

## Surgical treatment of arteriovenous malformations of the striatohalamocapsular region

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✓ Sixteen patients with arteriovenous malformations (AVM's) located in the striatohalamocapsular region were treated microsurgically at the Hua Shan Hospital, Shanghai. These AVM's had a tendency to bleed intracerebrally and typically presented with hemiplegia, hemianesthesia, and hemianopsia. Angiographically the lesions were primarily located in the triangle of Reil. Postoperative outcome was not as good as that of AVM's in other locations, but the operation may have prevented the risk of further hemorrhage. This report details the operative technique used and the clinical course in this group of patients.

**KEY WORDS** • arteriovenous malformation • intracerebral hemorrhage • subarachnoid hemorrhage • surgical excision

**A**MONG 108 cases of intracranial arteriovenous malformations (AVM's) treated by microsurgery, 16 cases (14.8%) were located in the striatohalamocapsular (STC) region. These AVM's were found in the deep portion of the cerebral hemisphere, lateral to the body of the lateral ventricle, and medial to the island of Reil. The most frequent clinical manifestation was hemorrhage into the cerebrum resulting in three typical neurological deficits: hemiplegia, hemianesthesia, and hemianopsia. Because of the close approximation to the ventricle, intraventricular and subarachnoid hemorrhage commonly occurred.

On the lateral projection of arteriograms these lesions are located in the triangle of Reil (Fig. 1 *left*) and may extend to adjacent areas. On the anteroposterior view the lesions are seen lateral to the A<sub>2</sub> and A<sub>3</sub> segments of the anterior cerebral artery (ACA), medial to the M<sub>2</sub> and M<sub>3</sub> segments of the middle cerebral artery (MCA), and above the M<sub>1</sub> portion of the MCA (Fig. 1 *right*). The arterial supply arises from the lenticulostriate artery, the anterior choroidal artery, cortical branches of the MCA and the ACA, the artery of Heubner, and the posterior choroidal artery. The venous drainage is to the deep cerebral veins such as the thalamostriatal, internal cerebral, and basal veins.

The treatment of these AVM's has been controversial. Most authors have suggested that they should not be approached surgically,<sup>1-5</sup> and others have recommended treatment by embolization. All of the patients in the present series were treated with a direct operative approach to the AVM.

### Summary of Cases

#### *Patient Population and Presentation*

There were eight males and eight females in this series of patients with AVM's in the STC region; their ages ranged from 15 to 38 years with a mean of 26 years. The lesion was located on the left in seven cases. Clinical signs and symptoms are summarized in Table 1. Subarachnoid hemorrhage (SAH) occurred in all cases and was the initial symptom in 14 cases; it occurred twice in four cases, three times in three cases, and four times in one case. In one case the initial symptom was subjective numbness and weakness on the right side; these episodes recurred for 7 years until the patient presented with SAH, right hemiparesis, and dysphasia. These symptoms were presumably due to repeated small parenchymal hemorrhages. One patient had focal seizures as the first symptom. Clinical findings of hemiplegia, hemianesthesia, and hemianopsia appear to be the most typical features of this lesion.

#### *Diagnosis and Treatment*

Computerized tomography scans were carried out in eight cases. On plain scans, four showed intracerebral hemorrhages and four had abnormal attenuation. After contrast enhancement, irregular areas of increased attenuation were seen in all eight patients. Carotid arteriography was performed in all 16 cases, unilaterally in 10 and bilaterally in six. Vertebral arteriography was carried out in one patient. The angiographic circulation of these malformations is summarized in Table 2.

