

# Radial Artery Graft for an Extracranial-Intracranial Bypass in Cases of Internal Carotid Aneurysms

## Report of Two Cases

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Two cases of internal carotid aneurysms, trapped and bypassed, by means of radial artery grafts are discussed. Neither case has permanent neurological deficit possibly because of an adequate blood supply via the radial artery graft bypass. Although the radial artery graft has been in common use among cardiac surgeons, it is still rare in the neurosurgical field. The advantage of the radial artery is discussed with comparison to other graft materials such as the saphenous vein and the superficial temporal artery. In properly selected cases, the radial artery graft is useful in preventing the ischemic damage caused by an aneurysm being trapped at the main arterial trunk.

**KEY WORDS:** Radial artery graft; Extracranial-intracranial bypass; Internal carotid aneurysm; Saphenous vein; Superficial temporal artery

In cases of unclippable cerebral aneurysms, such as giant aneurysms or internal carotid cavernous aneurysms, trapping of the aneurysm is one of the radical approaches. In this procedure, it is important to protect the brain from ischemic damage caused by the trapping of the main arterial trunk. Generally, grafts of the superficial temporal artery (STA) or saphenous vein are used for the bypass.

Recently, the radial artery was used as graft material in aneurysmal trapping operations with good postoperative results. We report in this article two such cases and discuss the radial artery with respect to its special advantages.

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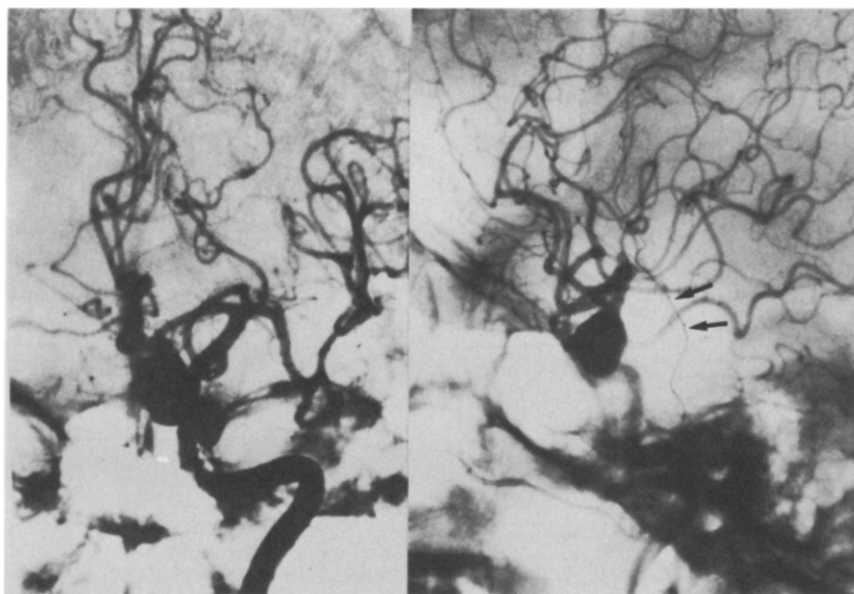
## Case Reports

### Case 1

A 46-year-old woman had a severe headache on September 7, 1985. A computed tomography (CT) scan taken on that day showed a subarachnoid hemorrhage. Left carotid angiography revealed a left internal carotid-ophthalmic aneurysm with the neck partially in the cavernous sinus (Figure 1). Because of the difficulty of clipping the neck of the aneurysm, a decision was made to trap the aneurysm and perform an extracranial-intracranial (EC/IC) bypass. We chose the radial artery as the graft material for two reasons. One was that the STA was too small in diameter, as shown in Figure 1 (*arrows*). The other reason was that the patient had a long-standing history of thrombophlebitis in both lower extremities. Left brachial angiography was performed to make sure there was sufficient blood supply to the left hand through both the radial artery and the ulnar artery.

An operation was performed on the 12th day after the hemorrhage. The radial artery was removed from the left forearm; its length was 22 cm. The left common carotid artery and its bifurcation were prepared for anastomosis. A left craniotomy was performed in preparation for the graft anastomosis to the cortical branch of the middle cerebral artery (MCA). The distal end of the radial artery was anastomosed to the cortical branch of the MCA with 10-0 monofilament sutures in an end-to-side fashion. The proximal end of the radial artery was anastomosed to the origin of the external carotid artery with 7-0 monofilament sutures. The radial artery was passed under the mandible and the zygomatic arch. After the completion of the anastomosis procedure, the aneurysm was trapped by occluding the internal carotid artery at its origin in the neck and at the supraclinoid portion intracranially.

