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Surgical Options of Hypertensive Intracerebral Hematoma: Stereotactic Endoscopic Removal versus Stereotactic Catheter Drainage

The authors analyzed the difference between two surgical procedures, stereotactic endoscopic removal (SER) and stereotactic catheter drainage (SCD), in 18 patients of ganglionic intracerebral hematoma (ICH). Ten patients underwent SCD and eight SER within 24 hours of insult. The mean age was 53.3 (33-81) years and male to female ratio was 11:7. The mean volume of hematoma was 34.4 (23-105) ml. All patients had major neurological deficits without signs of transtentorial herniation. Mean follow-up was 8 (6-10) months. Under local anesthesia, Otzuki's cannula was placed through a burr hole. ICH was removed with suction and forceps under endoscopic guidance. Hemostasis was performed with Nd-YAG laser. For SCD, we used silicone catheter and urokinase. The hematoma was drained in 3-5 days in SER, whereas 7-10 days in SCD. Postoperative rebleeding occurred in one case of SER. Mortality rate was 13% in SER, 10% in SCD. The patients who gained most from these treatments were those who had been admitted with an impaired level of consciousness. The whole procedure can be done under direct vision in SER, so SER might replace SCD with similar mortality.

Key Words : *Cerebral hemorrhage; Hematoma, intracerebral; Stereotactic techniques; Drainage; Urokinase*

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INTRODUCTION

The management of intracerebral hematoma (ICH) is still controversial (1-4). Despite of numerous efforts by experts in many medical fields, the prognosis for patients suffering from spontaneous hypertensive ICH still remains poor (5). Some authors advocate early surgery (6-10), and others prefer a nonsurgical approach (11-14). The operative treatment should try to remove as much of the clot as possible, with minimal disruption of surrounding brain, in order to reduce local and generalized intracranial pressure and to preserve CSF circulation (15). The two generally accepted surgical options for spontaneous ICH are conventional craniotomy or stereotactic evacuation of the hematoma, which can be performed under local anesthesia and followed by hematoma lysis (16, 17). Because of the clot location and other associated medical conditions, operative mortality can be high, ranging from 20% to 90% (3, 4, 7-9, 11, 19). These grim results have launched a search for more tolerable, less traumatic, and safer methods of clot removal (18, 19). 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 endoscope fitted with irrigation, suction, and a laser with or without stereotactic techniques in evacuating spontaneous ICH (6, 20, 21); their results were not encouraging, however. We compared the results of two recent stereotactic operative methods in this study.

CLINICAL MATERIAL AND METHODS

Patient population

From September 1993 to October 1996, we operated on 81 patients with hypertensive ICH in our hospital. Twenty-three patients (19 basal ganglia, 4 cerebellar) underwent conventional microscopic craniotomy, 44 patients (30 basal ganglia, 11 subcortical, 3 cerebellar) underwent stereotactic catheter drainage (SCD), 14 patient, who had basal ganglia hemorrhage, underwent stereotactic endoscopic removal (SER) and silicone tube insertion within 24 hours of insult. We planned a prospective study of two modern surgical techniques and their results. Among these operated cases, 18 patients (SCD 10, SER 8) were selected for entry into this study based on the following criteria: hypertensive ganglionic ICH, a minimum hematoma diameter of 3 cm, decreased level of consciousness, no clinical signs of herniation, a hematoma not older than 24 hours, no aneurysm or arteriovenous malformation, no systemic bleeding disorder, the patients who could be followed at least 6 months. The informed consent was obtained from the patients and/or their relatives. The method of operation was selected by the desire of patients and/or their relatives.

Radiographic procedures

An initial computed tomographic (CT) scan was obtained from all patients, and the diameter and volume of the hematoma were assessed. Patients in whom a vascular malformation or an aneurysm could be suspected, underwent cerebral angiography within 24 hours.

