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Stereotactic Endoscopic Removal of Hypertensive Intracerebral Hemorrhage

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= **Abstract** =

고혈압성 뇌출혈의 두부정위술을 응용한 신경내시경적 제거술

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최근 뇌출혈에 대한 보다 비침습적인 수술법의 개발로 고혈압성 뇌출혈 환자의 수술 결과가 괄목할 정도로 좋아지고 있다. 본인은 이러한 시도의 일환으로 두부정위술과 신경내시경을 결합한 방법으로 8예의 뇌출혈 환자에 대해 수술을 시행하고 그 결과를 다른 수술법에 의한 결과와 비교하고자 하였다.

대상 환자는 33세에서 81세 사이의 남자 4명, 여자 4명이었으며 평균 연령은 53.5세였다. 출혈 부위는 모두 기저핵이었으며 출혈량은 평균 43.4ml(20~105ml)였다. 환자 모두가 심한 신경학적 결손 상태를 보였으나 뇌탈출의 징후는 없었다. 수술은 출혈 후 24시간 이내에 시행되었다. 수술방법은 전두부 두피 절개부에 국소마취를 시행하고 뇌압측정기를 설치한 후, 1개의 두개천공을 만들어 두부정위기를 사용하여 혈종의 중앙에 오츠키씨 관을 삽입하고 이를 통해 막대형 내시경을 삽입하였다. 내시경으로 시야를 확보한 후 오츠키씨 관의 측면에 있는 구멍을 통해 뇌압이 반 이상 저하될 때까지 혈종을 흡입해냈고 출혈이 있는 경우 레이저를 이용하여 지혈하였다. 어느 정도 제거된 혈종의 중앙에 잔여 혈종을 제거하기 위한 도관을 위치시킨 후 수술을 마치고 이후 3~5일간 유로키나아제를 사용하여 용혈 및 배액을 시행하였다.

수술은 재출혈이 있었던 연구 초기 환자 1명을 제외하고 모두 성공적으로 시행되었으며 사망율은 13%였다. 이러한 치료로 가장 현저하게 증상이 개선된 점은 빠른 의식의 회복이었으며 신경학적 결손도 비교적 빠르게 호전되었다.

두부정위술을 응용한 신경내시경적 혈종 제거술은, 고전적인 개두술은 물론이고 최근 가장 널리 시행되고 있는 두개천공후 도관삽입 및 배액술에 비하여, 비교적 간단하고, 안전하며, 정확한 수술방법으로서 빠르게 뇌압을 감소시킬 수 있다는 이점이 있다. 또한 수술의 전 과정을 모두 내시경을 통해 직접 보면서 시행할 수 있어서 합병증을 예방할 수 있고 예후를 예측할 수 있을 것으로 사료된다.

KEY WORDS : Intracerebral hematoma · Stereotactic endoscopic removal · Intracranial pressure · Urokinase.

Introduction

The management of intracerebral hematomas(ICHs) is still controversial[1-5]. Despite the best efforts of experts in many medical fields, the prognosis for patients suffering from spontaneous hypertensive ICH remains poor[6]. Some authors advocate early surgery in spite of the additional risk of damaging intact brain tissue[7-13]. Others prefer a nonsurgical approach[2)14-17]. The aim of operative treatment should be the removal of as much of the clot as possible, with minimal disruption of surrounding brain tissue, to reduce local and generalized intracranial pressure(ICP), and to preserve cerebrospinal fluid(CSF)[18]. The two generally accepted surgical options to treat spontaneous ICH are conventional open craniotomy or computerized tomography(CT) guided stereotactic evacuation of the hematoma ; both procedures are performed with the patient under local anesthesia and are followed by hematoma lysis[19-20]. The standard operative treatment for ICH, consisting of craniotomy and clot evacuation under direct vision, is not difficult or time-consuming. Depending on clot location and associated medical conditions that may be present, the operative mortality rate can be extremely high, ranging from 20% to 90%. These grim results have stimulated a search for a more tolerable, less traumatic, and safer methods of clot removal[10)21-22]. Less traumatic methods of clot evacuation have focused on stereotactic methods, instillation of fibrinolytic agents, mechanically assisted aspiration, and more recently, endoscopic methods. Several authors reported the use of an endoscope fitted with irrigation and suction devices and a laser, with or without stereotactic capabilities, in evacuating spontaneous ICH[5-7]. Their results were not encouraging. So I tried this study and analyzed my results.

