Immediate Surgery Reduces Mortality in Deeply Comatose Patients with Spontaneous Cerebellar Hemorrhage

Kiyoyuki YANAKA^{*,**}, Kotoo MEGURO^{*}, Keishi FUJITA^{*}, Kiyoshi NARUSHIMA^{*},
and Tadao NOSE^{**}

^{*}Department of Neurosurgery, Tsukuba Medical Center, Tsukuba, Ibaraki; ^{**}Department of Neurosurgery, Institute of Clinical Medicine, University of Tsukuba, Tsukuba, Ibaraki

Abstract

Cerebellar hemorrhage is regarded as a neurosurgical emergency. However, patients with deteriorating consciousness are very likely to die irrespective of the choice of therapy, and it is not clear if surgical intervention can benefit patients in a deeply comatose state. We reviewed 20 patients with a Glasgow Coma Scale score of 3 at admission to ascertain the salvage rate and determine the prognostic factors. Four patients who were managed conservatively died within 2 days. Sixteen patients underwent decompressive suboccipital craniectomy and hematoma evacuation. At discharge, three patients were moderately disabled, three were severely disabled, four were persistently vegetative, and six had died. The overall mortality was 50%. The mean interval between the onset of symptoms and the operation was 1.67 ± 0.29 hours in patients with favorable outcome, and significantly longer at 2.42 ± 0.49 hours in patients with an unfavorable outcome ($p = 0.025$). Immediate evacuation of the hematoma reduces morbidity and mortality even in deeply comatose patients, especially if the time interval between the onset and surgery is within 2 hours.

Key words: cerebellum, coma, hemorrhage, stroke, surgical treatment

Introduction

Ischemic and hemorrhagic stroke is the third leading cause of death in the United States and Japan. The morbidity and mortality of intracerebral hemorrhage remain unacceptably high despite diagnostic and therapeutic advances in recent years.³⁾ Cerebellar hemorrhage represents about 10% of all intracerebral hemorrhages.^{9,11)} The symptomatology of this lesion is related to the rapidity of bleeding, the size of the hematoma, compression of the brain stem, upward cerebellar herniation and tonsillar herniation, and the development of hydrocephalus.¹¹⁾ Some patients present in a coma and die rapidly, whereas others follow a more gradual course.¹⁷⁾

Cerebellar hemorrhage causing stupor and signs of brain stem compression is regarded as a neurosurgical emergency because fatality rates approach 100% without treatment.^{1,5,7,9,14,25)} The life-saving nature of the decompressive suboccipital

craniectomy and hematoma evacuation is widely recognized.^{4,9,12,14)} Various criteria have been proposed for surgical treatment, but most authors agree that a small hematoma can be treated conservatively, whereas a large one requires surgical treatment.¹²⁾ However, patients with a deteriorating level of consciousness are very likely to die irrespective of the choice of therapy,^{4,5,7,10,15,18)} and whether early hematoma evacuation will benefit patients in a deeply comatose state is unclear.^{5,12,15,23)} The outcome is poor (mortality 88.9–100%) for deeply comatose patients and surgery may offer no benefit,^{1,2,5,8,12–14,20,22,23)} so most deeply comatose patients are managed conservatively.^{5,12)} Thus, the question remains as to what the outcome might have been if all deeply comatose patients underwent surgical treatment.

The current study reviewed patients with poor neurological grades who underwent surgery to ascertain the salvage rate and determine the prog-

Received November 2, 1999; Accepted February 24, 2000

Author's present address: K. Yanaka, M.D., Department of Neurosurgery, Institute of Clinical Medicine, University of Tsukuba, Tsukuba, Ibaraki, Japan.

nostic factors.

Methods

We treated 74 patients with spontaneous cerebellar hemorrhage confirmed by computed tomography (CT) between April 1989 and September 1998. Twenty patients (16 males and 4 females) aged 38 to 77 years (mean 59.3 years) were deeply comatose (Glasgow Coma Scale [GCS] score of 3) at admission and were retrospectively reviewed. The remaining 54 patients with GCS score of 4 or higher at admission were excluded, including three patients with cerebellar arteriovenous malformation.

