

Early Aneurysm Surgery using Eyebrow Incision for Poor Grade Patients

Chul-Jae Lee, M.D., Byung-Chan Jeon, M.D., Young-Soo Kim, M.D.,
Tae-Sang Chun, M.D., Nam-Kyu Kim, M.D.

Department of Neurosurgery, Kosin University College of Medicine, Busan, Korea

Objective : This study is aimed to assess the clinical outcome in early and minimally invasive surgery using an eyebrow incision for the patients with poor grade aneurysm.

Methods : The authors retrospectively reviewed all 46 poor grade patients of Hunt and Hess(H-H) grade IV and V who suffered aneurysmal subarachnoid hemorrhage(SAH) between 1999 and 2004. All 35 patients harboring 43 aneurysms who underwent early surgery within 72 hours were included in this study. Clinical outcome was assessed by Glasgow outcome scale(GOS) and compared with that of conventional pterional approach.

Results : Twenty four patients were operated with conventional pterional approach and 11 with eyebrow approach within 72 hours after SAH. Seven multiple aneurysm patients harbor 15 aneurysms. Forty one aneurysms were treated with clippings. All 11 patients of eyebrow surgery group(ESG) were in H-H grade IV, 3 in Fisher grade III and 8 in Fisher grade IV. Among 24 patients of pterional approach group(PAG), 20 were in H-H grade IV and 4 in H-H grade V, 3 were in Fisher grade III and 21 in Fisher grade IV. Overall favorable outcome was achieved in 41.7% and 54.5% in PAG and ESG, respectively. Favorable outcome of H-H grade IV in PAG showed 45.0%. Overall mortality rate was 14.3%.

Conclusion : It is concluded that the clinical outcome of early and minimally invasive aneurysmal surgery using eyebrow incision in the selected poor grade aneurysm patients can be compatible with that of conventional pterional surgery.

KEY WORDS : Aneurysm · Poor-grade · Early surgery · Eyebrow incision · Pterional approach.

Introduction

Patients with aneurysmal SAH of H-H grade IV and V are categorized as poor clinical grade, and comprise 20% to 40% of whom admitted to the hospital presenting with aneurysmal SAH^{1,5,14,19)}. The majority of these patients subsequently end up by death if left untreated. Rebleeding, vasospasm and generally such poor condition as life-threatening cardiopulmonary complications in addition to neurological deficits are contributing factors to the high mortality^{5,12,14)}.

Many neurosurgeons, however, are still hesitant about early surgery in these patients including urgent surgical clipping of aneurysms because of several conditions previously mentioned. Early surgery in patients with ruptured aneurysms of H-H grade I to III is generally accepted to prevent rebleeding and minimize the morbidity and mortality¹⁹⁾. But the outcome

of early surgery in poor-grade patients is not yet optimistic even though there has been outstanding progress in operative implements and techniques, and timing of operation according to clinical course is also debatable. It is mainly contend that there are many intraoperative difficulties such as difficult access due to brain swelling, premature aneurysm rupture, long-standing temporary clipping, retraction injury and early post-operative infarction, etc. Because of these reasons, it is fact that there is the reluctance of neurosurgeons toward early surgery in poor-grade patients. However, recently reported studies suggests that early surgery combined with aggressive postoperative management could improve the clinical course of poor-grade aneurysm patients^{12,18,19)}.

Until a recent date, conventional approach, like pterional craniotomy, has been mainly used not only in good-grade aneurysm patients but also in poor-grade. With development

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• Address for reprints : Byung-Chan Jeon, M.D., Department of Neurosurgery, Kosin University College of Medicine, 34 Amnam-dong, Seo-gu, Busan 602-702, Korea Tel : +82-51-990-6465, Fax : +82-51-990-3042, E-mail : jbcstar@kosinmed.or.kr

of neurosurgical techniques and tools, there were also much advancement in surgery of aneurysm, and new surgical approaches through eyebrow and endoscopy-assisted surgery were developed and became the alternative to conventional approaches.

