

# Clinical Efficacy and Safety of Neuroendoscopic Surgery for Severe Ventricular Thalamic Hemorrhage

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## Research Article

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# Abstract

**Objective** To summarize and analyze the clinical efficacy and safety of neuroendoscopic surgery in the treatment of patients with severe ventricular thalamic hemorrhage.

**Methods** Eighty-three patients with severe ventricular thalamic hemorrhage were treated in the Neurosurgery Department of Anqing Hospital Affiliated to Anhui Medical University from July 2019 to August 2021. Of the 83 patients, 41 underwent neuroendoscopic surgery and 42 underwent simple extraventricular drainage. The hospital stay, GCS scores on the 1<sup>st</sup> and 14<sup>th</sup> days postoperatively, the incidence of intracranial infections, and the clearance of postoperative hematomas were compared and analyzed between the two groups. The patients were followed up to 6 months. The prognosis was evaluated by the activity of daily living (ADL) score. A head CT or MRI was obtained to determine whether there was hydrocephalus, cerebral infarction, or other related complications.

**Results** The postoperative hospital stay was  $17.42 \pm 1.53$  days, the GCS score was  $6.56 \pm 0.21$  points on day 1 and  $10.83 \pm 0.36$  points on day 14, intracranial infections occurred in three patients (7.31%) and the hematoma clearance rate was  $83.6 \pm 5.18\%$  in the neuroendoscopy group, all of which were significantly better than the simple extraventricular drainage group ( $P < 0.05$ ). After 6 months of follow-up, 28 patients (68.29%) had a good prognosis, 5 patients (12.19%) died, and 4 patients (9.75%) had hydrocephalus in the neuroendoscopy group. In the extraventricular drainage group, the prognosis was good in 15 patients (35.71%), death in 12 patients (28.57%), and hydrocephalus in 17 patients (40.47%). The follow-up results showed that the good prognosis, mortality, and incidence of hydrocephalus in the neuroendoscopy group were significantly better than the extraventricular drainage group ( $P < 0.05$ ).

**Conclusion** Compared with traditional ventricular-puncture drainage, simultaneous endoscopic sinus surgery for severe ventricular thalamic hemorrhage had a higher hematoma clearance rate, fewer intracranial infections, and hydrocephalus, which together improve the clinical prognosis, and is thus recommended for clinical use.

## Introduction

Ventricular thalamic hemorrhage is a common type of intracerebral hemorrhage, accounting for 10%–20% of spontaneous intracranial hemorrhage cases<sup>[14, 9]</sup>. Acute onset, rapid progression, high mortality and disability rates, and severe ventricular thalamic hemorrhage, are all associated with obstructive hydrocephalus, intracranial hypertension, disturbance of consciousness, and even death<sup>[23]</sup>. At present, the overall curative effect for severe ventricular thalamic hemorrhage is poor. Moreover, the surgical treatment methods available for patients with ventricular thalamic hypertension are different. How to remove a thalamic and ventricular hematocoele, open the cerebrospinal fluid circulation, reduce intracranial pressure, and improve neurological symptoms are the key to successful rescue and treatment<sup>[15]</sup>. This study retrospectively summarized and analyzed 83 patients with severe intraventricular hemorrhage treated by neurosurgery in Anqing Hospital Affiliated to Anhui Medical

University from July 2019 to August 2021. Of the 83 patients, 41 underwent neuroendoscopic surgery and 42 underwent simple extraventricular drainage. The clinical data of the two groups were compared to determine the clinical efficacy of neuroendoscopic surgery in the treatment of severe intraventricular hemorrhage and improve the level of diagnosis and treatment.

