Endoscopic Surgery for Intraventricular Hemorrhage (IVH) Caused by Thalamic Hemorrhage: Comparisons of Endoscopic Surgery and External Ventricular Drainage (EVD) Surgery

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Key words
- Endoscopic surgery
- External ventricular drainage
- Intraventricular hemorrhage
- Thalamic hemorrhage

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
ETV: Endoscopic third ventriculostomy
EVD: External ventricular drainage
GCS: Glasgow Coma Scale
ICU: Intensive care unit
ICH: Intracerebral hemorrhage
IVF: Intraventricular fibrinolysis
IVH: Intraventricular hemorrhage
VP: Ventriculoperitoneal

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BACKGROUND: **Intraventricular hemorrhage (IVH) caused by thalamic hemorrhage has high mortality and morbidity. The aim of this study was to investigate the efficacy and the results of endoscopic surgery for the evacuation of IVH caused by thalamic hemorrhage compared with that of external ventricular drainage (EVD) surgery.**

METHODS: **From January 2006 to December 2008, 48 patients with IVH caused by thalamic hemorrhage were enrolled and treated in our department. Patients with IVH caused by thalamic hemorrhage who also resulted in acute hydrocephalus were indicated for surgery; the patients who were included were randomly divided into an EVD group and an endoscopic surgery group. The clinical evaluation data included the Glasgow Coma Scale, length of intensive care unit (ICU) stay, age, intracerebral hemorrhage volume, and severity of IVH. Outcome was measured using the 30-day and 90-day mortality rate, ventriculoperitoneal (VP) shunt dependent rate, and Glasgow Outcome Scale after three months.**

RESULTS: **The clinical features of the 24 patients in each group showed no significant differences in age or Glasgow Coma Scale assessment on admission. There was also no significant difference in intracerebral hemorrhage volume or Graeb score between the endoscopic group and the EVD group. The length of ICU stay was 11 ± 5 days in the endoscopic surgery group and 18 ± 7 days in the EVD group. The endoscopic surgery group had a shorter ICU stay ($P = 0.04$) compared with the EVD group. The 30-day and 90-day mortality rates were 12.5% and 20.8% in the endoscopic surgery group and 12.5% and 16.6% in the EVD group, respectively. The mean Glasgow Outcome Scale score was 3.08 ± 1.38 in the endoscopic surgery group and 3.33 ± 1.40 in the EVD group. Outcome significantly correlated with initial consciousness level; the severity of IVH did not influence the outcome in all of the cases. There was no significant difference in mortality rate or outcome between the endoscopic group and the EVD group. The VP shunt rates were 47.62% in the endoscopic surgery group and 90.48% in the EVD group. Endoscopic surgery group had a significant lower VP shunt rate ($P = 0.002$; odds rate = 9.8) compared with the EVD group.**

CONCLUSIONS: **Endoscopic surgery was found to have significantly lower shunt-dependent hydrocephalus, and the ICU stay was shorter compared with EVD surgery. This can decrease the need for permanent VP shunts in patients with IVH caused by thalamic hemorrhage.**

INTRODUCTION

Hypertensive intracerebral hemorrhage (ICH) is a neurosurgical emergency frequently encountered in clinical practice. Approximately 10% to 15% of cases of ICH involve thalamic hemorrhage (1, 22). Evacuation of a thalamic hematoma by craniotomy is generally considered controversial because of the high rates of mortality and morbidity observed after this procedure. Thalamic hemorrhages are clinically significant as they are located close to the internal capsule and the ventricular system. They have been classified into medial, posterolateral, anterior and dorsal types according to the vessel involved and subsequent clinical picture (10). Many studies had found that ICH volume, intraventricular hemorrhage (IVH), hydrocephalus, Glasgow Coma Scale (GCS) and age are the best predictors for mortality and functional outcome after thalamic ICH (10, 11, 15, 20). IVH caused by thalamic hemorrhage is generally treated with external ventricular drainage (EVD) (2). However, although appropriate treatment is offered, the clinical response to EVD is not known in detail. We used endoscopy to evacuate IVH caused by thalamic hemorrhage (3). The results were promising with

