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Orbitozygomatic Approach in Early Surgery for Cerebral Aneurysms

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Introduction

The primary purpose of surgery for ruptured cerebral aneurysms is to prevent rebleeding. Accordingly, it would appear logical that surgery should be performed as soon as possible after the subarachnoid hemorrhage(SAH). Recently, the early surgery is a trend for patients with aneurysmal SAH[1~6]. However, there is some difficulty in brain retraction during early surgery because the brain is swollen by recent SAH. The brain is softer and more prone to brusing[7] even if cerebrospinal fluid(CSF) is drained via extraventricular drainage(EVD) or lumbar drainage. Therefore, we think the more exposure of the skull base with minimized brain retraction may be an aid in the early surgery.

Many authors published the method of wide exposure of skull base for orbital tumors[8~11], skull base tumors[12~14], intracranial brain base tumors[10, 11, 15~20], cavernous sinus lesions[21~24], and intracra nial aneurysms[10, 16~18, 25~28]. Smith et al[28] published an orbitocranial approach for complex aneurysms of the anterior circulation and stressed several advantages of this approach such as multidirectional viewing of the aneurysm, surgical direction via multiple routes, and minute brain retraction with basal exposure.

Jane et al[10] also published the technical method of the supraorbital approach and recommended this approach in early surgery for aneurysms of the anterior cerebral artery complex when brain edema may be a complicating factor.

We attempted an orbitozygomatic approach in early surgery for ruptured cerebral aneurysms in order to minimize brain retraction during surgery. The surgical technique and some experiences with this approach are described.

Materials and Methods

1. Clinical material

Among six hundred forty patients who underwent surgery for a cerebral aneurysm from September, 1982 to February, 1994 at Dong San Medical Center, we clipped the aneurysms with an orbitozygomatic approach within four days after the SAH in fourteen patients between June and September 1990. These fourteen patients were selected as a clinical material. A follow-up was done on these patients for more than three years after their surgeries. After collecting data on these patients, an evaluation was made of the merits and demerits of this approach in early surgery for cerebral aneurysms in compared with conventional pterional approach. We also evaluated the indication of this approach for other intracranial lesions.

2. Surgical technique

a. Position and scalp incision

The patient is placed in the supine position. The head is rotated about 30 degrees to the opposite side, drop the vertex of the head about 30 degrees downward, and fixed in the Mayfield headrest. A bicoronal scalp incision is made, starting about 1 cm anterior to the targus, extending upward and forward, running within the hairline to a level 2 cm above the upper margin of the contralateral zygomatic arch(Fig. 1). The scalp is reflected anteriorly with dissection from the periostium of the frontal bone and superficial fascia of the temporalis muscle. Do not attempt to force the dissection of the scalp downward at the temporal area, in order to prevent injury of facial nerve branches. The scalp flap retracts anteriorly and inferiorly with hook retractors after putting a gauze roll under the scalp flap. The periostium of the frontal bone is cut, by an electrical cutting system, about 1 cm above the orbital rim. The superficial layer of the temporalis fascia is also cut along its insertion to the medial surface of the zygoma and frontal zygomatic process. This cutting extends posteriorly along the zygomatic arch. This incision should be made 1 cm above, and pararell to the zygomatic arch in order to avoid injury of the facial nerve(Fig. 2).

The periostium of frontal bone, in continuation with the periorbita, is dissected free from the frontal bone, the margin of the roof and the lateral wall of the orbit until confirming the inferior orbital fissure. The supraorbital nerve is preserved by freeing it from the supraorbital notch or foramen by opening it with a small chisel. The superficial fascia of the temporalis, including the fat layer, is dissected from the deep fascia of the temporalis toward the zygomatic arch and exposed the entire zygomatic arch subperiosteally.

The insertion of the some muscle fascia to the zygomatic arch is cut on the superior side by an electric cutting system. The zygomatic arch is also dorsally dissected from the temporal muscle, using the Penfield's dissector. The scalp flap is

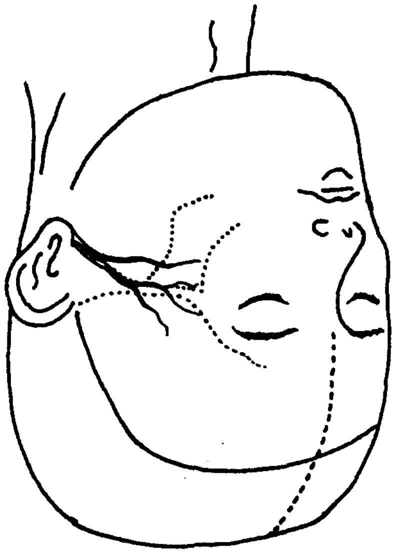

Fig. 1. Scalp incision. Bicoronal scalp incision starts about 1cm anterior to the targus, extending upward and forward, running within the hair line to a level 2cm above the upper margin of the contralateral zygomatic arch.

