—Original—

Utility of the Orbitocranial Approach for Clipping of Anterior Communicating Artery Aneurysms: Significance of Dissection of the Interhemispheric Fissure and the Sylvian Fissure

Takayuki Mizunari[1,2], Yasuo Murai[1], Shiro Kobayashi[1,2], Shigeru Hoshino[1,2] and Akira Teramoto[1]

[1]Department of Neurosurgery, Graduate School of Medicine, Nippon Medical School
[2]Department of Neurosurgery, Neurosurgical Institute, Nippon Medical School Chiba Hokusoh Hospital

Abstract

Objective: To investigate the importance of sufficient dissection of the interhemispheric and sylvian fissures, an orbitocranial approach was used for clipping of ruptured anterior communicating artery aneurysms.

Patients and Methods: From January 1998 through March 2009, 41 patients underwent surgery for subarachnoid hemorrhage caused by rupture of an anterior communicating artery aneurysm. Their mean age was 58.4 years, with a range of 37 to 84 years. The preoperative World Federation of Neurosurgical Societies grade was I to III in 32 patients and IV to V in 9 patients. The direction of the aneurysm was upward in 23 patients, forward in 14 patients, and backward in 4 patients. Seven patients had a large aneurysm.

Results: All patients underwent surgery during the acute stage following the subarachnoid hemorrhage (day 0–2). A right orbitocranial approach was used for most patients, but a left orbitocranial approach was used for 9 patients because of the presence of a complicated aneurysm and the positional relationship of the left-right A2 segment. In 12 patients, external decompression was performed. The outcome, using the Glasgow Outcome Scale, was good recovery in 24 patients, moderately disabled in 8 patients, and severely disabled in 4 patients, and 5 patients died. Temporary eye movement disorders developed after surgery in 5 patients but resolved in all patients within 2 months. No patients had olfactory disturbance.

Discussion: Using the orbitocranial approach and sufficient dissection of the interhemispheric and sylvian fissures, we could secure a broad field of vision and surgical field, which contributed to a safe operation. The only postoperative complication caused by the surgical approach was temporary eye movement disorder. Thus, for some patients with aneurysms of the anterior communicating artery, the orbitocranial approach contributes to improved outcomes.
(J Nippon Med Sch 2011; 78: 77–83)

Key words: cerebral aneurysm, anterior cerebral artery, approach, clipping

Correspondence to Takayuki Mizunari, MD, Department of Neurosurgery, Nippon Medical School Chiba Hokusoh Hospital, 1715 Kamagari, Inba-mura, Inba-gun, Chiba 270–1694, Japan
E-mail: tmizunari@gmail.com
Journal Website (http://www.nms.ac.jp/jnms/)

Introduction

The main approaches for clipping aneurysms of the anterior communicating artery (Acom) are the interhemispheric approach[1–4] and the pterional approach[5–7]. The interhemispheric approach[1–4] is indicated for various types of Acom aneurysms but has disadvantages[1,5,7,8], such as a complicated technique, olfactory nerve injury, postoperative cerebrospinal fluid leakage or infections from the opening of the frontal sinus, difficulty in washing a hematoma in the sylvian fissure, and difficulty if complicated aneurysms are present in the internal carotid artery and middle cerebral artery. On the other hand, the pterional approach[5–7] is extensively used in various situations and has the significant advantage of being a familiar technique. Nevertheless, due to its limited field of vision, the pterional approach is difficult[7,9–11] if ACom aneurysms are in a high position or are superiorly or posteriorly oriented. To resolve these issues, studies[9–15] have examined various other approaches for eliminating the orbital bone. We have been using an orbitocranial[8,9] approach that eliminates the bone from the supraorbital margin to the orbitofrontal suture, and Smith et al.[9] have used the orbitocranial approach[8,9] mainly for internal carotid aneurysms. Our method has not been used in past reports[9–13] of the orbitocranial approach. Because the interhemispheric fissure is also dissected, we can secure a sufficient surgical field around the Acom. Our method and results using the orbitocranial approach[8,9] to clip ruptured ACom aneurysms during the acute stage following subarachnoid hemorrhage (SAH) are reported.