## Material And Methods

### 1. Inclusion criteria and methods

Eighty-three patients with severe ventricular thalamic hemorrhage treated by neurosurgery in Anqing Hospital Affiliated to Anhui Medical University from July 2019 to August 2021 were enrolled in the current study, including 41 patients who underwent neuroendoscopic surgery and 42 patients who underwent simple extraventricular drainage. The inclusion criteria were as follows: (1) met the diagnostic criteria for ventricular thalamic hemorrhage formulated by the American Stroke Association in 2015; (2) < 75 years of age; (3) Glasgow Coma Scale (GCS) score = 4-8; (4) head CT examination confirmed spontaneous thalamic hemorrhage breaks into the ventricle, combined ventricular casting, and a Graeb score  $\geq 8$ ; (5) anesthesiologists could perform intubation tolerance surgery under general anesthesia; and (6) the patient's family members signed the informed consent form. The exclusion criteria were as follows: (1) brain stem failure, bilateral mydriasis and fixation, and inability to maintain vital signs; (2) suspected or confirmed intracranial aneurysms, arteriovenous malformations, tumor, and other causes of secondary intraventricular hemorrhage; and (3) bleeding due to coagulation dysfunction caused by blood diseases, liver diseases, infections, and drugs.

There were 41 patients in the neuroendoscopy group and 42 patients in the simple extraventricular drainage group. In the neuroendoscopy group, there were 20 males and 21 females, with an average age of  $61.3 \pm 3.9$  years, a mean preoperative GCS score of  $5.85 \pm 0.21$ , and a mean Graeb score of  $10.92 \pm 0.53$ . In the simple extraventricular drainage group, there were 22 males and 20 females, with an average age of  $62.1 \pm 4.3$  years, an average preoperative GCS score of  $5.65 \pm 0.19$ , and an average Graeb score of  $10.86 \pm 0.36$ . There was no significant difference between the two groups ( $P > 0.05$ ).

### 2. Clinical treatment

In the neuroendoscopy group, after intubation and general anesthesia was established, the patients were placed in the supine position, and ipsilateral endoscopic access was selected for thalamic hemorrhage. A transverse arc incision with a length of 5.0–6.0 cm (1 cm in front of the coronal suture, the Kocher point as the center, and a 2.5-cm radius), was made. A 2–3 cm bone flap was created with a milling cutter, the dura mater was cut, the surface of the cortex was burned in the middle of the frontal gyrus, the lateral ventricle was entered with an Endoport transparent sleeve retractor according to the puncture angle and direction of the ventricle, the sleeve was fixed, and a 0 degree endoscope was introduced into the sleeve to remove the thalamic and intraventricular hemorrhage. The insertion direction and depth of the sleeve were adjusted, the hemocele in the third ventricle was aspirated through the interventricular hole, the hemocele in the contralateral ventricle was aspirated along the damaged transparent septum, and an

indwelling ventricular drainage tube was inserted after clearing the ventricular hematoma. Intraoperative bleeding was controlled by compression. If there was active bleeding, bipolar electrocoagulation was used to obtain hemostasis.

In the simple extraventricular drainage group, the Kocher point was the puncture point. According to the amount and location of intraventricular hemorrhage, unilateral or bilateral intraventricular puncture and drainage was selected. The depth of the tube was 5.0–6.5 cm away from the cortex. Bloody cerebrospinal fluid outflow was noted intraoperatively, which was controlled by a subcutaneous tunnel and connected to a special drainage bottle for the ventricle. The two groups of patients were admitted to the neurological intensive care unit postoperatively, and were managed and treated according to neurological intensive care unit protocol.

### **3. Clinical efficacy and evaluation criteria**

A head CT was repeated within 24 h postoperatively to evaluate the degree of hematoma clearance and whether there was rebleeding. The hematoma clearance rate was calculated as follows:  $\frac{\text{preoperative hematoma volume} - \text{postoperative hematoma volume}}{\text{preoperative hematoma volume}} \times 100\%$ . GCS scores were performed on the 1st and 14th days postoperatively. The patients were evaluated for catheter-related intracranial infection, postoperative epilepsy, and cerebral infarction. The patients had follow-up evaluations for 6 months postoperatively. The follow-up evaluations included a repeat cranial CT to evaluate hydrocephalus. Prognosis was determined based on activity of daily living (ADL). If the Barthel Index (BI) was  $\geq 90\%$ , the prognosis was deemed to be good.

### **4. Statistical evaluation**

SAS 10.0 software is used for data processing and analysis, and normality test is carried out for all measurement data. The results expressed in the  $\bar{x} \pm S$ . T-test was used for comparison between groups. The counting data were expressed in percentage or number of cases.  $X^2$  test was used for comparison between groups,  $P < 0.05$  was taken as significant difference.