In this study we provide a comprehensive report on our experience with early and minimally invasive eyebrow surgery in poor-grade aneurysm patients, compared with that of the conventional pterional approach.

Materials and Methods

Patient selection

Between October 1999 and August 2004 a total of 292 patients with aneurysmal SAH were operated at our institute. Of 292 patients, 35 patients were included in this study, who were in H-H grade IV and V on admission, and managed by early surgery. Patients, not managed by early surgery because of overwhelming medical complications, sudden preoperative death, or kin's refusal to allow treatment were excluded in this study. The cases treated by other than surgical clippings, such as coil embolizations were also excluded. This article describes a clinical management outcome of 35 consecutive poor-grade patients of all ages whose aneurysmal SAH was managed by eyebrow surgery or standard conventional (pterional) approach in their early phase. All surgeries were performed by one neurosurgeon. The results were verified in all cases by a retrospective review of medical records and radiological investigations. Operation time and peri- and intraoperative events such as preoperative rebleeding, intraoperative premature rupture of aneurysms, early postoperative infarction, retraction injury, other complications related to operation, vasospasm were also reviewed. Patients were divided into two groups by the type of operation performed. One was pterional approach group (PAG) and the other was eyebrow surgery group(ESG). All patients were followed up at least over 3 months unless they died before this period had elapsed. Clinical outcomes were assessed according to the Glasgow outcome scale(GOS). Patients with a GOS of good or moderately disabled living independently, these patients were classified as having a favorable outcome. Patients who died or were not capable of living independently were classified as having an unfavorable outcome. This outcome assessment was performed by routine

clinical reviews or telephone survey. Neuropsychological assessment was not performed.

Operation

Early pterional or eyebrow approach was performed randomly. However, ruptured aneurysm with intracerebral hematoma more than 10cc in amount, giant aneurysm, H-H grade V patients were excluded for treatment with eyebrow approach. Pterional approach for aneurysm clipping was conducted in the usual conventional fashion : frontotemporal craniotomy and trans-sylvian approach. For eyebrow surgery, superior orbital rim or superolateral orbital rim craniotomy via an eyebrow incision was used with respect to the location of aneurysms. Author's detailed operative procedure and tactics were previously reported⁷⁻⁹⁾. All operations were performed within 72 hours after patients were presented.

Results

Surgical outcome

Among 35 poor-grade patients who underwent early aneurysm surgery, 24 harboring 28 aneurysms were operated by

Table 1. Location of aneurysms of 35 poor-grade aneurysm patients

Location	Pterional approach	Eyebrow approach	Total
ACoA	11	7	18
MCA bif	9	1	10
PCoA	7	5	12
AChoA	1	2	3
Total	28	15	43

ACoA : anterior communicating artery, MCA bif : middle cerebral artery bifurcation, PCoA : posterior communicating artery, AChoA : anterior choroidal artery

Table 2. Clinical outcome of 35 poor-grade aneurysm patients by Hunt and Hess grade

Glasgow outcome scale	Pterional approach group		Eyebrow approach group		Total
	H-H Gr. IV	H-H Gr. V	H-H Gr. IV	H-H Gr. V	
Good recovery	3	0	4	0	7
Moderate disability	6	1	2	0	9
Severe disability	5	0	2	0	7
Vegetative	4	1	2	0	7
Death	2	2	1	0	5
Total	20	4	11	0	35

H-H : Hunt and Hess, Gr : Grade

Table 3. Clinical outcome of 35 poor-grade aneurysm patients by Fisher grade

Glasgow outcome scale	Pterional approach group		Eyebrow approach group		Total
	Fisher Gr. III	Fisher Gr. IV	Fisher Gr. III	Fisher Gr. IV	
Good recovery	0	3	0	1	4
Moderate disability	0	3	2	3	8
Severe disability	1	5	0	2	8
Vegetative	0	3	1	1	5
Death	2	7	0	1	10
Total	3	21	3	8	35

