

# Endoscopic assisted key-hole surgery for subacute subdural hematoma evacuation in emergency situations

guo-chen Sun

PLA Army General Hospital

Chong Li

PLA Army General Hospital

Hao Tang

PLA Army General Hospital

Ke-fan Yi

PLA Army General Hospital

Fang-ye Li

PLA Army General Hospital

Bai-nan Xu

PLA Army General Hospital

xin-guang yu (✉ [sgc3130@126.com](mailto:sgc3130@126.com))

PLA General Hospital

---

## Research article

**Keywords:** endoscopic key-hole surgery; subacute subdural hematoma; evacuation; emergency situations

**Posted Date:** February 13th, 2020

**DOI:** <https://doi.org/10.21203/rs.2.23501/v1>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

Background Endoscopic removal of subacute subdural hematoma is seldom performed, but there is no standard technique till date. We investigated whether a simple endoscopic method is effective for the evacuation of subacute subdural hematoma. Methods A total of 51 patients with subacute subdural hematoma requiring surgery were enrolled in this study. Endoscopic hematoma evacuation was performed through a small bone window for 22 patients. Hematoma evacuation by open surgery was performed in 29 patients. Pre- and postoperative Glasgow coma scale (GCS), operation time, displacement of midline, and intraoperative blood loss were recorded and analyzed. Results The median time from incision to suture completion was 40 min (range: 31.25–43.75 min) for endoscopic group, and 70 min (range: 65–80 min) for open surgery group ( $P<0.01$ ). The average total blood loss was 50(30-50) ml for endoscopic group, and 250(200-300) ml for open surgery group ( $P<0.01$ ). No patient showed postoperative re-bleeding in both groups. The mean preoperative mid-line displacement for the two groups was  $11.51\pm 3.51$ mm for study group vs  $10.47\pm 2.93$ mm for control group ( $P>0.05$ ). Mid-line displacement showed significant improvement on the day after surgery to  $5.29\pm 1.91$ mm for study group vs  $6.75\pm 1.37$ mm for control group ( $P<0.01$ ). At 1-month follow-up, the midline was normal in both groups. Computed tomography revealed almost no residual hematoma, representing an average evacuation rate of 100% in both groups. The mean preoperative GCS score was 13(12.25,15) for study group vs 13(12,14) for control group ( $P>0.05$ ). GCS score on the day after the operation was improved to 15 for each patient in endoscopic surgery group, while 15(14,15)in the open surgery group ( $P<0.01$ ). Conclusions Endoscopic subacute subdural hematoma removal through a small bone window achieved a satisfactory hematoma removal with minimally invasive method when compared to open surgery.

## Introduction

Cranioplastic craniotomy, or even large decompressive craniectomy is needed for removing the acute subdural hematoma.<sup>2,3,5,6</sup> The surgical approach that is used for chronic cases is the [Burr-Hole Drainage](#),<sup>8</sup> whereas subacute cases were treated by craniotomy or [Burr-Hole Drainage](#). [Burr-Hole Drainage](#) is a less invasive procedure that is performed after complete liquefaction of the hematomas.<sup>7</sup> We herein reported cases of subacute subdural hematoma requiring emergency surgery due to progressive neurological dysfunction or patients with a decreased level of consciousness. These patients were treated by means of small bone window craniotomy endoscopic hematoma evacuation, and achieved satisfactory results.

## Methods

### *Patient population*

A total of 22 patients were included in the study group, another 29 patients were enrolled as control group. Preoperative hematoma volume and postoperative residual hematoma volume were calculated automatically with 3DSlicer software (<https://www.slicer.org/>). Pre- and postoperative GCS, bleeding

volume, operation time, and intraoperative blood loss were recorded. The study protocol was approved by the Hospital Ethics Committee (PLA General Hospital, Beijing China) and patients or their family members provided informed, written consent.

### *Inclusion and exclusion criteria*

Patients with subacute subdural hematoma requiring surgery (based on the number of days from the time of injury and hematoma density from a cranial computed tomography [CT] scan) were included in the study. Patients with severe clotting disorders or for whom extensive craniotomy/craniotomy was contraindicated were excluded.