Clinical material and methods

Between September 1993 and October 1995, we surgically treated 81 patients presenting with spontaneous ICH at our hospital. Twenty-three patients underwent conventional microscopic craniotomy, 44 patients underwent CT-guided stereotactic catheter placement with urokinase infusion and drainage, and 14 patients underwent CT-guided stereotactic endoscopic hematoma removal and silicone tube insertion within 24 hours of the insult. Of these 81, 8 patients(4 women and 4 men), with a mean age of 53. 5 years(range 33－81 years), were included in this study. All patients had a hypertensive ICH in the basal ganglia. Informed consent for treatment was obtained from all the patients and/or their relatives. Patients were followed for at least 6 months after treatment. The 8 patients were chosen on the basis of the following criteria : a decreased level of consciousness ; no clinical sign of herniation ; a hematoma with a minimum diameter of 3cm ; a hematoma present less than 24 hours and in a ganglionic location ; no aneurysm or arteriovenous malformation ; and no systemic bleeding disorder.

An initial CT scan was obtained in all patients, and the diameter and volume of the hematoma were assessed. Patients in whom a vascular malformation or an aneurysm were suspected underwent additional angiography within 24 hours.

All operations were performed after local anesthesia was induced in the patient. We placed the ring from a Codman-Roberts-Wells stereotactic system on the patient's head and 5-mm axial CT slices were obtained through the hematoma. A trajectory was calculated from the point of entry through the main axis of the hematoma using cartesian coordinates x, y, and z. The patient was taken to the operating room and the stereotactic aiming bow was placed in the patient's headring after the coordinate points were computed. After making a 2cm scalp incision, a burrhole was made with the airtome. The exposed dura was coagulated and incised in a cruciate pattern. Just in front of the burr hole, a parenchymal ICP monitoring catheter was placed through a second drill hole. A silicone catheter was placed stereotactically and an Otzuki guiding cannula(8mm in diameter, 20cm long, with a side window) was inserted through the specially designed stereotactic guiding block[23]. The stylet was removed at the target point and a thin, rigid telescope(angled, 2mm in diameter) was introduced into the guiding tube. Various flexible microsurgical instruments, such as suction tubes, forceps, and laser fibers, were inserted through the window of the guiding tube(Fig. 1). Under direct vision, stepwise removal of the hematoma was accomplished until the ICP was significantly reduced(Fig. 2). This procedure was followed by placement of an indwelling silicone catheter in the center of residual hematoma.

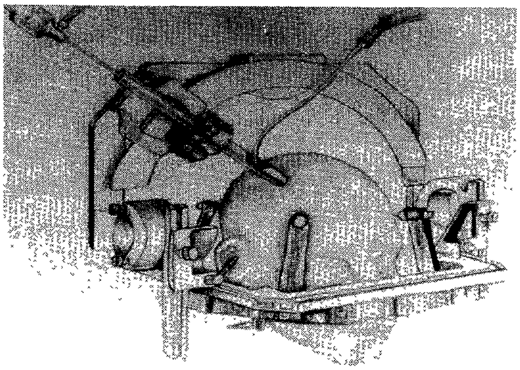

Fig. 1. Artist's rendering of the stereotactic endoscopic system. An Otzuki guiding cannula(8mm in diameter, 20cm long, with a 1 by 2cm side window) is attached to a stereotactic Cosman-Roberts-Wells headframe using a specially designed guiding block. A various flexible microsurgical instruments such as suction tubes, forceps, and laser fibers can be used through the side window of the guiding cannula.

