

Stereotaxic Evacuation and Urokinase Treatment of Hypertensive Intracerebral Hematomas

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고혈압성 뇌출혈에 대한 뇌정위 및 Urokinase 치료

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1995년 1월부터 1996년 2월까지 본 동대문병원 신경외과에 고혈압성 뇌출혈로 입원한 38명의 환자에 대하여 ZD(Zamorano-Dujovny) 기구를 이용하여 혈종을 제거하고 Urokinase 배액을 하였다.

수술후 합병증으로는 재출혈이 3례(7%)였고 이는 초기사용으로인한 수기미숙, 수술후 고혈압치료 실패로 보이며 뇌농양은 3례(7%)로 Urokinase 배액과 관련된 합병증으로 사료되었다. 사망은 6례(15%)로 2례는 재출혈, 4례는 폐염에 의한 것이었다. 13개월에 걸쳐 38례를 치료한 결과 비록 짧은 기간, 적은 레이지만 뇌전산화 단층촬영에 의한 뇌정위적 혈종제거 및 Urokinase배액술은 수술조작이 간단하고 안전하며, 국소마취하에서 뇌조직 건인없이 완전히 혈종제거가 가능한바 고령이나 고위험도의 환자 및 응급치료에 장점이 될 수 있다.

KEY WORDS : Stereotaxic evacuation · Urokinase · Hypertensive intracerebral hemorrhage.

Introduction

Stroke is the third leading cause of death in Korean adult. Hypertensive intracerebral hemorrhage is the cause of 8 to 13 percent of strokes and 15 to 20 percent of deaths due to strokes in the United States¹⁾.

There are two purposes for actually removing hematomas : to preserve life and to maximize recovery of function. In 1978, Backlund and von Holst²⁾ proposed a new principle of stereotaxic subtotal removal of intracerebral hematomas in which a special instrument with a manadrel-like Archimedes screw inside a cannula is used to destroy and remove dense

clots. Together with the proliferation of computed tomography guided stereotaxic systems, there has been a rapid increase in stereotaxic operation, there has been a rapid increase in stereotaxic operations for intracerebral hematomas³⁾⁴⁾⁵⁾.

Stereotaxic system was also much developed. We used the ZD system(Fischer, USA) for operation from Jan 95. In this paper, we describe the operative technique and the result of stereotaxic evacuation of hypertensive intracerebral hemorrhage.

Clinical Materials and Methods

From Jan, 95 to Feb, 96, 38 patients with hy-

pertensive hemorrhage were admitted to our Dong Dae Moon Neurosurgical institute. Patients ranged in age from 37 to 82 years(mean age : 60 years) : 18 patients were male, and 20 were female(Table 1,2). The most critical test for the investigation was CT for initial diagnosis and for surgical planning. The presence of primary intracranial lesions, including tumors and congenital vascular abnormalities, were excluded. The grading scheme based on level of consciousness was classified according to Kanaya and Kuroda⁷(Table 3).

The estimated volume of the hematoma on CT was 15 to 72ml. The aspiration of the hematoma was performed 7 to 36 hours after ictus. The stereotaxic apparatus was a ZD stereotaxic system. Aspiration target was calculated with a computer.

An outcome grading scheme has been developed with scores of activity of daily living(ADL)(Table 4)

Table 1. Age distribution

Age	No. of patients
<30	0
31 - 40	2
41 - 50	2
51 - 60	17(44%)
61 - 70	13(34%)
>71	4
Total	38

Table 2. Sex distribution

Sex	No. of patients
Male	18(47%)
Female	20(53%)
Total	38

Table 3. Neurologic grades for hypertensive intracerebral hematoma

Grade	Criteria*	No. of patients
1	Alertness or confusion	4
2	Somnolence	12(31%)
3	Stupor	14(36%)
4a	Semi-coma without herniation signs	5(13%)
4b	Semi-coma with herniation signs	2
5	Deep coma	1

*Herniation signs : 1) Uni- or bilateral mydriasis(over 5mm) and no reaction to light, or
2) Uni- or bilateral decorticate or decerebrate rigidity.

on the postoperative 6 months. however, we can't evaluate the score because of the short follow-up period, and than estimate the result in hematoma removal.