Operative techniques

All operations were performed under local anesthesia. We used a Cosman-Roberts-Well stereotactic system (Codman, USA), and placed the ring onto the patient's head in the computed tomography unit. After 5-mm axial slices were obtained throughout the hematoma, a trajectory was calculated from the critical two points, the point of entry and the center of target through the main axis of the hematoma, using phantom base. The patient was then carried to the operation room, where the stereotactic aiming bow was placed on the head-ring. This was followed by a 2-cm scalp incision and by a burrhole made with the airtome. The exposed dura was coagulated and incised as cruciate pattern.

Stereotactic catheter placement and urokinase drainage (SCD)

A silicone ventricular drainage catheter was used for our purpose (Codman International, Hamburg, Germany). The catheter was placed stereotactically, and careful manual hematoma aspiration was attempted. We did not use hematoma evacuators in this study. Then a subcutaneous tunnel for the distal end of the tube was created, several pieces of coagulative materials were placed into the burrhole, and the wound was closed. This was followed by a CT scan for the control of correct catheter placement within the hematoma.

Stereotactic endoscopic removal (SER)

Just in front of the burr hole, a parenchymal ICP catheter (Camino, USA) was placed through the drill hole. After the trajectory brain tunnel was made using a silicone catheter stereotactically, Otzuki's guiding cannula (8-mm diameter, 20-cm long, with a side window) was inserted into this trajectory through the specially designed stereotactic guiding block (22). At the target point, the stylet was removed and thin, rigid (varied angled, 2-mm diameter: Storz, Germany) telescope was introduced into the guiding tube. With this telescope, various flexible microsurgical instruments such as suction tubes, forceps, laser fibers could be utilized through the window of the guiding tube (Fig. 1). Under direct vision, stepwise aspiration of the hematoma was done until the ICP fell significantly (Fig. 2). This was followed by placement of a indwelling silicone catheter in the center of the residual hematoma.

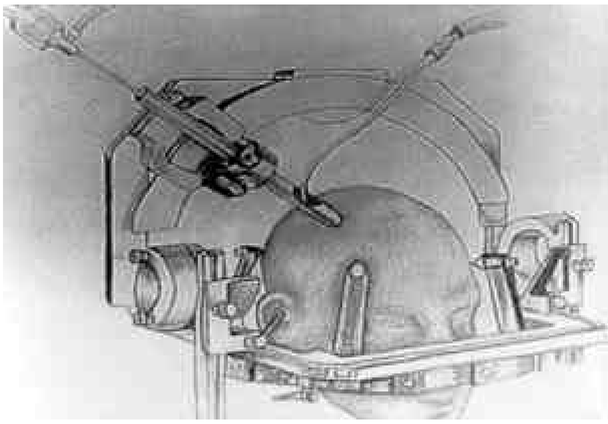

Fig. 1. The operative settings of stereotactic endoscopic system. A guiding cannula (8-mm diameter, 20-cm long, with a 1 by 2 cm side window) is attached to a stereotaxic CRW frame through a specially designed stereotactic guiding block. A thin, rigid (varied angle, 2-mm diameter: Storz, Germany) telescope is introduced into this guiding cannula. With this telescope, various flexible microsurgical instruments such as suction tubes, forceps, laser fibers can be utilized through the side window of the guiding cannula.

Lysis protocol

We used urokinase, 6,000 U in 5 ml saline, injected into the hematoma cavity every 6 hours. The catheter was closed after the administration of urokinase and normal saline. It was reopened and drained against 0 cm of pressure after 2 hours into a conventional cerebrospinal fluid collection system. The first control CT scan was performed 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 when the visible hematoma was totally evacuated.