## **Results**

### **1. Postoperative hematoma clearance and consciousness improvement in the two groups**

Based on the head CT scan obtained 24 h after surgery, the average hematoma clearance rate in the neuroendoscopic surgery group was  $83.6 \pm 5.18\%$  and rebleeding occurred in four patients (9.75%). In the simple extraventricular drainage group, the hematoma clearance rate was  $20.6 \pm 3.05\%$ , with rebleeding in five patients (11.90%). The hematoma clearance rate in the neuroendoscopy group was significantly greater than the extraventricular drainage group ( $P < 0.05$ ). There was no significant difference in the incidence of rebleeding between the two groups ( $P > 0.05$ ). The consciousness evaluation of the two groups improved postoperatively. The GCS score in the neuroendoscopic operation group was  $6.56 \pm 0.21$

on the 1st day and  $10.83 \pm 0.36$  on the 14th day. In the simple external ventricular drainage group, the GCS score was  $5.03 \pm 0.25$  on day 1 and  $6.51 \pm 0.32$  on day 14 postoperatively. The improvement in consciousness in the neuroendoscopy group was significantly better than that the extraventricular drainage group ( $P < 0.05$ ; Table 1).

## 2. Hospital stay and incidence of intracranial infection in the two groups

The mean postoperative hospitalization time of patients in the neuroendoscopy and simple extraventricular groups was  $17.42 \pm 1.53$  days and  $26.86 \pm 2.86$  days, respectively; the difference was statistically significant ( $P < 0.05$ ). There were three (7.31%) and eight patients (19.04%) with postoperative intracranial infections in the neuroendoscopy and extraventricular drainage groups, respectively; the difference was not statistically significant ( $P > 0.05$ ; Table 1).

## 3. Clinical follow-up after surgery in the two groups after 6 months

The clinical data of the two groups were collected for 6 months. The BI was  $\geq 90\%$ , which indicated a good prognosis. In the neuroendoscopy group, 28 patients (68.29%) had a good prognosis and five patients (12.19%) died. There were four patients with hydrocephalus (9.75%), two patients with epilepsy, and three patients with cerebral infarction. In the simple extraventricular drainage group, 15 patients (35.71%) had a good prognosis and 12 patients (28.57%) died. There were 17 patients with hydrocephalus (40.47%), seven patients with epilepsy, and five patients with cerebral infarction. The follow-up results showed that the prognosis, mortality rate, and incidence of hydrocephalus in the neuroendoscopy group were significantly better than the extraventricular drainage group ( $P < 0.05$ ). There was no significant difference in the incidence of cerebral infarction and epilepsy between the two groups ( $P > 0.05$ ; Tables 1 & 2).

**Table 1.** Comparison of clinical data of patients with severe intraventricular thalamic hemorrhage between the two groups

Project	Neuroendoscopy group (n=41)	Extraventricular drainage group (n=42)	t/X <sup>2</sup>	P
<b>Age (<math>\bar{x}\pm s</math>, years)</b>	61.3 $\pm$ 3.9	62.1 $\pm$ 4.3	1.36	0.168
<b>Sex (male/female [n])</b>	20/21	22/20	2.13	0.133
<b>Evaluation before surgery (<math>\bar{x}\pm S</math> point)</b>				
GCS score	5.85 $\pm$ 0.21	5.65 $\pm$ 0.19	1.29	0.072
Greab score	10.92 $\pm$ 0.53	10.86 $\pm$ 0.36	1.86	0.062
<b>Onset time to surgery (<math>\bar{x}\pm s</math>,h)</b>	3.39 $\pm$ 0.27	3.39 $\pm$ 0.27	1.23	0.183
clearance rate of hematoma ( $\bar{x}\pm s$ %)	85.9 $\pm$ 5.93	19.8 $\pm$ 3.16	4.78	0.0019
<b>GCS after surgery (<math>\bar{x}\pm S</math> point)</b>				
GCS at 1 <sup>st</sup> day	6.56 $\pm$ 0.21	5.03 $\pm$ 0.25	3.86	0.0051
GCS at 14 <sup>th</sup> day	10.83 $\pm$ 0.36	6.51 $\pm$ 0.32	3.59	0.0071
<b>In cranial infection after surgery [n (%)]</b>	3(7.31)	8(19.04)	4.17	0.0083
<b>Rebleeding after surgery [n (%)]</b>	4(9.75)	5(11.90)	1.25	0.097
Hospitalization time ( $\bar{x}\pm s$ ,d)	17.42 $\pm$ 1.53	26.86 $\pm$ 2.86	6.13	0.0031