Preoperative Calculations of Lesions

Preoperative CT scanning was used to analyze the size and location of the hematoma and its CT density, the degree of brain edema, the presence of mass effect, and whether there was penetration of blood into the ventricles. The volume of the hematoma was estimated from CT scans in two ways : a planimetric method was used to calculate the hematoma area and depth on each scan, so as to establish the total volume of the hematoma from all cuts on which it appears, and by estimating the volume of the hematoma as the volume of an ellipsoid using the following formula :

$$V = \frac{4}{3} \pi abc$$

The CT slice with the largest image of the hematoma was determined the target point which calculated with a ancillary computer for the introduction of the cannula(Fig. 2).

We usually choose a point 1 to 2 cm posterior to the center of the hematoma, assuming that during stereotaxic aspiration with the patient in the supine position the pieces of clot will sink to the cannula by force of gravity.

Operative Technique

The patient is placed in a supine position with his

Table 4. Code for postoperative evaluation of patients

Code*	Description
ADL1	Well(full work)
ADL2	Minimal disability(self-sufficient)
ADL3	Partial disability(partially self-sufficient)
ADL4	Total disability(bedridden)
ADL5	Vegetative
Died	

*ADL=activity of daily living

head on a special headrest and fixed in a stereotaxic frame under the local anesthesia.

A burr hole, 25mm in diameter, is made close to the right or left coronal suture, and the dura is incised. The stereotaxic apparatus is attached to the skull, and the aspiration device is positioned in the burr hole.

The aspiration cannula with the first attachment inside is introduced into the selected target in the hematoma. After the target point is reached, the attachment is removed from the cannula and is replaced by a catheter. At this stage, a test aspiration using an ordinary

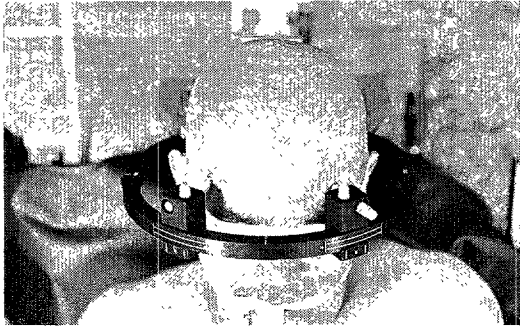


Fig. 1. View of the operative set-up and the device for stereotaxic evacuation of intracerebral hematomas is shown assembled.

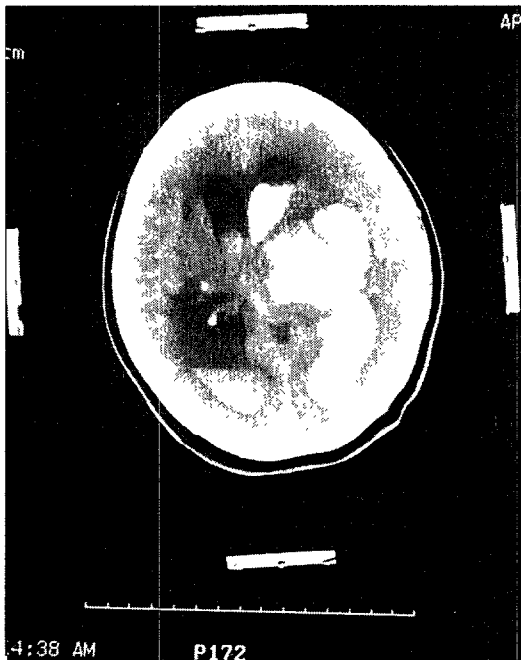


Fig. 2. The CT slice with the largest image of the hematoma was determined the target point.

syringe drew back liquid blood in our cases. Aspiration power is below 150mmHg, usually 70mmHg in clot form and 20 to 40mmHg in liquified blood. After the completion of aspiration, a drainage tube with a 3mm outer diameter is inserted toward the target point and 6000 units of urokinase dissolved in 3ml of physiological saline is injected through the tube every 6 hours after the operation to liquefy the residual hematoma. The drainage tube is removed on the postoperative third day after CT confirmed that rebleeding and residual hematoma had not occurred.

Results

During the last 13 months, we have used this method to evacuate hematomas in 38 patients 18 men and 20 women, aged 37 to 82 years.

