Surgical Treatment of Carotid-Siphon Aneurysms

Tohru MITSUGI, Haruhiko KIKUCHI, Jun KARASAWA,
Kenjiro ITOH and Nobuaki TAKAHASHI

Department of Neurosurgery, National Center of Circulatory Disease, Suita

Abstract

The direct surgical attack on carotid-siphon aneurysm is hazardous and difficult as compared with other intracranial aneurysms because of its location adjacent to the skull base, the optic nerves and chiasm. The authors report and discuss the surgical treatment of carotid-siphon aneurysms based on our surgical experience of 20 such aneurysms in 18 cases during the period from October 1971 to September 1980.

1. Many aneurysms arising from the C₂ carotid-ophthalmic portion of the internal carotid artery can be treated by neck clipping through the pterional approach. It is preferable to clip the neck through a contralateral pterional approach in some cases where the fundus projects posteromedially.

2. For giant aneurysms, it is advisable, along with internal carotid artery trapping, to perform superficial temporal-middle cerebral artery anastomosis.

3. Small aneurysms arising from the C₃ or C₄ portions of the internal carotid artery will become only faintly visible in angiograms after internal carotid artery ligation with superficial temporal-middle cerebral artery anastomosis, which indicates its effectiveness as a treatment for such aneurysms.

Key words: carotid-siphon aneurysm, neck clipping, internal carotid ligation, internal carotid trapping, superficial temporal-middle cerebral artery anastomosis

Introduction

Many authors agree that the best treatment for intracranial aneurysms is direct surgical attack with neck clipping. But direct surgery on aneurysms arising from the carotid-siphon (carotid-siphon aneurysms) has been considered particularly hazardous and technically difficult because such aneurysms lie on the skull base near the cavernous sinus and are situated close to the optic nerve and chiasm. Therefore, carotid-siphon aneurysms are more problematic than other intracranial aneurysms in regard to the choice of operation, such as neck clipping, internal carotid ligation and trapping. Many reports are available concerning the surgical treatment of carotid-siphon aneurysms, but the results of the direct attack on such aneurysms have been unsatisfactory. The authors report and discuss the surgical treatment of carotid-siphon aneurysms which are classified by their angiographical locations and by the projections of the aneurysmal fundi.

Clinical Materials and Methods

Twenty carotid-siphon aneurysms were found among 583 intracranial aneurysms experienced during the period from October 1971 to September 1980. Twenty carotid-siphon aneurysms in 18 cases were treated surgically, and are summarized. All of the cases underwent preoperative bilateral carotid and vertebral angiography whether or not other intracranial aneurysms had previously been found. Most patients were operated in the chronic, not the acute stage of subarachnoid hemorrhage. However, some patients with highly positioned carotid-siphon aneurysms accompanied by other intracranial aneurysms or vascular lesions causing subarachnoid hemorrhage were treated in the acute stage. Neck clipping of the aneurysm was performed, as a rule in the chronic stage. Most of the patients were checked for the quality of collateral blood flow using Matas' test, along with EEG recording or CBF measurement in some of the cases, to determine the feasibility of neck clipping.

First, the cervical internal carotid artery was exposed under general anesthesia. In the case of an aneurysm located in a high position, such as in the neck at C₂, the aneurysm was treated through the pterional

approach.²²⁾ The frontal lobe was gently retracted after frontolateral craniotomy. At the parasellar cistern, the anterior clinoid process at the upper roof of the optic nerve was shaved by Hall's air jet drill. The carotid-siphon aneurysm was treated after it had been separated from the optic nerve, the internal carotid artery, and the origin of the ophthalmic artery. Some of the cases of medium-sized aneurysms whose sacs projected posteromedially were amenable to neck clipping from between the bilateral optic nerves via the contralateral pterional approach. Large carotid-siphon aneurysms were treated with internal carotid artery trapping. Small aneurysms which originated in the cavernous portion were treated with internal carotid ligation. In those cases treated with internal carotid trapping or ligation, superficial temporal-middle cerebral artery anastomosis was performed at the same time to prevent cerebral ischemia. Aneurysms whose necks could not be exposed completely and those whose broad neck might cause stenosis of the internal carotid artery when clipped were treated by coating.