Materials and Methods

From January 1998 through March 2009, 41 patients underwent operations for SAH caused by the rupture of ACom aneurysms. Their mean age was 58.4 years, with a range of 37 to 84 years. The preoperative World Federation of Neurosurgical Societies grade[16] was I to III in 32 patients and IV to V in 9 patients. The direction of the aneurysm was upward in 23 patients, forward in 14 patients, and backward in 4 patients. Seven patients had a large aneurysm. During the same time period, surgeries were performed via the conventional pterional approach or interhemispheric approach for 67 patients other with ruptured ACom aneurysms. Because the orbitocranial approach is often used for cases in which treatment of the aneurysm is difficult, the orbitocranial approach was not compared with other surgical approaches in the present study.

Description of the Orbitocranial Approach[8,9]

A standard frontotemporal skin incision is made, after which a 7-mm skull perforator is used to create a burr hole in the lateral wall of the orbit. Then, the superior wall of the orbit is cut immediately medial to the supraorbital notch with a sagittal saw, and a bone flap is removed in 1 piece. At this time, the periorbita is sufficiently detached, and the dura mater and orbital contents are protected from damage with brain spatulas to prevent postoperative eye movement disorders. **Figures 1–3** show the differences between the scope of bone flap removal with this orbitocranial approach and the pterional approach.

There is debate over whether the bone flap should be removed in 1 or 2 pieces[9,13] with this orbitocranial approach. We prefer to remove the flap in 1 piece because of the esthetic and postoperative immobilization aspects. However, in the case of external decompression, it is necessary to prevent fusion of the periorbita and the dura in preparation for cranioplasty, and we remove the superior wall of the orbit as 2 pieces or place artificial dura mater between the periorbita and the dura. As for the position for preserving the superior wall of the orbit, it is sufficient to cut it immediately medial to the supraorbital notch; however, for craniotomy of the frontal bone, it is necessary to cut as much as possible in the direction of the midline from this position. At the time of detachment of the bone flap, the superior wall of the orbit is fractured manually.

With a microscope, first, the sylvian fissure is

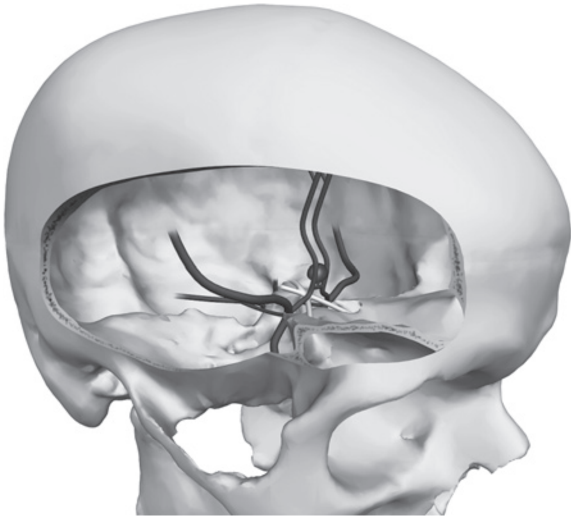

Fig. 1 The area of cranial bone removal with the conventional pterional approach.

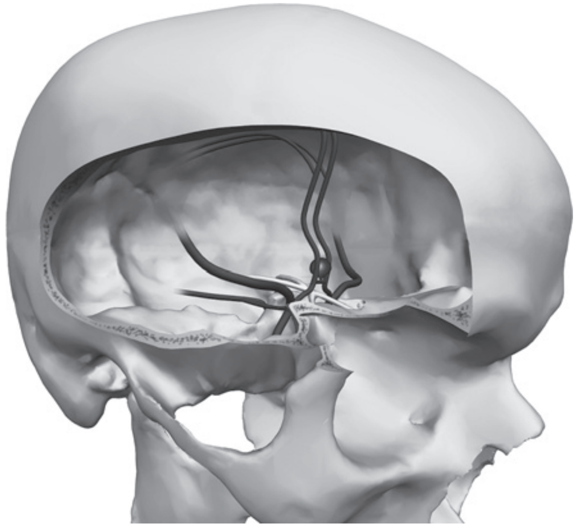

Fig. 2 The area of cranial bone removal with the orbitocranial approach. The operative field is secured from a more caudal position, while the lateral and medial operative fields are broad.