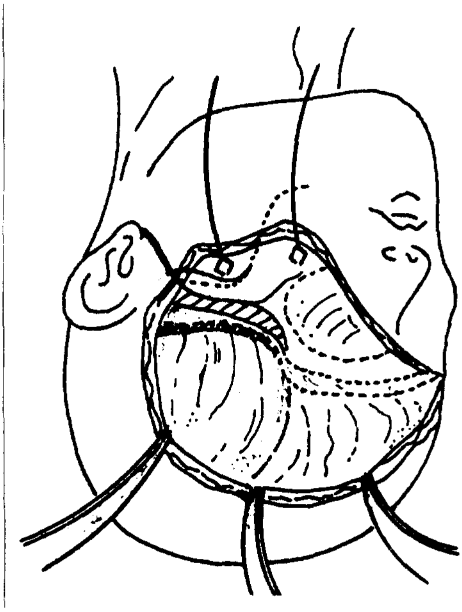

Fig. 2. The cutting of the superficial temporalis fascia. The superficial temporalis fascia is cut with an electrical cutting system along its insertion to the medial surface of the zygoma and frontal zygomatic process. This cutting extends posteriorly along and pararell(1cm above) to the zygomatic arch.

retracted more anteroinferiorly and dissected from part of the zygomatic body until the zygomaticofacial foramen of zygomatic bone is exposed.

b. Craniotomy

Five burr holes are made to remove the bone flap. A large burr hole is made in the frontal bone immediately above the superior orbital notch or foramen. The second large burr hole is made in the temporal fossa at the frontal sphenoid junction, just behind the zygomatic process of the frontal bone, after dissecting the temporalis muscle from the frontal process of zygomatic bone. The third small burr hole is made on the superior temporal crest of the frontal bone. The fourth small burr hole is made on the parietal bone. And the fifth small burr hole is made in the temporal bone just above the pedicle of the zygomatic process of the temporal bone. The first and third, third and fourth, fourth and fifth burr holes are connected with a craniotome or gigli saw. The remaining base of the temporal bone is made linear narrow craniectomy with rongeur from the second and fifth burr holes. The dura is detached from the frontal base with Penfield's dissector through the first and second burr holes in order to prevent injury during orbital roof cutting. The orbital rim is cut obliquely with a reciprocating saw. The oblique cutting prevents depression of the bone flap after the operation. The roof and lateral wall of the orbit, to the inferior orbital fissure, are divided using a thin chisel. The zygomatic bone, just above zygomaticofacial foramen, is divided using a reciprocating saw, from the inferior lateral corner of the orbit obliquely backward toward the inferior orbital fissure. The posterior end of the zygomatic arch is also cut obliquely, using a reciprocating saw.

The fronto−orbito−zygomatico−temporal bone flap(Fig. 3) is hinged on the temporal muscle, which is retracted posteriorly and inferiorly. The remaining sphenoid wing forming the posterolateral orbital wall and the anterolateral part of the middle fossa, and the posterior portion of the orbital roof, lateral to the superior orbital fissure, are divided using a chisel at the level of the superior orbital fissure as a second bone flap. In this procedure, the chisel should be directed from the intracranial side to the orbital side obliquely in order to prevent injury of the optic nerve.

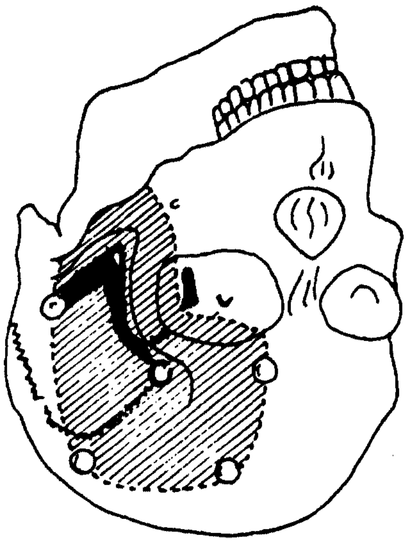

Fig. 3. The first bone flap. The fronto−orbito−zygomatico−temporal bone flap is made by a craniotomy and hinged on the temporal muscle.