Results

After surgery of the 18 cases; 13 were in excellent condition, 1 was good, 2 were fair, and 2 died. The two cases which had not undergone surgery both died (Table 1): One case died of severe subarachnoid hemorrhage and the other died of hemorrhagic infarction before surgery. The ages were from 21 to 65 years old. There were three times as many female cases (15) as male (5). Two cases had bilateral carotid-ophthalmic aneurysms and another had cerebral AVM as well. There were 7 cases of subarachnoid hemorrhage. **Case 4**, who was thought to have bled from another aneurysm, had postoperative angiospasm and developed a slight recent memory disturbance. In **Case 6**, the hemorrhage was conceivably due to AVM, attributable to an intracerebral hematoma localized in the left temporo-occipital lobe, and was left with slight aphasia and right hemiparesis. **Case 17**, who had a C₃ aneurysm of anteromedial projection, was treated by neck-clipping. However, return to society was difficult in this case because of CSF-rhinorrhea. Even though **Case 9** bled during the operation, the

Table 1 Summary of carotid-siphon aneurysms

Case No.	Sex	Age	Signs & Symptoms	Associated aneurysm or AVM	Interval to operation after SAH	Surgery	Results
1	M	35	headache	none	39 days	neck clipping	excellent
2	F	21	headache	none	—	neck clipping	excellent
3	F	37	unconsciousness	none	—	none	dead
4	M	40	headache	lt. ICPC, rt. ICPC lt. IC-Ant. chor.	2 days	coating	good
5	M	44	dementia	none	—	coating	excellent
6	M	38	somnolence headache	AVM	2 months	coating	fair
7	F	21	headache	none	—	coating	excellent
8	F	65	diplopia	—	—	trapping + ST · MC coating	excellent
9	F	58	headache	none	1 month	trapping + ST · MC	dead
10	F	46	headache	none	2 years	coating	excellent
11	F	46	diplopia blepharoptosis	none	—	trapping + ST · MC	excellent
12	F	32	diplopia	none	—	ligation + ST · MC	excellent
13	M	52	lt. hemiparesis	none	—	ligation + ST · MC	excellent
14	F	53	drowsy	none	7 days	neck clipping	dead
15	F	45	headache	—	7 months	neck clipping neck clipping	excellent
16	F	46	diplopia	none	—	neck clipping	excellent
17	F	55	lt. hemiparesis	none	—	neck clipping	fair
18	F	53	lt. hemiparesis	none	—	neck clipping	excellent
19	F	65	rt. hemiparesis	none	—	none	dead
20	F	50	vertigo	none	—	trapping + ST · MC	excellent

trapping + ST · MC: IC trapping with ST · MC anastomosis, ligation + ST · MC: IC ligation with ST · MC anastomosis

aneurysm was treated with left internal carotid artery trapping and with left superficial temporal-middle cerebral artery anastomosis. This patient died of extensive brain swelling postoperatively. **Case 14**, who was in the acute stage of subarachnoid hemorrhage, died of angiospasm.

The following is an investigation of the origins of the aneurysms, and projection and size of the fundus. We examine the following methods of treatment: 1) neck-clipping; 2) internal carotid artery ligation or trapping with superficial temporal-middle cerebral artery anastomosis; 3) coating of aneurysm.

