www.jkns.or.kr 10.3340/jkns.2008.44.4.190
Print ISSN 2005-3711 On-line ISSN 1598-7876
J Korean Neurosurg Soc 44 : 190-195, 2008

Clinical Article

Clinical and Angiographic Results after Treatment with Combined Clipping and Wrapping Technique for Intracranial Aneurysm

Sang Jun Suh, M.D.,[1] Sang Chul Kim, M.D.,[1] Dong Gee Kang, M.D.,[1] Kee Young Ryu, M.D.,[1] Hyuk Gee Lee, M.D.,[1] Jae Hoon Cho, M.D.[2]
Department of Neurosurgery,[1] Daegu Fatima Hospital, Daegu, Korea
Department of Neurosurgery,[2] Kosin University Gospel Hospital, Busan, Korea

Objective : There have been numerous follow-up studies of patients who had ruptured or unruptured intracranial aneurysms treated by wrapping technique using various materials have been reported. Our objective was to ascertain whether our particular wrapping technique using the temporalis muscle provides protection from rebleeding and any aneurysm configuration changes in follow-up studies.
Methods : Clinical presentation, the location and shape of the aneurysm, outcomes at discharge and last follow-up, and any aneurysm configuration changes on last angiographic study were analyzed retrospectively in 21 patients. Reinforcement was acquired by clipping the wrapped temporalis muscle. Wrapping and clipping after incomplete clipping was also done. Follow-up loss and non-angiographic follow-up patient groups were excluded in this study.
Results : The mean age was 53 years (range 29-67), and 15 patients were female. Among 21 patients, 10 patients had ruptured aneurysms (48%). Aneurysms in 21 patients were located in the anterior circulation. Aneurysm shapes were broad neck form (14 cases), fusiform (1 case), and bleb to adjacent vessel (6 cases). Five patients were treated by clipping the wrapped temporalis, and 16 patients by wrapping after partial clipping. The mean Glasgow coma scale (GCS) at admission was 14.2. The mean Glasgow outcome scale (GOS) at discharge was 4.8, and 18 patients were grade 5. The mean period between initial angiography and last angiography was 18.5 months (range 8-44). Aneurysm size was not increased in any of these patients and configuration also did not change. There was no evidence of rebleeding in any of these treated aneurysms.
Conclusion : Our study results show that wrapping technique, using the temporalis muscle and aneurysm clip(s), for intracranial aneurysm treatment provides protection from rebleeding or regrowth.

KEY WORDS : Aneurysm · Wrapping technique · Temporal muscle.

INTRODUCTION

Clipping the aneurysmal neck is generally considered as the treatment of choice for intracerebral aneurysms. Recently, coiling the intra-aneurysm space has come into the spotlight as a more non-invasive treatment. However, when clipping or coiling is impossible, neurosurgeons have to decide on another treatment such as wrapping or aneurysm neck remodeling[6]. Many authors had reported the efficacy of the wrapping technique, and the rebleeding and regrowth rates in wrapped aneurysms[2-4,7,11,15,17]. There have been numerous materials for wrapping have been used to reinforce the aneurysmal sac including muslin gauze[10,17], surgicel, muscle[5,14], biobond adhesive and histoacryl adhesive[2], etc. The aim of this study was to share the results and efficacy of surgical wrapping or wrapping after the partial clipping of the aneurysmal sac with temporalis muscle in angiographic and clinical follow-up.

• Received : May 9, 2008 • Accepted : August 18, 2008
• Address for reprints : Jae Hoon Cho, M.D.
Department of Neurosurgery, Kosin University Gospel Hospital, 34 Amnam-dong, Seo-gu, Busan 602-702, Korea
Tel : +82-51-990-6465, Fax : +82-51-990-3042
E-mail : fhjhcho@yahoo.co.kr

MATERIALS AND METHODS

Patient information

The study group was obtained from patients who were operated for ruptured or unruptured intracranial aneurysms in our hospital between February 2002 and December 2006. Patient data were analyzed retrospectively from hospital records, operating records and neuroimaging studies. Follow-up study data were obtained through outpatient records and telephone interview. These included