Gr : Grade

25 pterional approaches (Table 1, 2, 3). The ratio of male to female is 7:17. The age of patients ranged from 36 to 79 years (mean age, 57.3 years). Twenty patients were in H-H grade IV on admission and 4 in V. Three patients were grouped into Fisher grade III and 21 into IV according to initial brain computed tomography (CT) scans. The site of aneurysms were identified on preoperative angiography those were as follows : anterior communicating artery (ACoA) in 11 cases, bifurcation of middle cerebral artery (MCA bif) in 9, posterior communicating artery (PCoA) in 7, anterior choroidal artery (AChoA) in 1. Three patients who had multiple aneurysms underwent a single session craniotomy, and 1 patient did additional contralateral craniotomy for the treatment of contralateral aneurysm.

Eleven patients harboring 15 aneurysms underwent 12 eyebrow surgeries. Multiple aneurysms were identified in 4 patients. There were 4 males and 7 females, aged between 47 and 80 years (mean age, 61.4 years). On admission, all 11 patients were in H-H grade IV. Three patients were in Fisher grade III and 8 in IV. The site of aneurysms were as follows : ACoA in 7 cases, MCA bif in 1, PCoA in 5, AChoA in 2 cases (Table 1, 2, 3).

A total of 41 aneurysms in 35 patients were clipped by pterional approach or eyebrow surgery successfully. One patient harboring ruptured Acom aneurysm was converted to pterional approach following initial eyebrow approach due to severe brain edema. External ventricular drainage was performed in 6 patients of PAG, but 1 in ESG as preoperative management. However, the opening of lamina terminalis was done in 7 Acom aneurysms patients in ESG. Intraoperative transfusion was done in all patients of PAG, but not in ESG. Brain retraction was necessitated to operate patients in PAG, but not in ESG. Operation time was defined as the period of induction to wake-up from anesthesia. It ranged from 4.3 to 8.0 hours (mean duration 7.7 hours) in PAG and 3.2 to 4.5 hours (mean duration 4.1) in ESG. Premature ruptures occurred in 4 cases, 3 in PAG, 1 in ESG, and all of which were clipped successfully. The evidence of retraction injury or early postoperative infarction was seen on postoperative CT scans in 4 cases of PAG, but not in ESG cases.

Clinical outcome

The clinical outcome of early surgery among the total group of 35 patients were as follows (Table 2) : of 24 patients of PAG, good recovery showed in 3 patients, moderate disability in 7, severe disability in 5, persistent vegetative state in 5, death in 4 patients. Of 11 cases treated by early eyebrow surgery, good recovery showed in 4 case, moderate disability in 2, severe disability in 2, persistent vegetative state in 2, and death in 1. Overall favorable outcome showed 41.7% and 54.5%

in PAG and ESG, respectively. Favorable outcome of H-H grade IV in PAG showed 45.0%. Overall mortality rate was 14.3%.

Complications related to operation were as follows : in PAG, retraction injury or postoperative infarction in 4 cases, subdural hygroma in 1 case, while in ESG subdural hygroma in 3 cases, CSF leakage in 2. Hydrocephalus was developed in 7 cases of PAG and in 2 of ESG, respectively. Vasospasm occurred in 4 patients of PAG and 2 of ESG during the postoperative period and proved just clinically. As stated previously, all patients with vasospasm were treated with hypertensive, hypervolemic and hemodilution therapy, with outcome results as follows : Three patients died and one patient was in persistent vegetative state among 4 symptomatic vasospasm patients in PAG. All 2 patients in ESG were also in persistent vegetative state.

Discussion

Early surgery in poor grade aneurysm patients gets widespread acceptance as a general treatment modality to minimize the mortality and morbidity due to rebleeding and delayed ischemic complications^{3-5,15,16,20,21}.