I. Neck clipping

Eight carotid-siphon aneurysms in 7 cases were treated by neck clipping (Table 2). Five aneurysms were treatable with neck clipping via the ipsilateral pterional approach. Although the aneurysm neck was at the C₃ portion of the carotid-siphon in **Case 17**, who postoperatively developed the complication of CSF-rhinorrhea, the neck was at C₂ in all the other cases. Aneurysms whose fundi projected upward or superomedially could be treated with neck clipping by the ipsilateral pterional approach without any damage to the optic nerve or internal carotid artery. **Case 14**, who had been perfectly treated by clipping, died postoperatively after complications due to angiospasm. Others were able to return to society without neurological deficit after clipping of the aneurysm. Here follow some representative cases. **Case 15**, a 45-year-old female who had experienced persistent hypertension for five years, visited another hospital on January 1st, 1978 because of severe headache, nausea, and vomiting. She

Fig. 1 Case 15; Left carotid angiogram showing a carotid-ophthalmic aneurysm (→), with fundus projecting posteromedially. *left*; frontal view, *right*; lateral view

was alert. After 3 days she became free from headache and neurological problems. She was introduced to our hospital July 4th, 1978. On her admission, she did not have any neurological deficits. She underwent bilateral carotid and vertebral angiography. The left internal carotid angiogram demonstrated a medium-sized aneurysm projecting superomedially from the C₂ portion of the left internal carotid artery (Fig. 1). An additional aneurysm, projecting posteromedially and arising from the C₂ portion of the right internal carotid artery, was revealed in the right internal carotid angiogram. The crossflow from the right internal carotid artery through the anterior communicating artery was in good condition. Upon performing Matas' test for 20 minutes, no neurological ischemic sign appeared either clinically or in the EEG monitor, such as the appearance of slow waves.

Table 2 Carotid-siphon aneurysms treated with neck clipping

Case No.	Age Sex	Origin of aneurysm	Projection of fundus	Approach
1	35 M	rt. C ₂	superior	rt. pterional
2	21 F	lt. C ₂	supero-medial	lt. pterional
14	53 F	rt. C ₂	superior	rt. pterional
15	45 F	lt. C ₂	superior	lt. pterional
		rt. C ₂	postero-medial	lt. pterional*
16	46 F	lt. C ₂	postero-medial	rt. pterional*
17	55 F	rt. C ₃	postero-medial	rt. pterional
18	53 F	rt. C ₂	postero-medial	lt. pterional*

*: Neck clipping through contralateral approach

Fig. 2 Case 15; Photograph of operative findings. Two clips applied to right (→), and left carotid-ophthalmic aneurysms (⇔) through the left pterional approach. rt.IC; right internal carotid artery, lt.IC; left internal carotid artery, lt.II; left optic nerve.

Fig. 3 Case 15; Postoperative left carotid angiogram showing disappearance of aneurysm with clipping.

The aneurysm and the origin of the left ophthalmic artery were dissected and separated through the left pterional approach and the carotid-siphon aneurysm was satisfactorily clipped. The right carotid-siphon aneurysm was clipped from the space between both optic nerves through the left pterional approach (Fig. 2). She developed right upper quadrant anopsia of the right eye. However, after one month she was free from neurological deficit and was discharged from our hospital. In the postoperative angiogram (Fig. 3), the aneurysms were shown to have disappeared.

Case 18, a 53-year-old woman, was admitted on April 2, 1980 because of sudden left-sided hemiparesis. CT scan showed right putaminal hemorrhage. Right carotid angiogram revealed an aneurysm arising from the wall of the right carotid artery, just distal to the ophthalmic artery, whose fundus projected posteromedially (Fig. 4). Left frontolateral craniotomy was performed on May 6, 1980 under general anesthesia. The right carotid-siphon aneurysm was exposed and clipped satisfactorily through the space

Fig. 4 Case 18; Right carotid angiogram showing a carotid-ophthalmic aneurysm (→), with fundus projecting posteromedially.

