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ORIGINAL ARTICLE

Observational Study

# Efficacy evaluation of neuroendoscopy *vs* burr hole drainage in the treatment of chronic subdural hematoma: An observational study

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## Abstract

### *BACKGROUND*

Chronic subdural hematoma (CSDH) is a common disease in neurosurgery. The traditional treatment methods include burr hole drainage, bone flap craniectomy and other surgical methods, and there are certain complications such as recurrence, pneumocephalus, infection and so on. With the promotion of neuroendoscopic technology, its treatment effect and advantages need to be further evaluated.

### *AIM*

To study the clinical effect of endoscopic small-bone approach in CSDH.

### *METHODS*

A total of 122 patients with CSDH admitted to our hospital from August 2018 to August 2021 were randomly divided into two groups using the digital table method: the neuroendoscopy group (*n* = 61 cases) and the burr hole drainage group (*n* = 61 cases). The clinical treatment effect of the two groups of patients with CSDH was compared.

### *RESULTS*

At the early postoperative stage (1 d and 3 d), the proportion of 1/2 re-expansion of brain tissue in the hematoma cavity and the proportion of complete re-expansion was higher in the neuroendoscopy group than in the burr hole drainage group, and the difference between the two groups was statistically significant ($P$ < 0.05). The recurrence rate of hematoma in the neuroendoscopy group was lower than that in the burr hole drainage group, and the difference between the two groups was statistically significant ($P$ < 0.05). No intracranial hematoma, low cranial pressure, tension pneumocephalus or other complications occurred in the neuroendoscopy group.

*CONCLUSION*

The neuroendoscopic approach for the treatment of CSDH can clear the hematoma under direct vision and separate the mucosal lace-up. The surgical effect is apparent with few complications and definite curative effect, which is worthy of clinical promotion and application.

**Key Words:** Neuroendoscopy; Small bone window approach; Chronic subdural hematoma; Curative effect; Burr hole drainage



**Core Tip:** Minimally invasive neuroendoscopic surgery uses smaller surgical incisions and bone windows to achieve effective removal of intracranial hematoma, minimal trauma to brain tissue and effective reduction of recurrence rate. Due to variations in hematoma site, shape, size and degree of clots, the location of the bone hole and approaches for minimally invasive endoscopy are different for each patient. To better treat chronic subdural hematoma patients using minimally invasive neuroendoscopy, we use computed tomography scanning to locate chronic subdural hematoma and select the best endoscopic micro-mirror approach before performing minimally invasive neuroendoscopic surgery and analyzed the clinical data and treatment efficacy.

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## INTRODUCTION

Chronic subdural hematoma (CSDH) is a common disease in the neurosurgery department. At present, the specific mechanism of CSDH is still unclear, and there are quite a few theories such as inflammation. There are many studies on the treatment of CSDH, and surgical treatment is still advocated at present. Burr hole drainage has been the main surgical approach for clinical treatment[1-4]. Nevertheless, for CSDH with separation, organization or subacute, the treatment effect is poor[5,6]. It often needs to be converted to craniotomy, and it is reported that there is still a 5%-33% recurrence after burr hole drainage[7-10].

With the continuous improvement and promotion of neuroendoscopy technology and the use of new camera systems and instruments, the conditions for the treatment of CSDH through the small bone window approach under neuroendoscopy have been met[11]. In this paper, the therapeutic effect of the small bone window approach under neuroendoscopy for CSDH was compared with the technique of burr hole drainage to understand the technical key points and evaluate the curative effect. The results of a study of 122 patients with CSDH treated from August 2018 to August 2021 were reported.

## MATERIALS AND METHODS

### Ethics approval and consent to participate

This study was reviewed and approved by the Ethics Committee of our hospital. Informed consent was obtained, and this investigation was conducted according to the principles expressed in the Declaration of Helsinki. The authors obtained written informed consent from all patients or their legal guardian.