Each patient received 6000 U urokinase in 5ml saline, which was injected into the hematoma cavity every six hours. The catheter was closed after each administration of urokinase and saline and reopened and drained into a conventional CSF collection system at 0cm of pressure after 2 hours. The first control CT scan was obtained approximately 12 hours after treatment initiation, and all subsequent CT scans were obtained every 48 hours. After the final control CT scan, the catheter was removed. The coagulation status was assessed routinely.

Follow-up information was obtained for all patients 6 months after treatment. The results were graded according to the Glasgow Outcome Scale[15], ranging from Grade V(good recovery) to Grade I(dead).

Statistical significance was analyzed using a comm-

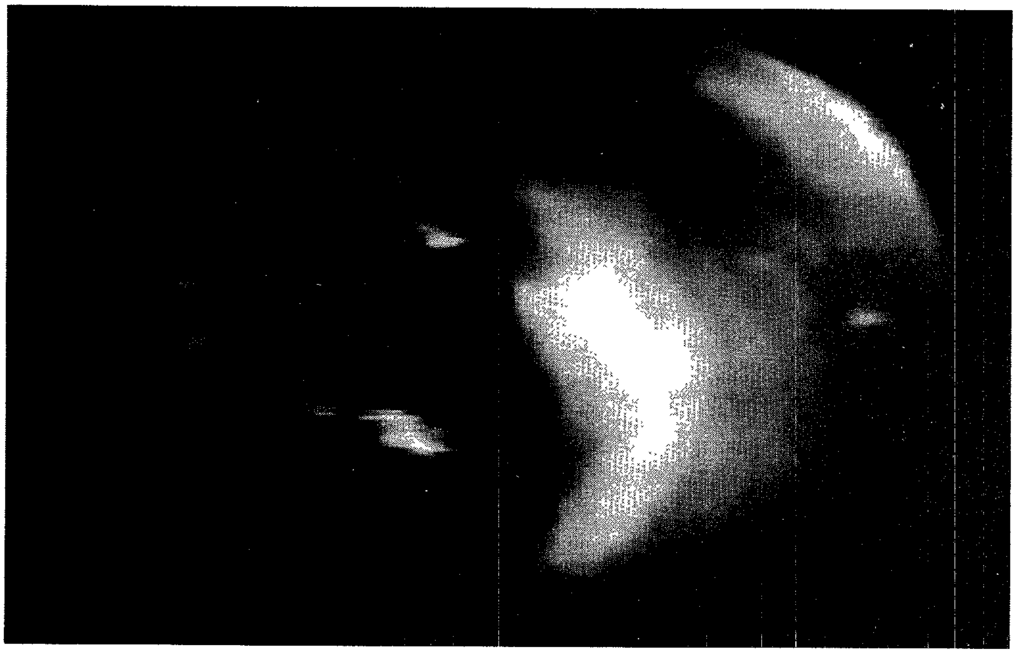

Fig. 2. Intraoperative photograph obtained using a rigid endoscope showing a dark-brown hematoma and adjacent brain tissue. The hematoma can be aspirated with minimal suction under direct vision without injury to brain tissue.

ercially available computer software(SAS, Windows version 6.11, Cary, NC). I used the Pearson chi-square test to compare groups and a discriminant analysis to assess the retrospective weights of the prognostic factors.

Results

Intraoperative endoscopic hematoma removal was easy using the Stereotactic endoscopic removal(SER) procedure. The amount of clot aspirated ranged from 10 to 57ml(mean 23.5ml), producing a removal rate of 54.1%(Fig. 3). We were very careful not to touch the part of clot that was attached to the wall so as not to cause vascular injury and rebleeding. Active bleeding was controlled by irrigation and laser coagulation. Patients' ICPs ranged from 12 to 45mmHg (mean 24.3mmHg) ; their final ICPs ranged from 3 to 15mmHg(mean 6.1mmHg). The mean reduction of ICP during SER was 74.5%(Fig. 4). The removal of the hematoma using the SER method allowed a rapid reduction of ICP in most patients without causing a large lesion.