Fig. 5 Case 18; Postoperative right carotid angiogram showing disappearance of aneurysm with clip applied through the contralateral pterional approach.

between the bilateral optic nerves and the tuberculum sellae via the contralateral pterional approach, without sacrificing the internal carotid artery or the optic nerves. The carotid-siphon aneurysm was well clipped and was shown to have disappeared in a postoperative angiogram (Fig. 5). Though a slight left hemiparesis remained, the patient was discharged from the hospital.

II. Internal carotid artery ligation with superficial temporal-middle cerebral artery anastomosis

Internal carotid artery ligation was performed in two cases with small aneurysms at the cavernous portion or C₄ of the internal carotid artery (Table 3). Postopera-

Table 3 Carotid-siphon aneurysms treated with IC ligation or trapping with ST-MC anastomosis

Case No.	Age Sex	Origin of aneurysm	Projection of fundus	Operation
8	65 F	rt. C ₃	antero-lateral	rt. IC trapping
9	58 F	rt. C ₃	anterior	rt. IC trapping
11	46 F	lt. C ₃	antero-lateral	lt. IC trapping
12	32 F	lt. C ₄	anterior	lt. IC ligation
13	54 M	rt. C ₄	anterior	rt. IC ligation
20	54 F	rt. C ₃	lateral	rt. IC trapping

tively, both of them were in excellent condition without neurological deficit. Their postoperative carotid angiograms showed very faint aneurysm. A representative case is demonstrated.

Case 12, a 32-year-old female, was referred to

Fig. 6 Case 12; Left carotid angiogram showing an aneurysm arising from the cavernous portion, with fundus projecting inferiorly.

Fig. 7 Case 7; Postoperative carotid angiogram showing faint aneurysm and patent ST-MC anastomosis, and carotid-siphon filled via the ophthalmic artery.

our hospital for double vision over the previous two years. Left abducens paresis was noted on her admission, but the other cranial nerves were intact. A carotid aneurysm at the cavernous portion was revealed in the left carotid angiogram (Fig. 6). Matas' test and an EEG were performed; which failed to demonstrate signs of cerebral ischemia. Left carotid ligation and superficial temporal-middle cerebral artery anastomosis were performed. A postoperative left carotid angiogram revealed a faint carotid aneurysm, and showed the cortical branches of the middle cerebral artery to be well-filled via the anastomosed superficial temporal artery (Fig. 7). After the operation, the abducens paresis showed a slight improvement, and the patient was discharged from our hospital without neurological deficit.

III. Internal carotid artery trapping with superficial temporal-middle cerebral artery anastomosis

Four comparatively large carotid-siphon aneurysms with necks at C_2 or C_3 were treated with this method (Table 3). This method was applied in these cases because complete exposure of the aneurysmal necks was not possible due to large size, even though the aneurysms were at high positions. In **Case 9**, the aneurysm ruptured during the operation and the patient died postoperatively of marked brain swelling. However, the other cases have returned to society.

Case 8, a 65-year-old female, visited our hospital on February 1, 1975, after suffering from right oculomotor nerve paresis for the previous three months. The patient complained of right blepharoptosis and diplopia, and right oculomotor paresis was noted upon admission. Other neurological deficits were not found. Right carotid angiogram revealed an aneurysm which projected anterolaterally, arising from the internal carotid artery at the origin of the ophthalmic

Fig. 8 Case 8; Right carotid angiogram showing a comparatively large aneurysm (—) arising from C_3 , with fundus projecting anterolaterally.

Fig. 9 Case 8; Postoperative right carotid angiogram showing good filling of the middle cerebral artery via the anastomosed superficial temporal artery. left; 2.0 sec after injection, right; 2.5 sec after injection.

artery (Fig. 8). A left carotid angiogram showed an aneurysm at the cavernous portion. Cerebral ischemic signs did not appear with Matas' test or EEG. Right internal carotid trapping was performed on April 9, 1975. The ophthalmic artery was coagulated at its origin and superficial temporal-middle cerebral artery anastomosis was performed. In addition, the left carotid-siphon aneurysm was treated by coating. The patient showed transient slight left-sided hemiparesis postoperatively; however, she did not show any neurological deficits after one week. The right carotid aneurysm was not visualized in the post-operative carotid angiogram, and the cortical branches of the middle cerebral artery were well filled through the anastomosed superficial temporal artery (Fig. 9).