Stereotaxic aspiration was carried out at different times after the onset about 7 to 36 hours : 3(7%) operations within 8 hours, 25(65%) within 24 hours,

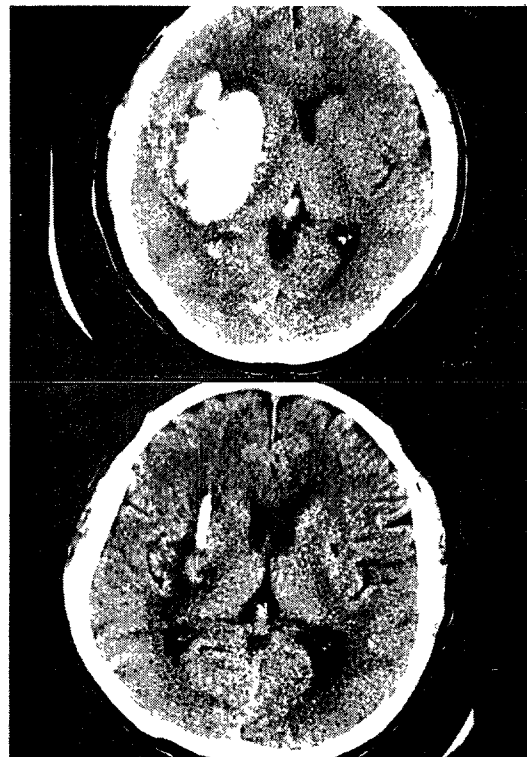


Fig. 3. The comparative CT scan of the initial(left) and postevacuation(right).

10(27%) to 36hours. and most patients were admitted in a grave condition : grade 1,4 grade 2, 12, grade 3, 14, grade 4a, 5, grade 4b, 2, grade 5, 1 case.

The CT scans disclosed the locations of hematomas : basal ganglia 19(50%), thalamus 13(34%), subcortex 6(16%), and massive penetration of blood into the ventricular system was noted in 8 cases.

The average volume of hematoma according to site was 35ml in basal ganglia, 42.8ml in thalamus and 21ml in subcortex(Table 5).

The preoperative hematoma volume varied from 15ml to 72ml, being less than 30ml in 12 cases, 30 to 50ml in 23 cases, more than 50ml to 72ml in 3 cases.

In spite of sufficient aspiration of hematoma on the operative field, over 70% of initial hematoma was observed in postoperative first day CT in 12cases, eight of them showed communication with the ventricular system.

It is important to stress that in a majority of cases it was also possible to remove almost all clots from the ventricles along the following five days.

In most patients the postoperative condition was poor, as is usually true after removal of spontaneous hemorrhages. All patients required a long period of intensive care.

Repeat hemorrhages developed in 3 patients(6.7%) in whom total hematoma removal had been confirmed by CT investigation : basal ganglia, 1(5%)

Table 5. Anatomical location and average volume of hematoma

Location	No. of patients	Average volume of Hematoma(ml)
Putamen	19(50%)	35
Thalamus	13(34%)	42.8
Subcortical	6(16%)	21

Table 6. Mortality and the rebleeding rate, the abscess formation based on the location of hematoma

Location	No. of patients	Mortality	Rebleeding	Abscess
		No. percent	No. percent	No. percent
Putamen	19(50%)	3(15%)	1(5%)	2(10%)
Thalamus	13(34%)	2(15%)	2(15%)	1(7%)
Subcortical	6(16%)	1(16%)		
Total	38	6(15%)	3(7%)	3(3%)

thalamus, 2(15%). Two of them underwent re-operation by the same method and one was delayed the removal of the original catheter.

Brain abscess was developed in the long installation of the catheter up to 5 days. 1 case was treated conservatively, 2 cases were operated in a general craniotomy with the removal of the abscess cavity.

There were 6 deaths(15%) that occurred between 7 days and 4 wks after the operation. Death was caused by recurrent hemorrhage in 2 cases(34%), pneumonia in 4 cases(66%).

The surviving 32 patients(84%) have been followed from 2 to 5 months postoperatively.

Discussion

The vasculopathy of chronic hypertension affect the perforating arteries including the lenticulostriate arteries, the thalamoperforating arteries and the paramedian branches of the basilar artery which arise directly from much larger trunks to enter the brain at right angles and which are end arteries^{8,9}.