### *Localization of a small bone window*

In the study group, For the most common frontal-temporal-parietal subdural hematoma, a bone window with diameter about 3.5cm was created posterior to the parietal protuberance since this allowed the hematoma to be viewed and removed more easily. For more limited cases, an optimal position near the hematoma center was selected based on surface projection of the hematoma within the head. for the control group, a relatively larger bone flap which can nearly cover the hematoma was designed.

### *Surgical procedure*

An arc incision was made around the intended bone flap (which was opened forward to prepare for large bone craniotomy). After local anesthesia, the scalp was cut and a hole was drilled using a milling cutter to create a bone flap of about 3–3.5 cm in diameter. The dura and outer neomembranes of hematoma were cut open, resulting in liquefied hematoma outflow. An endoscopic aspirator was used to aspirate the solid hematoma visibly. The cavity was irrigated with warm saline until it was clean and there was no active bleeding. Drainage tube placement was monitored endoscopically, after which the dura was sutured, the bone flap replaced, and the scalp sutured. For the control group, the hematoma was evacuated and closed as common open surgery way.

### *Bipolar electrocoagulation with attractor*

Since the bone window was small, the operation space was limited. We therefore developed a suction device with a bipolar coagulation function (Fig. 4) that allowed the surgeon to hold the endoscope in the left hand while using the right hand to perform hemostasis, thereby improving the efficiency of the procedure. Once the site of bleeding was identified, the blood was easily removed during coagulation. This method overcame the shortcomings of a one-handed operation that does not allow the surgeon to simultaneously perform the suction and stop the bleeding.

### *Imaging follow-up*

Brain CT scans were performed on the day after and 1 month after surgery. 3DSlicer software was used to calculate the volume of hematoma, midline shift recovery changes.

## *Statistics*

Pre- and postoperative GCS, operation time, Displacement of midline, and intraoperative blood loss were recorded and analyzed.  $P < 0.05$  was considered statistically significant. Data were analyzed using SPSS v.19.0 software (SPSS Inc., Chicago, IL, USA).

## **Results**

The median time from incision to suture completion was 40 min (range: 31.25–43.75 min) for endoscopic group, and 70 min (range: 65–80 min) for open surgery group ( $P < 0.01$ ). The average total blood loss was 50(30-50) ml for endoscopic group, and 250(200-300) ml for open surgery group ( $P < 0.01$ ). No patient showed post-operative re-bleeding in both groups. The mean preoperative mid-line displacement for the two groups was  $11.51 \pm 3.51$  mm for study group vs  $10.47 \pm 2.93$  mm for control group ( $P > 0.05$ ). Mid-line displacement showed significant improvement on the day after surgery to  $5.29 \pm 1.91$  mm for study group vs  $6.75 \pm 1.37$  mm for control group ( $P < 0.01$ ). At 1-month follow-up, the midline was normal in both groups. Computed tomography revealed almost no residual hematoma, representing an average evacuation rate of 100% in both groups. The mean preoperative GCS score was 13(12,25,15) for study group vs 13(12,14) for control group ( $P > 0.05$ ). GCS score on the day after the operation was improved to 15 for each patient in endoscopic surgery group, while 15(14,15) in the open surgery group ( $P < 0.01$ ). Patient details are shown in Table 1.

### *Case 1*

A 63-year-old male patient was admitted to our hospital following traumatic brain injury. He had undergone left carotid artery stent implantation 2 years before, and was on antiplatelet therapy since that time. Brain CT at the time of admission revealed a left frontal-temporal-parietal acute subdural hematoma with a midline offset of 0.84 cm (Fig. 1A). As the patient had no neurological dysfunction, he was given a conservative treatment. After 1 week, the patient exhibited a decreased level of awareness and abnormal behavior, and an emergency brain CT suggested a significant shift in the midline by about 1.31 cm (Fig. 1B). Endoscopic hematoma removal from the small bone window near the parietal protuberance was performed (Fig. 1F). The diameter of the bone window was about 3.5 cm (Fig. 1C). Brain CT performed on the next day revealed satisfactory hematoma evacuation, with a midline displacement of 0.63 cm (Fig. 1D). The patient regained full consciousness and fluency in his speech, and brain CT after 1 month surgery revealed a normal midline (Fig. 1E).