Nineteen of the 20 patients were transferred to our hospital directly within 2 hours of the onset of symptoms and the other patient was referred from another hospital within 8 hours. All patients were resuscitated in the emergency room, and neurological and radiological examinations were carried out immediately. After the initial CT examination, mannitol was administered. Although we intended to perform routine decompressive craniectomy and hematoma removal even in patients with cerebellar hemorrhage in deep coma as a general rule, the

surgical procedure was abandoned if the patient's vital signs were unstable (e.g. systolic blood pressure <80 mmHg). Sixteen patients (80%) were treated within 3 hours of the onset of symptoms. Each patient underwent decompressive suboccipital craniectomy and hematoma evacuation. Ventricular drainage was not immediately performed for associated hydrocephalus. The remaining four patients (20%) including the patient who was referred within 8 hours of the onset of the ictus were judged inoperable because their blood pressure was unstable despite dopamine administration.

The level of consciousness and the outcome were assessed using the GCS at admission and the Glasgow Outcome Scale (GOS) at discharge. CT findings including the maximum diameter of the cerebellar hematoma, obliteration of the perimesencephalic cistern, and presence of hydrocephalus were recorded. The degree of obliteration of the perimesencephalic cistern was graded as normal cistern or compressed/absent cistern.²³⁾ Hydrocephalus was measured by the bicaudate index.²²⁾ Patient profiles are summarized in Table 1. To determine the prognostic factors, surgically treated patients were divided into two groups according to

Table 1 Clinical characteristics of the patients

Case No.	Age	Sex	Circulation/ respiration disturbance	Pupillary abnormality	Interval between onset and surgery (hrs)	Hematoma size (mm)	Hydro- cephalus	PMC abnor- mality	Hospitalized period (days)	Glasgow Outcome Scale
Surgically treated										
Group I (favorable outcome)										
1	55	M	C, R	bilaterally dilated	1.5	60	+	+	96	MD
2	75	F		anisocoria	1.5	70	+	+	106	MD
3	48	M	C, R	bilaterally dilated	2	65	+	+	116	MD
Group II (unfavorable outcome)										
4	64	M		anisocoria	1.5	70	+	+	140	SD
5	58	M		anisocoria	2	65	-	+	110	SD
6	67	M		anisocoria	2	70	+	+	61	SD
7	56	M		bilaterally dilated	2	50	-	+	61	PVS
8	63	F	R	bilaterally dilated	2.5	60	+	+	78	PVS
9	70	M	R	bilaterally dilated	2.5	65	+	+	85	PVS
10	76	M	R	bilaterally dilated	3	70	+	+	104	PVS
11	48	M		anisocoria	2	50	+	+	37	D
12	66	M	R	bilaterally dilated	2.5	65	+	+	45	D
13	38	M		anisocoria	2.5	60	+	+	111	D
14	44	M	R	bilaterally dilated	3	70	+	+	155	D
15	47	F	C, R	bilaterally dilated	3	50	+	+	8	D
16	52	M		anisocoria	3	40	+	-	14	D
Conservatively managed										
17	58	M	C, R	bilaterally dilated	NA	60	+	+	1	D
18	52	M	C, R	bilaterally dilated	NA	70	+	+	1	D
19	77	M	C, R	bilaterally dilated	NA	60	+	+	2	D
20	72	F		bilaterally dilated	NA	60	+	+	2	D

C: circulatory arrest, D: death, MD: moderate disability, NA: not applicable, PMC: perimesencephalic cistern, PVS: persistent vegetative state, R: respiratory arrest, SD: severe disability.

the GOS score: Group I (good recovery and moderate disability, $n = 3$), and Group II (severe disability, persistent vegetative state, and dead; $n = 13$).

All values are expressed as the mean $\pm$ SD. Comparisons between the two groups were made using the single factor analysis of variance. Analysis of discrete values used the chi-square test with Yates' rectification. Differences were considered significant at $p < 0.05$.

Results

All 20 patients had a history of hypertension. The level of consciousness of all patients deteriorated abruptly to deep coma within 1–2 hours after the onset of symptoms. At admission, all 20 patients showed signs of brain stem compression: six (30%) patients had cardiopulmonary arrest, and 11 (55%) had respiratory dysfunction. All 20 patients showed pupillary abnormality: seven patients had anisocoria and 13 patients had dilated pupils bilaterally. Four patients who were not treated surgically died within 2 days of the onset of symptoms. Three patients (15%) recovered from deep coma with moderate disability; they exhibited a slight ataxic gait, but could walk without assistance at the time of discharge. Two patients had double vision and slight speech disturbance, and one showed right lower facial weakness, tongue deviation, and difficulty in swallowing. However, their cognitive functions were within normal limits, and they were independent at the time of discharge. Two patients (Cases 1 and 3) returned to work and their capacity for work was at the same level. One patient (Case 2) did not restart working after discharge because of his age (75 years), but his social and leisure activities, and interpersonal relationships were at the same level as before admission. Three patients (15%) were severely disabled, four (20%) were persistently vegetative at discharge, and six (30%) died. Therefore, the overall mortality of the deeply comatose patients was 50%.