Table 1. Clinical Data for the Patients with Thalamic ICH with IVH

Data	EVD (n = 24)	Endoscopic (n = 24)	*P* Value
Age	62.17 ± 10.74	65.54 ± 11.70	0.30
Initial GCS (range)	9.83 ± 3.09 (4–13)	8.54 ± 2.78 (4–12)	0.13
ICH volume (mL)	11.5 ± 9.56 (4–20)	10.5 ± 10.74 (4–25)	0.42
Graeb Score	4.54 ± 3.11 (2–8)	6.9 ± 2.98 (2–10)	0.47
ICU length of stay	18 ± 7	11 ± 5	0.04

EVD, external ventricular drainage; GCS, Glasgow Coma Scale; ICH, intracerebral hemorrhage; ICU, intensive care unit; IVH, intraventricular hemorrhage.

respect to the prevention of shunt-dependent hydrocephalus. The aim of this study was to investigate the efficacy and the results of endoscopic surgery for IVH from thalamic hemorrhage and compare them with those from EVD surgery.

MATERIAL AND METHODS

Patients

From January 2006 to December 2008, 72 patients with thalamic hemorrhage were treated in our department. All patients were screened and the surgical indication was patients with IVH from thalamic hemorrhage that caused acute hydrocephalus. Patients with thalamic hemorrhage not associated with IVH, patients with bleeding tendency, or secondary parenchymal hemorrhage were excluded. This study was prospective and randomized. The selected patients were randomly divided into two groups: an EVD group and an endoscopic surgery group.

Operation

In the EVD group, traditional EVDs were performed on patients in the supine position under local anesthesia. Patients with ventricular blood received continuous drainage at 10 cm H_2O until there was no further reduction in cerebrospinal fluid (CSF) blood content. The EVD catheter was then sequentially weaned in daily increments of 5 cm H_2O and removed. Patients were considered as having failed catheter "weaning" if they developed hydrocephalus, or if their level of conscious worsened as a result of the weaning process. Permanent ventriculoperitoneal (VP) shunt surgery was performed if patients failed EVD weaning. No intraventricular injection of an anticoagulant (eg, urokinase) was given during the procedure.

In the endoscopic surgery group, the surgical procedure was performed with the patient in the supine position with a pillow under the shoulder and the head turned approximately 60° away, while under general anesthesia. A 3-cm incision was made in the parietal-occipital scalp ipsilateral to IVH and the thalamic hematoma. A burr hole (1 cm in diameter) was drilled using the navigator system guide. A transcortical transventricular puncture was made with a 7-mm rigid endoscope sheath. When the ventricle was reached, the stylet was removed and a 2.7-mm, 0° endoscope (Storz) and a suction tube were inserted through this tube, permitting the simultaneous removal of intraventricular and thalamic hematomas. When a bleeding vessel was encountered, the suction tube was replaced with a 3-mm unipolar suction, coagulation tube to cauterize the vessel. When all procedures were complete, an EVD was left in the ventricle for 3 ± 2 days until there was no further reduction in CSF blood content after which it was removed. Permanent VP shunt surgery was performed if patients failed the "weaning" of the EVD. No urokinase was given during this procedure.

Clinical Evaluation

The clinical evaluation data included the Glasgow Coma Scale (GCS), age, ICH volume, length of ICU stay, and severity of IVH. The volume of ICH was calculated using the simplified equation $1/2A \times B \times C$, where A is the maximum width measured, B is the length, and C is the height (9). Severity of IVH was graded according to the amount of blood in each ventricle using the Graeb score of 0 to 12, which is the sum of the score in each ventricle; 4 is the maximum in each lateral ventricle, and 2 is the maximum in the third and fourth ventricles (6). The clinical data of the patients with thalamic ICH with IVH are listed in **Table 1**.

Outcome Analysis

A telephone interview was conducted with all surviving patients at the time of the study, and the outcome at 90 days after onset of the disease was determined. Patient function was evaluated using the Glasgow Outcome Scale. The 30-day and 90-day mortality rate and 90-day VP shunt dependent rates were also evaluated.