### *Case 2*

A 35-year-old woman was admitted to our hospital with severe headache that persisted for 10 days. A brain CT revealed a space-occupying lesion with mixed density in the right frontal lobe (Fig. 2E), and a brain magnetic resonance imaging scan showed short T1 (Fig. 2A), long T2 (Fig. 2B), and a strong signal on the T2-flair image (Fig. 2C). A diffusion-weighted scan indicated that the lesion was a mixed signal, with the main lesion showing a strong signal (Fig. 2D) and the enhanced scan showing a slightly

enhanced circular area (Fig. 2F). The lateral ventricle was compressed and the midline was shifted, suggesting a subacute subdural hematoma. The distance of the midline shift was determined to be 0.86 cm from the preoperative T2 image (Fig. 3A). Based on the location of the hematoma, a bone flap of 3 cm in diameter was created at a lateral position to the sagittal plane of the head and nearly parallel to the ground (Fig. 3D), and this was 4 cm next to the midline with its center at the coronal seal. This was positioned in such a way to remove the hematoma from the posterolateral partition of the lesion. We observed that most of the hematoma did not liquefy, and after complete endoscopic removal of the hematoma and repeated washes with saline, a drainage tube was placed (Fig. 3E). The brain CT scan performed on the following day showed complete clearance of the hematoma and reduction in the midline shift to about 0.26 cm (Fig. 3B). A brain CT scan performed 1 month later, which revealed brain tissue regeneration (Fig. 3F) and a normal midline (Fig. 3C).

## Discussion

The incidence of subacute subdural hematoma (SSH) is increasing in our aging society. As we all know, many patients were treated with anticoagulants or antiplatelets prior to injury. Traumatic brain injury (TBI) patients with antiplatelet and anticoagulant were associated with increased risk of delayed hematoma enlargement, leading to the risk of increased morbidity and mortality. Creation of a large bone flap during craniotomy for evacuation of hematoma might be due to more trauma and bleeding than burr hole surgery<sup>12</sup>. Evacuation cannot be achieved by burr hole drainage if the hematoma is not fully liquefied. There is currently no standard approach for the treatment of subacute subdural hematomas.<sup>4,10,13</sup>

We previously reported that endoscopic removal of intracerebral hematomas arising from spontaneous non-vascular malformations achieved satisfactory results.<sup>9</sup> In this study, endoscopic removal of subacute subdural hematomas was performed. The small bone window created in the present study group was slightly larger than that made in burr hole drainage, but a much smaller window was created than that used in common bone flap craniotomy in control group.

### *Feasibility of endoscopic subacute subdural hematoma removal through a small bone window*

When only a part of the hematoma is liquefied, burr hole drainage cannot achieve complete evacuation. Since the brain tissue is compressed for a relatively prolonged period of time, it does not immediately recover during the hematoma removal. So, the surgeon has enough space to remove the hematoma that is located in the proximal to distal of the bone window. As there is no active bleeding at this stage. The neurosurgeon does not require searching for the bleeding point after hematoma evacuation most of the time.<sup>1</sup>

### *Advantages of endoscopy*

Endoscopic subacute subdural hematoma removal through small bone window can overcome the shortcomings of burr hole drainage, wherein the inner part of the hematoma capsule cannot be observed.

The endoscope allows easy removal of the hematoma under direct visualization through a small bone window, ensuring safety of the operation. Coagulation at the bleeding site can be induced by an aspirator with bipolar hemostasis capability. The endoscope can guarantee optimal position of the drainage tube.<sup>11</sup>

### *Hematoma removal skills*

After opening the dura, evacuation of the hematoma was facilitated by endoscope-guided suction under direct visualization. In some patients, a bridge vein was observed in the capsule cavity, wherein a great care should be taken to avoid injury. The hematoma cavity can be repeatedly rinsed with Ringer's solution until the water turns clear to reduce the osmotic pressure of the hematoma capsule. Aspiration should be gentle and meticulous to avoid brain injury and bridge vein damage. If bleeding occurs, electrocoagulation for hemostasis can be induced by bipolar hemostasis by using a suction device. After endoscopic placement of a drainage tube within the capsule in the optimal position, the periosteum can be removed to repair the dura and prevent the entry of epidural blood into the hematoma capsule. The bone flap is then replaced and fixed.