The mean interval between the onset of symptoms and surgery was 2.28 ± 0.55 hours in all patients, 1.67 ± 0.29 hours in Group I, and 2.42 ± 0.49 hours in Group II. The interval for Group I was significantly shorter than for Group II ($p = 0.025$). The mean age was 59.3 ± 11.4 years for all patients, 59.3 ± 14.0 years for Group I, and 57.6 ± 11.3 years for Group II. The mean hospitalization time was 66.7 ± 50.4 days for all patients, 106.0 ± 10.0 days for Group I, and 77.6 ± 45.6 days for Group II. CT findings showed the mean hematoma size was 61.3 ± 9.2 mm in all patients, 65.0 ± 5.0 mm in Group I, and 60.4 ± 9.9 mm in Group II. There were no sig-

nificant differences in age, hospitalization time, and hematoma size between Groups I and II. Eighteen (90%) of 20 patients had obstructive hydrocephalus, and 19 (95%) had obliteration of the perimesencephalic cistern. There were no significant differences in these factors between Groups I and II.

Discussion

The clinical course must be considered to determine the surgical indication for severely ill patients. Some patients suffer sudden onset with rapid deterioration of consciousness and die within 24–48 hours.¹⁶⁾ Others also have a sudden onset, but remain awake or responsive for several days.²⁰⁾ If the brain stem is severely injured by rapid and massive bleeding, the patient will show a fulminant clinical course and die shortly. Some patients in a profound coma preoperatively have made a useful recovery with prompt decompression,^{4,14)} but most such patients became comatose gradually. In contrast, all of our patients showed a fulminant clinical course and fell into deep coma within 1–2 hours of the onset of symptoms. To determine the appropriate treatment it is essential to differentiate neurological deficits caused by the bleeding or by the associated hydrocephalus.⁶⁾ The consciousness level of some previous cases may have been influenced by hydrocephalus, but all of our cases represent brain stem injury caused by the bleeding. Prompt surgical intervention to evacuate cerebellar hemorrhage has been emphasized even for comatose patients,^{4,9,10,14)} but little evidence is available to support the efficacy of treatment. Surgery for deeply comatose patients is thought to be contraindicated, but 15% of critically ill patients in the current study showed a favorable outcome after immediate hematoma evacuation despite the fulminant clinical course. Although the number of patients who showed a favorable outcome was small, they returned to an independent life.

Management of patients presenting with spontaneous cerebellar hemorrhage depends on several factors: level of consciousness,^{1,12,14,15,17–19,21–24)} neurological course,^{2,5,7,22)} size of the hematoma,^{12,13,19,25)} obliteration of the perimesencephalic cistern,^{6,23,24)} and the presence of obstructive hydrocephalus.^{17,19)} Brain stem damage should be detected preoperatively to determine the management method. Measurement of auditory brain stem responses is a widely accepted method to investigate brain stem functions, but there was no time to perform this examination in such patients. Previously, we investigated the magnetic resonance imaging findings of the brain stem postoperatively, and found that high

signal intensity in the brain stem was a significant factor for determining poor prognosis in patients with spontaneous cerebellar hemorrhage.²⁴⁾ The present study tried to determine the prognostic factor preoperatively. In this series, the level of consciousness and neurological course over time was very similar in patients with good and poor outcomes. In addition, there were no significant differences in the hematoma size, the presence of hydrocephalus, and obliteration of the perimesencephalic cistern. Multivariate analysis should be performed to determine the prognostic factors in the clinical settings. However, this study revealed that only the delay from the onset of symptoms to surgery was of therapeutic importance. All patients underwent surgical treatment within 3 hours after the onset of symptoms, which is a shorter interval than that of previously reported cases.^{4,14)} There was only one hour difference between patients with good and poor outcomes, suggesting that a single hour delay could result in an unfavorable outcome. The final outcome is thought to be dependent upon the anatomical damage to the brain stem.¹¹⁾ Irreversible brain stem injury might occur during this one hour period, so immediate surgical intervention should be carried out to increase the potential for a favorable outcome.