Hypertensive intracerebral hemorrhage is usually classified by putaminal, thalamic, subcortical, pontine and cerebellar hemorrhages¹⁰.

Hematoma destroys brain tissue by mass effect at first and as time is going there seems hypoxia, acidosis, reduction of cerebral blood flow, and toxic effect of blood¹¹.

Mizukami¹² reported hematoma formation was usually completed within 6 hours after bleeding and edema was slowly appeared from this time.

In electronmicroscopic study¹³, degeneration of glial cell began to appear in 3 hours, was aggregated in 12 hours and glial cell necrosis occurred in 1 day.

Degeneration of axon began to appear in 6 hours

and was aggregated in 12 hours to 1 day.

Surgical treatment of hypertensive intracerebral hemorrhage has improved during the past three decades, but many important problems still remain to be resolved.

There are many different and sometimes opposite viewpoints with regard to indications for surgery, tim-

ing of the operation, and surgical techniques.

The classic method of removal of intracerebral hematomas by craniotomy is not technically difficult and the operation is risky in gravely ill patients, having a mortality rate as high as 90%^{14,15}.

The principle of stereotaxic evacuation of intracerebral hematomas proposed by Backlund and von Holst²

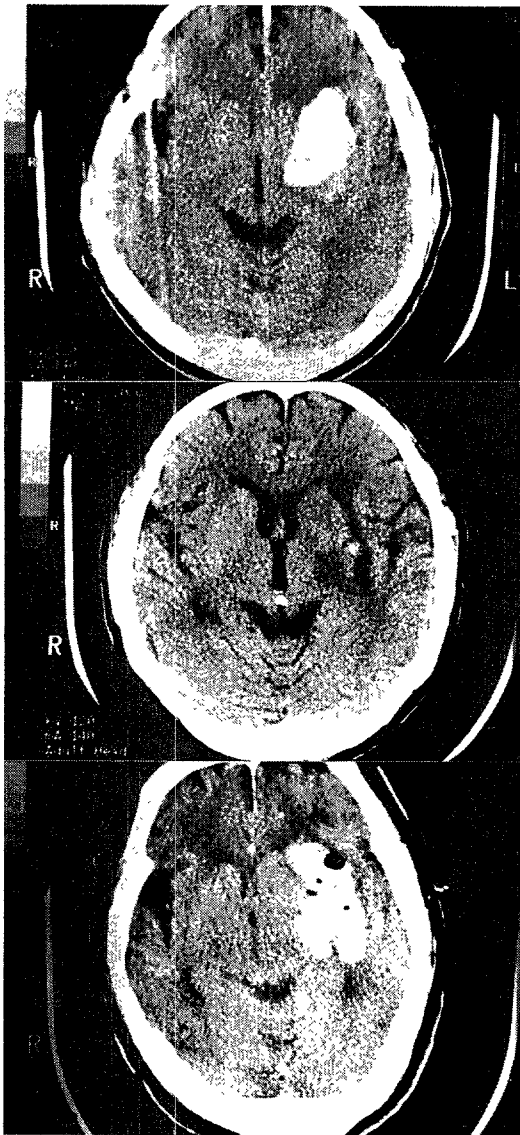


Fig. 4. Computerized tomography scans in a patient with a large ganglionic hematoma. Upper, before aspiration; Middle, postevacuation 1 day is partially removed with a hematoma; Bottom, postoperative rebleeding.