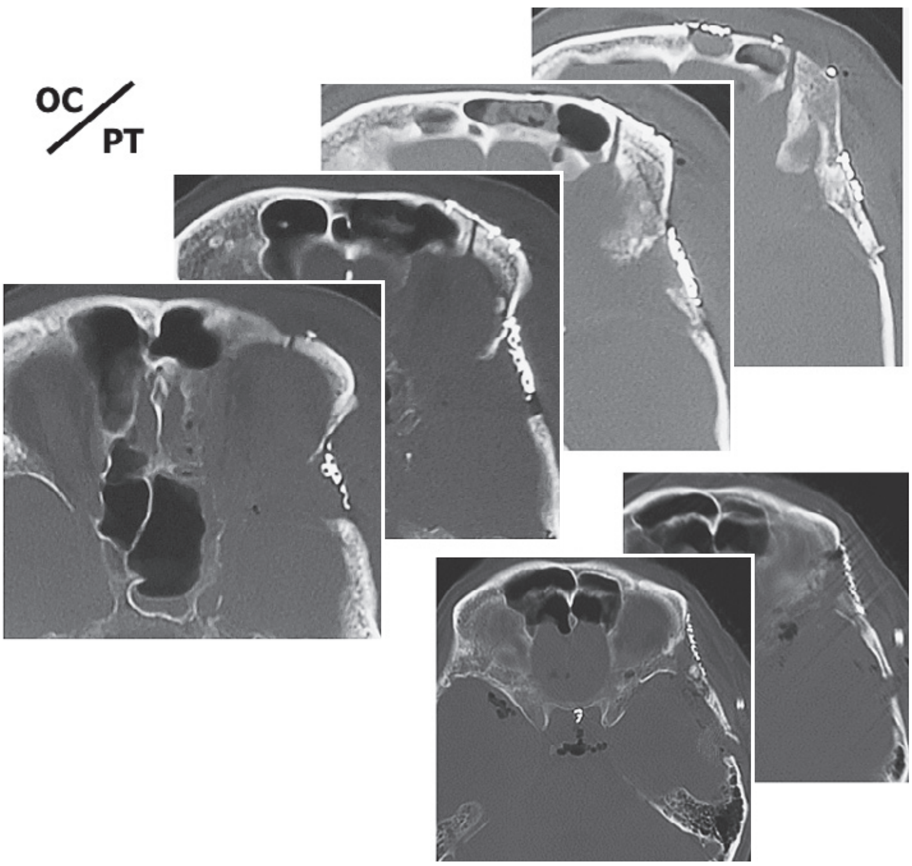

Fig. 3 Postoperative bone window computed tomographic imaging. Orbitocranial approach (upper left) and pterional approach (lower right).

adequately and gradually separated so that retraction of the frontal lobe will be minimal, and the ipsilateral internal carotid artery is secured. Next, the prechiasmatic cistern is washed, the contralateral internal carotid artery and A1 portion of the anterior cerebral artery (A1 segment) and the