This exposure is suitable for middle cerebral artery(MCA), anterior communicating artery (Acom), and most of the posterior communicating artery(Pcom) aneurysms. For the management of the ophthalmic artery aneurysm, paraclinoid or carotid cave aneurysm[34], and carotid cavernous sinus aneurysm of the internal carotid artery, remove the remaining medial part of the minor sphenoid wing and the anterior clinoid process with an air drill. After the opening of the dura, the other procedures are same.

c. Reconstruction

After finishing the intracranial procedure and suturing of the dura, the roof and lateral wall of the orbit are reconstructed by repositioning the bone flap, which is made by a wire fixation between the first and second bone flaps(Fig. 4). This procedure prevents enophthalmos and orbital pulsation after the operation. The bone flap is secured with miniplates to the skull(Fig. 5).

Fig. 4. Reconstruction. The first and second bone flaps are fixed with wire. This bone flap, after repositioning, has the value of preventing enophthalmos and orbital pulsation after operation.

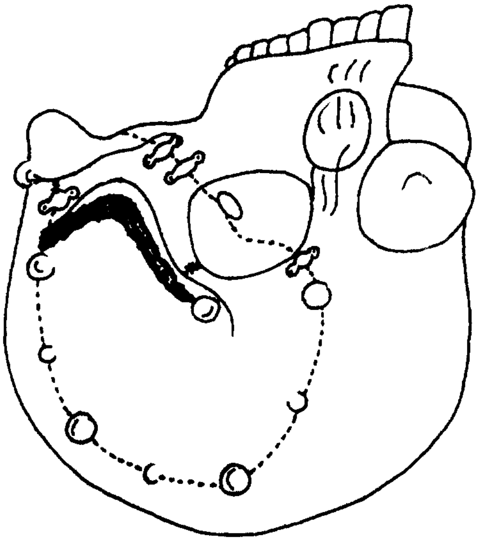

Fig. 5. Reconstruction. The final bone flap, made by the first and second bone flaps, is secured with miniplates to the skull at the end of the intracranial procedure.

Results

1. Summary of cases(Table 1)

a. Patient population and aneurysm sites

Between June and September 1990, fourteen patients with ruptured intracranial aneurysms underwent operations using the orbitozygomatic approach within four days after SAH. The mean age was 53 years(ranged from 34 to 67 years). There were one man and thirteen women. Aneurysm sites were Pcom in four cases, Acom in five, MCA in three, Acom and MCA in one, and Acom and anterior choroidal artery in one.

b. Complications

Small frontal lobe laceration occured in two cases during removal of the orbital roof. Orbital swelling with mild ptosis was seen in five cases immediately after the operations. This complication resolved spontaneously within one or two weeks after the operations in all patients. During the follow-up period, one patient complained of numbness in the zygomatic area of the operation site. Temporal muscle atrophy was observed in another one case.

c. Surgical outcome.

We obtained a good outcome without neurological deficits in twelve cases. Two patients died due to cerebral vasospasm.

2. Advantages and disadvantages of the orbitozygomatic approach compared to the conventional pterional approach(Table 2)

We found that the orbitozygomatic approach in the early surgery for ruptured cerebral aneurysm had several advantages: a) minimal brain retraction; b) short distance to the aneurysm; c) an easy intra-and extradural approach for ophthalmic or paraclinoid aneurysms; and d) multidirectional viewing of the aneurysm, making it is easier to confirm the proximal MCA in MCA aneurysms and to confirm the contralateral

Table 1. Clinical summary of 14 aneurysm cases*

Case	Age (yr)	Sex	Location	Complications: During op.	Complications: Immediate after op.	Complications: Late follow-up	Result** (death cause)
1.	63	F	Acom. MCA	None	Orbital swelling Ptosis	None	Good
2.	34	F	Acom	None	Orbital swelling Ptosis	None	Good
3.	65	F	MCA	None	None		Death (spasm)
4.	67	F	Pcom	None	Ptosis	None	Good
5.	35	F	Acom	None	None	Numbness on zygomatic area	Good
6.	61	M	Acom	Frontal lobe laceration	None	None	Good
7.	48	F	Acom	None	Orbital swelling. Ptosis	Temporal muscle atrophy	Good
8.	64	F	Pcom	None	Orbital swelling. Ptosis	None	Good
9.	53	F	Pcom	Frontal lobe laceration	Orbital swelling. Ptosis	None	Good
10.	49	F	MCA	None	None	None	Good
11.	48	F	Acom	None	None	None	Good
12.	46	F	Acom Acho	None	None		Death (spasm)
13.	51	F	MCA	None	None	None	Good
14.	54	F	Pcom	None	None	None	Good

* Abbreviation: Acom=anterior communicating artery; MCA=middle cerebral artery; Pcom=posterior communicating artery; Acho=anterior choroidal artery; op=operation.