Left carotid angiography was performed on the second day after surgery (Figure 2). The radial artery graft was patent and the cortical branches of the MCA were visualized. The filling of the middle cerebral artery



**Figure 1.** Case 1. Left carotid angiography reveals an internal carotid–ophthalmic aneurysm with its proximal portion in the cavernous sinus.

distribution through the radial artery graft was not as luxuriant as might be expected. This situation was thought to be due to the “washout” from the circulation of the right side which had been shown in the preoperative right carotid angiography.

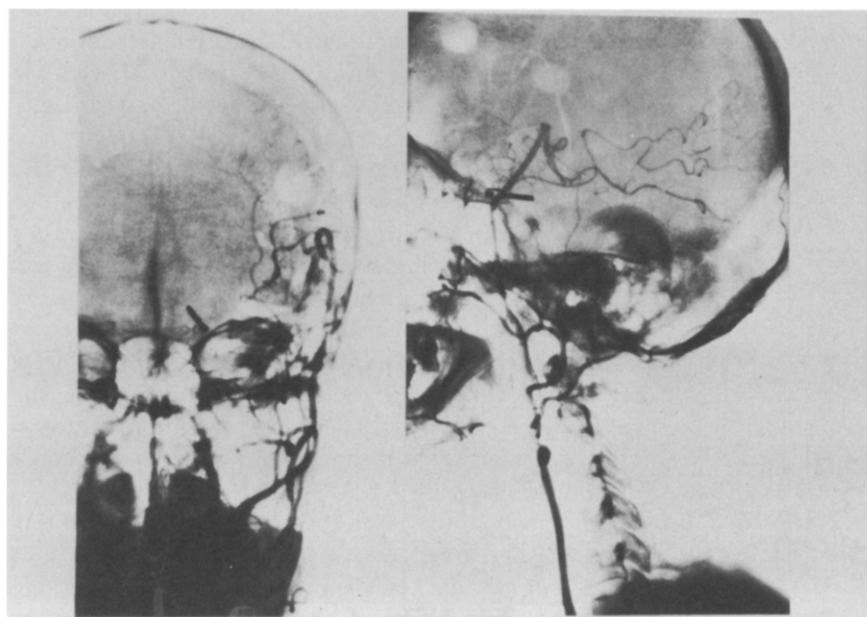
The patient was stuporous for 4 days postoperatively. She also had mild right hemiparesis and speech disturbance during this period. However, these neurological symptoms cleared completely in the following 2 weeks.

Eighteen months after the operation, follow-up angiography was performed (Figure 3). The graft patency

was excellent and the diameter of the graft had become larger compared with its previous size. The cortical branches of the middle cerebral artery were more extensively seen via the radial artery graft. No clinical symptoms were found in the left arm resulting from circulatory disturbance by excision of the radial artery.

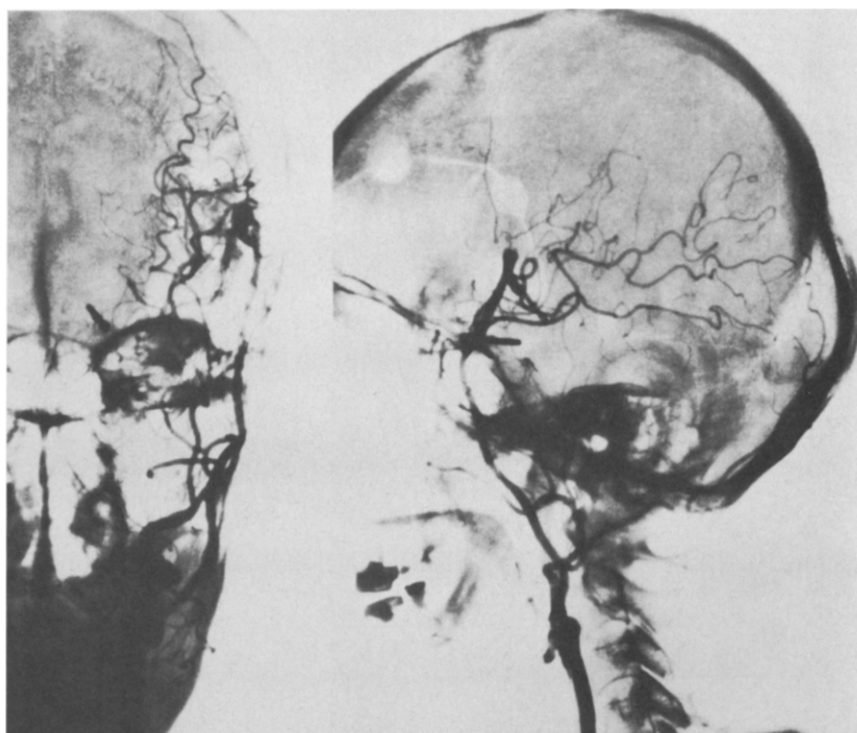
#### Case 2

A healthy 59-year-old woman began to suffer from double vision and temporal headache on July 18, 1986.