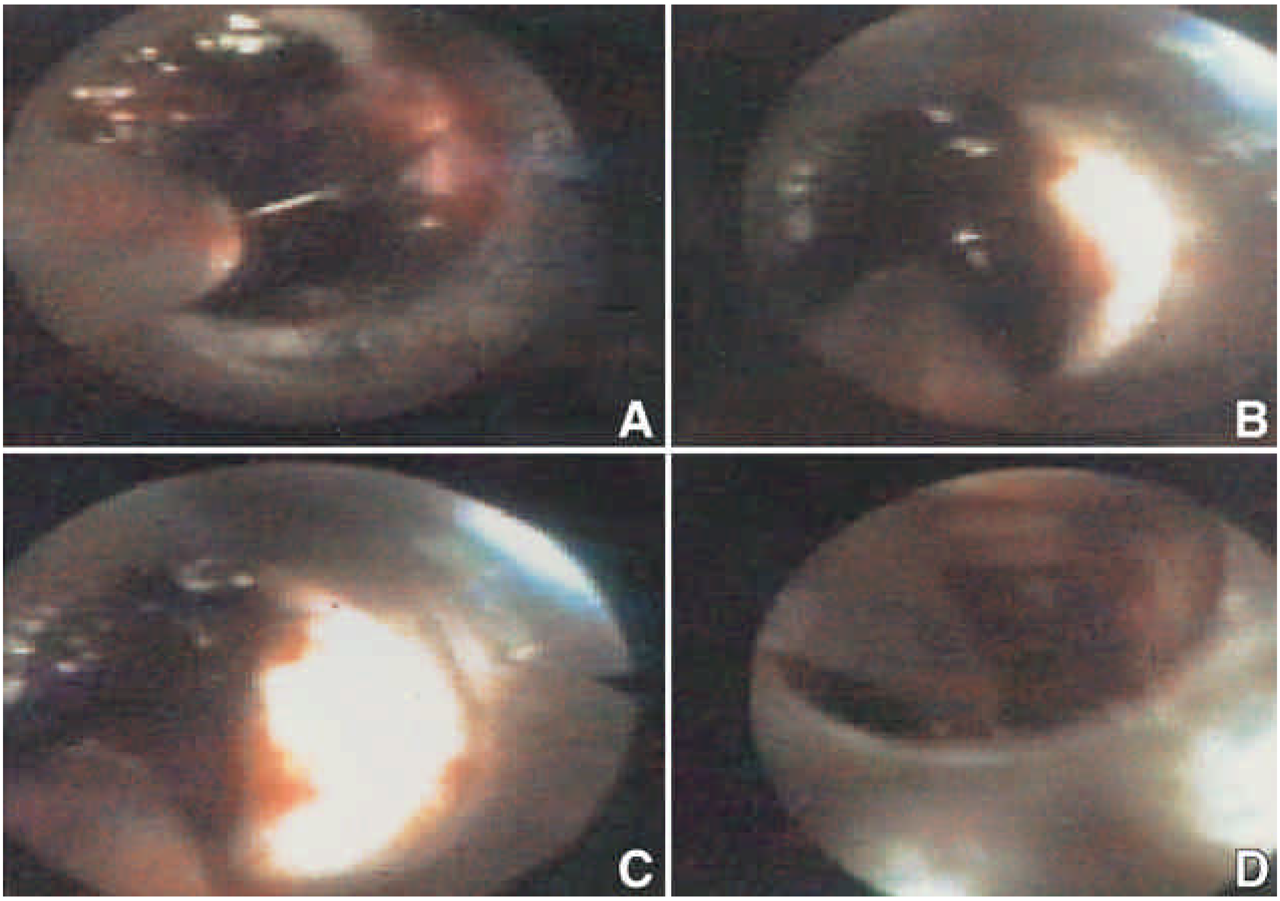

Fig. 2. The endoscopic finding of stereotactic endoscopic hematoma removal. (A) (B) (C) Dark-brown colored hematoma and adjacent brain tissue are visible through the rigid endoscope. We can aspirate the hematoma with a small suction under direct vision without injury to brain tissue. (D) underlying brain tissue is exposed at the end of operation.

Follow-up

Follow-up information was obtained after 6 months except death. Mean follow-up was 8 (6-10) months. The results were graded according to the Glasgow outcome score, ranging from Grade V (good recovery) to Grade I (dead) (23).