In this study, the median time from incision to suture completion was 40 min (range: 31.25–43.75 min) for endoscopic group, and 70 min (range: 65–80 min) for open surgery group ( $P < 0.01$ ). Moreover, the endoscopic surgery was more micro-invasive, causing less iatrogenic injury, with less intraoperative bleeding and better GCS recovery the day after surgery.

Patients with acute subdural hematoma were excluded from this study due to the following reasons. 1) In cases with acute subdural hematoma, the hematoma volume continued to increase, making the site of bleeding difficult to find; and sometimes the combined brain contusion injury requires evacuation. 2) These patients often had high brain pressure during hematoma evacuation, with quick brain tissue swelling. This would in turn make the removal of distant hematoma through the bone window difficult or would require stretching of the brain by brain retractor to create working canal, probably leading to tissue damage. 3) In some of these patients, decompression of the bone flap is needed, which is not possible by our endoscopic method.

Although endoscopic evacuation of subacute subdural hematomas is promising, the sample size in the present study was small. So, a prospective randomized controlled study is warranted to more thoroughly evaluate the effectiveness of this approach.

## **Conclusion**

In summary, endoscopic subacute subdural hematoma removal through a small bone window achieved a satisfactory result.

## **Abbreviations**

GCS= Glasgow Coma Scale TBI= Traumatic brain injury SSH=subacute subdural hematoma

## Declarations

### Ethics approval and consent to participate

The study protocol was approved by the Hospital Ethics Committee (PLA General Hospital, Beijing China) and patients or their family members provided informed, written consent.

### Consent for publication

Not applicable

### Competing interests

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

### Funding

- The research was supported by Supported by
- Hainan Provincial Natural Science Foundation of China(819QN378) ;
- Natural Science Foundation of Hainan Province (20168362);
- National Natural Science Foundation of China (81271515);
- Key Research and Development Project of Hainan Province (ZDYF2016118)

### Authors' contributions

Conception and design: Yu, Xu. Acquisition of data: Yu, Sun, Tang, Ch Li. Analysis and interpretation of data: Yu, FY Li. Drafting the article: Yu, Sun. Critically revising the article: Yu. Reviewed submitted version of manuscript: Yu. Approved the final version of the manuscript on behalf of all authors: Yu. Statistical analysis: Yu, Sun. Administrative/technical/material support: Yu, Chen. Study supervision: Yu, Xu.

### Acknowledgements

We thank the members of the Department of Neurosurgery,PLA General Hospital (Zhe Xue, MD; Xuan Zheng, MD), for their collaborative support.

## References

1. Boyaci S, Gumustas OG, Korkmaz S, Aksoy K: Endoscopic Evacuation of Subdural Collections. Turk Neurosurg 26:871-877, 2016