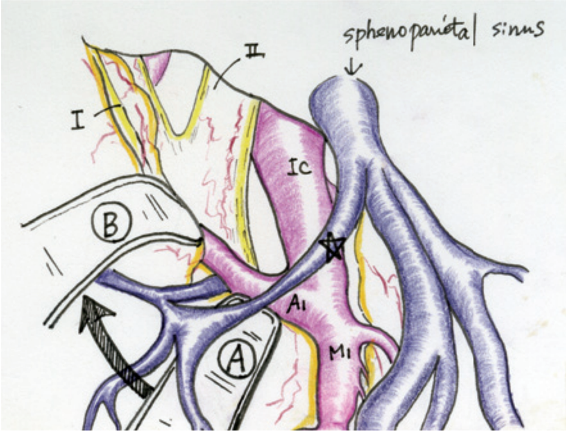

Fig. 4 Schematic diagram of intraoperative findings related to dissection of the sylvian fissure and the A1 portion using a brain spatula. After dissection of the sylvian fissure and the sylvian veins, the brain spatula should be replaced from A to B with the orbitocranial approach.
I, olfactory nerve; II, optic nerve; IC, internal carotid artery; A1, A1 portion of the anterior cerebral artery; M1, M1 portion of the middle cerebral artery.

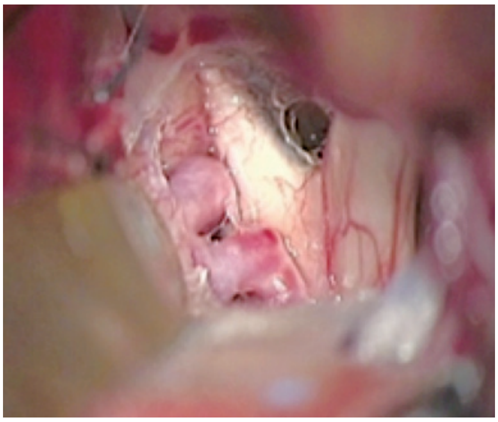

Fig. 5 Intraoperative findings of the ACom via the right orbitocranial approach before dissection of the interhemispheric fissure. The superior surface of the left optic nerve is seen.

Fig. 6 Intraoperative findings of the ACom aneurysm via the right orbitocranial approach after dissection of the interhemispheric fissure. Bilateral optic nerves are not seen, but the upwardly projected ACom aneurysm is seen via the upward visual field through the orbitocranial approach and the dissected interhemispheric fissure.

M1 portion of the middle cerebral artery (M1 segment) are secured, and the clot inside the contralateral carotid cistern is completely aspirated. In addition, the ipsilateral A1 segment is secured, and the bilateral A1 segments are followed distally until the Acom complex with dissection of the interhemispheric fissure.

With regard to the approach to the Acom complex, as a first step, when the direction of the aneurysm is upward[7], the so-called subfrontal approach should be used. The brain spatulas are placed deeper, along the lower surfaces of the bilateral A1 segments immediately superior to the chiasms, thus allowing access to the Acom (**Fig. 4**). When the direction of the aneurysm is forward, a brain spatula is placed shallowly, only on the ipsilateral frontal lobe, and the interhemispheric fissure is widened as much as possible. This makes it safe to obtain an operative field near the interhemispheric fissure, from a more posterior direction, and to access the Acom (**Fig. 5 and 6**). Once the Acom complex, including the aneurysm, has been confirmed to some extent, when deemed necessary, the rectal gyrus should be retracted or aspirated to open the interhemispheric fissure[5–7], and the aneurysm should be detached from the surrounding tissue. This permits a safer surgical procedure, and the perforators can be preserved more easily. However, with the orbitocranial approach it is difficult to adequately confirm the perianeurysmal region if the aneurysm faces backward or is a giant aneurysm; in such cases, the interhemispheric approach[1–4] is clearly superior. As noted earlier, with regard to whether the approach should be from the right or the left, regardless of A1 segment dominance, we consider the positional relationships of the bilateral A2 segments. However, we usually approach from the right side, because doing so is more convenient for a right-handed surgeon and because of the risk of brain contusion due to brain retraction. Eye movement disorders developed after surgery in a number of our patients, most likely because of mechanical damage to the periorbita at the time of craniotomy, and such disorders were temporary. Moreover, this complication has rarely been seen in our more recent surgical cases, because injury was prevented by the use of brain spatulas at the time of craniotomy.