The patient's level of consciousness, the intraventricular extension of blood, the volume of hematoma, and the patient's age correlated well with a poor outcome in decreasing order of frequency(Table

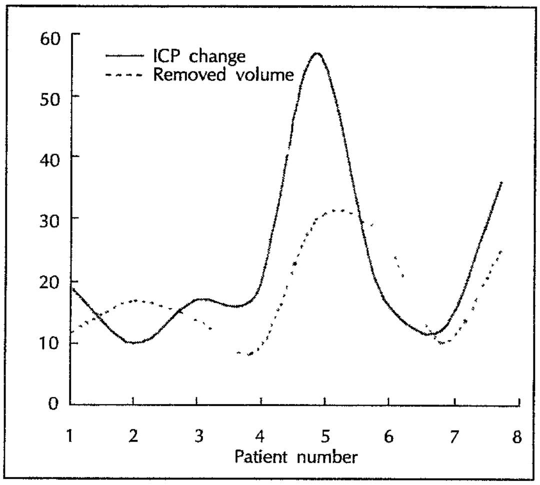

Fig. 4. A graph showing changes in intracranial pressure (ICP) related to volume of hematoma removed in eight patients undergoing stereotactic endoscopic procedures.

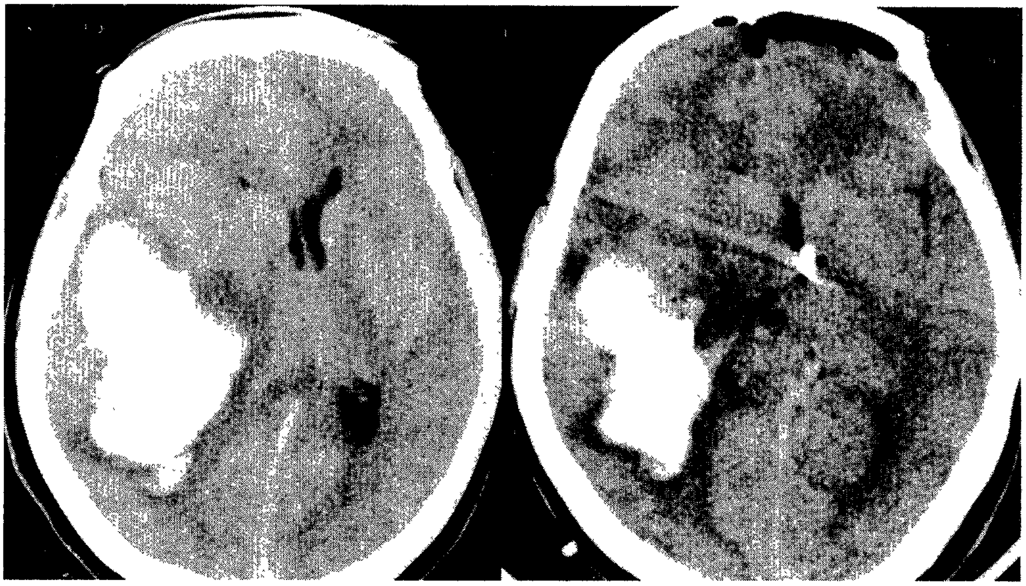

Fig. 3. Case 8. Computerized tomography(CT) scans obtained in an 80-year-old woman with a large right putaminal intracerebral hemorrhage. Upper : Admission CT scan showing compression of the right lateral ventricle and midline shift to the left with some intraventricular hemorrhage(Day 0). Lower : Cranial CT scan obtained approximately 12 hours after the patient underwent the SER procedure. Note the significant decrese of midline shift and reduction of hematoma size(Day 1) and the artifact caused by the trajectory of the inserted ventricular and parenchymal catheters.