Table 1. Clinical summary of 21 patients

Patient number	Sex/Age	Initial study	Follow-up study	Follow-up period (mon)	Presentation (Fisher grade)	Location	Shape	Operation	Complication	Angiographic follow-up	Initial GCS	Discharge GOS	Last GOS
1	F 56	Angio	Angio	25	SAH (3)	Rt. MCA	Bleb, to M2	Partial clip & warp	ICH, ipsilateral	No change	14	5	5
2	F 61	Angio	Angio	16	Headache	Lt. MCA	Bleb, severe AS	Wrap & clip	Infarction	No change	15	4	4
3	F 64	Angio	Angio	32	Incidental (multiple sac) -BA rupture	Rt. AChoA	Bleb, to AChoA	Partial clip & wrap	N-S	No change	14	5	5
4	F 50	Angio	Angio	21	Incidental (multiple sac) -AcomA rupture	Rt. MCA	Broad neck	Partial clip & wrap	N-S	No change	15	5	5
5	F 63	Angio	Angio	12	Incidental (multiple sac) -PcomA rupture	Rt. MCA	Fusiform	Wrap & clip	N-S	No change	15	5	5
6	F 53	Angio	Angio	11	SAH (3)	Lt. MCA	Broad neck	Partial clip & wrap	N-S	Decrease	15	5	5
7	F 40	Angio	Angio	8	Incidental (multiple sac) -Lt. PcomA rupture	Rt. MCA	Broad neck	Partial clip & wrap	N-S	No change	14	5	5
8	M 65	Angio	Angio	28	Seizure	Rt. MCA	Broad neck with AS	Wrap & clip	ICH, contralateral	No change	15	5	5
9	F 67	Angio	Angio	24	SAH (3)	Rt. MCA	Giant, bleb to M2	Partial clip & wrap	N-S	Decrease	13	5	5
10	M 45	Angio	CTA	15	SAH (4)	Lt. MCA	Broad neck	Partial clip & wrap	N-S	No change	13	5	5
11	M 45	Angio	CTA	14	Incidental (multiple sac) -Lt. MCA rupture	Rt. MCA	Broad neck with AS	Partial clip & wrap	N-S	No change	15	5	5
12	M 61	Angio	CTA	44	SAH (2)	Rt. MCA	Broad neck	Partial clip & wrap	N-S	No change	15	5	5
13	M 40	Angio	MRA	18	SAH (3)	Rt. PICA	Bleb, to PICA	Partial clip & wrap	N-S	Decrease	13	4	5
14	F 67	Angio	CTA	12	SAH (3)	Rt. PcomA	Bleb, to PcomA	Partial clip & wrap	N-S	No change	14	5	5
15	F 63	Angio	angio	26	Headache	Rt. MCA	Broad neck	Wrap & clip	EDH, contralateral	No change	15	5	5
16	F 29	Angio	CTA	13	SAH (4)	Rt. MCA	Broad neck	Partial clip & wrap	N-S	Decrease	10	3	2
17	F 62	Angio	CTA	25	Headache	Lt. MCA	Broad neck	Partial clip & wrap	Optic neuropathy	No change	15	5	5
18	M 41	Angio	CTA	11	SAH (2)	AcomA	Bleb, to A2	Partial clip & wrap	N-S	No change	15	5	5
19	F 65	Angio	Angio	14	Dizziness	Rt. MCA	Board neck, bifurcation sac	Partial clip & wrap	N-S	No change	15	5	5
20	F 47	Angio	Angio	8	Dizziness	Rt. MCA	Broad neck	Wrap & clip	N-S	No change	15	5	5
21	F 46	Angio	Angio	12	SAH (3)	Rt. MCA	Bleb, to M2	Partial clip & wrap	N-S	Decrease	13	5	5

angio : 4-vessel angiography, CTA : computed tomographic angiography, MRA : magnetic resonance angiography, SAH : subarachnoid hemorrhage, ICH : intracerebral hemorrhage, BA : basilar artery, MCA : middle cerebral artery, AcomA : anterior communicating artery, PcomA : posterior communicating artery, AChoA : anterior choroidal artery, PICA : posterior inferior cerebellar artery, AS : atherosclerosis, N-S : no specific complication

clinical presentation, neuroimaging finding, location and shape of aneurysm sac, reason for wrapping, operation technique, complication after surgery, GOS by hospital records, last GOS by out-patient records, and telephone interview.

Thirty-eight patients were treated by wrapping or wrapping after partial clipping using the temporalis muscle and aneurysm clip(s). All patients were studied using four-vessel angiography prior to surgery. The non-angiographic follow-up group and follow-up loss group were excluded, and 21 patients remained. Follow-up angiographic studies included conventional angiography, computed tomographic angiography (CTA), magnetic resonance angiography (MRA).