Statistical Analysis

All statistical analyses were performed using the SPSS 16.0 Statistics program. A probability value of less than 0.05 was considered statistically significant. Normally distributed data are expressed as the means ± the standard deviations and were compared using the unpaired *t* test.

Illustrative Case

A 71-year-old woman was admitted to our hospital because of an altered level of consciousness and left hemiparesis. On admission, she was drowsy (GCS score, 9). A computed tomographic scan revealed a right-sided thalamic hemorrhage with rupture into the ventricle and acute hydrocephalus (**Figure 1**). The volume of the hematoma was estimated to be 40 mL. As

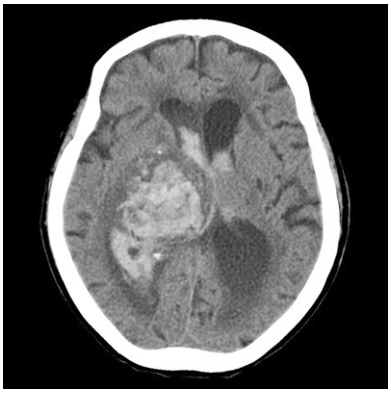

Figure 1. Preoperative axial computed tomographic scan revealing the rupture of a thalamic hematoma into the ventricle.

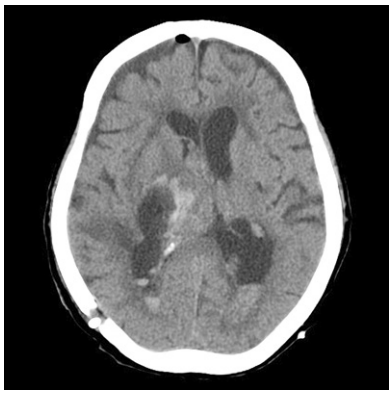

Figure 2. Postoperative axial computed tomographic scan revealing complete evacuation of the hematoma.

previously described, the patient was intubated and underwent endoscopic surgery to evacuate the hematoma. Postoperative computed tomographic scanning revealed complete removal of the thalamic hematoma (**Figure 2**). A ventricular drain was kept in place for three days after the operation. No intraventricular injection of an anticoagulant (eg, urokinase) was needed for this patient. She regained consciousness 1 week later and displayed a left-sided hemiparesis; three months later she had a Glasgow Outcome Scale of 3.

RESULTS

From January 2006 to December 2008, 48 patients with thalamic hemorrhage and IVH were enrolled and treated in our department. All the patients had hypertensive hemorrhaging. These patients were randomly divided into an EVD group and an endoscopic surgery group. The clinical features of each group are shown in **Table 1**. No significant differences in age or GCS assessment on admission were found between the two groups. There was no significant differences in ICH volume or Graeb score between the endoscopic group and the EVD group. The length of ICU stay was 11 ± 5 days in the endoscopic surgery group and 18 ± 7 days in the EVD group. Patients in the endoscopic surgery group stayed in the ICU for a shorter time ($P = 0.04$) compared with EVD group (**Table 1**).

The 30-day and 90-day mortality rates were 12.5% and 20.8% in the endoscopic surgery group and 12.5% and 16.6% in the EVD group, respectively. The mean Glasgow Outcome Scale score was 3.08 ± 1.38 in the endoscopic surgery group and 3.33 ± 1.40 in the EVD group. Outcome was significantly correlated with initial consciousness level, the severity of IVH did not influence the outcome in all cases. There was no significant difference in mortality rate or outcome between the endoscopic group and EVD group. The VP shunt rates were 47.62% in the endoscopic surgery group and 90.48 in the EVD group. The endoscopic surgery group had lower VP shunt rate ($P = 0.002$; odds rate = 9.8) compared with the EVD group (**Table 2**). There was no intracranial infection and re-bleeding after surgery in any cases, and of the total there were 10 cases in which there was an increase of hematoma observed.

