Postoperative angiography and the “slipped” clip

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After intracranial surgery for an aneurysm, postoperative angiography should be routine. This may demonstrate lesions such as arterial spasm and hematoma, and may also show, sometimes quite unexpectedly, that the sac has not been completely obliterated. A clip or ligature may be merely misplaced, not be closed tightly enough, slip, or include the parent artery. In our series of 329 patients who underwent postoperative angiography, contrast filling of a significant part of the sac still occurred in 43 (13%); at least 12 of these rebled. Further intracranial surgery was carried out in 18, with satisfactory obliteration of the sac in 16. An incompletely obliterated aneurysm should be reoperated on as soon as possible. The risk involved at this time is minimal and far less than the possibility of another catastrophic hemorrhage.

KEY WORDS intracranial aneurysm slipped clip postoperative angiography recurrent subarachnoid hemorrhage

Routine postoperative angiography should be obligatory to check the results of surgery for an aneurysm, both to assess the efficiency of the technique and to be able to give an honest prognosis to the patient. This can be and has been done without any serious consequences.

If all or part of the sac is still patent postoperatively, some surgeons may feel that further operative intervention is unlikely to improve the situation. Even so, the information should still be available so that the patient can be warned that another hemorrhage is possible. However, we feel that in most patients, a second operation should be considered, since the procedure is reasonably safe and will usually result in occlusion of the sac.

Clinical Material

At Victoria Hospital, 329 patients underwent postoperative angiography following an attempt to obliterate an aneurysm by clip or ligature. In 43 of these (13%), all or a significant part of the sac still filled with contrast material. Clips had been applied in 37 and ligatures in six. At least 12 of the 43 patients rebled. The site of the aneurysm and the type of clip used were not significant in the incidence of bad placement. However, many of the sacs in these patients had broad necks or were multilocular, and misplacement was often due to a loculus being mistaken for the main aneurysm.

Results

Twenty-five of the 43 patients were not reoperated on; one refused to consider further
operation, four were deemed unsuitable because of their general condition, and three were irretrievable following further hemorrhage. In the other 17 patients, the risk of another operation was considered unwarranted; this was early in the series when the danger of leaving an improperly clipped aneurysm had not been appreciated. Since that time the use of deep hypotension has made aneurysm surgery much safer, and fear of torrential hemorrhage if rupture occurs has largely been removed. It is now possible in most patients to expose the whole aneurysmal neck with its connections, and to apply the clip in a suitable position.

The presence of some anatomical anomaly which prevents complete occlusion of the aneurysm is a contraindication to reoperating. This was illustrated in one of our patients in whom the superior cerebellar artery formed part of the base of the sac, so that only the fundus could be obliterated (Fig. 1). This patient died 12 days after reoperation from a further hemorrhage from the base of the sac proximal to the clip, although the original bleeding had been from the fundus.

Of the 18 patients who underwent further intracranial surgery, one twice, 16 (89%) underwent repeat angiography which showed that the sac had been obliterated in all cases. Two patients were not studied again; one died before angiography could be repeated; in the other, at reoperation, such dense adhesions were found around the base of an aneurysm at the basilar bifurcation that complete dissection of the neck seemed unduly hazardous. With this scarring further bleeding seemed unlikely, especially as the dome had been occluded previously.

Sometimes the clip had obviously slipped. In one patient with a broad-based aneurysm of the posterior communicating artery, the first postoperative angiogram (Fig. 2 upper left), showed that the clip was completely off the neck. A second attempt at clip placement 2 weeks later was equally unsuccessful (Fig. 2 upper right). At the
Postoperative angiography and the "slipped" clip

Fig. 2. Upper Left: Angiogram after first operation showing posterior communicating aneurysm, and that clip has slipped off neck. Upper Right: After a second operation, the sac is only slightly smaller, and clip has slipped again. Lower Left: Angiogram during the third operation demonstrates that there is still some filling of the sac. Lower Right: Postoperative angiogram shows that sac is obliterated.

third operation 3 months later dissection was difficult because of scar tissue. A Sundt clip was applied, but intraoperative angiography showed that placement was still unsatisfactory (Fig. 2 lower left). Reapplication occluded the sac, and this was
Charles G. Drake and John M. Allcock

FIG. 3. Angiograms showing an aneurysm of the left superior cerebellar artery (left); after first operation, clip is only on fundus (center); and (right) after second operation, sac is obliterated.

confirmed 7 days later (Fig. 2 lower right). The patient developed a hemiparesis, which was followed by nearly complete recovery. This case illustrates the benefits of angiography during surgery.

Other clips may merely be misplaced as in one patient with a superior cerebellar aneurysm (Fig. 3 left). A considerable portion of the base could be seen remaining (Fig. 3 center); another clip was positioned properly on the neck at a second operation with a good result (Fig. 3 right).

