THE SURGICAL TREATMENT OF INTRACRANIAL ANEURYSMS OF THE INTERNAL CAROTID ARTERY*

WALTER E. DANDY, M.D.
BALTIMORE, MD.

INTRACRANIAL ANEURYSMS arise on any part of the arterial vascular tree. Over one-half spring from the circle of Willis, the remaining are distributed throughout the brain and from the vertebral and basilar arteries. There are three types of intracranial aneurysms: (1) Congenital, comprising about 80 per cent of the entire number; (2) arteriosclerotic (about 15 per cent); and (3) mycotic (about 5 per cent). Contrary to a very prevalent opinion, syphilis plays no rôle, or almost none, in the formation of these aneurysms. There are no surgical possibilities in the mycotic aneurysms, which are one of the terminal phases of endocarditis, and are almost always in the brain substance and on the middle cerebral artery or one of its branches. Arteriosclerotic aneurysms offer very little returns from surgery; as yet none have been cured, though it is quite probable that the vertebral and basilar aneurysms may be benefited by ligation of one vertebral artery in the neck. It is principally with the congenital aneurysms that surgery has a place in treatment. Usually they are small berry-like nubbins in one of the vascular trunks—not uncommonly they are multiple. Since their walls are congenitally defective, they give rise to intracranial hemorrhage—usually the so-called subarachnoid hemorrhage—and in the early years of life, although they may rupture in later life.

Until a sudden rupture, aneurysms are usually silent. The immediate result of the hemorrhage depends in large degree upon the presence or absence of opposing tissue at the site of the rupture. If the rupture is into cerebral substance, the bleeding may be controlled, and a large progressive false aneurysmal sac will form and in time, by gradual expansion, give signs and symptoms like those of a brain tumor. Should the rupture be along a structure like the third nerve or the carotid artery itself, the bleeding may be controlled temporarily, but subsequent ruptures will probably occur and usually end fatally. Should there be no opposing tissue, the bleeding would then be into the cerebrospinal fluid (the cisternae) and rapid, fatal hemorrhage is almost inevitable.

The great deterrent to operative intervention in subarachnoid hemorrhage is the inability to localize the aneurysm by symptoms or signs. At times, there are prodromal manifestations but all too frequently the patient passes quickly into coma and then, all too frequently, there are no objective localizing signs.

* Read before the American Surgical Association, White Sulphur Springs, W. Va., April 28, 29, 30, 1941.

If it were even possible to localize the side (right or left) of the aneurysm, the operative exposure would be adequate to disclose the aneurysm, if it were located on the circle of Willis. This is a hope for the future, for up to the present time the only aneurysms that have been operated upon successfully are those causing a third nerve palsy or paralysis—a sign that is almost but not quite pathognomonic of an aneurysm and its location.

In a search for better and earlier means of diagnosis of aneurysms and their location, I have analyzed 103 cases that have appeared in the records of the Johns Hopkins Hospital. In a very high percentage of cases, no help was elicited, but in many of them there was adequate information to determine the side of the lesion. In nearly all of the aneurysms of the middle cerebral artery there was hemiplegia, but it is highly improbable that more than an occasional aneurysm of this vessel can ever be cured without a permanent hemiplegia, and treatment of this character would not be considered. On the other hand, some aneurysms of the anterior cerebral artery give a partial hemiplegia or Babinski, and these are amenable to treatment, although none have as yet been cured. Bilateral cerebellar and brain-stem signs of sudden onset may also indicate aneurysms of the basilar and vertebral arteries, but here again there are little prospects of a cure by surgical means, at least none have yet been successfully treated. It is the silent aneurysms, with few or no signs or symptoms arising from the internal carotid arteries and the circle of Willis, that offer the maximum from prompt surgical treatment.