The small sample size, and retrospective and non-random character of the study do not permit the establishment of firm conclusions. However, we tried to perform surgical procedures for all patients initially, but we had to abandon surgery for four patients because their vital signs were unstable in spite of the resuscitation procedures. The condition of these conservatively managed patients could be considered as essentially brain dead. The remaining 16 patients underwent the same surgical procedures, and three treated within 2 hours showed a favorable outcome. Therefore, if the vital signs are stable after resuscitation, and if the surgical procedure can be started within 2 hours after the onset of the symptoms, patients should be treated surgically irrespective of neurological signs such as dilated pupils. We conclude that deep coma of very recent onset is not a contraindication for surgery, and immediate surgical relief of brain stem compression is the most important factor for a major reduction in mortality in patients with spontaneous cerebellar hemorrhage.

Acknowledgments

The authors would like to thank Stephen R. Spellman, B.A. of Department of Neurosurgery, University of Minnesota, Minneapolis, Minnesota,

U.S.A. for his assistance in preparation of this manuscript.

References

- 1) Auer L, Auer T, Sayama I: Indications for surgical treatment of cerebellar haemorrhage and infarction. *Acta Neurochir (Wien)* 79: 74-79, 1986
- 2) Brennan RW, Bergland RM: Acute cerebellar hemorrhage: Analysis of clinical findings and outcome in 12 cases. *Neurology* 17: 527-532, 1977
- 3) Camarata PJ, Heros RC, Latchaw RE: "Brain attack": The rationale for treating stroke as a medical emergency. *Neurosurgery* 34: 144-158, 1994
- 4) Chin D, Carney P: Acute cerebellar hemorrhage with brain stem compression in contrast with benign cerebellar hemorrhage. *Surg Neurol* 19: 406-409, 1983
- 5) Da Pian R, Bazzan A, Pasqualin A: Surgical versus medical treatment of spontaneous posterior fossa hematomas: A cooperative study on 205 cases. *Neurol Res* 6: 145-151, 1984
- 6) Donauer E, Loew F, Faubert C, Alesch F, Schaan M: Prognostic factors in the treatment of cerebellar haemorrhage. *Acta Neurochir (Wien)* 131: 59-66, 1994
- 7) Fisher CM, Picard EH, Polak A: Acute hypertensive cerebellar hemorrhage: Diagnosis and surgical treatment. *J Nerv Ment Dis* 140: 38-57, 1965
- 8) Heiskanen O: Treatment of spontaneous intracerebral and intracerebellar hemorrhages. *Stroke* 24 (Suppl I): I-94-95, 1993
- 9) Heros RC: Current concepts of cerebrovascular disease — Cerebellar hemorrhage and infarction. *Stroke* 13: 106-109, 1982
- 10) Heros RC: Surgical treatment of cerebellar infarction. *Stroke* 23: 937-938, 1992
- 11) Kaufman HH: Spontaneous intraparenchymal brain hemorrhage, in Wilkins RH, Rengachary SS (eds): *Neurosurgery*, ed 2. New York, McGraw-Hill, 1996, pp 2567-2585
- 12) Kobayashi S, Sato A, Kageyama Y, Nakamura H, Watanabe Y, Yamaura A: Treatment of hypertensive cerebellar hemorrhage — Surgical or conservative management? *Neurosurgery* 34: 246-251, 1994
- 13) Little JR, Tubman DE, Ethier R: Cerebellar hemorrhages in adults. Diagnosis by computerized tomography. *J Neurosurg* 48: 575-579, 1978
- 14) Lui TN, Fairholm DJ, Shu TF, Chang CN, Lee ST, Chen HR: Surgical treatment of spontaneous cerebellar hemorrhage. *Surg Neurol* 23: 555-558, 1985
- 15) Luparello V, Canavero S: Treatment of hypertensive cerebellar hemorrhage — Surgical or conservative management? *Neurosurgery* 37: 552-553, 1995 (letter)
- 16) McKissock W, Richardson AE, Walsh L: Spontaneous cerebellar hemorrhage: A study of 34 consecutive cases treated surgically. *Brain* 83: 1-9, 1960
- 17) Mezzadri JJM, Otero JM, Ottino CA: Management of 50 spontaneous cerebellar haemorrhages. *Impor-*