Statistical analysis

We used the Pearson chi-square to compare groups and discriminant analysis to analyze the respective weights of the prognostic factors.

RESULTS

Hematoma size and localization

All hematomas (eleven right, seven left) were located deep in the ganglia and involved the internal capsule in the distribution area of the lenticulostriate arteries. The hematoma volume reached 105 ml from 23 ml, with a mean of 37.2 ml (Table 1).

Intraoperative hematoma removal

Stereotactic catheter placement and urokinase drainage (SCD)

Intraoperative blood aspiration via the inserted catheter was possible in all patients to some degree. The amount of blood ranged from 4 to 14 ml (mean, 7.7 ml), so the removal rate is 23.9% at immediately postoperative period. It was calculated by the difference of hematoma volume between the initial and immediately postoperative CT scanning (Fig. 3).

Stereotactic endoscopic removal (SER)

Intraoperative endoscopic hematoma removal was easier than SCD because the former could be done under direct vision. The amount of blood ranged from 10 ml to 57 ml (mean, 23.5 ml), so the removal rate is 54.1%

Table 1. Clinical data of 18 patients with hypertensive ganglionic hematoma

Patient No.	Sex, age	Hematoma volume (ml)			Symptoms / Admit status	IVH†	Operation§	Complication	Outcome‖
		Volini*	Volfin†	Localization					
1	M, 33	27	8	Right	Confusion / Hemiparesis	−	SER	−	GOS V
2	M, 38	20	10	Left	Drowsy / Dysphasia / Hemiparesis	−	SER	−	GOS V
3	F, 44	28	11	Right	Confusion / Hemiparesis	−	SER	−	GOS V
4	M, 50	24	6	Right	Drowsy / Hemiparesis	+	SER	−	GOS V
5	M, 52	80	23	Right	Stupor / Hemiparesis	+	SER	Rebleeding	GOS I
6	F, 57	40	21	Left	Confusion / Dysphasia / Hemiparesis	−	SER	−	GOS III
7	F, 73	23	11	Right	Confusion	−	SER	−	GOS V
8	F, 81	105	69	Right	Stupor / Hemiparesis	+	SER	Cardiac	GOS II
9	M, 33	25	21	Right	Confusion / Hemiparesis	−	SCD	−	GOS V
10	M, 37	20	16	Right	Drowsy / Hemiparesis	−	SCD	−	GOS V
11	M, 41	38	34	Left	Semicoma	+	SCD	Cardiac	GOS I
12	M, 45	35	30	Right	Confusion / Hemiparesis	−	SCD	−	GOS IV
13	F, 47	33	27	Right	Confusion / Hemiparesis	−	SCD	−	GOS V
14	F, 52	36	30	Right	Confusion / Hemiparesis	−	SCD	−	GOS IV
15	M, 54	23	9	Left	Confusion / Dysphasia	−	SCD	−	GOS V
16	M, 67	65	52	Left	Stupor / Dysphasia / Hemiparesis	+	SCD	−	GOS III
17	M, 77	23	11	Left	Stupor / Hemiparesis	+	SCD	Pulmonary	GOS I
18	F, 79	24	15	Left	Semicoma	−	SCD	Pulmonary	GOS II

* Initial preoperative volume of hematoma.
† Immediate postoperative volume of hematoma.
† Presence of intraventricular hemorrhage. +, present; −, absent.
§ Method of operation. SER, stereotactic endoscopic removal; SCD, stereotactic catheter drainage.
‖ GOS, Glasgow Outcome Scale; GOS V, good recovery; GOS IV, moderate disability (independent); GOS III, severe disability (dependent); GOS II, vegetative state; GOS I, dead.

at immediately postoperative period (Fig. 4). It seemed very important that part of clot attached to the wall should not be touched because it might risk vascular injury and rebleeding. The active bleeding could be controlled with irrigation and laser coagulation.