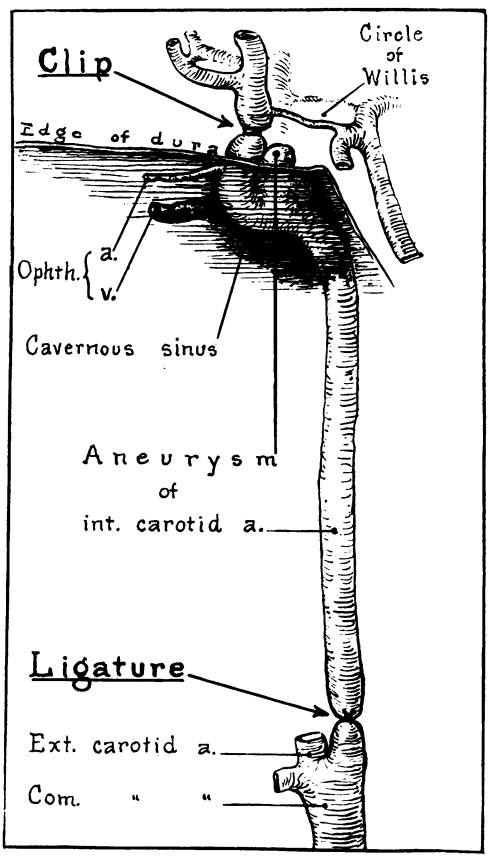

FIG. 1.—Diagrammatic drawing illustrating the method of curing carotid aneurysms arising within the carotid canal. A clip is placed on the internal carotid artery intracranially, and the internal carotid artery is ligated in the neck. This traps the aneurysm between the two ligatures, and the only sizeable branch between the ligature is the ophthalmic artery. Vision is not lost as the result of the ligation.

The only symptom that is useful in detecting the side of the aneurysm is an unilateral headache, or pain in one eye. This may or may not be present, either as a prodromal symptom before rupture, or as an excruciating pain at the time of rupture; and even occasionally it may be misleading. A positive

Babinski sign may at times betray the side of the lesion; but by far the most important sign of all is weakness of a third nerve.

Intra-arterial injections of thorotrast have for some time been used to define aneurysms and with remarkable results. Against its use is the risk of cerebral emboli, the frequent necessity of injecting both internal carotid arteries, since only one side fills well with one injection; and in the acute stage of bleeding the patient is much too ill. For patients who are not in the acute stage of subarachnoid bleeding, it will doubtless be a distinct asset, but should be employed with caution and discrimination.

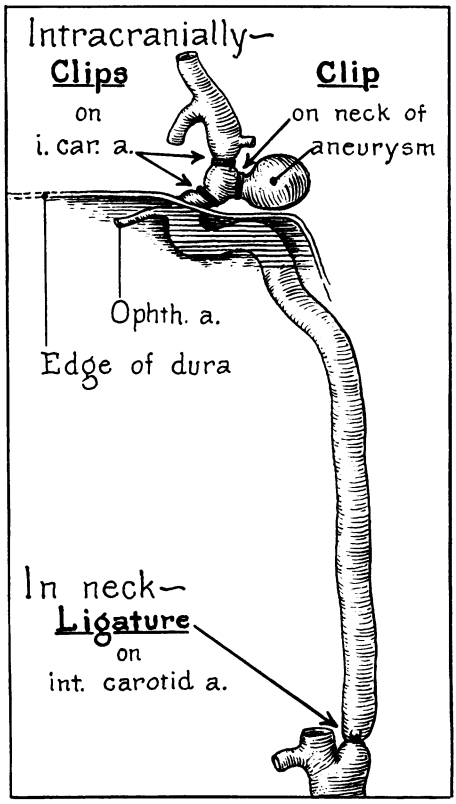

FIG. 2.—Diagrammatic drawing illustrating the method of treating intracranial aneurysms arising from the internal carotid artery, before the first branch is given off. The neck of the aneurysm may be clipped and nothing done to the internal carotid, or the internal carotid may be clipped on either side of the neck of the aneurysm, thus isolating it. The aneurysm is then shrunk by the electrocautery, in order to remove its contact with the third nerve, or it may actually be removed; this was done in one case.

Thirteen intracranial aneurysms of the internal carotid artery have been operated upon; all have been diagnosed and localized by a third nerve palsy or paralysis, plus sharp, severe, sudden pains in the eye and the corresponding side of the head. Six of these arose in the carotid canal and broke through into the cranial chamber alongside the internal carotid artery. Five of these are cured, the longest for four and one-half years. The single death was due to a rupture of the carotid artery in applying to a very large arteriosclerotic vessel a silver clip that was too small. This was a case of an arteriovenous aneurysm (pulsating exophthalmos). The arterial aneurysm which had ruptured and caused this arteriovenous fistula was found at necropsy. Seven arose from the internal carotid artery intracranially, before the anterior cerebral artery is given off. Five of these are cured and two have died.

Two of the five cures were obtained by placing a silver clip on the neck of the aneurysm, leaving the carotid artery intact. The remaining three cures were obtained by clipping or coagulating with the cautery the internal carotid artery on both sides of the aneurysm. The two deaths were due to (1) an abnormally placed posterior communicating artery, which was between the two clips and prevented collateral circulation; and (2) to subsequent rupture of the electrically coagulated internal carotid artery. This

occurred one month postoperative, after the patient had returned home, and was presumably cured. Ligation of the internal carotid artery in the neck would have prevented this death.

The mortality in this series is, therefore, 23 per cent—the cures 77 per cent.