IV. Coating

Coating of the aneurysm was carried out on 6 carotid-siphon aneurysms (Table 4). In Cases 4, 5 and 7,

Table 4 Carotid-siphon aneurysms treated with coating

Case No.	Age Sex	Origin of aneurysm	Projection of fundus	Other aneurysm or other vascular diseases
4	40 M	rt. C ₃	postero-medial	rt. ICPC, lt. ICPC lt. IC-Ant. chor.
5	44 M	lt. C ₃	postero-medial	none
6	38 M	rt. C ₂	postero-medial	AVM
7	21 F	lt. C ₃	posterior	none
8	65 F	lt. C ₂	superior	rt. IC-oph.
9	46 F	rt. C ₂	antero-medial	none

aneurysms at C₃ or C₄ of the carotid artery could only be exposed at the distal part, so they were only treated by coating through the inner surface of the dura mater. As Case 8 was treated by internal carotid artery trapping with superficial temporal-middle cerebral artery anastomosis for another carotid-ophthalmic aneurysm, the left carotid-siphon aneurysm was treated by coating to avoid stenosis of the internal carotid artery. In Cases 6 and 9, aneurysms projecting medially were only coated, because the optic nerve and distal portion of the internal carotid artery prevented approach. Case 9 was the only case of bleeding at the site of the carotid-siphon aneurysm.

Discussion

In Locksley's cooperative study, there were 143 carotid-ophthalmic aneurysms out of 2,672 intracranial aneurysms (5.4%);¹¹⁾ Pool and Potts reported 2 of 15 aneurysms (13%);¹⁴⁾ and according to Jeanmart, intracavernous aneurysms account for 5%;⁹⁾ with the carotid-siphon aneurysm reported as a rare incidence. The authors experienced 20 carotid-siphon aneurysms out of 583 cases of intracranial aneurysms; a comparatively low incidence. Because of their anatomical locations, direct surgical approach is hazardous and difficult. Consequently, even given the low frequency of these aneurysms, there are a number of documents concerning their therapy, though often with poor operative results. Therefore various surgical treatments have been employed, including neck clipping,^{1,3,4,6,23)} common carotid ligation,⁸⁾ internal carotid trapping, and gradual carotid ligation.²¹⁾ However, the choice of operation depends on the location of the aneurysm, the projection of its fundus, and its anatomical relationship to the neighboring structures. The authors grouped the locations of carotid-siphon aneurysms and their fundi projections as seen by cerebral angiograms, for discussion of the surgical treatments accordingly.

I. Aneurysms arising from the C₂ portion

The so-called carotid-ophthalmic aneurysms, are ordinarily classified into the suboptico-chiasmal type, which project anteromedially, and the latero-chiasmal type, which project superoanteriorly. In addition, Thurel added the global type¹⁹⁾ and there is also the para-ophthalmic aneurysm with its posteromedial projecting sac, which Pia *et al.*¹³⁾ regarded as comparatively frequent. In many cases, the latero-chiasmal type of aneurysm can be clipped through the ipsilateral pterional approach without any damage to the optic nerve. However, the suboptico-chiasmal type is frequently more difficult to treat by the direct ap-