- tance of obstructive hydrocephalus. *Acta Neurochir (Wien)* 122: 39-44, 1993
- 18) Mohadjer M, Eggert R, May J: CT-guided stereotactic fibrinolysis of spontaneous and hypertensive cerebellar hemorrhage: Long-term results. *J Neurosurg* 73: 217-222, 1990
  - 19) Nose T, Maki Y, Ono Y, Yoshizawa T, Tsuboi K: [Computed tomography in hypertensive cerebellar hemorrhage]. *No Shinkei Geka* 9: 1409-1415, 1981 (Jpn, with Eng abstract)
  - 20) Ott KH, Kase CS, Ojemann RG, Mohr JP: Cerebellar hemorrhage: Diagnosis and treatment. A review of 56 cases. *Arch Neurol* 31: 160-167, 1974
  - 21) Suzuki A, Yasui N: [Surgical indication of hypertensive cerebellar hemorrhage]. *Neurol Med Chir (Tokyo)* 27: 505-510, 1987 (Jpn, with Eng abstract)
  - 22) van der Hoop RG, Vermeulen MV, van Gijn J: Cerebellar hemorrhage: Diagnosis and treatment. *Surg Neurol* 29: 6-10, 1988
  - 23) van Loon J, Calenbergh FV, Goffin J, Plets C: Controversies in the management of spontaneous cerebellar haemorrhage. A consecutive series of 49 cases and review of the literature. *Acta Neurochir (Wien)* 122: 187-193, 1993
  - 24) Yanaka K, Meguro K, Fujita K, Narushima K, Nose T: Postoperative brainstem high intensity is correlated with poor outcome for patients with spontaneous cerebellar hemorrhage. *Neurosurgery* 45: 1323-1328, 1999
  - 25) Yoshida N, Kagawa M, Takeshita M, Kitamura K: [Grading and operative indication for hypertensive cerebellar hemorrhage]. *No Shinkei Geka* 14: 725-731, 1986 (Jpn, with Eng abstract)

Address reprint requests to: K. Yanaka, M.D., Department of Neurosurgery, Institute of Clinical Medicine, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8575, Japan.

Commentary

The authors have carefully analyzed a retrospective series of twenty deeply comatose patients with spontaneous cerebellar hemorrhage. They have demonstrated that with prompt surgical evacuation a small percentage of patients will make a rewarding recovery. This article illustrates several important points. First of all, it is clear that only a small percentage of patients will recover favorably with rapid surgical evacuation of a cerebellar hemorrhage (15% in this series). A larger number of patients will be left with severe disability or remain in a persistent vegetative state as a result of this aggressive surgical management (35% in this series). Rapid evacuation of the hematoma appears to be the only factor influencing the likelihood of a good recovery in this series. Although the series is small, particularly for the group

of patients with a favorable outcome, this study provides some guidelines when counseling a patient's family and making decisions regarding the likelihood of success in dealing with this unfortunate group of patients.

Daniel L. BARROW, M.D.
Department of Neurosurgery
Emory University School of Medicine
The Emory Clinic
Atlanta, Georgia, U.S.A.

This report is of considerable interest to practicing neurosurgeons. It confirms what most have thought intuitively, that the chances of at least surviving a spontaneous cerebellar hematoma are better with emergency evacuation, preferably within two hours of onset, even in patients with bilaterally dilated pupils and respiratory arrest. A favorable outcome (the description of Cases 1, 2 and 3 in the Results section inclines one to describe them as "good recovery" rather than moderate deficit) was seen in nearly one fifth of the total of operated patients, and in three of the eight operated inside two hours.

Two caveats should be kept in mind:

1. In most centers around the world, surgery with such a short time interval is not usually possible. In our situation here, one would more or less have to be physically inside the hospital at the time of onset. This is unfortunate, since even with these small numbers, the interval to surgery was significantly less in the three with favorable outcomes.
2. In spite of those three, the overall outcome of the group remained dismal. Hospital stays were very long in all the survivors and in many who eventually died. I have doubts concerning the cost effectiveness and ethics of operating at all on these patients; however, when the results of surgery within two hours are looked at separately, a recovery in three out of eight to the point of being able to resume a previous occupation or lifestyle (including one 75 years old) does seem to justify this ultra-early surgery in this group.