Results

All patients underwent surgery during the acute stage following the SAH (day 0–2) (**Table**). A right orbitocranial approach was usually used, but a left orbitocranial approach was used for 9 patients because of the presence of a complicated aneurysm and the positional relationship of the left-right A2 segment. In 12 patients, external decompression was performed without the bone flap being replaced. The outcome, using the Glasgow Outcome Scale, was good recovery in 24 patients, moderately disabled in 8 patients, and severely disabled in 4 patients, and 5 patients died. Temporary eye movement disorders developed after surgery in 5 patients, but all cases resolved within 2 months. No patients were left with olfactory disturbance. The eye movement disorders were attributed to entrapment of the lateral and superior orbital contents in a "trapdoor" fashion, as in a blow-out fracture.

Discussion

The interhemispheric approach appears appropriate for treatment of ACom aneurysms because it provides the broadest field of vision. However, the approach that is used most often in Japan is the pterional approach. The pterional approach is probably used more often because surgeons are most familiar with this approach, it is useful for complicated aneurysms, and it has a low risk of frontal sinus opening and olfactory nerve injury. However, with the pterional approach the surgical field is limited[5–7,9–11], and confirming the Acom perforators and the bilateral A1 and A2 segments can be difficult. In contrast, with the orbitocranial approach[9–13], a favorable surgical field can be obtained through modification of the pterional approach.

Smith et al.[9], in 1989, were the first to report an orbitocranial approach for aneurysms of the anterior circulation; they operated on 25 patients, mainly for internal carotid aneurysms. Only 6 patients were operated on for ACom aneurysms, and the authors presented no detailed discussion, merely stating that it was easy to reach the surgical field from the more medial side[9]. In 1986, Fujitsu et al.[8] reported the usefulness of the orbitocraniobasal approach for ACom aneurysms, but they performed bone removal at a lower position of the zygomatic bone compared with our approach and that of Smith et al.[9]. That is, they recommended bone removal at a point 1.5 cm more inferior to the frontozygomatic suture. With their method, there is greater risk for facial nerve paralysis and cerebrospinal fluid (CSF) leakage, but there is no difference from our method in the field of vision in relation to ACom aneurysms because of the presence of the eyeball. It is on the basis of these facts that Andaluz et al.[12], who investigated the usefulness of the orbitocranial approach for ACom aneurysms in 2003, Smith et al.[9], and we all use similar orbitocranial approaches.

Andaluz et al.[12] named their method the orbitopterional approach, but it is almost the same as the orbitocranial approach of Smith et al.[9], which is considered the original method. For that reason, we also use the same name, because the method and the scope of bone removal are the same as those of Smith et al.[9] and Andaluz et al.[12]. We have used this approach to treat approximately 40 consecutive patients with ACom aneurysms. As for the characteristics of this craniotomy, Smith et al.[9] and Andaluz et al.[12] have reported that the surgical fields from the frontal and inferior directions were broader, that no cases required dissection of the sylvian fissure, and that only 7.5% of patients required removal of the rectal gyrus by aspiration.

Our method for the orbitocranial approach differs from those reported[9–12] by other groups. We have