## AVM of the striatohalamocapsular region

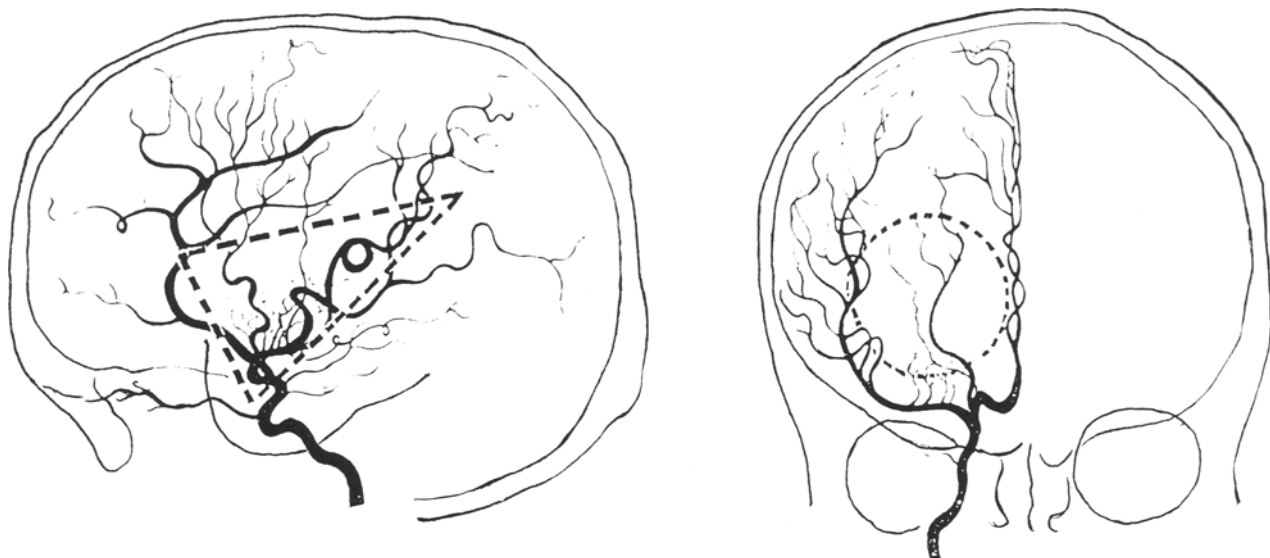


FIG. 1. Diagrams of a carotid arteriogram showing the striatohalamocapsular region which defines this group of arteriovenous malformations within a *triangle* on the lateral view (*left*) and within a *circle* on the anteroposterior view (*right*).

TABLE 1  
*Symptoms and signs of 16 AVM's of the STC region\**

Symptoms & Signs	Cases	
	No.	Percent
<b>symptoms</b>		
subarachnoid hemorrhage	16	100
headache	12	75
hemiparesis	10	62.5
impaired consciousness	10	62.5
hemianesthesia	5	31.2
dysphasia	5	31.2
seizure attacks	3	18.8
weakness of limbs	3	18.8
paresthesia	2	12.5
<b>signs</b>		
hemiplegia	14	87.5
pyramidal signs	13	81.2
increased tendon reflex	12	75.0
hemianesthesia	10	62.5
dysphasia	5	31.2
hemianopsia	4	25.0
meningismus	3	18.7
ataxia	2	12.5
anisocoria	1	6.2
paralysis of conjugate upward gaze	1	6.2
muscular atrophy of lower limb	1	6.2
no neurological sign	2	12.5

\* AVM = arteriovenous malformation; STC = striatohalamocapsular.

All 16 patients were treated by direct operation: 14 by excision (13 of which were complete) and two by ligation of the feeding arteries. In one case treated by ligation there was complete resolution of arteriovenous shunting on postoperative angiography, and in the other a reduction was noted in the size of the AVM.

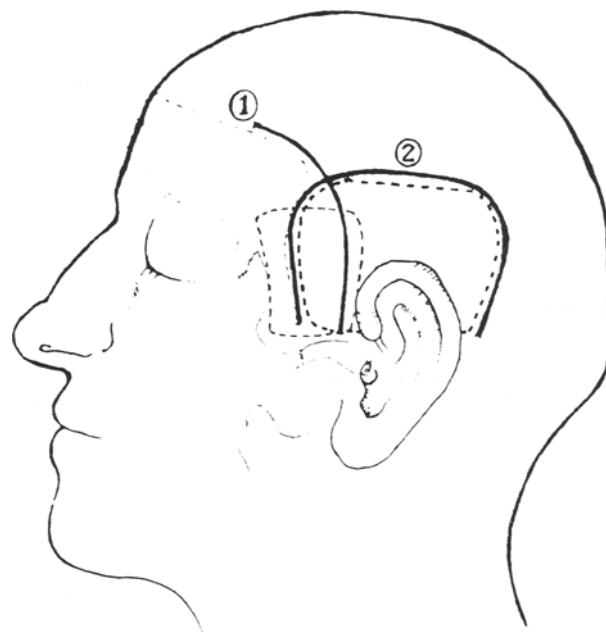


FIG. 2. Incisions and approaches for arteriovenous malformations of the striatohalamocapsular region: incision for a pterional approach (1), and incision for a midtemporal approach (2). The *dotted lines* indicate bone flaps.