Those surgeries in poor grade aneurysm patients were always done with conventional approach necessitating a standard craniotomy. With aneurysmal surgery by conventional pterional approach, generally the large craniotomy, brain retraction, complete sylvian dissection and long operation time would be so essential that the normal structure might be damaged occasionally. Additionally, the field angle view of pterional approach from the sylvian fissure to the bifurcation or proximal end of MCA might result in several procedure-related complications⁷⁻¹¹.

Thus it inspired a lot of neurosurgeons to discard the conventional approach and to explore the minimally invasive technique in the aneurysmal surgery^{1,2,12-14,17-19}. However, the literatures contained no reports about minimally invasive aneurysmal surgery using eyebrow incision in the patients with poor grade aneurysm. According to Jeon's article⁷, the supra-orbital rim approach via an eyebrow incision was reported about treating 27 anterior communicating artery aneurysms^{7,8}. Among them 3 patients of poor grade were treated with eyebrow surgery and favorable outcome was achieved in 2 patients.

In this study actually there were some problems to be solved in eyebrow surgery of poor-grade aneurysm patients. We had difficult access to the site of aneurysms, especially in the stage of initiation after superior orbital rim craniotomy mainly due to relatively small operative field, compared with that of pterional approach and brain edema. However, we could obtain space enough to access to the site of aneurysms if only opening of carotid cistern or lamina terminalis cistern was possible.

One of the key tactics was drainage of cerebrospinal fluid at initial stage, which make possible to perform all procedures under spontaneous brain retraction without any brain retractor. Sometimes we needed increased infusion of intravenous mannitol more than 50gm. Another key tactic was to increase head elevation to facilitate the approach to carotid cistern and decrease brain edema. At this time the key landmark was the optic nerve during approach in the anterior circulation aneurysms except MCA bifurcation aneurysm. Extraventricular drainage(EVD) was taken in 2 patients during eyebrow approach, in contrast with 8 during pterional approach. One patient who underwent extraventricular drainage for eyebrow approach was converted to standard pterional craniotomy, who had severe brain edema. During operation, neither brain retraction nor transfusion was necessitated. With respect to duration of operation, the mean time of eyebrow surgery was shorter than that of standard pterional approach so that it had some advantages in surgery of poor-grade aneurysm patients with old age and initially unstable vital state. With respect to outcome of surgery according to a favorable GOS, eyebrow approach group have performed better results than pterional approach group, especially in H-H IV patients.

Traditionally the clinical outcome for H-H grade IV and V patients presenting with aneurysmal SAH has been dismal. Since operation was considered dangerous in grade IV and V patients because of cerebral edema, increased ICP, and poor neurological status, many patients suffered potentially preventable but yet serious insults like intracranial hypertension, acute hydrocephalus and intracranial hemorrhage. Most literatures^{1,2,12,14,19)} have described the surgical outcomes and have either excluded all or included only a few poor graded patients. Excellent outcome in several literatures^{1,12,19)} was depended on selected and referred patients who have survived a period of preoperative conservative treatment, thus actually representing a small group of a large population of patients^{1,12,19)}. In this study 11 patients were excluded because of being dead before operation, not undertaking operation due to irreversible brain damage and delayed surgery. Furthermore only 11 among 35 patients were selected for eyebrow surgery.

Supraorbital CSF collection and subdural hygroma were common complications after eyebrow approach. The former could be prevented by tight closure of the dura and be overcome by lumbar drainage without exception. The latter occurred in 27% in this eyebrow surgery group, not stated in other literatures^{3,7,10,11)}. It is likely that the possible mechanism of subdural hygroma may be overdrainage of CSF or overuse of mannitol. It was also treated spontaneously in time. Among them, an 80-year-old patient underwent subduroperitoneal shunt. However, the craniotomy related complications such as infarction, hemorrhagic contusion, and subdural hematoma

did not occur, which are often shown in pterional craniotomy group.

The selection criteria of approach method was not definite in this study. However, ruptured aneurysm with intracerebral hematoma more than 10cc in amount, giant aneurysm, H-H grade V patients were excluded for treatment with eyebrow approach. And also Fisher grade IV on preoperative CT scan was seen in 72 % in eyebrow surgery group, in contrast 87% in pterional group. Mean age showed 61.4 in eyebrow surgery group, compared with 57.3 in pterional group.