### Trial design

The study was a prospective, controlled, randomized, monocentric, clinical trial in patients with symptomatic CSDH that required surgical evacuation.

### General data

A prospective cohort study of CSDH patients admitted to our hospital from August 2018 to August 2021 was established based on inclusion criteria and exclusion criteria. The inclusion criteria were as follows: (1) Age 30-85 years; (2) Willing to choose neuroendoscopy or burr hole drainage surgery and agreed to participate in the study follow-up; (3) The clinical manifestations were headache, nausea, vomiting and decreased limb strength; (4) No history of head trauma surgery; (5) No history of oral atorvastatin treatment; (6) Skull computed tomography (CT) or magnetic resonance imaging excluded intracranial tumors, acute cerebral parenchymal hemorrhage or infarction; and (7) No serious systemic disease (untreated or uncontrolled hypertension, diabetes, severe heart, liver, lung and/or kidney disease). The exclusion criterion was if any of the above conditions were not satisfied. According to the voluntary will of the patients in the database, they were divided into the neuroendoscopy group or the burr hole drainage group by the fixed surgery physician. Follow-up was performed 0-3 mo after surgery. An independent observer (not a physician or nurse) contacted patients through the clinic, a call, a letter or an email to obtain qualitative and quantitative follow-up of the clinical curative effect. Three months after the operation, follow-up was conducted once a month.

### Technique

Patients in the neuroendoscopy group were treated by small bone window craniotomy under neuroendoscopy. After general anesthesia, the patient was placed in a supine position with their head tilted to the unaffected side. The shoulder of the affected side was padded high with the head tilted 60-90 degrees. According to preoperative head CT positioning, the thickest layer of the hematoma was selected, and a longitudinal straight incision about 4 cm in length was made on the scalp. After cutting the scalp, the retainer was unfolded to expose the skull. After a small bone hole was drilled with the Storz grinding drill, a 2 cm × 3 cm bone window was milled through a milling cutter, the dura mater was suspended after hemostasis by bone wax, and the dura was cut open with an "X" shape and suture fixation. The subdural hematoma capsule can be opened by the external membrane of the hematoma and slowly release the subdural hematoma. Then the STORZ neuroendoscopy was placed and gradually moved from the proximal end of the bone window to the distance under direct vision. The adhesions and bands were separated while being attracted, and the hematoma cavities were observed and cleaned with warm saline irrigation. Stale blood, blood clots and cellulose exudation were aspirated under endoscopy, and electrocoagulation was used to remove any septum and cord. The area was rinsed repeatedly in all directions until the outflow of fluid was clear, the drainage tube, which had several side holes cut at the head, was placed and fixed on the scalp. The skull was fixed with titanium and sutured.

Burr hole drainage was performed in the other group. Preoperative CT examination was performed to determine the scope of the hematoma, and local anesthesia or general anesthesia was used. Routine disinfection was performed. A 3 cm straight incision was made at the thickest layer of the hematoma, and the whole layer of the scalp was cut open. After hemostasis by electrocoagulation, the scalp was propped open by a mastoid retractor. An electric bone drill was used to drill holes in the skull, and gun forceps were used to enlarge and form a bone hole about 1.5 cm in diameter. The bone wax was used to stop the bone bleeding. The dura mater and the outer membrane of the hematoma were cross-incised, the hematoma cavity was opened, the subdural hematoma was slowly released, and then the dura was suspended and electrocoagulated. The drainage tube was placed into the hematoma cavity, and the hematoma cavity was rinsed repeatedly with warm physiological saline until the outflow of fluid was clear. Then the drainage tube was placed, and the scalp was layered and sutured.

### Observation

Skull CT was performed on days 1, 3, and 12 after surgery in the two groups to observe the proportion of the size of brain tissue re-expansion in the hematoma cavity (1/2 or complete re-expansion). Complications in both groups were recorded 3 mo after the operation.