**Table 2.** Six-month follow-up data and results of two groups with severe ventricular thalamic hemorrhage after neuroendoscopic surgery

Project [n (%)]	Neuroendoscopy group (n=41)	Extraventricular drainage group (n=42)	t/X <sup>2</sup>	P
hydrocephalus	4(9.75)	17(40.47)	4.83	0.0019
epilepsy	2(4.87)	7(16.67)	2.05	0.093
Cerebral infarction	3(7.31)	5(11.90)	1.68	0.119
Good prognosis	28(68.29)	15(35.71)	3.56	0.0039
death	5(12.19)	12(28.57)	4.67	0.0068

## Discussion

Severe ventricular thalamic hemorrhage is characterized by acute onset, severe clinical symptoms, thalamic nerve function damage, hemorrhage entry into the ventricle, obstruction of the cerebrospinal fluid circulation, and severe hydrocephalus<sup>[6, 12]</sup>. The thalamus, fornix, basal ganglia, brainstem, and other important nerve structures are located around the ventricle. Acute intraventricular hemorrhage easily causes damage and extrusion effects of peripheral nerve structure, resulting in secondary damage<sup>[2]</sup>. Most patients have a severe disturbance of consciousness, and even clinical manifestations, such as pupil enlargement and respiratory circulation failure, the latter of which is life-threatening<sup>[8]</sup>. The location of the ventricular thalamic hemorrhage is deep and the surrounding structures are important. It is difficult to remove a hematocoele from the thalamus and ventricle, relieve the ventricular infarction, and restore the cerebrospinal fluid circulation in a timely fashion<sup>[5]</sup>. The clinical curative effect is usually poor, and the disability and mortality rates are high. According to the literature, the mortality rate of severe ventricular thalamic hemorrhage is 60%–75%<sup>[7]</sup>.

The key to the clinical treatment of severe ventricular thalamic hemorrhage is to remove the hematocoele in the thalamus and ventricle as soon as possible, reduce the intracranial pressure, restore the cerebrospinal fluid circulation, and reduce the secondary damage of important peripheral nerve structures<sup>[10, 11]</sup>. The traditional surgical treatment for severe ventricular thalamic hemorrhage most often involves simple ventricular puncture and external drainage. This surgical procedure is fast and simple, and has been mastered and adopted by most medical units. Simple ventricular puncture and external drainage has become a common method for the treatment of severe intraventricular thalamic hemorrhage<sup>[4]</sup>. Continuous drainage of bloody cerebrospinal fluid and lumbar cistern cerebrospinal fluid replacement in the middle and late stage have a positive therapeutic effect on the treatment of severe intraventricular thalamic hemorrhage<sup>[20]</sup>; however, patients with severe intraventricular hemorrhage have more intraventricular blood clots and intraventricular casting. The drainage tube outside the ventricle is easily obstructed and the drainage does not flow smoothly. It is difficult to remove a large amount of hematocoele from the thalamus and ventricle in a short time<sup>[22]</sup>. It is difficult to relieve the infarction and hematoma compression of the intraventricular system as soon as possible, so the clinical effect is not ideal. In addition, the retention time of the ventricular drainage tube is too long, which increases the risk of intracranial infection<sup>[16]</sup>. With the development and progress of neuroendoscopy technology, clinical studies have reported that removal of a hematocoele in the thalamus and ventricle through neuroendoscopy has achieved gratifying results. By integrating the advantages of modern surgery with high-definition neuroendoscopy, hematocoele in the thalamus and ventricle can be removed and smooth cerebrospinal fluid circulation can be restored with minimal invasion, which has become an effective new method for the surgical treatment of severe intraventricular thalamic hemorrhage.