2. Chrastina J, Šilar Č, Zeman T, Svoboda M, Krajsa J, Musilová B, et al: Reoperations after surgery for acute subdural hematoma: reasons, risk factors, and effects. *Eur J Trauma Emerg Surg*. 2019 Jan 23. doi: 10.1007/s00068-019-01077-6. [Epub ahead of print]
3. Koliass AG, Viaroli E, Rubiano AM, Adams H, Khan T, Gupta D, et al: The current status of decompressive craniectomy in traumatic brain injury. *Curr Trauma Rep* 4:326-332, 2018
4. Kpelao E, Beketi KA, Moumouni AK, Doleagbenou A, Ntimon B, Egbohoun P, et al: Clinical profile of subdural hematomas: dangerousness of subdural subacute hematoma. *Neurosurg Rev* 39:237-240; discussion 240, 2016
5. McGinity MJ, Michalek JE, Rodriguez JS, Floyd JR: Surgical evacuation of acute subdural hematoma in octogenarians: a ten-year experience from a single trauma center. *Br J Neurosurg*:1-4, 2017
6. Miki K, Abe H, Morishita T, Hayashi S, Yagi K, Arima H, et al: Double-crescent sign as a predictor of chronic subdural hematoma recurrence following burr-hole surgery. *J Neurosurg*. 4:1-7, 2019
7. Sivaraju L, Moorthy RK, Jeyaseelan V, Rajshekhar V: Routine placement of subdural drain after burr hole evacuation of chronic and subacute subdural hematoma: a contrarian evidence based approach. *Neurosurg Rev*, 2017
8. Soleman J, Kamenova M, Lutz K, Guzman R, Fandino J, Mariani L: Drain Insertion in Chronic Subdural Hematoma: An International Survey of Practice. *World Neurosurg*, 2017
9. Sun GC, Chen XL, Hou YZ, Yu XG, Ma XD, Liu G, et al: Image-guided endoscopic surgery for spontaneous supratentorial intracerebral hematoma. *J Neurosurg*:1-6, 2016
10. Takeuchi S, Takasato Y, Otani N, Miyawaki H, Masaoka H, Hayakawa T, et al: Subacute subdural hematoma. *Acta Neurochir Suppl* 118:143-146, 2013
11. Ueba T, Yasuda M, Inoue T: Endoscopic burr hole surgery with a curettage and suction technique to treat traumatic subacute subdural hematomas. *J Neurol Surg A Cent Eur Neurosurg* 76:63-65, 2015
12. Vega RA, Valadka AB: Natural History of Acute Subdural Hematoma. *Neurosurg Clin N Am* 28:247-255, 2017
13. Yeo CG, Jeon WY, Kim SH, Kim OL, Kim MS: The Effectiveness of Subdural Drains Using Urokinase after Burr Hole Evacuation of Subacute Subdural Hematoma in Elderly Patients: A Preliminary Report. *Korean J Neurotrauma* 12:101-106, 2016