Changes of ICP during SER

The initial ICP ranged from 12 mmHg to 45 mmHg (mean, 24.3 mmHg), the final ICP ranged from 3 mmHg to 15 mmHg (mean, 6.1 mmHg). The mean reduction of ICP during SER was 74.5%. The removal of hematoma allowed a rapid reduction of ICP without putting additional strain on the patients and significant brain lesion.

Prognostic factors

The level of consciousness, intraventricular extension of blood, volume of hematoma, and age correlated well with unfavorable outcome (Table 2).

CT scan controlled results

This has led to almost complete hematoma dissolution in all but one patient. All patients drained blood or bloody cerebrospinal fluid through their catheters. Medical complication occurred in 4 patients but there were no systemic side effects related to urokinase. Many patients, especially in case 7, showed fast improvement (within 24 hours) in their drowsy or stupor state compared with the others. The initial volume reduction after operation was remarkable in SER. Rebleeding occurred in case 5 and he died. Total drainage time, which was defined as absence of blood clot by serial CT scanning, ranged from 3 days to 5 days in SER, from 5 days to 9 days in SCD ($p<0.05$).

Table 2. Mean values in patients with a *favorable outcome and an †unfavorable outcome and a significant level of difference

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

* Favorable, Glasgow outcome scale IV, V.
† Unfavorable, Glasgow outcome scale I, II, III.
† GCS, Admit status as Glasgow Coma Scale.
§ IVH, Presence of intraventricular hemorrhage.