Surgical technique

Prior to operation, we planned to treat the aneurysm using wrapping when the aneurysm sac had a broad neck or fusiform shape, or was associated with severe atherosclerosis. We also decided on wrapping when it appeared that direct clipping was impossible to preserve the adjacent artery, such as our case of an anterior choroidal artery aneurysm, because multiple clips to secure a broad-based or fusiform aneurysm can cause luminal stenosis, followed by cerebral hypoxia or infarction. Also, in some aneurysm cases with severe atherosclerosis, clipping had the possibility of sliding and leave-out.

For many years, gauze, adhesive or muscle was used as wrapping material. At our institution in 1998, a case of granuloma and infection occurred after wrapping using muslin gauze and the patient had a poor outcome. Since then, we have used the temporalis muscle as a wrapping material.

We obtained fingernail-sized amount of temporalis muscle and smoothened it out until the muscle became thin and broad without a hump. Then, an incision of the fanned muscle was made to make a Y-shaped wrapping muscle. If there were any perforators or branching arteries around the aneurysmal sac, we made wrapping material with more than three-divisions to avoid vessel or brain injury. The aneurysmal sac was wrapped using a microforcep. After covering the aneurysmal sac with multi-divided muscle, each divided muscle was clipped together to enhance the power of the covering (wrap and clip technique or clip-reinforced wrapping technique). Transcranial doppler was used before and after clipping to confirm adequate blood flow velocity. If there was no abnormality in blood flow and complete wrapping was confirmed, remnant muscle distal to the clip was cut away.

If there was a definite weak or ruptured point and direct complete clipping was impossible, partial clipping was intentionally done to avoid bleeding or rebleeding. Since then, we have used the same wrapping technique described above (clip-wrap technique).

RESULTS

Between February 2002 and December 2006, 201 cases underwent craniotomy and clipping or wrapping of the aneurysm sac and 71 cases underwent endovascular embolization of the aneurysm sac at our hospital. Among these, 21 cases (7.7%) were chosen for our study. The mean age was 53 years (range 29-67). Ten patients had ruptured aneurysms and 20 cases were located in the anterior circulation. The mean GCS at admission was 14.2 (Table 1, 2). Aneurysm shapes were broad neck form (14 cases), fusiform (1 case), bleb to adjacent vessel (6 cases) (Table 3).

Five patients were treated by clipping of wrapped temporalis muscle, and the clip-wrap technique was used in 16 patients. In the subarachnoid hemorrhage (SAH) group, the clip-wrap technique was used in all patients, and in the non-SAH group, clip-wrap technique was used in 6 patients (55%). Postoperative complications were intracerebral hemorrhage not related to aneurysm rebleeding (3 cases), intracerebral infarction (1 case) and optic neuropathy (1 case). Hemorrhagic complications included small contusion hemorrhage on operation site (1 case) and opposite

Table 2. Location of wrapped aneurysm

Location	Number
Middle cerebral artery	17
Anterior communicating artery	1
Internal carotid artery	1
Posterior communicating artery	1
Posterior inferior cerebellar artery	1

Table 3. Reason of wrapping

Reason	Number
Broad neck	7
Unpreservable of adjacent artery by clipping	6
Incomplete clipping	4
Fusiform shape	1
Atherosclerosis with broad neck	3

Table 4. Glasgow Outcome Scale (GOS)

GOS	At discharge	Last F/u
5	18	19
4	2	1
3	1	-
2	-	1
1	-	-

F/u : Follow-up

site (1 case), and epidural hematoma located in the opposite site (1 case). One patient with a ruptured aneurysm experienced a small contralateral cerebral infarction after the 8th postoperative day. We thought this lesion was a result of vasospasm. One patient with an unruptured aneurysm showed optic nerve injury on the operative side due to external compression of the eyeball by the frontal scalp flap during the operation. This patient has had visual difficulty until now, about 4 years. There were no cases with infection or abscess associated with the wrapped temporalis muscle.

Outcome was classified according to the GOS. The mean GOS at discharge was 4.8 and 20 patients were grade four or five. One patient whose initial GCS was 10 had a final GOS of 3. The mean final GOS was 4.8, the same GOS as at discharge (Table 4).