## Table

Table 1. Statistical Analysis of parameters Between 2 Groups

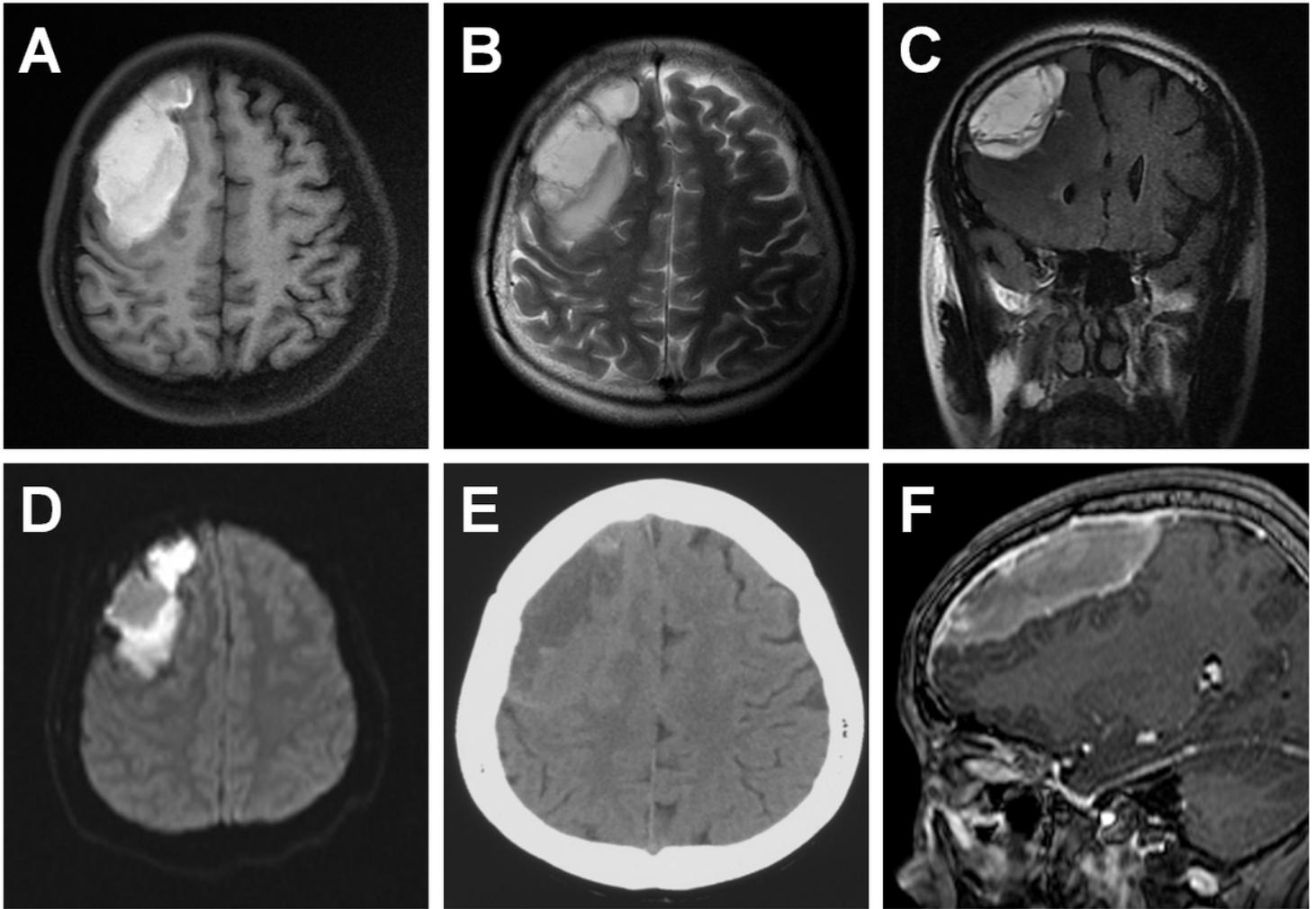
	Study group	Control group	Statistical Analyses	P Value
age lateral(L/R)	51.23±17.46 14/8	51.45±14.73 17/12	t=-0.0496 fisher's exact test	p=0.961 P=0.778
gender[F/Total] Volume (ml)	12/22 101.23±43.34	16/29 103.97±32.15	fisher's exact test t=-0.260	P=0.594 p=0.796
Preoperative displacement of midline (mm)	11.46±3.55	10.47±2.93	t=1.087	p=0.282
Displacement of midline (day after surgery, mm)	5.21±1.98	6.75±1.37	t=-3.116	p=0.004
Duration of surgery(min)	40[31.25,43.75]	70[70,80]	z=-6.100	p=0.000
bleeding(ml)	50[30,50]	250[200,300]	z=-6.169	p=0.000
Preoperative GCS	13[12.25,15]	13[12,14]	z=-1.476	p=0.140
GCS 1 day after surgery	15[15,15]	15[14,15]	z=-3.416	p=0.001