proach^{1,4,16,23)} because the optic nerve and distal portion of the internal carotid artery cover the aneurysm. Therefore, the ipsilateral optic nerve must be cut off in some cases so as to expose the internal carotid artery, the origin of the ophthalmic artery, and the aneurysm.^{1,3)} The authors had similar cases where the aneurysms projected medially. Such aneurysms were treated by coating because they could not be exposed completely through the ipsilateral pterional approach. However, such aneurysms, especially those of postero-medial projection, could be exposed and dissected from the internal carotid artery and the origin of the ophthalmic artery from the space between the bilateral optic nerves and the tuberculum sellae, through the contralateral pterional approach. This method was considered effective. Through the contralateral pterional approach, the authors could satisfactorily clip the neck of 3 carotid-siphon aneurysms projecting postero-medially without sacrificing the optic nerve. However, When the aneurysm is treated through the contralateral pterional approach, there must be a normo- or post-fixed chiasm with sufficient space between the optic chiasm and the tuberculum sellae. According to Shaefer's classification of the optic chiasm, a pre-fixed chiasm accounts for 5%.¹⁵⁾ In these cases, it is impossible to perform a direct attack through the contralateral pterional approach. Consequently, it is necessary to check the location of the optic chiasm before the operation. The authors checked its location by using metrizamide CT cisternography.¹²⁾

It is impossible to clip the neck of the large-sized aneurysm, when the internal carotid artery must be trapped. The authors prefer internal carotid trapping on large aneurysms, because it is unclear whether or not internal carotid ligation alone prevents hemorrhage. Such trapping is combined with superficial-middle cerebral artery anastomosis to protect against cerebral ischemia. Using this method on 4 cases, no aneurysm was visualized in postoperative angiograms. Three of the cases are in excellent condition without neurological deficit. Therefore, the authors consider that this is an effective treatment of such large aneurysms. However, one patient died who required emergency internal carotid trapping because of aneurysm hemorrhage during the operation. The authors consider this type of emergency carotid trapping as having a poor prognosis, as Guidetti *et al.* reported.⁶⁾

II. Aneurysms arising from C₃ or C₄ portions

These intracavernous portion aneurysms are effectively treated by internal carotid ligation with superficial temporal-middle cerebral artery anastomosis. The

authors ligated the internal carotid artery on 2 aneurysms which were revealed very faintly in the postoperative angiograms, and whose middle cerebral artery was well filled via the anastomosed superficial temporal artery. Further, as compared with carotid-ophthalmic aneurysms which have about the same incidence of hemorrhage as other intracranial aneurysms,^{6,10)} the intracavernous portion aneurysm has a low possibility of intracranial hemorrhage and, can be safely treated with this method, as others have reported.^{10,20)} It is necessary to combining an EC-IC bypass with internal carotid ligation or trapping not only to prevent cerebral ischemia but also to prevent later development of aneurysms at other points. It is necessary to determine the resistance of the brain against cerebral ischemia with a preoperative Matas' test monitored by EEG and CBF. Cases where ischemia might be induced by internal carotid ligation should be treated with an EC-IC bypass first, even though, according to Sundt *et al.*,¹⁸⁾ the lower CBF limit is 30 ml/100 g brain/min in internal carotid ligation. The authors performed EC-IC bypasses on those cases where cerebral ischemia was shown to be possible. However, whether or not cerebral ischemia is prevented by the EC-IC bypass, monitoring of EEG and CBF is necessary during the operation. A definitive conclusion cannot be reached, however. The authors performed superficial temporal-middle cerebral artery anastomosis and internal carotid ligation or trapping at the same time on cases with such aneurysms, because there is otherwise a danger of hemorrhage with increasing blood pressure.

References

- 1) Almeida GM, Shibata MN, Bianco E: Carotid-ophthalmic aneurysms. *Surg Neurol* 5: 4-45, 1976
- 2) Anderson RD, Liebeskind A, Schechter MM, Zingesser LH: Aneurysms of the internal carotid artery in the carotid canal of the petrous temporal bone. *Radiology* 102: 639-642, 1972
- 3) Benedetti A, Curri D: Direct attack on carotid-ophthalmic and large internal carotid aneurysm. *Surg Neurol* 8: 49-54, 1977
- 4) Drake CG, Vanderlinden RG, Amacher AL: Carotid-ophthalmic aneurysms. *J Neurosurg* 29: 24-31, 1968
- 5) German WJ, Black SPW: Cervical ligation for internal carotid aneurysms. An extended follow up. *J Neurosurg* 23: 572-577, 1965
- 6) Guidetti B, La Torre E: Management of carotid-ophthalmic aneurysms. *J Neurosurg* 34: 544-548, 1971
- 7) Gurdjian ES, Linder DW, Thomas LW: Experiences with ligation of the common carotid artery for treatment of aneurysms of the internal carotid artery