1).

Computerized tomography was used to monitor hematoma dissolution in all patients and revealed that 7 of 8 patients experienced near-complete dissolution of their clot. Medical complications occurred in one patient but we did not discern any systemic side effects related to urokinase administration. Many patients, especially the patient in Case 7, showed immediate improvement(within 24 hours) of their drowsiness or stupor. The initial volume reduction of the hematoma after operation was marked. Rebleeding occurred in Case 5 and that patient died (Table 2). Total drainage time ranged from 3 to 5 days.

At follow-up evaluation, one patient had died(12.5%) from rebleeding after the SER procedure. Five patients(62.5%) were classified as Grade V according to the Glasgow Outcome score(Cases 1－4, 7), one patients(12.5%) was classified as Grade Ⅲ, and one(12.5%) was Grade Ⅱ.

Table 1. Mean values and level of significant difference in patients with a favorable outcome and an unfavorable outcome

Variables	Favorable Group	Unfavorable Group	p value
GCS	12.5	4.6	0.0001
IVH	4(5)	1(13)	0.0007
Hematoma Volume	27.6ml	52.0ml	0.0226
Age	48.5 years	66 years	0.0304

GCS, Glasgow Coma Scale ; IVH, intraventricular hemorrhage ; *values are expressed as mean values

Discussion

The natural course of spontaneous ICH leads to a 30-day mortality rate of 45%[24]. McKissock, et al.[17], found no group of surgically treated patients for whom outcome was better than for patients treated without surgery. They also determined that only one-half of the patients with deep hemorrhages survived. A prospective study from Finland[16], composed of 52 patients, has proposed that surgical intervention has no advantage over conservative therapy. Little progress has been made in highlighting the pathophysiology of ICH[24], and there is great controversy about patient selection for respective treatments. It is now generally recommended in the European and world literature that patients with smaller hematomas who are alert, stable, or improving should be treated medically and that patients with larger hematomas who show progressive neurological deficit, prolonged functional impairment, and intracranial hypertension should be treated surgically.

During the early period after ictus, ICHs may cause neurological deterioration as a result of an increasing mass effect caused by surrounding edema[25], and this mass effect may last up to 4 weeks after the bleeding, even with decreasing density of the clot[26-27]. This deterioration does not always respond to osmotherapy or steroids alone, and, therefore, removal of hematoma should be accomplished as soon as possible (within 24 hours of insult) to decompress the clot(to

Table 2. Clinical and outcome data in 8 patients with spotaneous intracerebral hematoma

Sex, Age	Hematoma volume Vol 1	Hematoma volume Vol 2	BG location	Adm symptomes	IVH	Complication	Outcome
M, 33	27	8	rt	Hemiparesis	－	－	GOS V
M, 38	20	10	lt	Dysphasia/hemi	－	－	GOS V
F, 44	28	11	rt	Hemiparesis	－	－	GOS V
M, 50	24	6	rt	Hemiparesis	＋	－	GOS V
M, 52	80	23	rt	Stupor/hemiparesis	＋	Rebleed	GOS Ⅰ
F, 57	40	21	lt	Dysphasia/hemi	－	－	GOS Ⅲ
F, 73	23	11	rt	somnolent	－	－	GOS V
F, 81	105	69	rt	Stupor/hemiparesis	＋	Cardiac	GOS Ⅱ

Vol 1, preoperative hematoma volume ; Vol 2, postoperative hematoma volume ; BG, basal ganglia ; Adm, admission ; IVH, presence of intraventricular hemorrhage ; rt, right ; lt, left ; GOS, Glasgow Outcome Scale ; hemi, hemiparesis

30－70ml), decrease ICP, which prevents secondary deterioration, and to improve perifocal vasogenic edema and local cerebral blood flow[12].