Nicholas W. C. DORSCH, M.D.
Department of Surgery
Westmead Hospital
Sydney, Australia

A large cerebellar hemorrhage causing stupor and signs of brain stem compression is regarded as a neurosurgical emergency, and decompressive suboccipital craniectomy and hematoma evacuation has been widely performed. However, selection or timing for acceptable surgical treatment are not clear in patients with deeply comatose state. The authors reviewed 16 patients who were comatose (GCS 3) and

were aggressively treated surgically within 3 hours after the onset, and conclude that immediate evacuation of the hematoma reduces mortality and morbidity even in deeply comatose patients, especially if the time interval between the onset and surgery is within 2 hours. However, in this series, the factors affecting degree of functional recovery after surgery (Groups I and II) have not been presented clearly.

I think that every neurosurgeon has experienced a few cases who were in a similar clinical category and had excellent results after emergency surgery. Judging from our experiences, the results of this study seems to be reasonable and practical, but more detailed investigations will be required to clarify the different clinical factors suggesting postoperative function. The authors also presented the significance of preoperative evaluation of brain stem lesions and function by MR imaging and auditory brain stem response, although they were canceled in this series to perform surgery more quickly. I believe that these examinations will be necessary, if emergency surgery can be established as a completely reliable method. We are also interested in the difference of location and extension of hematoma, and degree of intracranial fourth ventricle hemorrhage. I expect that more detailed investigations will be continued to assess the postoperative morbidity.

Shunro ENDO, M.D.

Department of Neurosurgery

Toyama Medical and Pharmaceutical University
Toyama, Japan

The authors retrospectively investigated 20 patients with spontaneous cerebellar hemorrhage and Glasgow Coma Scale score of 3 at admission and concluded that immediate evacuation of the hematoma, especially if the time interval between the onset and the surgery was within two hours, reduced morbidity and mortality.

Considering the high prevalence of intracerebral hemorrhage (ICH), randomized clinical therapeutic trials are surprisingly very few and proven benefit for surgery to remove an ICH is lacking.¹⁾ The American Heart Association Stroke Council proposed guidelines concerning cerebellar hemorrhage more than 3 cm in diameter of surgical removal as soon as possible with low levels of evidence (grade C recommendation¹⁾). They also stated that ultra-early removal of ICH is promising but untested (no recommendation).¹⁾

The authors propose immediate surgical decompression for all physically stable but moribund patients with cerebellar hemorrhage irrespective of neurological condition only when surgical procedures can be started within two hours after the onset of the symptoms. The key point of this issue is detection of

reversible brain stem dysfunction caused by increased infratentorial intracranial pressure. Other exclusion criteria such as episode of anoxia, signs of caudal brain stem dysfunction and electrophysiological evaluation should be taken into consideration to conduct future prospective trials aiming at a higher level of evidence.

Reference

- 1) Broderick JP, Adams HP Jr, Barsan W, Feinberg W, Feldmann E, Grotta J, Kase C, Krieger D, Mayberg M, Tilley B, Zabramski JM, Zuccarello M: Guidelines for the management of spontaneous intracerebral hemorrhage: A statement for healthcare professionals from a special writing group of the Stroke Council, American Heart Association. *Stroke* 30(4): 905-915, 1999

Yoshiaki SHIOKAWA, M.D.

Department of Neurosurgery

Kyorin University School of Medicine
Mitaka, Tokyo, Japan

Spontaneous cerebellar hemorrhage becomes a life threatening condition when rapid consciousness deterioration and signs of brain stem compression occurs. Immediate decompression procedure is recognized as the only choice of treatment for this devastating situation. However, the correlation between clinical outcome and the time interval between the onset of hemorrhage and surgery has rarely been investigated. In this article, the authors analyzed 20 patients with cerebellar hemorrhage and an initial Glasgow Coma Scale score of 3. Their results revealed all the patients with a favorable outcome had received surgery within 2 hours after the onset of hemorrhage. Thus, the authors concluded that early surgery (within 2 hours of the onset of hemorrhage) is critical for the patient's outcome. Accordingly, the emphasis here is clearly on the amount of time between onset of hemorrhage and surgery. However, such results are masked when the patients are compared according to the successfulness of the treatment. Furthermore, when the comparison is divided by degree of outcome, only 3 patients fell into Group I, as compared to 13 in Group II. Yet, if the groups were divided as received surgery with 2 hours of onset, and after 2 hours of onset, not only are the subjects more evenly divided for comparison, but the results are still maintained with only two outliers for the previous group, and places the emphasis on the major findings relating to time of surgery. Further research with a larger subject pool may help to further support these results.

Yong-Kwang TU, M.D.

Department of Neurosurgery

National Taiwan University

Taipei, Taiwan, R.O.C.