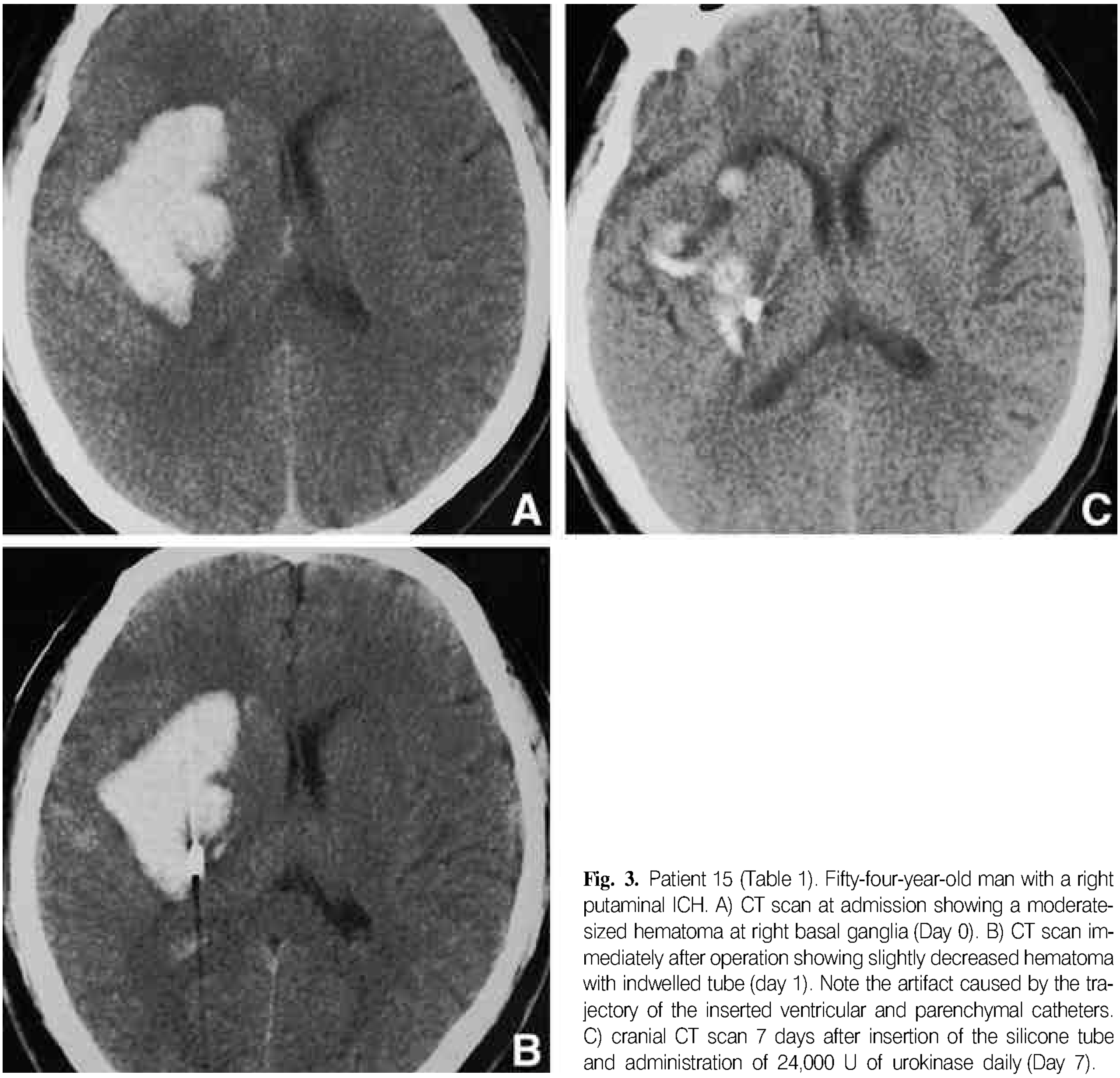

Fig. 3. Patient 15 (Table 1). Fifty-four-year-old man with a right putaminal ICH. A) CT scan at admission showing a moderate-sized hematoma at right basal ganglia (Day 0). B) CT scan immediately after operation showing slightly decreased hematoma with indwelled tube (day 1). Note the artifact caused by the trajectory of the inserted ventricular and parenchymal catheters. C) cranial CT scan 7 days after insertion of the silicone tube and administration of 24,000 U of urokinase daily (Day 7).

Follow-up

At follow-up, three patients had died (16.7%), two in SCD (20%) and 1 in SER (12.5%). The first patient (case 11), who was admitted in a semicomatose mentality and ventilated, died. The second patient, who was admitted in a stuporous mentality and 77 years old, had cardiac arrest during his stay in our intensive care unit. The last patient died from rebleeding after SER. Nine patients (50%) were Grade V according to the Glasgow outcome score (case 1-4, 7, 9-10, 13 ,15). Two patients were Grade IV (11.1%), two were Grade III (11.1%), and two were Grade II (11.1%).

DISCUSSION

The natural course of spontaneous ICH leads to a 30-day mortality rate of 45% (24). McKissock et al. (14), in 1961 found no examples of patients who were operated on, that had better results than patients who did not have surgery. They also determined that only half of the patients with deep hemorrhages survived. A prospective study from Finland comprised of 52 patients had proposed that a surgical intervention had no advantage over conservative therapy (13). Little progress has been made in highlighting the patho-physiology of ICH (24), there is a lot of controversy over patient selection for respective