Table Clinical data of 41 cases

	age	sex	WFNS	site	size (mm)	projection	Day	GOS	decompression	complications
1	84	F	Ⅳ	R	6	F	0	D	○	
2	66	M	Ⅰ	R	7	U	1	GR		
3	37	F	Ⅰ	R	4	U	1	GR		○
4	55	M	Ⅱ	L	5	F	1	MD	○	
5	72	M	Ⅰ	R	9	F	1	MD	○	○
6	60	F	Ⅰ	R	6	U	0	GR		
7	49	F	Ⅳ	R	7	U	1	MD	○	
8	56	M	Ⅰ	L	6	U	1	D	○	○
9	48	F	Ⅱ	R	8	B	2	GR		
10	58	F	Ⅳ	R	11	F	1	D	○	
11	63	F	Ⅰ	R	6	U	1	GR		
12	55	M	Ⅰ	R	5	B	1	GR		
13	51	M	Ⅰ	R	7	F	0	GR		
14	58	M	Ⅰ	L	8	F	1	GR		
15	74	F	Ⅳ	L	10	U	2	D	○	
16	68	M	Ⅰ	R	7	U	0	MD		
17	45	M	Ⅰ	L	11	F	1	GR		
18	39	M	Ⅰ	R	5	U	0	GR		
19	55	M	Ⅰ	R	3	U	1	GR		
20	51	M	Ⅴ	R	6	U	1	D	○	
21	56	F	Ⅱ	R	3	U	0	GR		○
22	68	M	Ⅰ	R	4	F	2	GR		
23	63	M	Ⅰ	L	11	U	1	GR		
24	74	M	Ⅳ	R	6	U	1	MD		
25	54	M	Ⅱ	R	7	F	1	MD		
26	60	F	Ⅲ	R	8	U	1	GR		
27	46	M	Ⅲ	L	7	F	1	SD	○	
28	62	M	Ⅱ	R	5	U	2	MD		
29	51	M	Ⅰ	R	18	U	0	GR		
30	48	F	Ⅱ	L	4	F	1	GR		
31	73	M	Ⅱ	R	17	F	2	MD		○
32	59	M	Ⅰ	R	6	U	0	GR		
33	62	F	Ⅱ	R	5	B	0	GR		
34	76	F	Ⅰ	R	4	U	1	GR		
35	56	F	Ⅱ	L	4	F	0	GR		
36	47	M	Ⅳ	R	8	U	0	SD	○	
37	58	M	Ⅳ	R	6	U	0	SD	○	
38	62	F	Ⅳ	R	11	B	0	SD	○	
39	49	F	Ⅰ	R	3	U	0	GR		
40	64	M	Ⅰ	R	5	U	0	GR		
41	64	M	Ⅰ	R	4	U	1	GR		

B, backward; complications, cases of postoperative temporary eye movement disorder; D, dead; Day, days from the ictus to the operation; F, forward; GOS, Glasgow Outcome Scale; GR, good recovery; MD, moderately disabled; projection, projection of the aneurysm; SD, severely disabled; size, size of aneurysm; U, upward; WFNS, World Federation of Neurosurgical Societies

tried to expand the field of vision of the aneurysm by dissecting the sylvian fissure from an adequate lateral direction and releasing the interhemispheric fissure from the frontal direction. That is, because ACom aneurysms are always located in the subarachnoid space, an operative field from the lateral side of the aneurysm can be secured by adequately releasing the sylvian fissure from the lateral direction, aspirating the CSF, and washing out the hematoma in the sylvian fissure, making it possible to secure the proximal portion of the A1 segment in preparation for premature rupture of the aneurysm. In other words, because we use the orbitocranial[9–13] approach only for more difficult ACom aneurysms, we think that adequate dissection of the sylvian and interhemispheric fissures is more necessary. Andaluz et al.[12], who have reported the largest number of cases of ACom aneurysms for which the orbitocranial approach was used, stated that the advantages of this approach are that it does not require detachment of the sylvian fissure and that a sufficient visual field can be obtained by releasing the lamina terminalis from a direct subfrontal approach and draining the CSF. On the other hand, we would prefer to use the interhemispheric approach for most patients. Andaluz et al.[12] treated patients with the orbitocranial approach, and we think this is the reason for the difference in the need for release of the sylvian fissure.

As a postoperative complication of surgery for ACom aneurysms with the pterional approach, olfactory nerve damage reportedly occurs at a rate of 15% to 30%[4,5,17]. Previous reports also indicate that unilateral olfactory nerve damage occurs owing to the approach to the ACom aneurysms, but to date, we have not observed olfactory nerve damage after this surgery in any of our patients. Fujitsu et al.[8] have pointed out the possibility of CSF leakage due to releasing the frontal sinus, but we close the released mucosa with tobacco sutures and fibrin glue, and we have never had a problem with CSF leakage with either the orbitocranial approach or the basal interhemispheric approach.

