methods. Sjögren encountered, with the percutaneous method, real difficulties in about 10 to 15 per cent of the total. Freshwater\textsuperscript{7} has had 17 failures in 68 cases. Olsson,\textsuperscript{12} on the other hand, reported failure of the catheter method in 1 out of 240 examinations. On closer scrutiny one finds, however, that these figures apply only to cases investigated “after final elaboration of the method.” The excellent results, then, are obtained by operators who are very familiar with the method. For one who is not especially trained, it is often difficult to pass the catheter up into the vessel and perforations have been reported (Sjögren). The number of severe complications seems to be higher with the

![Diagram of blood vessels visualized by indirect vertebral filling. (Reproduced by courtesy of Dr. Arthur Ecker. 6)]
Fig. 2. Large berry aneurysm arising from right posterior cerebral artery, indirect vertebral filling.

Fig. 3. Same case as in Fig. 2. Carotid injection on the left demonstrating a second berry aneurysm arising from left middle cerebral artery.
Fig. 4. Superior cerebellar arteries rising above the level of the posterior cerebral arteries, indicating "upward herniation" of the cerebellum into the tentorial notch. (Note posterior choroidal arteries.) Pathological diagnosis: cystic astrocytoma (grade 1–2) of cerebellum.

Fig. 5. Note filling of internal carotid and its branches through posterior communicating artery, which is not visualized in direct vertebral injection. No abnormalities noted.
catheter method than with any other method. A very useful method in experienced hands, it should be approached with great caution by the novice. In comparison with the percutaneous and the catheter methods, the open indirect method is found to satisfy the initially postulated requirements very well and to be ideally suited for the needs of a smaller neurosurgical service. This holds true for the open method of carotid injection as well. The higher our standards of the quality of pictures become and the more attention we pay to details and the need of using varying positions, the less satisfactory the percutaneous methods in general become. After a period of extensive use of the percutaneous method, we have returned for the past 3 years to the open method of carotid injection, which eliminates the uncertainty in the interpretation of films whether or not unsatisfactory filling is the result of vascular pathology, such as spasm, or merely the result of technical difficulties of the injection. If, during the course of an examination, it becomes evident that vertebral visualization would be desirable, this can easily be accomplished during the same session. In cases of subarachnoid hemorrhage, we feel rather strongly that as complete an angiographic study as possible should be done. Having demonstrated one aneurysm should not mislead one to perform an incomplete examination. Figs. 2 and 3 demonstrate this point quite well.

![Fig. 6. Large arteriovenous malformation, causing hemiathetosis since the patient was 12 years old. Recent subarachnoid hemorrhage. Filled by indirect vertebral injection; occipital view.](image-url)
Our method of complete study leaves one small area undemonstrated, that of the left vertebral artery, and shows the left posterior communicating artery in only about one-fourth of the cases. The most common cause of failure would probably be an extremely narrow or absent right vertebral artery. It is conceivable that in such a case the same technique could be used on the left side as well. Richter\textsuperscript{15} published a picture of what we believe to be indirect vertebral filling in a case of thrombosis of the left carotid artery which would support this idea. We had no opportunity so far to try the method on the left side.

In contrast to the direct methods of vertebral filling, visualization of the carotid syphon and sometimes even of the carotid branches often occurs. This is, of course, produced by changes in the dynamics of blood flow caused by the carotid occlusion (Fig. 5). Gillingham\textsuperscript{8} stated that it is helpful to perform vertebral angiography with simultaneous carotid compression on the same side as the lesion, in visualizing minor implications of the posterior cerebral arteries in arteriovenous malformations. Using the open indirect method, this is automatically accomplished.

Subarachnoid hemorrhage has already been mentioned as a main indication for vertebral angiography as part of a complete cerebral angiographic study. Large arteriovenous malformations commonly are fed by carotid and vertebral circulation. French and Peyton\textsuperscript{6} pointed out that hydrocephalus occurs with vascular malformations in the region of the great vein of Galen, which they could demonstrate only by vertebral angiography. Other indications are the investigation of supratentorial tumors in the posterior part of the brain, and investigation of infratentorial tumors. In tumor diagnosis based on vascular displacement, the greater variability of the normal pattern of the vertebral system as compared to the carotid system causes definite limitations and additional air studies are frequently necessary.

As to the complications, the open methods in general produce a lesser variety than the closed methods. Complications are caused by either the effect of Diodrast as such (which may be a direct toxic effect on the nervous tissue or an indirect one by producing cerebral ischemia secondary to vasospasm) or by a hypersensitive vascular system, which may respond with vasospasm merely upon being stimulated mechanically by the introduction of the needle into the artery. It seems that this type of complication is less likely to occur with the patient under general anesthesia than with local anesthesia. However, this is merely an impression based on too small a series to be conclusive. The fact that Diodrast is a potentially dangerous contrast medium sharply limiting the indications for angiography cannot be overemphasized. It is true that one often sees local narrowing of the carotid caused by spasm at the site of the puncture. This no doubt is secondary to mechanical irritation by the needle and probably by the tape we place around the artery. This, however, never leads to a significant diminution of the blood stream and is readily reversible in contrast to narrowing following injection of contrast medium into the sheaths of the vessels as occurs with the percutaneous method. We cannot agree with the statement of Abbott, Gay and
Goodall\(^1\) that percutaneous angiography (in general) is followed by fewer complications. The importance of the total amount injected, if the injections are made at proper intervals, has probably been overrated. We frequently inject as much as 100 cc. of Diodrast, without running into more complications than workers using much less. Radner, e.g., had one fatality after only 9 cc. were injected. Nevertheless, we agree that as little as possible should be injected and believe that arrangements allowing simultaneous lateral and anteroposterior views, thereby necessitating fewer injections, are of definite value.

**SUMMARY**

An open indirect method of vertebral angiography is described. Based on a series of 52 cases its merits as compared with the percutaneous and the catheter methods are discussed. The conclusion is reached that in certain settings it is recommendable as the method of choice.

**REFERENCES**

4. Eckel, A. The normal cerebral angiogram. *Springfield, Ill.: Charles C Thomas*, 1951, xx, 190 pp. (see Fig. 5).