Debate in Europe is ongoing as to which method is safest and most effective. A direct open surgical approach seems best when evacuating large lobar hemorrhages. On the other hand, the results of such surgery in hematomas within the basal ganglia and other deep structures are unacceptable[18]. This type of surgical approach for decompression and evacuation of the hematoma can cause further tissue damage. Elevated ICP may be decreased by surgery, improving chances of survival. Removal of the clot may diminish secondary tissue destruction and edema in the vicinity of the hematoma, either by preventing compartmental pressure changes and consecutive reduction of the blood flow perfusion pressure or by removing the changes caused by toxic blood byproducts[7]. Fibrinolysis aids rapid dissolution of the remaining blood. The aim is to achieve a mass reduction as well as to reduce the extension of perifocal edema and minimize the amount of tissue damage. A urokinase washout can be performed for up to 7 days after the bleeding[28]. Mohadjer and colleagues[29-30] have reported good results with stereotactic evacuation and urokinase lysis of cerebral and cerebellar hemorrhage, after demonstrating that urokinase lacks neurotoxicity in an animal model[29]. Lerch, et al.[19], published data on 58 patients who underwent stereotactic puncture of a spontaneous ICH. They instilled 5000 U urokinase after calculating that the residual hematoma was less than 20% of its original volume, and they repeated the administration of 5000 U urokinase up to six times. This led to a 15% rate of new bleeding among the 46 patients who received urokinase therapy. Niizuma and coworkers[20] reported a 7% rate of new bleeding. Hokama, et al.[31], however, have presented sufficient data to support the use of CT-guided stereotactic hematoma evacuation without subsequent lysis. Other investigators believe that endoscopic removal proved to be superior to medical treatment alone in a group of 100 patients[7]. However, endoscopic removal did not prove to be superior to medical treatment alone in patients suffering from putaminal or thalamic hemorrhage ; these patients represent more than one-half of the entire patient population with ICH[32]. The more elegant methods for removal of deep-seated hematomas are ultrasound-guided endoscopy or stereotactic subtotal evacuation, followed by placement of a silicone catheter for urokinase administration and washout[7]. Stereotactically controlled endoscopic evacuation permits localization of the lesion, and removal of the clot is performed under optic control, which may be important in cases of cryptic arteriovenous malformations. This high-tech method may be simple, fast, safe, and effective. As opposed to the SCD procedure, stereotactically guided endoscopy allows continuous intraoperative volume removal[7]. Urokinase or other fibrinolytic substances may also be administered. In our series, use of the SER method made it easier to remove the hematoma and decrease ICP than did the Stereotactic catheter drainage(SCD) method, although the mortality, morbidity, and rebleeding rates were similar for both.

The patient's initial level of consciousness, hemorrhage size, and intraventricular extension of blood have proven to be accurate predictors of outcome. Less commonly, age, sex, hypertension, and mass effect may indicate harmful effects on outcome in patients with ICH[33-34]. In our study, the level of consciousness, intraventricular extension of blood, volume of hematoma, and age were well-correlated with a poor outcome ; these occurred in order of decreasing frequency.

Many patients in our study showed immediate improvement in their level of consciousness. This seemed to be related to the CT-documented decrease of their hematoma size. For such patients, stereotactic treatment proved safe and only minimally distressing. Because these patients regained better levels of consciousness soon after treatment initiation, they could be mobilized earlier for physiotherapy, and this led to a decrease of secondary complications such as pneumonia or pulmonary embolism. Neurological deficits caused by eloquent tissue destruction were not affected by this method. Although the first results are promising, a large randomized clinical trial is needed for evaluation of the methods reported.

Conclusions

Given the right indications, patients suffering from spontaneous ICH may benefit from stereotactic hematoma lysis, with or without use of endoscopy. Stereotactic endoscopic removal is a simple, precise, safe, and brief procedure with very low rebleeding and mortality rates, can replace SCD and allow for direct visualization. Stereotactic endoscopic removal also shortens the hospital stay.

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