In this study, 41 patients with severe intraventricular thalamic hemorrhage were treated with neuroendoscopic frontal surgery to remove hematocoele in the thalamus and ventricle. An Endoport transparent sleeve was inserted during the operation to remove hematocoele in thalamus and ventricle under direct vision. By adjusting the insertion direction and depth of the sleeve, the hematocoele in the third ventricle is aspirated through the interventricular hole, and the hematocoele in the contralateral

ventricle is aspirated along the damaged transparent septum, which can clear hematocele in the thalamus and ventricle and restore the cerebrospinal fluid circulation. Within 24 h postoperatively, the hematoma clearance rate reached 83.6%, and had a very good hematoma clearance rate. Forty-two patients with severe intraventricular thalamic hemorrhage were treated by simple extraventricular drainage. The clearance rate 24 h postoperatively was 20.6% as revealed by CT scan. There was a significant difference between the two groups. It has been reported that the effective hematoma clearance rate is 73.8%–93.5%<sup>[18]</sup>, which is consistent with the results of this study. Hematocele in the thalamus and ventricle were removed and the cerebrospinal fluid circulation was restored better in the neuroendoscopy group than the simple extraventricular drainage. The intraventricular drainage tube is retained for 3-7 days postoperatively. The retention time was shorter, and the incidence of postoperative hydrocephalus and intracranial infection was significantly reduced. According to the data of this group, the incidence of postoperative hydrocephalus and postoperative intracranial infection was 9.75% and 7.31%, respectively. In the extraventricular drainage group, the drainage tube was retained for a longer time and the hematoma was difficult to be removed in a short time. Some patients required urokinase lavage. The incidence of postoperative hydrocephalus and intracranial infection was higher. The incidence of postoperative intracranial infection was 19.04% and the incidence of hydrocephalus was 40.47%. There were significant differences between the two groups. Kellner et al. compared neuroendoscopic hematoma removal and simple ventricular drainage in the treatment of patients with moderate and severe ventricular thalamic hemorrhage<sup>[13]</sup>. The former had a shorter drainage tube placement time and lower postoperative hydrocephalus and intracranial infection rate. Neuroendoscopy has many advantages. Neuroendoscopy can provide good lighting during deep operation of brain tissue, a good field of view, and no dead corners. Bleeding points can be found in some patients intraoperatively<sup>[19]</sup>. In the case of venous bleeding, cotton pieces and hemostatic gauze can be pressed to control bleeding. In case of active arterial bleeding, bipolar electrocoagulation and cauterization can effectively reduce the incidence of postoperative rebleeding. According to the data of this study, the incidence of postoperative rebleeding in the neuroendoscopy group was 9.75%, and the incidence of postoperative rebleeding in the extraventricular drainage group was 11.90%.

In this study, with the improvement in postoperative GCS score and follow-up at 6 months, the improvement in postoperative GCS and ADL scores in the neuroendoscopy group were significantly better than the simple extraventricular drainage group. Neuroendoscopic treatment of patients with severe intraventricular thalamus hemorrhage can improve the prognosis and the quality of life, and reduce the mortality. Neuroendoscopic treatment can effectively clear a hematocele from the thalamus and ventricle, reduce intracranial pressure, restore the cerebrospinal fluid circulation, reduce secondary nerve injury, and effectively reduce the incidence of postoperative hydrocephalus and intracranial infection.

With good illumination, neuroendoscopy can be performed under direct vision to remove a hematocele from the thalamus and ventricle<sup>[1]</sup>. The choice of the surgical approach<sup>[1]</sup> is very important. The common approaches reported in the literature include the transtriangular, transfrontal, and transoccipital approaches<sup>[21]</sup>. It is difficult to remove a hematoma<sup>[21]</sup> in the anterior horn of the lateral ventricle through the

triangular and occipital approaches, which cannot unblock the interventricular foramen effectively, the lateral or prone position is often required, and the placement of the body position is time-consuming and cumbersome. In this study, the middle frontal gyrus approach through the Kocher point was used, and the Endoport endoscopic sleeve was inserted, which can better enter the ventricle for endoscopic procedures. The middle frontal gyrus is a non-functional area with few blood vessels. The operation had little damage to nerve function, which was easy to master and in line with the concept of micro-invasion.