### Statistical analysis

SPSS 20.0 statistical software (IBM Corp., Armonk, NY, United States) was used. Measurement data were expressed as mean ± SD, and the $t$ test was used. Enumeration data were presented by rate and $\chi^2$ test was used. $P < 0.05$ was considered statistically significant.

## RESULTS

A total of 174 cases of CSDH was admitted and treated between August 2018 and August 2021. A total of 122 samples met the inclusion criteria. All patients had varying degrees of headache, dizziness, nausea, vomiting, decreased muscle strength, hemiplegia or other phenomena. The digital table method was adopted to divide them into two groups, with 61 cases in each group. Among the patients in the neuroendoscopy group, 19 were female and 42 were male. The maximum age was 83-years-old, the minimum age was 36-years-old, and the median age was 57.26 ± 9.58-years-old. Among the patients in the burr hole drainage group, 22 were female and 39 were male, with the maximum age being 85-years-old, the minimum age being 41-years-old and the median age being 56.41 ± 8.66-years-old. Statistical software was used for sex/age/preoperative Markwalder grading scale of patients with CSDH in the two groups, showing no statistically significant difference ($P > 0.05$) (Table 1).

### *Comparison of brain tissue re-expansion between the two groups*

The proportion of 1/2 and complete re-expansion of brain tissue in the hematoma cavity on days 1 and 3 after the operation in the neuroendoscopy group was higher than that in the burr hole drainage group ($P < 0.05$), but there was no statistically significant difference on day 12 after the operation ($P > 0.05$) (Tables 2 and 3).

### *Comparison of complications between the two groups*

The recurrence rate of hematoma in the neuroendoscopy group was lower than that in the burr hole drainage group. There were no intracranial hematomas in the neuroendoscopy group. No complications such as low cranial pressure and tension pneumocephalus occurred in the two groups (Table 4).

## DISCUSSION

CSDH refers to the hematoma that occurs between the dura mater and arachnoid membrane and has envelopment. Symptoms often begin 3 wk after trauma and appear as headache, nausea and/or vomiting. The bleeding source of hematoma and pathogenesis has not yet reached a consensus. The mainstream view is that after craniocerebral trauma, the subdural space is inflamed, new blood vessel walls are fragile and cannot form a complete repair of the vascular net to absorb the hematoma cavity. The activities of protease fiber can cause fibrin degradation, a large amount of fibrinogen is consumed, and platelet aggregation is restrained. This promotes hematoma capsule capillary blood extravasation, slowly expanding the hematoma cavity[12,13].

Relevant studies have shown that the expansion of CSDH is relevant to the decrease of intracranial pressure, increase of venous pressure, coagulation dysfunction, brain atrophy and so on. Various risk factors, such as age, drainage, and antiplatelet and anticoagulant medications, may be associated with recurrence, but these findings remain controversial[12,14-16]. Other scholars proposed that traumatic subdural effusion was the real origin of CSDH, and elderly age was a risk factor[17-19].

Although atorvastatin drug therapy has been proposed for the treatment of CSDH [20], the majority of patients are still treated by surgery first in clinical practice[21,22]. Customary surgical methods mainly employ burr hole drainage[23], which has the following advantages: simple and effective, transitory operation time, lower hematoma cavity after surgery, eliminates dead hematoma and achieves clinical cure[24]. At the same time, there are also some disadvantages: (1) The hematoma cavity does not have direct sight through the bone hole during the operation. The drainage tube can only be placed and flushed in every direction by feeling. For cases of separation and capsule, the single borehole drainage cannot open all the subcavities, and the flushing and drainage of the hematoma is not complete[5,6]; (2) Postoperative recovery of patients depends on the degree of brain tissue re-expansion. However, due to the fact that a subdural hematoma has two layers of capsule, which is composed of fibrous tissue and has a certain degree of toughness, plus the separation of the hematoma cavity in some patients, the clinical application of traditional burr hole drainage for brain tissue re-expansion is relatively slow; (3) The trabeculae in the separation hematoma is accompanied by thickening of fibrous connective tissue and mixed flocculent fibrinoid tissue, which adheres closely to the capsule and is difficult to remove by flushing; and (4) If there is fresh hemorrhage during the operation, the only way to resolve it is by repeated irrigation. For severe bleeding, craniotomy must be chosen to stop the bleeding. However, a craniotomy is exceedingly traumatic, and some elderly patients or patients with severe organ lesions cannot tolerate craniotomy under general anesthesia.