The mean period between initial angiography and last angiography was 18.5 months (range 8-44). There were no cases where aneurysm size increased on follow-up angiography. Five cases showed reduced size on follow-up angiography, and no patient experienced bleeding or rebleeding.

Case study

Case 1

A 56-year-old woman presented with severe headache. CT showed SAH of Fisher grade 3. She had no neurologic deficit on admission. Initial 4-vessel angiography revealed a right middle cerebral artery (MCA) aneurysm that had a broad neck and bleb formation to both M2 branches (Fig. 1A). In the postoperative CT, the patient had small contusive hemorrhage on the right frontal lobe, caused by traction. However, the patient recovered without any sequela. Follow-up angiography after 25 months showed no change in aneurysm size or shape (Fig. 1B).

Case 2

A 63-year-old woman with a history of a ruptured posterior communicating artery (PcomA) aneurysm secured by clipping 10 years earlier. Initial 4-vessel angiography showed a fusiform shaped right MCA aneurysm (Fig. 2A). She underwent an operation by wrapping technique, and was discharged without complication. Follow-up angiography after 12 months showed no change in aneurysm size or shape (Fig. 2B).

Case 3

A 63-year-old woman presented with severe headache. Initial 4-vessel angiography showed multiple aneurysms, including a right MCA aneurysm with broad neck (Fig. 3A), two PcomA aneurysms (one : contralateral side), an anterior choroidal artery aneurysm, two internal carotid artery (ICA) bifurcation aneurysms, and a proximal basilar artery aneurysm. Coiling was scheduled for the ICA bifurcation and bailar artery aneurysms and open surgery was done for the remnant anterior circulation aneurysms. Clip-reinforced wrapping technique (wrap and clip technique) was applied to the right MCA bifurcation aneurysm. Postoperative CT showed contralateral epidural hematoma. Follow-up angiography after 26 months showed no change in aneurysm size or shape (Fig. 3B). She has had no complications or neurologic deficits until now.

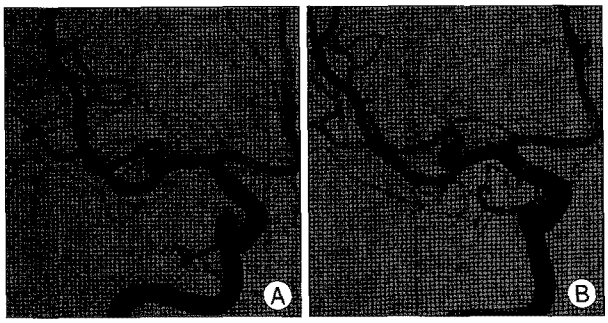

Fig. 1. Initial cerebral angiogram showing a right middle cerebral artery aneurysm with a broad neck and bleb formation to both M2 branches in a 56-year-old woman (A). Follow-up angiography after 25 months shows no change in aneurysm size or shape (B).

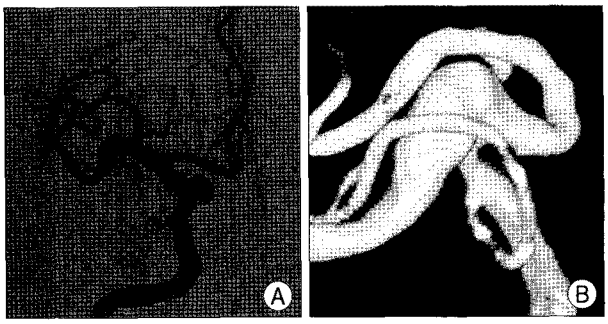

Fig. 2. Initial angiogram showing a right middle cerebral artery aneurysm of fusiform shape in a 63-year-old woman who had a remote history of a ruptured posterior communicating artery aneurysm (A). Follow-up 3-dimensional angiography after 12 months shows no change in aneurysm size or shape (B).

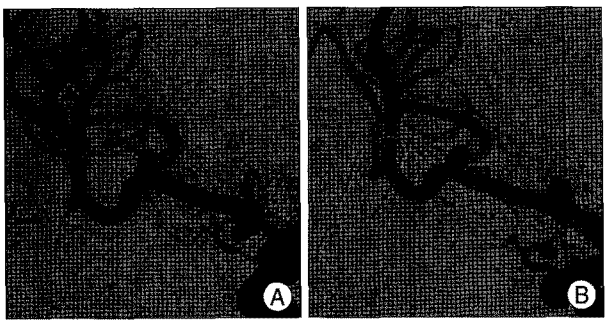

Fig. 3. Initial angiogram showing right middle cerebral artery aneurysm with broad neck in a 56-year-old woman (A). Follow-up angiography after 26 months shows no change in aneurysm size or shape (B).