A third type of problem may arise if the clip is in the right position but not properly closed. One of our patients with a third nerve palsy and hemiplegia had a large fusiform sac arising from the first part of the posterior cerebral artery (Fig. 4 left). A McKenzie clip was placed on the origin of this vessel, but postoperative angiography showed some contrast medium passing through the center of the incompletely closed clip (Fig. 4 center). Carotid angiography revealed that the sac was also filling distally from the posterior communicating artery (Fig. 4 right), which had not occurred previously. At a second operation, the McKenzie clip was closed more thoroughly; a Sundt clip was also applied over the posterior cerebral and posterior communicating arteries and their common aperture into the sac; the vessels and sac were then aspirated and collapsed. The patient has since made an almost complete recovery from her hemiplegia.

Ten of the 18 patients undergoing a second operation were considered good risks and nine did well. In the remaining case an incompletely ligated aneurysm was found to be enlarging 4 years later; during an attempt to dissect the aneurysm which was now surrounded by dense adhesions, the sac was ruptured, and permanent amnesia resulted. Eight patients were in Grades III or IV at the time of reoperation; many had deteriorated from good grades because of rebleeding in the interval, but two made an adequate recovery.

A further benefit of angiography during or immediately after surgery is that accidental occlusion of a major vessel may be demonstrated at a time when there may still be hope of relieving the obstruction. Constriction or occlusion of the siphon occurred in four of our patients. In two, this was shown angiographically during the operation.
Postoperative angiography and the “slipped” clip

and patency was reestablished. In a third, a ligature was applied to the neck of a large posterior communicating artery aneurysm (Fig. 5 left). Although perfectly well for 16 hours, the patient then gradually developed a hemiplegia, and angiography showed occlusion of the siphon and some filling of the sac (Fig. 5 center); at a second operation, patency of the siphon was restored and the sac obliterated (Fig. 5 right), but the patient subsequently died of pseudomonas meningitis. In the fourth patient the lesion was not demonstrated until the following day; the clip was then removed. Three of these four patients died while the other remained hemiplegic.

Fig. 4. Left: Large fusiform sac is seen arising from right posterior cerebral artery. Center: A jet of contrast medium is seen passing through the clip (arrow). Right: The sac now fills from the posterior communicating artery (arrow).

Fig. 5. Left: Angiogram showing large posterior communicating aneurysm. Center: Postoperative angiogram demonstrates occlusion of the distal siphon and faint filling of the sac. Right: Angiogram after a second operation shows obliteration of the sac and patency of the siphon restored.
Discussion

Incomplete obliteration of the aneurysmal sac is not uncommon, even in experienced hands, and it can be disastrous if there is further bleeding. Several steps can be taken to avoid it. The blades of the clip should completely cross the neck of the aneurysm, preferably by 2 or 3 mm if there is room. The sac can often be aspirated to make sure that it collapses. Under deep hypotension, aspiration with a small needle is quite safe; we have had no instance of slipping of a clip or ligature when the sac has collapsed completely and permanently after aspiration. After careful and thorough dissection of the neck of the aneurysm, multiple trial applications of the clip may be safely performed under deep hypotension to obtain the best position. Another method of preventing slipping is the use of a clip which either encloses the parent artery (Sundt) or has an aperture in its base for a major adjacent branch to pass through (Drake).

The definitive step is to carry out angiography during surgery. This raises various technical problems; either a needle has to be inserted into the artery under conditions which are not exactly ideal, or a catheter must be left within a vessel for some time, perhaps introduced by a superficial temporal route. We believe these problems can and should be overcome.

The next best thing is to carry out angiography as soon as the operation is over and under the same anesthetic, so that remedial measures can be taken at once if improper occlusion is revealed. An example of the effectiveness of this method is seen in Fig. 6. The patient underwent clipping of a large aneurysm at the vertebral junction, and there was some doubt at the time of surgery as to whether the clip was on properly; this doubt was confirmed by immediate angiography which showed that the clip was only on a loculus (Fig. 6 right). At a second operation the same evening, it was necessary to separate the basilar artery from the pons so that a clip could be worked beneath onto the neck. Angiography 7 days later showed occlusion of the sac. It also demonstrated an unexpected block in the mid-portion of the basilar artery, possibly due to a small embolus. In spite of this the patient was perfectly well.

Even if angiography during or imme-
Postoperative angiography and the “slipped” clip

diately after surgery shows that the sac has been obliterated, it is still advisable to repeat the examination after a week, as clips may slip with the arterial pulsations and postoperative hypertension.

These results show that the risk associated with a second operation is scarcely more than with the first, and that leaving a patient with an improperly clipped aneurysm is usually unnecessary and may be disastrous. Reoperation should be carried out within a few days, before scarring makes the dissection difficult. Our only problems at the time of repeat surgery occurred after long delays (3 months, 6 months, and 4 years); nothing could be accomplished in one patient, another suffered a temporary hemiplegia, and a permanent amnestic syndrome resulted in the third.

References


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