There are no reports concerning early eyebrow surgery in poor-grade aneurysm patients so far. With respect to outcome of surgery according to GOS, eyebrow surgery group have performed better results than pterional group, especially in H-H IV patients. We accept the criticism that our series has too small to get the statistical significance. Our series may indicate that although eyebrow surgery had been performed only in the few selected patients, it could be applied to patients even with poor-grade aneurysmal SAH.

Conclusion

It is concluded that the clinical outcome of early and minimally invasive aneurysmal surgery using eyebrow incision in the selected patients with poor grade aneurysm of Hunt and Hess grade IV can be compatible with that of conventional pterional surgery.

References

1. Bailes JE, Spetzler RF, Hadley MN, Baldwin HB : Management morbidity and mortality of poor-grade aneurysm patients. *J Neurosurg* 72 : 559-566, 1990
2. Chyatte D, Fode NC, Sundt TM : Early versus late intracranial aneurysm surgery in subarachnoid hemorrhage. *J Neurosurg* 69 : 326-331, 1988
3. Dare AO, Landi MK, Lopes DK, Grand W : Eyebrow incision for combined orbital osteotomy and supraorbital minicraniotomy : application to aneurysm of the anterior circulation. *J Neurosurg* 95 : 714-718, 2001
4. Delashaw JB, Jane JA, Kassell NF : Supraorbital craniotomy by fracture of the anterior orbital roof. *J Neurosurg* 79 : 615-618, 1993
5. Hutchinson PJA, Power DM, Tripathi P, Kirkpatrick PJ : Outcome from poor grade aneurysmal subarachnoid hemorrhage-which poor grade subarachnoid hemorrhage patients benefit from aneurysm clipping? *Bri J Neurosur* 14 : 105-109, 2000
6. Jane JA, Park TS, Pobereskin LH, Winn HR, Butler AB : The supraorbital approach : technical note. *Neurosurgery* 11 : 537-542, 1982
7. Jeon BC, Chen SY, Zheng YR, Cho YW, Kwon KY : Superior orbital rim approach for anterior communicating artery aneurysm : a surgical series of 27 patients. *J Korean Med Sci* 18 : 556-572, 2003
8. Jeon BC, Cho YW : Minimally invasive aneurysmal surgery : concept and technique. *Kosin Medical Journal* 16 : 120-126, 2001
9. Jeon BC, Cho YW : Superior orbital rim approach to the anterior circulation aneurys : surgical technique. *J Korean Neurosurg Soc* 33 : 428-432, 2003
10. Jho HD : Orbital roof craniotomy via an eyebrow incision : a simplified anterior skull base approach. *Minim Invasive Neurosurg* 40 : 91-97, 1997
11. Ko Y, Yi HJ, Kim YS, Oh SH, Kim KM, Oh SJ : Eyebrow incision using tattoo for anterior fossa lesions : technical case reports. *Minim Invasive Neurosurg* 44 : 17-20, 2001
12. Laidlaw JD, Siu KH : Poor grade aneurysmal subarachnoid hemorrhage : outcome after treatment with urgent surgery. *Neurosurgery* 53 : 1275-