## Figures



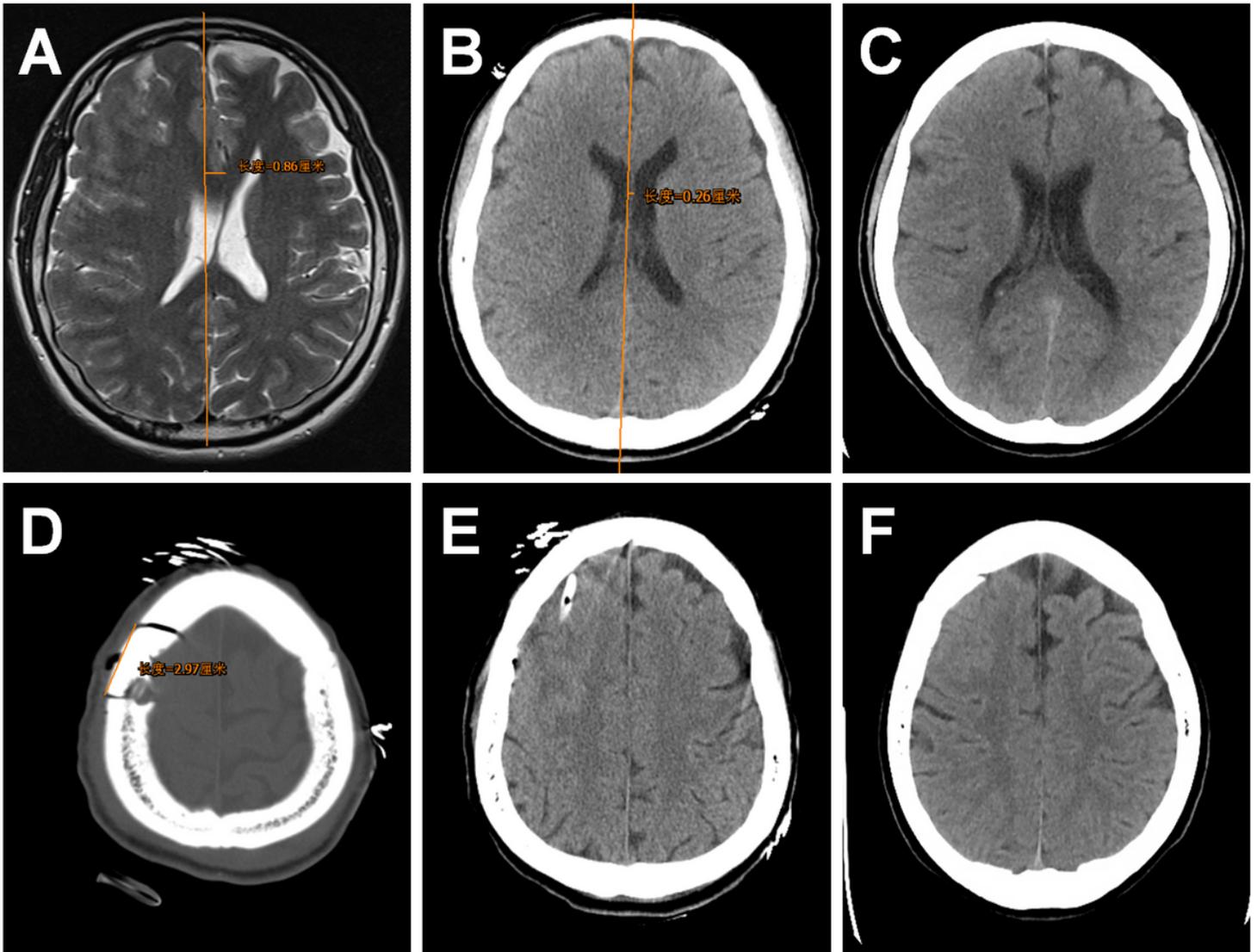
### Figure 1

Fig. 1A Brain CT at the time of admission revealed a left frontal-temporal-parietal acute subdural hematoma with a midline offset of 0.84 cm. Fig. 1B Emergency brain CT after 1 week suggested a significant shift in the midline by about 1.31 cm. Fig. 1C Endoscopic hematoma removal of hematoma from the small bone window with diameter of 3.5 cm Fig. 1D : Brain CT performed on the day after surgery revealed satisfactory hematoma evacuation, with a midline displacement of 0.63 cm Fig. 1F: Endoscopic suction of hematoma Fig. 1E: Brain CT 1 month after surgery revealed a normal midline



**Figure 2**

Brain CT revealed a space-occupying lesion with mixed density in the right frontal lobe (Fig. 2E), and a brain magnetic resonance imaging scan showed short T1 (Fig. 2A), long T2 (Fig. 2B), and a strong signal on the T2-flair image (Fig. 2C). A diffusion-weighted scan indicated that the lesion was a mixed signal, with the main lesion showing a strong signal (Fig. 2D) and enhanced scan showing a slightly enhanced circular area (Fig. 2F).



**Figure 3**

Fig. 3A: The distance of the midline shift was determined to be 0.86 cm from the preoperative T2 image. Fig. 3B: The brain CT scan performed on the following day showed complete clearance of hematoma and reduction in the midline shift to about 0.26 cm. Fig. 3C, F: Brain CT scan performed 1 month later revealed brain tissue regeneration and a normal midline. Fig. 3D: A bone flap of 3 cm in diameter was made to remove the hematoma Fig. 3E: After complete removal of the hematoma, a drainage tube was placed with the guidance endoscope.



**Figure 4**

The suction device with bipolar coagulation function is used in the study.