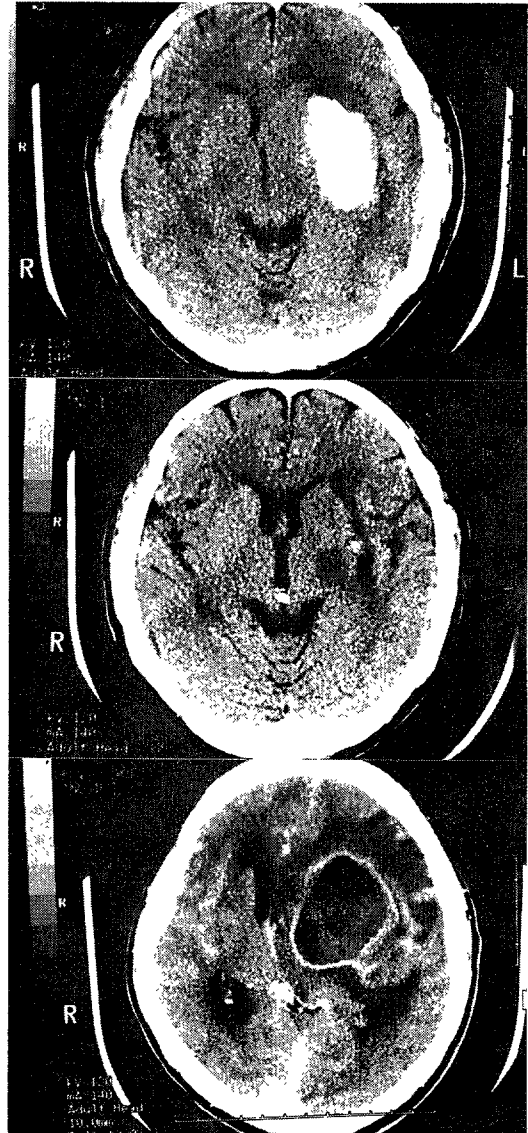


Fig. 5. Computerized tomography scans in a patient with a large ganglionic hematoma. Upper, Preoperative scan; Middle, the hematoma 3 days after the initial operation; Bottom, scan following total removal of hematoma and developed a abscess cavity.

is original and imaginative. The use of an Archimedes screw to fragment dense clots allows them to be removed through a relatively narrow cannula introduced stereotactically. The operation is much less traumatic than the classic open removal of hematomas. Several technical equipment has been developed in recent years¹⁶⁾¹⁷⁾¹⁸⁾¹⁹⁾.

It is known that, a few hours after the onset of symptoms, a hematoma consists of liquid blood (about 20% of its volume) and dense clots (about 80%).

We think total removal is not recommended that residual hematoma acts as a tamponade with spontaneous stopping of rebleeding.

Sixty percent removal of preoperative hematoma was recommended by Kanaya⁷⁾, seventy five percent by Kaufman¹⁰⁾.

We usually removed about 70% of initial hematoma by simple aspiration and in almost all cases were treated with urokinase irrigation.

Doi²⁰⁾ introduced a drain into the cavity of the hematoma and infused 6000 units urokinase every 3 hours postoperatively. The infusion of urokinase did not cause any apparent adverse reactions, such as bleeding, convulsions or intracranial infection. Urokinase has no neurotoxic effect in the subarachnoid space²¹⁾²²⁾ and confirmed in animal experiment²³⁾²⁴⁾, although it has been associated with rebleeding in 4% of cases²¹⁾²²⁾²⁵⁾. Some authors⁹⁾²²⁾ used urokinase for 2 to 7 or 8 days, but we used about 3.5 days.

Postoperative CT scan is important for the decision of the use of urokinase or removal of tube. We usually confirm it on the 3rd postoperative day.

The postoperative mortality which related the hemorrhage was 6 (15%) in our cases. The low rate of our study is thought due to good selection of patient and improvement of postoperative care.

Brain abscess was appeared in 3 cases (7%) in previous hematoma site after the disappearance of the hematoma. We think a contaminuous infection through the tube and the tube is replaced every 5 days if the long installation with adequate topical treatment.

Rebleeding in the same location occurred in 3 cases (7%) which thought a operative technical error, ina-

dequate medical care and may be a urokinase effect. To prevent this problem, We usually keep in mind an adequate aspiration power, a subtotal removal, an accurate control of blood pressure and an evaluation of other bleeding disorders.

Conclusion

The postoperative mortality was in 6 cases (15%), rebleeding in 3 cases (7%), brain abscess in 3 cases (7%) in all 38 cases.

We can summarize the favorable characteristics of CT-guided stereotactic evacuation of the hematoma in hypertensive intracerebral hematoma as follows :

- 1) The procedure can be carried out in a short time under local anesthesia
- 2) Operative intervention is minimal
- 3) The procedure is applicable to patients of advanced age or high-risk patients in poor general condition
- 4) It is also indicated for thalamic hemorrhage and other deep-seated hematomas of the brain

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