During endoscopic surgery, we should be familiar with the anatomy of the ventricle and surrounding structures<sup>[3]</sup>. First, the ventricular wall should be identified, the orientation determined, and the blood and blood accumulation in the ipsilateral lateral thalamus and contralateral ventricle along the hematoma should be removed to avoid damaging the choroid plexus, collicular vein, and transparent septal vein in the ventricle. Unnecessary damage to important nerve structures, such as the thalamus, fornix, and corpus callosum, should be avoided. For patients with severe casting of hematic fluid in the fourth ventricle, the effect of supratentorial intraventricular hematoma removal through neuroendoscopy is often poor, and obstruction of the cerebrospinal fluid circulation in the fourth ventricle is difficult to restore. The fourth ventricle hematoma should be removed through the posterior occipital median membrane using the same approach at the same time to restore the cerebrospinal fluid circulation, relieve the compression on the brainstem, and improve the success rate of rescue<sup>[17]</sup>.

In conclusion, it was feasible and effective to treat patients with severe intraventricular thalamus hemorrhage complicated with casting through Kocher point using the middle frontal gyrus approach. Compared with the traditional external drainage of the ventricle, it had a higher hematoma clearance rate, fewer intracranial infections and hydrocephalus. It could improve the prognosis of the patients, which was suitable for clinical use.

## Declarations

**Funding:**The clinical science research fund of Anhui Medical University ,*Anhui Province, PR China*(2019xkj225).

### Disclosure -Conflict of Interest

We confirm that all authors of this manuscript have directly participated in planning, execution, and analysis of this study.

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We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work.

## **Availability of data and material**

When authors submit a paper to a journal, the authors agree that the data provided in the publication, including the relevant raw data, will be freely available to any researcher who wants to use these for non-commercial reasons without jeopardising participant anonymity. All data generated or analysed during this study are included in this published article

**Code availability** (Not applicable)

## **Ethical approval**

Project name: Clinical efficacy and safety of neuroendoscopic surgery for severe ventricular thalamic hemorrhage

The main content of the involved in clinical research:

This project is to summarize and analyze the clinical efficacy and safety of neuroendoscopic surgery in the treatment of patients with severe ventricular thalamic hemorrhage. Its material and the results of the study for the purpose, there is no conflict of interest.

## **Ethical review opinions:**

The ethics committee review, the research of experimental design and scheme fully considering the safety and fairness principle, its research content will not cause harm to patients and risk. In patients under the principle of informed consent and will do my utmost to protect patients' rights and privacy, the research content and results there is no conflict of interest.

## **Consent to participate**

The experimental protocol was established, according to the ethical guidelines of the Helsinki Declaration and was approved by the Human Ethics Committee of Anqing Hospital Affiliated to Anhui Medical University. Written informed consent was obtained from individual or guardian participants.

## **Consent for publication**

Any person or any data of any person in this article has obtained consent and agreed to publish