DISCUSSION

Clipping the aneurysmal neck is generally considered as the treatment of choice for intracerebral aneurysms. Recently, endovascular treatment of aneurysms is increasingly accepted as an alternative form of treatment for intracerebral aneurysms. However, the size of the neck, the shape of the aneurysm sac and adjacent vessel of aneurysm are important factors in successful clipping or embolization. In some patients, surgical clipping or endovascular occlusion is technically impossible. In such cases, it is necessary to protect against aneurysmal rupture by reinforcement using external wrapping with an available material or by trapping after bypass surgery. We selected the temporalis muscle as a wrapping material in this study. In some cases, partial clipping before wrapping was done on the weak or ruptured point. If there was room for partial clipping, we chose the clip-wrap technique intentionally. We considered this method to be more protective than the wrapping only method. In the premicroscopic era of neurosurgery, wrapped aneurysms had a significantly higher risk of intraoperative complication or rebleeding, because surgical exposure of the aneurysmal neck was more difficult with the naked eye[15]. With the development of microsurgical equipment and techniques, neurosurgeons now able to illuminate and magnify the operative field much better. It is now easy to expose the aneurysm neck without adjacent vessel or brain injury. As a result, safer and perfective wrapping of the aneurysmal sac is possible without sacrificing an adjacent vessel. However, neurosurgeon must always be concerned about the possibility of rebleeding.

Several early studies have described the wrapping technique and clinical/angiographic outcomes. After the introduction of microsurgical technology, these studies showed that the rebleeding rate of wrapped aneurysms was generally low[4,16,17], but these studies suggested that the wrapping technique was still less effective than clipping in preventing early rebleeding. Todd et al.[17] reported that their early rebleeding rate (within the first 6 months) was 8.6%, and their late rate of rebleeding was 1.5% per year. Another study using biobond and histoacryl with gauze showed that the total rebleeding rate was about 10.5% (4/38)[2].

In our study, 21 wrapped aneurysms have had no evidence of rebleeding and the outcomes have been generally as good as grade four or five GOS. Our result has a relatively higher protection rate than the rate we thought initially and that other reports have presented. We now think that the clip-reinforcement technique has a more protective effect on cerebral aneurysms than the simple wrapping technique.

Several studies showed that the wrapping technique was as effective as clip ligation to aneurysm treatment on long-term follow up[3,4,14]. A number of materials have been used to treat aneurysms : muslin gauze[10,17], surgicel, muscle[5,14], biobond adhesive, and histoacryl adhesive[2]. In an early study, a high rebleeding rate was reported when biobond was used as a coating agent[11]. In an other study, it was reported that biobond induced chronic inflammatory changes, necrosis of the media and fibrosis in a rat model[9]. Muslin gauze is regarded as an effective material by inducing fibrosis which reinforces the aneurysm sac, and possibly inducing intraluminal thrombosis[6,14]. On the other hand, it has caused foreign body reaction such as infection or granuloma[8,10]. It can also cause cranial nerve injury, especially to the optic or oculomotor nerve in anterior circulation and brain edema, which causes chronic headache or mental deterioration[1,13]. In our study, a case of ipsilateral optic neuropathy developed after wrapping an unruptured MCA aneurysm. This complication was not associated with wrapping procedure itself, but resulted from external compression of the eyeball by the frontal scalp flap during the operation. Also, there was no granulomatous formation in this case. Our study is a retrospective analysis of wrapped aneurysms using the temporalis muscle. Because autologous tissue is less inflammatory than a foreign body as gauze or adhesive agent, no infectious complications such as granuloma was seen in our study.

Previous studies have shown that about 80% cases had reduced or unchanged aneurysm sac size on follow-up angiogram after wrapped operation[12]. In our study, there was no increase in size of aneurysm on follow-up angiographic finding in any of patients. Furthermore, there was no change in aneurysm size in 16 patients, and 5 cases showed a reduction in size. Our wrap-and-clip technique or clip reinforcement wrapping technique using temporalis can be a favored method in unclippable aneurysm cases. In earlier studies, there was a degeneration and resorption of the wrapped temporlis muscle, and resulted in late rebleeding[2,17]. However, such cases have not been found in our hospital yet. Our study, however, has several limitations, such as short-term follow-up period in small number of patients and the fact that this technique requires multiple clips for complete wrapping.