**Figure 2.** Case 1. A postoperative left carotid angiography shows a patent radial artery graft. The radial artery was anastomosed to the posterior temporal branch of the middle cerebral artery.

**Figure 3.** Case 1. A second postoperative carotid angiography was made 18 months after the bypass surgery. More extensive filling into the branches of the middle cerebral artery was demonstrated via the radial artery graft.



On admission, right oculomotor palsy and hypoesthesia in the territory of the first division of the right trigeminal nerve were revealed.

Right carotid angiography revealed a giant aneurysm at the right cavernous sinus area of the internal carotid artery (Figure 4). In this case, the MCA was not as filled as in case 1 via the anterior cross-circulation. For this reason, an EC/IC bypass was planned to use both the STA and the radial artery graft, in expectation of more shunt flow than could be gained from the radial artery alone. The left brachial angiography demonstrated sufficient blood supply via both the radial and ulnar arteries.

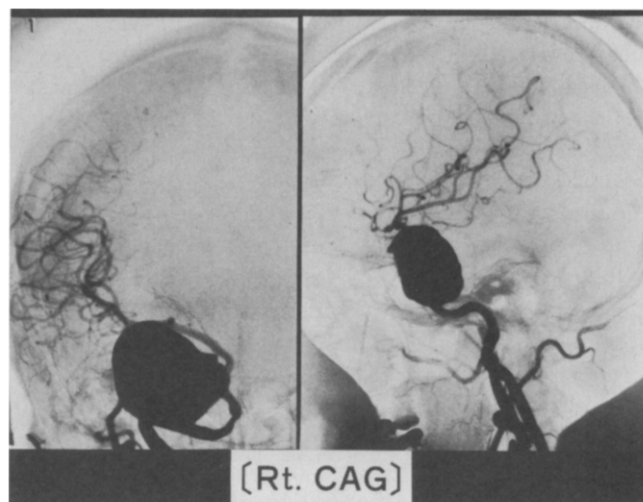
The operation was performed on July 24, 1986. An STA-MCA anastomosis and radial artery graft bypass were performed. The STA was anastomosed to the suprasylvian cortical branch and the radial artery graft was anastomosed to the infrasylvian cortical branch. The aneurysm was trapped by occluding at both the cervical section and the supraclinoid section of the internal carotid artery. The patient's condition was good after the operation, except for the right oculomotor palsy which had been present in the preoperative period.

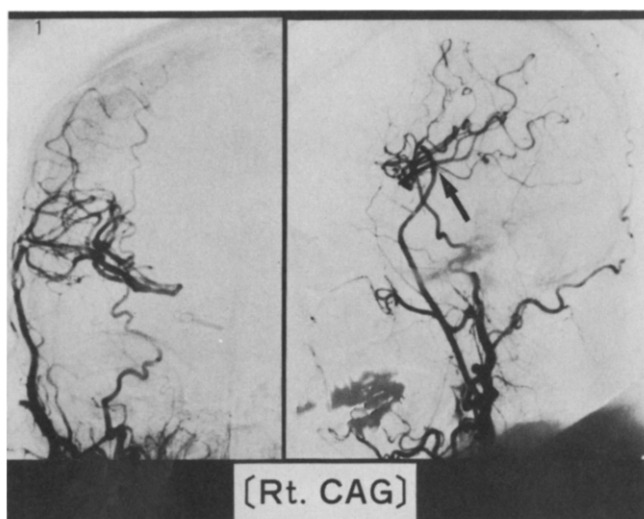
Postoperative angiography of the right internal carotid artery showed excellent filling of the whole MCA via both the STA and the radial artery graft (Figure 5, *arrow*). No symptoms resulting from circulatory disturbance were found in her left arm.

## Discussion

An EC/IC bypass may play an important role in preventing ischemic damage when an aneurysm is trapped at the main arterial trunk. Our problem was how could we preoperatively evaluate the severity of ischemia caused by trapping the aneurysm? Depending upon the amount of necessary blood flow via the bypass route, an

**Figure 4.** Case 2. A right carotid angiograph reveals an internal carotid giant aneurysm of the cavernous sinus area.





**Figure 5.** Case 2. A postoperative right carotid angiography shows excellent filling of the whole middle cerebral artery distribution via both the superficial temporal artery and the radial artery graft (arrow).

appropriate bypass material should be selected for use. The options available are the STA, the saphenous vein, the radial artery, and artificial vessels. Among these, the first two are the more popular. The main shortcoming of the STA is its small caliber, which limits the blood flow, especially immediately after the operation. To obtain better immediate extensive revascularization, an STA-proximal MCA anastomosis was introduced [4,9].