** Good=no neurological deficit.

Table 2. Advantages and disadvantages of the orbitozygomatic approach compared to the conventional pterional approach in early surgery for cerebral aneurysms

Advantages	Disadvantages
1. Minimal brain retraction	1. Long operation time
2. Short distance to the aneurysm	2. Required more surgical skill
3. An easy intra-and extradural approach for ophthalmic or paraclinoid aneurysm.	3. Large amount of blood loss during operation
4. Multidirectional viewing of the aneurysm.	4. Possibility of brain or optic nerve injury during removal of bone

anterior cerebral artery in Acom aneurysms.

This approach also had several disadvantages: a) long operation time; b) required more surgical skill; c) large amount of blood loss during operation; and d) the possibility of brain or optic nerve injury during the removal of bone.

Discussion

Most aneurysms of the anterior circulation can be managed surgically with the pterional approach. Minimal brain retraction can be achieved by opening the basal cistern, and doing the EVD or lumbar drainage during surgery[29~31]. However, in some cases of early operation for ruptured cerebral aneurysms, excessive retraction of the brain is required to approach the basal cistern for removing the CSF. This is need even after doing the EVD or lumbar drainage due to brain edema and swelling resulting from recent SAH[7, 32]. This excessive retraction of the brain may aggravate postoperative brain edema and affect the postoperative state of patients.

Many authors published methods of the wide exposure of the skull base for various intracranial or skull base lesions, and mentioned many advantages of these approaches[8~19, 21~28]. Among these advantages, the short distance from the brain surface to lesions and minimal retraction of the brain during surgery are prominant[10~11, 15~19, 25~28].

Jane et al[10] published the supraorbital approach and recommended this approach in early operation for aneurysms of the ACA complex when brain edema may be complicating factors. Smith et al[28] also published an orbitocranial approach to complex aneurysms of the anterior circulation during delay operation and compared this approach to the pterional approach for the management of an aneurysm of the Acom. They mentioned that retraction of the brain is less needed in the orbitocranial approach than in the pterional approach in order to visualize the A1 and A2. And the dissection of the adhesion between the aneurysm and the opposite A2 was easier in the orbitocranial approach than in the pterional approach.

The orbitozygomatic approach is somewhat different from the orbitocranial approach. In addition to removing the orbital rim and roof, the lateral wall of the orbit, a part of the zygomatic body and zygomatic arch, we are removed. This procedure provides a more anterior projection of vision along the orbital roof. Therefore, the retraction of the brain is required less during surgery than in the orbitocranial approach. The confirming of, both side A1 and A2, is easy in an aneurysm of the Acom and M1 in an aneurysm of the MCA(Fig. 6).

For the preservation of the frontotemporal branch of the facial nerve, an interfascial dissection between the superficial and deep fascia of temporalis muscle[27, 33] was used because the twigs of the frontotemporal branches of the facial nerve run through the subcutaneous tissue[33]. With this method, the frontotemporal branch is reflected with the fascia and protected by the reflected superficial fascia itself.

McDermott et al[11] made two seperate bone flaps, such as a free frontotemporo-sphenoid bone

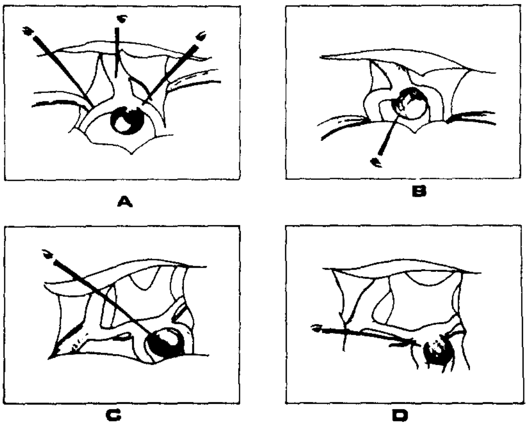

Fig. 6. Advantages: More anterior projection of vision along the orbital roof during operation, the confirming of the M1 in MCA aneurysm(A) and both sides of A1 and A2 in Acom aneurysm(C) are made easier than pterional approach(B: MCA, D: Acom.)

flap and en bloc removal of the superior and lateral orbital margins with the attached zygomatic arch. This was followed by removing the remaining roof of the orbit, the lesser and greater wings of the sphenoid. They reconstructed the apex of the orbit with an autologus inner table split thickness bone graft in order to prevent enophthalmos and orbital pulsation after operation. Hakuba et al[17] removed the fronto – orbito – zygomatico – temporal bone as one flap. This was followed by the removal of the remaining major sphenoid wing forming the posterolateral orbital wall and the anterolateral part of the middle fossa, and the posterior portion of the orbital roof lateral to the superior orbital fissure as a second bone flap. However, they did not mention the reconstruction method of the apex of the orbit. We followed the method of Hakuba et al[17] in removing the fronto – orbito – zygomatico – temporal bone as one bone flap because it was thought that one bone flap was more cosmetic than two. In the reconstruction method of the apex of the orbit, we achieved the reconstruction with repositioning the bone flap which was made by wire fixation between the first and second bone flap. This method is more convenient and easier than the autologus inner table split thickness bone graft which was used by McDermott et al[11].