### Operative Procedure

The operative procedure was designed to reduce damage to the surrounding structures by minimizing operative trauma and avoiding incisions causing neurological damage. In most cases a midtemporal osteoplastic flap was created (Fig. 2). In some cases, particularly in

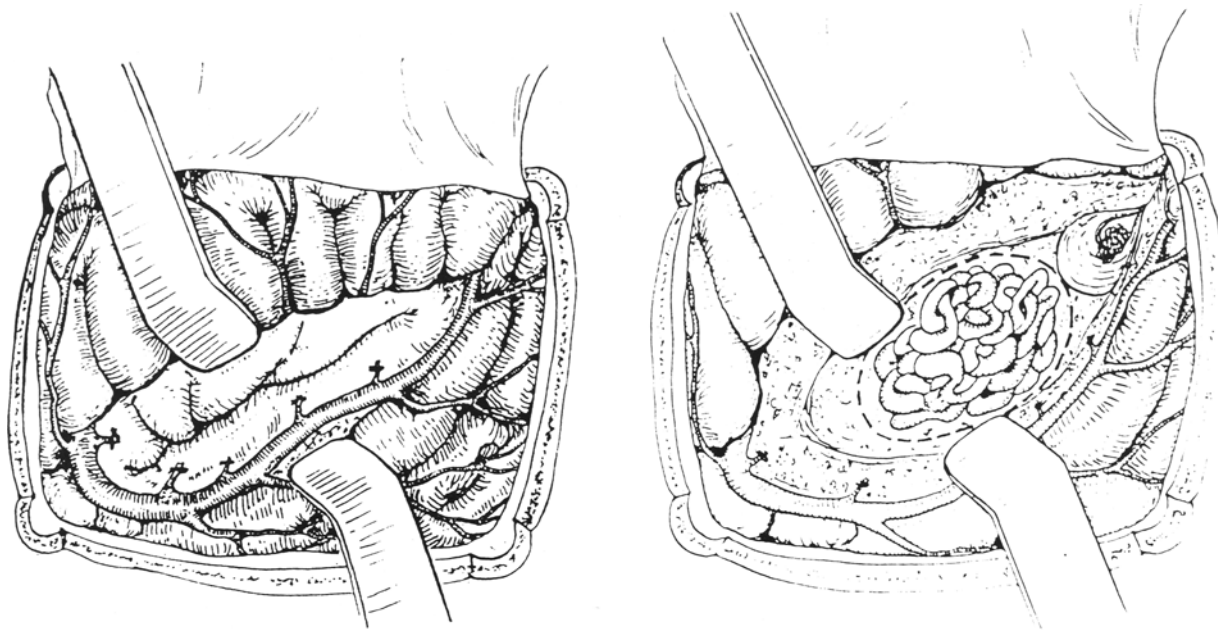


FIG. 3. Drawings showing the operative approach. *Left:* View of the split sylvian fissure and dissection along the middle cerebral artery with the medial branches divided. *Right:* Incision into the lateral ventricle through the base of the sylvian fissure exposing the vascular malformation in the striatocapsular region.

TABLE 2  
Circulation of 16 STC region AVM's\*

Feeding & Draining Vessels	No. of Cases
arterial supply	
anterior choroidal artery	10
lenticulostriate artery	7
M <sub>1</sub> branches	3
artery of Heubner	2
PCA & PCoA branches	1
venous drainage	
deep cerebral to internal cerebral vein	13
basal vein	2
lenticulostriate vein	1

\* STC = striatocapsular; AVM = arteriovenous malformation; M<sub>1</sub> = first segment of the middle cerebral artery; PCA = posterior cerebral artery; PCoA = posterior communicating artery.

lesions located anteriorly, the pterional approach described by Yaşargil and Fox was preferred.<sup>6</sup> The goal was to adequately expose the sylvian fissure. In the pterional approach, the anterior part of the sylvian fissure is usually visible upon reflection of the dural flap. With the use of a midtemporal flap, the sylvian fissure may be identified by locating the superficial sylvian veins which run anteriorly and inferiorly and delineate the upper margin of the temporal lobe (Fig. 3 *left*). The arachnoid overlying the sylvian veins is incised and the fissure is gently split with a pair of brain spatulas until the surface of the insula is reached.