In contrast to the STA, a saphenous vein graft has an advantage in that it gains a large-volume revascularization immediately after the anastomosis [7,8]. This advantage sometimes may lead to the hyperperfusion breakthrough phenomenon causing cerebral hemorrhage. There are also some technical difficulties and the long-term patency in using the saphenous vein graft is not certain.

The volume of blood flow of the radial artery graft is between that of the STA and that of the saphenous vein. The radial artery graft has been used as an aorta-to-coronary bypass graft. In the field of cardiac surgery, the radial artery as an aortocoronary graft was introduced as a possible solution for the occasional patient without suitable saphenous veins [3], or with prior vein graft failure. The radial artery graft has several advantages, including the adaptability of the graft size to the coronary artery, the elasticity of the arterial wall, the regularity of the lumen, and the absence of valves. These advantages can be applied to an EC/IC bypass operation in the neurosurgical field.

In Japan, Ito [6] was the first to introduce the actual use of the radial artery graft in a neurosurgical operation. After the establishment of the surgical technique

of radial artery graft bypass, Yasui et al [10] began to utilize the graft with some modifications. Prior to Ito, Ausman et al [2] used the radial artery graft as the interposed vessel for a posterior fossa revascularization from the vertebral artery to the posterior inferior cerebellar artery.

As a matter of fact, some authors who performed the radial artery bypass for cardiac surgery pointed out intimal hyperplasia as the biggest shortcoming. Curtis et al [5] showed the unsatisfactory status of the radial artery graft having an occurrence rate of intimal hyperplasia as high as 64.7% (22/34) in comparison to the lower incidence of the internal mammary artery and the saphenous vein, 17.6% and 8.3%, respectively. It is difficult to comment on whether this situation would occur during EC/IC bypass surgery using the radial artery graft in the neurosurgical field because there are too few surgical cases using the radial artery.

Our follow-up term after the radial artery graft bypass surgery is not long enough to make a definite comment on the long-term patency. According to the results in Case 1, the angiographic demonstration showed that the retrograde filling via the radial artery graft had increased by the second examination, 18 months after the bypass operation. Long-term patency seems to be good from this result.

The safety of excision of the radial artery should be confirmed prior to the operation. For this purpose, brachial angiography was carried out routinely. We also checked the blood supply to the hand by Allen's test [1]. Follow-up terms after the excision of the radial artery in these two cases were 2½ years in Case 1 and 1 year and 8 months in Case 2. No circulatory disturbance was found in either case.

No ideal graft material has been found in the neurosurgical field. The graft material should be selected so as to give adequate blood flow to the brain when an EC/IC bypass is planned. With this consideration, the radial artery might become one of the better selections.

## References

1. Allen EV. Thromboangitis obliterans: methods of diagnosis of chronic occlusive arterial lesions distal to the wrist with illustrative cases. *Am J Med Sci* 1929;678:237.
2. Ausman JI, Nicoloff DM, Chou SN. Posterior fossa revascularization: anastomosis of vertebral artery to PICA with interposed radial artery graft. *Surg Neurol* 1978;9:281-6.
3. Carpentier A, Guermonprez JL, Deloche A, Frechette C, Dubost C. The aorta-to-coronary radial artery bypass graft. *Ann Thorac Surg* 1973;16:111.
4. Collice M, Arena O, Frontana RA. Superficial temporal artery to proximal middle cerebral artery anastomosis: clinical and angiographic long term results. *Neurosurgery* 1986;19:992-7.
5. Curtis JI, Stoney WS, Alford WC Jr, Burrus GR, Thomas CS Jr. Intimal hyperplasia. *Ann Thorac Surg* 1975;20:628-35.

6. Ito Z. Extra–intracranial arterial bypass with long radial artery graft. In: 5th international symposium on microvascular anastomosis for cerebral ischemia, Vienna, 1980.
7. Little JR, Furlan AJ, Bryerton B. Short vein grafts for cerebral revascularization. *J Neurosurg* 1983;59:384–8.
8. Spetzler RF, Rhodes RS, Roski RA, Likavec MJ. Subclavian to middle cerebral artery saphenous vein bypass graft. *J Neurosurg* 1980;53:465–9.
9. Umansky F, Diaz FG, Dujovny M. Superficial temporal artery to middle cerebral artery anastomosed in the sylvian fissure: case report. *Vasc Surg* 1984;18:224–49.
10. Yasui N, Ohta H, Suzuki A, Kamiyama H. Cervical carotid artery to middle cerebral artery anastomosis with interposed radial artery graft. In: Spetzler RF, Carter LP, Selman WB, Martin NA, eds. *Cerebral revascularization for stroke*. Stuttgart: Georg-Thieme Verlag, 1985;379–85.