CONCLUSION

Although technically more demanding, our wrapping technique using temporalis muscle and aneurysm clip(s) for intracranial aneurysms is considered as a safe way to protect against rebleeding or regrowth of aneurysm, thus can be considered as an alternative modality for the treatment of

intracranial aneurysms with low rate of postoperative complications.

References

1. Carney PG, Oatey PE : Muslin wrapping of aneurysms and delayed visual failure. A report of three cases. **J Clin Neuroophthalmol 3** : 91-96, 1983
2. Cossu M, Pau A, Turtas S, Viola C, Viale GL : Subsequent bleeding from ruptured intracranial aneurysms treated by wrapping or coating : a review of the long-term results in 47 cases. **J Neurosurg 32** : 344-346; discussion 347, 1993
3. Cudlip SA, Kitchen ND, McKhahn GM, Bell BA : Wrapping of solitary ruptured intracranial aneurysms, outcome at five years. **Acta Neurochir (Wien) 140** : 1167-1170; discussion 1170-1171, 1998
4. Deshmukh VR, Kakarla UK, Figueiredo EG, Zabramski JM, Spetzler RF : Long-term clinical and angiographic follow-up of unclippable wrapped intracranial aneurysms. **J Neurosurg 58** : 434-442; discussion 434-442, 2006
5. Dott N : Intracranial aneurysms, cerebral arterio-radiography surgical treatment. **Edinb Med J 40** : 219-234, 1933
6. Ebina K, Iwabuchi T, Suzuki S : A clinico-experimental study on various wrapping materials of cerebral aneurysms. **Acta Neurochir (Wien) 72** : 61-71, 1984
7. Fujiwara S, Fujii K, Nishio S, Fukui M : Long-term results of wrapping of intracranial ruptured aneurysms. **Acta Neurochir (Wien) 103** : 27-29, 1990
8. Haisa T, Matsumiya K, Yoshimasu N, Kuribayashi N : Foreign-body granuloma as a complication of wrapping and coating an intracranial aneurysm. Case report. **J Neurosurg 72** : 292-294, 1990
9. Herrera O, Kawamura S, Yasui N, Yoshida Y : Histological changes in the rat common carotid artery induced by aneurysmal wrapping and coating materials. **Neurol Med Chir (Tokyo) 39** : 134-139; discussion 139-140, 1999
10. Kirollos RW, Tyagi AK, Marks PV, van Hille PT : Muslin induced granuloma following wrapping of intracranial aneurysms : the role of infection as an additional precipitating factor. Report of two cases and review of the literature. **Acta Neurochir (Wien) 139** : 411-415, 1997
11. Minakawa T, Koike T, Fujii Y, Ishii R, Tanaka R, Arai H : Long term results of ruptured aneurysms treated by coating. **Neurosurgery 21** : 660-663, 1987
12. Mount LA, Antunes JL : Results of treatment of intracranial aneurysms by wrapping and coating. **J Neurosurg 42** : 189-193, 1975
13. Onoue H, Abe T, Tashibu K, Suzuki T : Two undesirable results of wrapping of an intracranial aneurysm. **Neurosurg Rev 15** : 307-309, 1992
14. Sachs E Jr : The fate of muscle and cotton wrapped about intracranial carotid arteries and aneurysms. A laboratory and clinico-pathological study. **Acta Neurochir (Wien) 26** : 121-137, 1972
15. Sato K, Fujiwara S, Kameyama M, Ogawa A, Yoshimoto T, Suzuki J : Follow-up study on ruptured aneurysms treated by wrapping. **Neurol Med Chir (Tokyo) 30** : 734-737, 1990
16. Taylor JC, Choudhury AR : Reinforcement with gauze wrapping for ruptured aneurysms of the middle cerebral artery. **J Neurosurg 47** : 828-832, 1977
17. Todd NV, Tocher JL, Jones PA, Miller JD : Outcome following aneurysm wrapping : a 10-year follow-up review of clipped and wrapped aneurysms. **J Neurosurg 70** : 841-846, 1989