- with particular reference to complications. *J Neurosurg* 23: 311-318, 1965
- 8) Harrison TH, Odem GL, Kunkle EC: Internal carotid aneurysms arising in carotid canal. *Arch Neurol* 8: 328-331, 1963
 - 9) Jeanmart L, Noterman J, Baleriaux D: Les anevrysmes des la carotide intracaverneuse. *Neurochirurgie* 19: 61-73, 1973
 - 10) Kothandaran P, Dawson BH, Kruyt RC: Carotid-ophthalmic aneurysms: A study of 19 patients. *J Neurosurg* 34: 544-548, 1971
 - 11) Locksley HB: Report on the cooperative study of intracranial aneurysms and subarachnoid hemorrhage. Section V, Part I, Natural history of subarachnoid hemorrhage, intracranial aneurysms and AVM; based on 6,368 cases in the cooperative study. *J Neurosurg* 25: 219-239, 1966
 - 12) Mitsugi T, Kikuchi H, Karasawa J: Metrizamide CT cisternography of optic chiasm. *Progress in CT* 3: 551-555, 1981
 - 13) Pia HW, Langmaid C, Zierski J: *Cerebral Aneurysms, Advances in Diagnosis and Therapy*. Berlin, Springer-Verlag, 1979, pp 67-82
 - 14) Pool JL, Potts DC: Aneurysms and arterio-venous anomalies of the brain: *Diagnosis and Treatment*. New York, Harper & Row, 1965, 463 pp
 - 15) Schaefer JP: Some points in the regional anatomy of the optic pathway, with especial reference to tumors of the hypophysis cerebri; and resulting ocular changes. *Anat Rec* 28: 243-279, 1924
 - 16) Sengupta RP, Gryspeerdt GL, Hankinson J: Carotid-ophthalmic aneurysms. *J Neurol Neurosurg Psychiatry* 39: 837-853, 1976
 - 17) Spetzler RF, Schster H, Roski RA: Effective extra-cranial-intracranial arterial bypass in the treatment of inoperable giant aneurysm of the internal carotid artery. *J Neurosurg* 53: 22-27, 1980
 - 18) Sundt TM, Piepgras DG: Surgical approach to giant intracranial aneurysms. *J Neurosurg* 51: 731-742, 1979
 - 19) Thurel C, Rey A, Thiebaut JB, Chai N, Houdart R: Anevrysmes carotido-ophthalmiques. *Neurochirurgie* 20: 25-39, 1974
 - 20) Tytus JS, Ward AA: The effect of cervical carotid ligation on giant intracranial aneurysms. *J Neurosurg* 33: 184-190, 1970
 - 21) Wemple JB, Smith GW: Extracranial carotid aneurysm. Report of four cases. *J Neurosurg* 24: 667-671, 1966
 - 22) Yasargil MG, Fox JL: The microsurgical approach to intracranial aneurysms. *Surg Neurol* 3: 7-14, 1975
 - 23) Yasargil MG, Gasser JC, Hodosh RM, Rankin TV: Carotid-ophthalmic aneurysms: Direct microsurgical approach. *Surg Neurol* 8: 155-165, 1977

Request reprints to: T. Mitsugi, M.D., Department of Neurosurgery, National Center of Circulatory Disease, 5-125 Fujishirodai, Suita, Osaka 565, Japan.