During the course of the dissection several cortical branches of the MCA are encountered. By following these branches one reaches the main trunk of the MCA. Branches of the MCA that look dilated and run medially in the direction of the lesion should be coagulated or clipped but not those that traverse outwardly to the temporal lobe. This dissection should be carried as far medially as possible until the striatal arteries are exposed and coagulated or clipped. If the dissection is carried further the carotid bifurcation may be reached and the anterior choroidal and posterior communicating arteries may be seen. In general, dissecting this far or ligating these vessels at this stage is not advisable.

Attention should then be directed posteriorly to the inferior portion of the fissure which is the closest approach to the lateral ventricle. A transverse or oblique incision is then made in the bottom of the fissure and deepened until the lateral wall of the ventricle has been opened. A self-retaining retractor will keep the ventricle exposed. The AVM is usually embedded in the lateral wall of the lateral ventricle with dilated draining veins leading medially (Fig. 3 *right*). If the anterior choroidal artery is involved it may be dissected at this point, coagulated, and divided. The margin of the AVM should be well delineated and dissection carried out close to the margin. All arteries of whatever size may be thoroughly coagulated and divided. Arteries larger than 0.5 mm in diameter may be considered for clip ligation. Once the AVM mass is nearly free, our custom has been to dissect out the draining veins and then doubly ligate them with fine silk ligatures followed by

## AVM of the striatohalamocapsular region

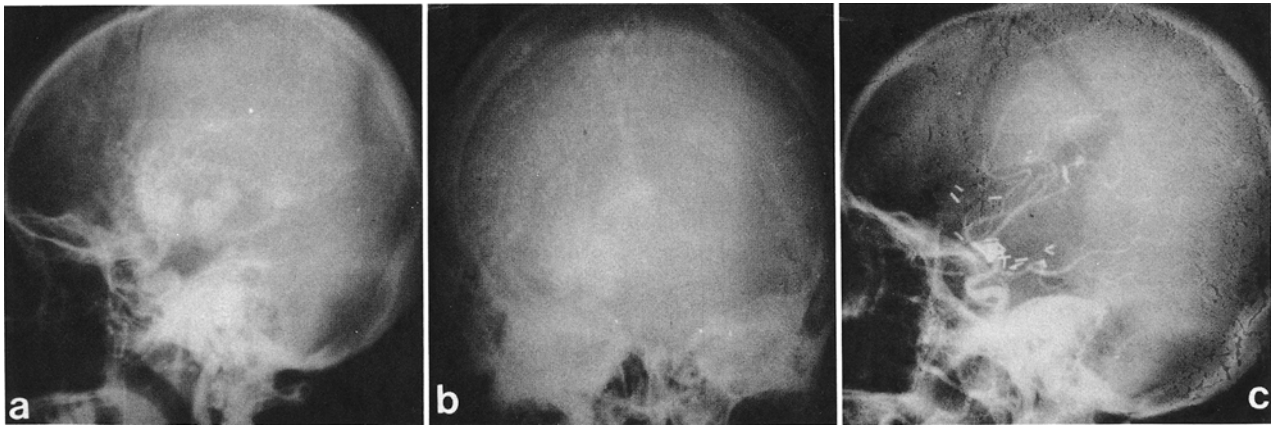


FIG. 4. Case 1. a: Preoperative carotid arteriogram, lateral view. b: Preoperative carotid arteriogram, anteroposterior view. c: Postoperative carotid arteriogram, lateral view. d: Excised surgical specimen (measure in centimeters).

coagulation and division. In this way, the AVM may be excised as a single mass. The veins should be ligated in close approximation to the AVM mass in order to minimize risk to the internal cerebral vein, lenticulostriate veins, and great vein of Galen.

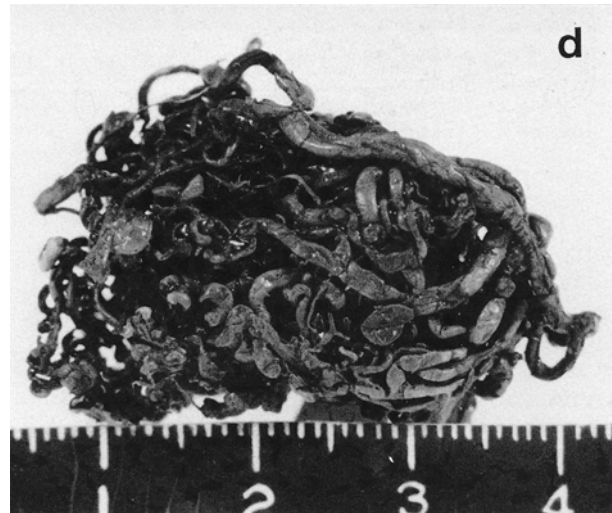
### Outcome

The only postoperative death was early in the series, for an operative mortality rate of 6%. Four patients (25%) had increased deficits after surgery. In one this completely resolved and in another the left arm remained paralyzed. The other two patients died more than 2 years after the operation, one from a febrile illness and the other from recurrent SAH presumably from an aneurysm although no autopsy was obtained. Thus, 12 (75%) of the patients had an excellent long-term outcome.