DISCUSSION

Thalamic hemorrhage can be divided into four types: posterior-lateral, anterior-lateral, medial, and dorsal (10). The posterior-lateral type is the type of hemorrhage that ruptures into the trigone of the lateral ventricle. This causes obstruction of normal CSF flow and also caused acute hydrocephalus. EVD was frequently used for the relief of hydrocephalus (2). But an EVD drain can not prevent shunt-dependent hydrocephalous. Hydrocephalus is associated with poor outcome, and VP shunt surgery is hampered by several problems, including obstruction, infection, and malfunction (5, 12). From the literature review, both IVH and thalamic hemorrhagic were strong predictors for a permanent VP shunt, and approximately 66% of all thalamic hemorrhagic patients need a shunt (14). In patients with IVH caused by thalamic hemorrhage, the shunt-dependent hydrocephalus rate was higher than 66%. In our present study, 33 patients of the 48 with IVH caused by thalamic hemorrhage needed a permanent VP shunt. The shunt-dependent hydrocephalus rate was 68%, but only 47.62% patients in the endoscopic surgery group needed a VP shunt, whereas 90.48% of those in the EVD group needed shunts. Endoscopic surgery had a significantly lower shunt-dependent hydrocephalus outcome ($P = 0.002$; odds ratio 9.8).

Several strategies to prevent hydrocephalus have been reported (7, 8, 12, 16, 17, 19, 21, 24). Huttner and colleagues (8) have recently reported success in reducing VP shunt rates after ICH by using temporary lumbar drainage. Oertel and coworkers (19) addressed the value of the endoscopic third ventriculostomy (ETV) in the treatment of patients who had suffered intracranial hemorrhage with obstructive hydrocephalus. They present data on 34 ETVs in 34 patients who suffered from acute obstructive hydrocephalus caused by intracranial hemorrhage with intraventricular extension. They observed clinical and radiological improvement without intraoperative complications. Only two patients (5.9%) underwent VP shunt placement in their series. They concluded that ETV is a safe treatment option in intraventricular hemorrhage-related obstructive hydrocephalus, with similar results to external drainage, but with less risk of infection and a very low subsequent shunt placement rate. Other strategies aim to mobilize sedentary blood and enhance CSF clearance through intraventricular fibrinolysis (IVF) (16, 21, 25). EVD combined with urokinase offers a simple operation technique with less injury to cerebral cortex. Staykov et al. (21) investigated the feasibility and safety of IVF followed by early lumbar drainage (LD) for the

Table 2. Results for Patients with Thalamic ICH with IVH

Data	EVD (n = 24)	Endoscopic (n = 24)	*P* Value	Odds Ratio (95% CI)
30-day mortality rate (%)	12.5	12.5	1.0	
90-day mortality rate (%)	16.6	20.8	0.71	
GOS	3.33 ± 1.40	3.08 ± 1.38	0.54	
VP shunt rate (%)	90.48	47.62	0.002	9.8 (2.28 ~ 42.06)

CI, confidence interval; EVD, external ventricular drainage; ICH, intracerebral hemorrhage; IVH, intraventricular fibrinolysis; GOS, Glasgow Outcome Scale; VP, ventriculoperitoneal.

treatment of posthemorrhagic hydrocephalus. They concluded that IVF is safe and feasible for posthemorrhagic hydrocephalus and may markedly reduce the need for shunt surgery. In our study, we did not perform ETV during endoscopic surgery, because our endoscopic surgery is not suitable for removing third and fourth ventricle hematomas. Therefore, ETV can not be done at the end of the operation. We also did not perform IVF to hasten IVH resolution, because secondary infection and re-bleeding may result from a less accurate setting of the catheter and drainage time is longer. In our endoscopic surgery, we immediately and aggressive removed the thalamus hematoma and IVH, because hematoma volume and IVH are the prognostic factors in the thalamus ICH (10, 11, 15, 20). To avoid rebleeding, we only removed the IVH and soft thalamus clot, leaving the hard clot in the hematoma cavity (no complete evacuation of the hematoma). Our present study shows that endoscopic surgery can decrease shunt-dependent hydrocephalus from 90.48% to 47.62% in IVH caused by thalamic hemorrhage. This may be due to the fact that endoscopic surgery can remove intraventricular blood fast and also rapidly reverse ventricular dilatation and normalize intracranial pressure. Fast removal of IVH and rapid reversal of ventricle dilatation can prevent hydrocephalus from developing. These goals can be achieved with our endoscopic procedure and the complications often observed with other traditional approaches are minimized. However, in our endoscopic surgery group there were 11 patients (47.62%) that had shunt-dependant hydrocephalus and most also had higher Graeb scores. Because our endoscopic procedure can evacuate lateral ventricle hematomas, but can not evacuate those in the third and fourth ventricle, there were still some severe IVH patients that needed permanent VP shunts.