Many authors secured the bone flap with wire[18, 23], heavy suture[8], nylon suture[16~17, 27], bioglue[16] or acrylic[11] to the skull at the end of procedures after dura closure. We used miniplates for securing the bone flap. This method was convenient and good for cosmetics.

We also used this approach for removing sphenoid ridge meningioma, recurrent pituitary tumor, and dumbell shaped, supra – and infratentorial trigeminal schwannoma which involved cavernous sinus. This approach is also useful for removing of these tumors with minimal retraction of the brain.

Summary

We presented the orbitozygomatic approach in early surgery for the intracranial aneurysms. This approach provided excellent wide exposure, minimized brain retraction under the brain swelling state resulting from recent SAH. However, this approach also has several disadvantages such as long operation time, required more surgical skill, and large amounts of blood loss during the operation. We conclude that this approach should be used in early surgery for anterior circulation aneurysms accompanied with brain edema and small ventricle, and upper basilar trunk aneurysms. However, we think this approach has significant advantages for surgery of ophthalmic, paraclinoid, intracavernous sinus and high positioned basilar top aneurysms, and skull base tumors.

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=국문초록=

뇌동맥류의 조기수술에서 Orbitozygomatic 접근

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뇌동맥류를 조기수술시 지연수술시와 비교하여 수술수기상 문제점이 되는 것중 중요한 하나는 뇌의 팽창때문에 안전한 대뇌견인이 어렵다는 점이다. 따라서 두개저골편을 광범위하게하고 대뇌견인을 최소화하는 방법을 고려해 볼 수 있다. 저자들은 과거 제한된 예들에서 이러한 방법을 시행하고 3년이상 추적관찰한 후 장단점, 합병증 및 결과을 분석하고 수술방법 및 적응증에 대하여 기술하고자 한다.

재료는 1982년 9월부터 1994년 2월까지 본원에서 수술한 640례의 뇌동맥류 환자중 1990년 6월부터 9월까지 뇌지주막하 출혈후 4일내에 두개저골편을 광범위하게 하고 뇌동맥류를 결찰한 14례를 대상으로 하였다. 수술방법은 전두-안와-협골-측두골을 연결하는 첫 골편을 만들고 두번째로 시신경관과 상안와열을 연결하는 골편을 만들었으며, 재건은 첫 골편과 두번째 골편을 철사로 연결후 두개골에 miniplate로 고정하였다.

결과는 12례에서 신경학적 장애없이 회복하였으며, 2례가 뇌혈관 연축에 기인하여 사망하였다. 합병증으로 수술중 2례가 경미한 전두엽 손상이 골편제거중 발생하였으며, 5례가 수술 직후에 심한 안와주위 부종과 안검하수가 관찰되었으나 자연적으로 소실하였고, 추적관찰중 1례가 수술부위의 협골부위에 감각소실, 1례가 측두근 위축소견을 보였다. 장점은 수술중 대뇌견인을 최소화할 수 있었으며, 중대뇌동맥류에서는 M1, 전교통동맥류에서는 양측 A1 및 A2를 확인하는것이 용이하였다. 단점으로는 수술시간이 길었고, 수술중 혈액 손실이 많았으며 고도의 수술수기가 요구되었다.

결론은 anterior circulation에 발생한 뇌동맥류의 조기수술에 이 방법을 일률적으로 적용하는 것은 무리이나 뇌부종으로 뇌실위축을 보이는 예들에서는 유용할 것으로 생각되었고, 기저동맥 상부에 발생한 뇌동맥류를 조기수술시에는 절대적으로 유용할 것으로 생각되었다. 아울러 안와동맥 주위에 발생한 뇌동맥류, 높이 위치한 기저동맥 동맥류에서도 수술시기에 관계없이 이 방법이 유용할 것으로 추정되었고 또한 해면정맥동내의 수술 및 두개저에 발생한 종양등의 수술시에도 이 방법은 많은 도움을 줄것으로 사료되었다.

Key Words : Cerebral aneurysm. Early surgery. Orbitozygomatic approach.