### Illustrative Cases

#### Case 1

This 23-year-old woman had been hospitalized twice for recurrent SAH, 4 years and 1 year previously. At the present admission she was found to have a left hemiparesis with the arm weaker than the leg. Bilateral cerebral angiography showed a large AVM in the STC region of the right hemisphere which was supplied by branches of the MCA and ACA with drainage through the deep cerebral veins to the straight sinus (Fig. 4). Complete excision of the AVM was carried out as described above. Postoperatively the hemiparesis was transiently worse. By 6 months she had returned to her preoperative status and was doing well. A letter from her family reported that she died 28 months after surgery of a presumably unrelated febrile illness.



#### Case 2

This 26-year-old woman was admitted for evaluation of repeated episodes of right-sided numbness followed by weakness of 7 years' duration. The most recent event occurred 10 months prior to admission and resulted in hemiparesis and difficulty with speech. A left carotid arteriogram revealed a small AVM in the STC region (Fig. 5). The arterial supply was from the anterior choroidal and lenticulostriate arteries, and venous drainage was to the deep cerebral veins. Complete excision of the AVM was carried out. In the immediate postoperative period the patient had no increase in her deficit and over the following year she gradually improved to the point where her only deficit was paralysis of the right hand.

### Comment

Arteriovenous malformations of the STC region are particularly hazardous because of their location and the apparent likelihood of hemorrhage with resulting neurological deficit. Although surgery for this lesion may

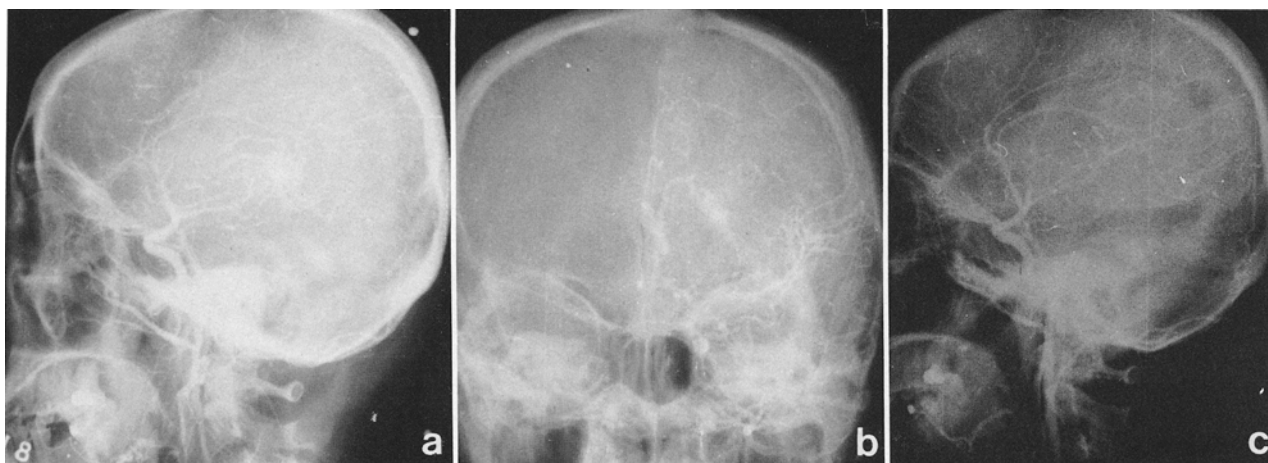


FIG. 5. Case 2. a: Preoperative carotid arteriogram, lateral view. b: Preoperative carotid arteriogram, anteroposterior view. c: Postoperative carotid arteriogram, lateral view. d: Excised surgical specimen (measure in centimeters).

carry a higher risk than that for AVM's in other locations, it appears justified in order to reduce the risk of recurrent hemorrhage. The operative procedure described here provides direct access to the AVM with minimal brain trauma, initial access to the arterial supply, and visualization of the venous drainage from the AVM to the deep venous structures.

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