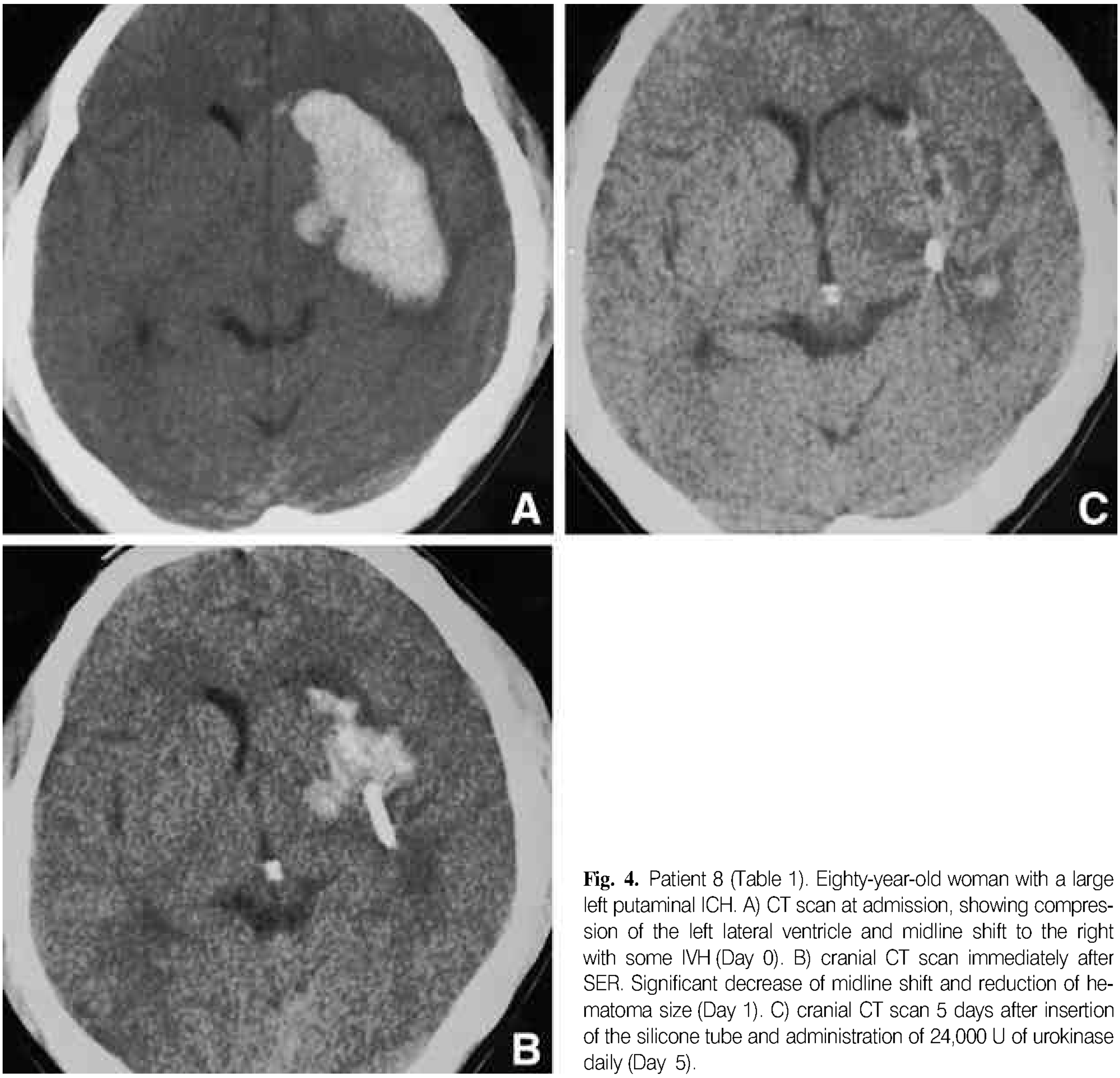

Fig. 4. Patient 8 (Table 1). Eighty-year-old woman with a large left putaminal ICH. A) CT scan at admission, showing compression of the left lateral ventricle and midline shift to the right with some IVH (Day 0). B) cranial CT scan immediately after SER. Significant decrease of midline shift and reduction of hematoma size (Day 1). C) cranial CT scan 5 days after insertion of the silicone tube and administration of 24,000 U of urokinase daily (Day 5).

treatments. It is now generally recommended in Europe and literature that patients with smaller hematomas who are alert, stable, or improving should be treated medically; patients with larger hematomas showed progressive neurologic deficit, prolonged functional impairment, and intracranial hypertension (15).