## **Authors' contributions**

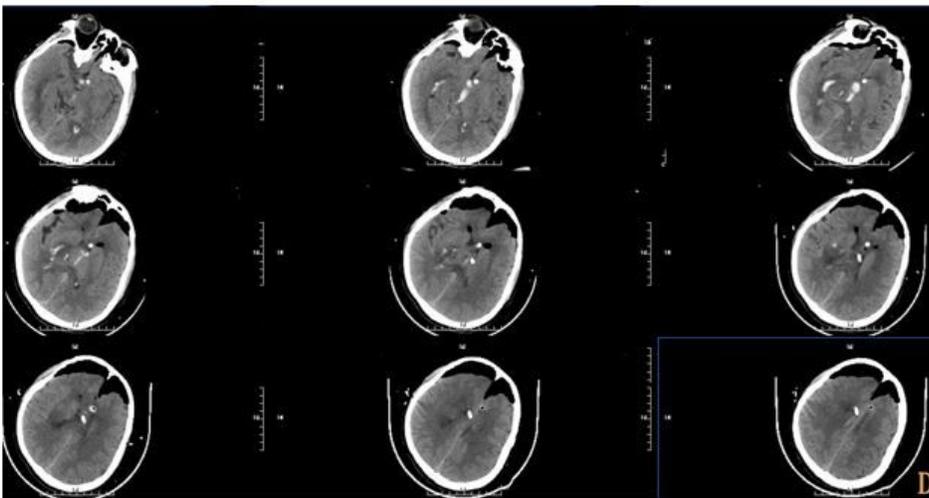
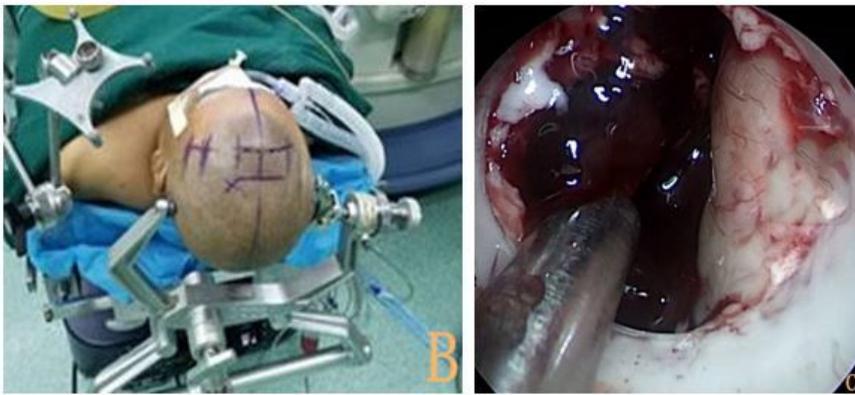
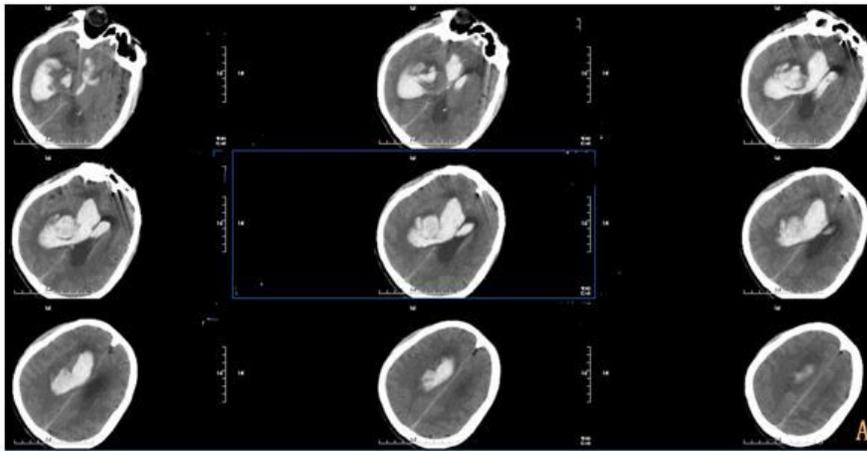
In this study, Heping Zhou completed the method design, operation and data analysis, Zhengjiang Cha participated in the operation implementation and technical guidance, Lei Wang completed the data analysis and statistics, min Chen participated in the method design and project implementation, and Qingchao Zhang and Jian Tang completed the patient tracking and follow-up. All authors read and approved the final manuscript.

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## Figures



**Figure 1**

Before and after neuroendoscopic surgery for severe ventricular thalamic hemorrhage: A: preoperative head CT images of severe ventricular thalamic hemorrhage, thalamic hemorrhage, and ventricular hemorrhage casting. B. position and incision of neuroendoscopic surgery for severe ventricular thalamic hemorrhage C: hematoma morphology and ventricular-related anatomic structure during

neuroendoscopic surgery. D: CT images of the head postoperatively of severe ventricular thalamic hemorrhage, removal of hemorrhage, and recovery of ventricular morphology.