- 1282, 2003
13. Lee CW, Kim YS, Ha HG, Park MS, Lee JS : A simplified skull base approaches for anterior aneurysms : superolateral orbital craniotomy and orbital roof craniotomy via an eyebrow incision. *J Korean Neurosurg* 31 : 305-310, 2002
 14. Roux PDL, Elliott P, Newell DW, Grady MS, Winn HR : Predicting outcome in poor-grade patients with subarachnoid hemorrhage : a retrospective review of 159 aggressively managed cases. *J Neurosurg* 85 : 39-49, 1996
 15. Sanchez MA, Calatayud PB, Vilella MM, Palmasilva JF, Carachure IJ, Gomezaguilar JM, et al : Transciliary subfrontal craniotomy for anterior skull base lesions. *J Neurosurg* 91 : 892-896, 1999
 16. Schwartz MS, Anderson GJ, Horgan MA, Kellogg JX, Mcmenomey SO, Delashaw JB : Quantification of increased exposure resulting from orbital rim and orbitozygomatic osteotomy via the frontotemporal transylvian approach. *J Neurosurg* 91 : 1020-1026, 1999
 17. Shanno G, Maus M, Bilyk J, Schwartz S, Savino P, Simeone F, et al : Image-guided transorbital roof craniotomy via a suprabrow approach : a surgical series of 72 patients. *Neurosurgery* 48 : 559-568, 2001
 18. Shidoma M, Oda S, Shibata M, Tominaga J, Kittaka M, Tsugane R : Results of early surgical evacuation of packed intraventricular hemorrhage from aneurysm rupture in patients with poor-grade subarachnoid hemorrhage. *J Neurosurg* 91 : 408-414, 1999
 19. Song JN, Huh JT, Cho CM : Management outcome of poor grade patients with aneurysmal subarachnoid hemorrhage. *J Korean Neurosurg Soc* 31 : 315-330, 2002
 20. Steiger HJ, Elsaesser RS, Stummer W, Uhl E : Transorbital keyhole approach to anterior communicating artery aneurysms. *Neurosurgery* 48 : 347-352, 2001
 21. Zuniga RR, Velazquez H, Barajas MA, Lopez R, Sanchez E, Trejo S : Trans-supraorbital approach to supratentorial aneurysms. *Neurosurgery* 51 : 125-131, 2002

Commentary

The authors seem to present the validity of their surgical approach such as superior orbital rim or superolateral orbital rim craniotomy via an eyebrow incision applied in ruptured aneurysms of poor grade. They concluded that the eye brow approach for Hunt and Hess grade IV aneurysms can be compatible with pterional approach. But, this is not true for the authors and it is misleading. Learning curve is very important in brain surgery especially in the surgery of ruptured aneurysms. The safety limit of aneurysm surgery is very narrow. Fatal disaster happens in a flash if the operating surgeons do not have perfect preoperative three dimensional orientations of the aneurysms. These are learned,

most importantly, through personal surgical experience.

The representing surgeon of the authors group may not be so experienced in aneurysm surgery. He made 16% (4/24) of premature rupture and made another 16% (4/24) of surgery related postoperative infarction performing pterional approach for ruptured aneurysms of Hunt and Hess grade IV and V. Regardless of the grade, complicated premature ruptures rarely occur in the surgery performed with experienced hands. It does not occur because they never approach aneurysms before the proximal control is guaranteed. It is hard to understand why the authors made so high percentage of postoperative infarction performing the pterional approach. The main cause of surgery related postoperative infarction in aneurysm surgery is the occlusion of the arterial branch in the clip or stenosis of the parent artery by the clip placement rather than retraction injury. Whichever of the causes, surgery related postoperative infarction must not be made.

Brain should not be retracted during surgery in every occasion. The use of brain retractor is for holding rather than retracting. Experienced brain surgeons never retract the brain as to make infarction after surgery. Retraction of the brain is not necessary for them because they make the brain slack before manipulation of the brain with every available method. Likewise, slacking of the brain is the gold standard in aneurysm surgery especially in the poor grade patents. If the slack brain is not attained with every possible method, the operation must be stopped because it is a morbid condition that can not be overcome by surgery. The representing surgeon of the authors group is recommended to finish a basic learning curve of aneurysm surgery before comparing different surgical method to approach ruptured aneurysm. Aneurysm surgery must be started by pterional approach and maintained until one can be comfortable enough to manipulate the complex situations of aneurysm surgery by two hands only without the help of brain holding retractor through a smaller craniotomy.

Han Kyu Kim, M.D.

Department of Neurosurgery, Eulji University Hospital