DISCUSSION.—DR. FRANCIS C. GRANT (Philadelphia, Pa.): This question of aneurysms and their treatment is a matter of considerable interest because I think we may find that a good many of the cases that we see which have been classified as subarachnoid hemorrhage are going to turn out to be aneurysms, and may offer post-operative treatment.

The case that Doctor Dandy referred to, that was operated upon by him, in which the diagnosis of aneurysm was made by the use of thorotrast, has, in our instance at least, opened a good many possibilities. We have had two similar cases since, in which the thorotrast has been used and the aneurysm identified, and we are hoping to have the opportunity to operate upon those particular cases.

Our experience with aneurysm has not been as fortunate, so far as the operative procedure is concerned, as Doctor Dandy's has been.

During the last ten years, we have had 14 cases of aneurysm that have gone through the clinic and been identified, nine of them clinically and five pathologically. The five pathologic cases have been found in a series of, roughly, 1,100 verified brain tumors, so I presume the percentage of aneurysm to all other cases is about one-half of 1 per cent. The cases that are considered as having been verified clinically are cases similar to the ones to which Doctor Dandy referred, where there has been a paralysis of the various optical nerves, usually with hemiplegia; and on the history; and, at times, by roentgenologic and other evidence, the case has been suggestive of aneurysm, but unfortunately we have not, as I say, realized the operative possibilities in those cases which have been sent home.

The type of case that we have seen most commonly is similar to one that we had two years ago, with aneurysm of the basilar artery; a presumptive diagnosis was made of a cerebellar lesion. The patient died rather suddenly, after the administration of an enema. This lesion was found.

The other kind has been of the type where there has been a large intracerebral aneurysm; the possibilities as far as operation is concerned in those cases, of course, being very limited. But I am quite sure that most of these cases of subarachnoid hemorrhage—certainly those that show clinical and pathologic evidence of the involvement of the ocular nerves, particularly the third—should be subjected to thorotrast injection. With the injection of thorotrast, one may very well find the position of the aneurysm. As Doctor Dandy has said, if it lies on the circle of Willis, very little can be done, but if it lies along the carotid, certainly, exposure is warranted and an attempt can be made either to trap the aneurysm between the silver clips, as he suggested, or to put a silver clip on the neck of the aneurysmal sac itself; and by that means I see no particular reason why a good many of these cases should not be cured. Of course, it is not quite as easy an operative procedure as one might gather from Doctor Dandy's description, but, nevertheless, it is an operative procedure which, to my mind at least, is entirely justified, because if nothing is done these aneurysms will go on to rupture, with ultimate death of the patient.

DR. GILBERT HORRAX (Boston, Mass.): This is a most important communication of Doctor Dandy's, and I am sure it interests all of us, but particularly the neurosurgeons. It has opened up a line of treatment for certain types of intracranial aneurysms, which I am sure we must all follow in the future.

We have not been fortunate enough to identify an aneurysm intracranially which we could clip or trap in the way Doctor Dandy has described. However, we have had six examples of intracranial aneurysms which we have exposed at operation and have treated in another way, a way which has been described by Mr. Jefferson, of Manchester, England, and by Mr. Dott, of Edinburgh. This method consists in packing pieces of muscle around the aneurysm and thus hope at least to prevent any further rupture. These

patients have all survived and are alive anywhere up to five or six years at the present time.

One aneurysm, upon which we have not operated, was demonstrated by thorotrast, and one was identified but nothing was done to it since nothing could be accomplished, except to divide the ninth nerve, because of the pain the patient was having.

It seems to me we must be a little conservative about the attitude we take in regard to operation upon aneurysms, as there have been a large number of patients passing through the clinic who have had the diagnosis of intracranial aneurysm made, because of third nerve palsy and pain over the eye of the same side. Whether they are aneurysms or not, we do not know because we have not subjected them all to thorotrast. In fact, we have only, in two instances, demonstrated the presence of aneurysm by thorotrast. The other cases have not, as a rule, shown anything roentgenologically from which a positive diagnosis could be made, so the aneurysm diagnoses have been made on symptomatology and signs, but a large number of cases with one rupture have recovered and gone on for many years in perfectly good health. Thus, it seems to me there is a chance for a good many of these aneurysms to take care of themselves, if they have only a single rupture, because very possibly when there has been subarachnoid bleeding around them a clot is formed, and, because of the organization of that clot, I believe some of the aneurysms permanently cure themselves.

It is a most interesting and valuable paper. I think we should be on the watch for those aneurysms which we can cure in this way by ligation. But if the aneurysm, as presented at operation, does not offer a chance of putting a silver clip on it, this method of putting the muscle around it, I think, is an excellent one.