References

1. Suzuki J, Mizoi K, Yoshimoto T: Bifrontal interhemispheric approach to aneurysms of the anterior communicating artery. J Neurosurg 1986; 64: 183–190.
2. Kikuchi K, Watanabe K: Modified bifrontal interhemispheric approach to aneurysms of the anterior communicating artery with the use of a trephine craniotomy. A review of personal experience with 25 cases. Acta Neurochir (Wien) 1993; 125: 127–131.
3. El-Noamany H, Nakagawa F, Hongo K, Kakizawa Y, Kobayashi S: Low anterior interhemispheric approach—a narrow corridor to aneurysms of the anterior communicating artery. Acta Neurochir (Wien) 2001; 143: 885–891.
4. Yonekawa Y: [Operative neurosurgery: personal view and historical backgrounds (3). Anterior circulation—pterional approach]. No Shinkei Geka 2007; 35: 703–718 (in Japanese with English abstract).
5. Aydin IH, Kadioğlu HH, Tüzün Y, Kayaoğlu CR, Takçi E, Oztürk M: Postoperative anosmia after anterior communicating artery aneurysm surgery by the pterional approach. Minim Invasive Neurosurg 1996; 38: 71–73.
6. Mori K, Yamamoto T, Nakao Y, et al.: Lateral supraorbital keyhole approach to clip unruptured anterior communicating artery aneurysms. Minim Invasive Neurosurg 2008; 51: 292–297.
7. Hino A, Fuse I, Echigo T, Oka H, Iwamoto Y, Fujimoto M: Clipping of upward projecting anterior communicating aneurysms via pterional craniotomy: approach from the side of A2 of anterior displacement. No Shinkei Geka 2006; 34: 149–158 (in Japanese with English abstract).
8. Fujitsu K, Kuwabara T: Orbitocraniobasal approach for anterior communicating artery aneurysms. Neurosurgery 1986; 18: 367–369.
9. Smith RR, Al-Mefty O, Middleton TH: An orbitocranial approach to complex aneurysms of the anterior circulation. Neurosurgery 1989; 24: 385–391.
10. de Souza JM, Rodrigues FF, da Silva MR, et al.: Cranio-orbital approach for the paraclinoidal and anterior communicating aneurysms. Arq Neuropsiquiatr 1995; 53: 592–597.
11. Kelleher MO, Kamel MH, O'Sullivan MG: Cranio-orbital approach for complex aneurysmal surgery. Br J Neurosurg 2005; 19: 413–415.
12. Andaluz N, Van Loveren HR, Keler JT, Zuccarello M: Anatomic and clinical study of the orbitopterional approach to anterior communicating artery aneurysms. Neurosurgery 2003; 52: 1140–1149.
13. Gupta SK, Sharma BS, Pathak A, Khosla VK: Single flap fronto-temporo-orbito-zygomatic craniotomy for skull base lesions. Neurol India 2001; 49: 247–252.
14. Mitchell P, Vindlacheruvu RR, Mahmood K, Ashpole RD, Grivas A, Mendelow AD: Supraorbital eyebrow minicraniotomy for anterior circulation aneurysms. Surg Neurol 2005; 63: 47–51.
15. Ramos-Zúñiga R, Velázquez H, Barajas MA, López R, Sánchez E, Trejo S: Trans-supraorbital approach to supratentorial aneurysms. Neurosurgery 2002; 51: 125–131.
16. World Federation of Neurological Surgeons Committee: Report of World Federation of Neurological Surgeons Committee on a universal subarachnoid hemorrhage grading scale. J Neurosurg 1988; 68: 985–986.
17. Park J, Lee SH, Kang DH, Kim JS: Olfactory dysfunction after ipsilateral and contralateral pterional approaches for cerebral aneurysms. Neurosurg 2009; 65: 727–732.

(Received, June 10, 2010)
(Accepted, November 29, 2010)