Among the prognostic factors associated with negative outcome in patients with IVH, the volume of intraventricular blood is certainly one of the most relevant (18). Therefore, efficient and rapid removal of intraventricular blood is the primary goal in the management of IVH, because it will reduce ventricular dilation and a allow re-equilibration of the CSF circulation. IVH severity influences the occurrence of acute hydrocephalus and the initial level of consciousness, which is significantly associated with prognosis. Priority treatment of IVH should be given to those ICH patients with IVH with Graeb score of 6 or more (18). Animal studies have demonstrated IVH causes inflammatory response in epidermal and subepidermal tissue layers, as well as inflammation and fibrosis of the arachnoidal villi surface (13). Therefore, fast removal of ventricular and subarachnoid blood may prevent prolonged irritation of the Pacchioni granulations and ongoing inflammatory response caused by the blood and its breakdown products. This may result in faster recovery of the granulation and avoid persistent hydrocephalus. In our series, the endoscopic group had higher Graeb scores, but the VP shunt rate is lower than in the EVD group. This may have occurred because our endoscopic procedure can remove the intraventricular blood faster, reduce ventricular dilatation, and re-equilibrate the CSF circulation, resulting in the avoidance of persistent hydrocephalus.

Thalamic hemorrhage is a severe clinical condition with an in-hospital mortality rate from 12% to 37% (4, 15), and even 52% in ventricular extensive hemorrhage (22). Altered consciousness, IVH, hydrocephalus, ICH volume, and advanced age were independent predictors of in-hospital mortality in patients with thalamic hemorrhage (10, 11, 15, 20). IVH has been found to be a strong predictor of in-hospital mortality in some studies (10, 22, 23), and IVH should be the priority treatment in thalamic hematomas with ventricular extension. The mortality rate of thalamic hemorrhage was 12% after 6 ± 6 days after stroke and 17.3% within 6 months in Mori et al's. (15) series. In Chung et al's. (4) series, the case fatality was 37% at the time of discharge. Steinke et al. (22) found that in-hospital mortality occurred in 52% of thalamic hematomas with ventricular extension and that intraventricular extension is a powerful independent predictor of mortality.

In this present study, the 30-day and 90-day patient mortality rates were between 12.5% and 20.8% for those who had thalamic hemorrhage with ventricular extension. The mortality rate was lower than in Steinke et al's (22) series. However, although endoscopic surgery can remove thalamic hematoma and IVH simultaneously, our results showed that there was no difference in mortality between endoscopic surgery and the EVD group. Some study showed that endoscopic surgery offers a better surgical outcome than EVD in IVH therapy (25), but in our present study, outcome was significantly correlated with initial consciousness level, which did not influence the severity of IVH in all patients. There was also no significant difference between endoscopic surgery and EVD surgery in IVH caused by thalamic hemorrhage.

Our study has some limitations. We did not perform ETV and IVF to reduce the need of shunt surgery. The alternative method, first of short EVD (with lysis), and then endoscopy, if possible with ETV, which was introduced by Zhang et al. (25) can perhaps reduce the need for shunt surgery and improve the prognosis in thalamus ICH patients. Further studies are necessary for this to be confirmed.

CONCLUSIONS

Both endoscopic surgery and EVD surgery can decrease the mortality rate in IVH caused by thalamic hemorrhage patients. Endoscopic surgery had a significant lower incidence of shunt-dependent hydrocephalus and a shorter ICU stay compared with EVD surgery, and this can decrease the need for permanent VP shunt in IVH caused by thalamic hemorrhage.

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