During the early stages ictus intracerebral hematomas 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 bleeding, even with the density of the clot decreasing (26, 27). This deterioration does not always respond to osmotherapy or to steroids therefore, removal of the hematoma should, ideally, be done as soon as possible (within 24 hours) to decompress (30-70 ml) and decrease ICP, to prevent secondary deterioration, and to improve perifocal vasogenic edema and local cerebral blood flow in such patients (5).

The decision as to what is the best, the mildest, and the most effective operative method is still being discussed in Europe. A direct open surgical approach seems best to evacuate large lobar hemorrhages. On the other hand, the results of such surgery for hematomas within the basal ganglia and other deep structures are unacceptable (15). The surgical approach for decompression and evacuation of the hematoma can cause further tissue damage. Elevated intracranial pressure may be decreased by surgery, improving the 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 by-products (6). Fibrinolysis aids rapid resolution of remaining blood. The aim of fibrinolysis is to achieve a mass reduction as well as to reduce the extension of perifocal edema and to minimize the amount of tissue damage. The urokinase washout can be carried out up to 7 days after bleeding (28). Mohadjer and colleagues (29, 30) have reported good results with stereotactic evacuation and urokinase lysis of cerebral and cerebellar hemorrhage, after having demonstrated that urokinase lacks neurotoxicity in an animal model (29). Lerch et al. (16), published data on 58 patients who had stereotactic puncture of spontaneous ICH. They instilled 5,000 units of urokinase after calculating the residual hematoma after aspiration was 20% of the original volume, and they repeated the administration of 5,000 units of urokinase up to six times. This led to a 15% rate of new bleeding among the 46 patients who underwent urokinase therapy. Niizuma and coworkers (17) reported a 7% rate of new bleeding. Hokama et al. (31), however, presented sufficient data supporting indications for computed tomographically guided stereotactic hematoma evacuation without subsequent lysis.

The more advanced methods for removing deep-seated hematomas are ultrasound-guided endoscopic or stereotactic subtotal evacuation, followed by the placement of a silicone catheter for urokinase washout (6). Also, stereotactically controlled endoscopic evcuation permits localization of the lesion. Removal of the clot is carried out under optic control, which may be important in cases of cryptic AVMs. This high-tech method may be simple, fast, safe, and effective, but it showed a grim results in the previous study by other authors. We thought that the details in operative procedure to be changed, because the maintenance of clean operative field and the free-handed control of suction tip or other instruments were not easy in the previous method. So we planned the operation through the specific cannula which had a side window for the various instruments including suction tip. In our series, SER made it easier to remove the hematoma and to decrease ICP than SCD. Furthermore its mortality, morbidity, and rebleeding rate were similar to SCD.

The initial level of consciousness, hemorrhage size, and intraventricular extension of blood have proven to be accurate predictors of the outcome. Less commonly, age, sex, hypertension, and mass effect may lead to harmful effects in the outcome of patients with ICH (12, 32). In our study, the level of consciousness, intraventricular extension of blood, volume of hematoma, and age correlated well with bad outcome.

Many patients from our study group showed fast improvement in the level of consciousness. This seemed to be related to a computed-tomography documented decrease in hematoma size. For such patients, the treatment could be safe and only minimally distressing. Because these patients regain a higher level of consciousness soon after treatment initiation, they can be mobilized earlier for physiotherapy, and this should lead to a decrease in secondary complications such as pneumonia or pulmonary embolism. Neurological deficits caused by eloquent tissue destruction cannot be affected by this method. Although the first results are promising, a large randomized study group is needed for evaluating of the reported methods.

In conclusion, patients suffering from spontaneous hypertensive ICH may benefit from stereotactic hematoma lysis with or without the use of endoscopy, which led to a rapid computed tomographically documented dissolution of the intracerebral clot in this study. SCD is a simple, precise, safe, and brief procedure with a very low rebleeding rate and mortality rate, but the effect of surgery seemed delayed. On the contrary, SER replaces blind procedure in SCD with similar mortality and shortens hospital stays, but we have only limited experiences. Further studies are needed.

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