In recent years, minimally invasive surgery for intracranial hematoma has attracted more and more attention. Neuroendoscopy is an important minimally invasive treatment for hematoma with a high clearance rate, few complications and a short operation time. The use of neuroendoscopic surgery for CSDH has the following advantages: (1) Simple operation, simple equipment requirements. The surgical procedure is performed under direct vision. The endoscope is used for illumination and flushing at the same time; and (2) Intuitive, safe and effective. When the endoscope is introduced into the hematoma cavity, the entire hematoma cavity can be observed under direct vision, avoiding brain tissue damage caused by blind operation. For the septal hematoma, the endoscope can be extended into the interval under direct vision for flushing to reduce the residual. If necessary, the fiber strip can be electrocoagulated and cut by bipolar coagulation under direct vision to open the hematoma interval[25-28]. In addition, blood clots or hematoma compounds on the hematoma wall can be maximally removed under direct vision to avoid postoperative recurrence of hematoma. For fresh bleeding on the hematoma wall, hemostasis can be performed under direct vision. In addition, the placement of a drainage tube under

**Table 1 Comparison of general data between the two groups**

| Group | *n* | Sex as male/female | Age in yr | PMGS |
|---|---|---|---|---|
| Neuroendoscopy | 61 | 42/19 | 57.26 ± 9.58 | 2.36 ± 0.96 |
| Burr hole drainage | 61 | 39/22 | 56.41 ± 8.66 | 2.18 ± 0.93 |
| *P* value | | > 0.05 | > 0.05 | > 0.05 |

Data are presented as *n* or mean ± SD. PMGS: Preoperative Markwalder grading scale.

**Table 2 Comparison of brain tissue 1/2 re-expansion by computed tomography at different time points after operation in chronic subdural hematoma patients**

| Group | *n* | Postoperative time in d | | |
|---|---|---|---|---|
| | | 1 | 3 | 12 |
| Neuroendoscopy | 61 | 25 (41) | 42 (69) | 60 (98) |
| Burr hole drainage | 61 | 13 (21) | 26 (43) | 57 (93) |
| $\chi^2$ | | 5.503 | 8.505 | 0.175 |
| *P* | | < 0.05 | < 0.05 | > 0.05 |

Data are presented as *n* (%), unless otherwise noted.

**Table 3 Comparison of brain tissue re-expansion by computed tomography at different time points after operation in chronic subdural hematoma patients**

| Group | *n* | Postoperative time in d | | |
|---|---|---|---|---|
| | | 1 | 3 | 12 |
| Neuroendoscopy | 61 | 14 (23) | 37 (61) | 57 (93) |
| Burr hole drainage | 61 | 5 (8) | 22 (36) | 51 (84) |
| $\chi^2$ | | 3.990 | 6.433 | 2.017 |
| *P* | | < 0.05 | < 0.05 | > 0.05 |

Data are presented as *n* (%), unless otherwise noted.

**Table 4 Comparison of postoperative complications of chronic subdural hematoma patients**

| Group | *n* | RH | IH | LCP | TP |
|---|---|---|---|---|---|
| Neuroendoscopy | 61 | 1 (2) | 0 | 0 | 0 |
| Burr hole drainage | 61 | 5 (8) | 3 (5) | 0 | 0 |
| $\chi^2$ | 4.319 | | | | |
| *P* | < 0.05 | | | | |

Data are presented as *n* (%), unless otherwise noted. RH: Recurrence of hematoma; IH: Intracranial hematoma; LCP: Low cranial pressure; TP: Tension pneumocephalus.

endoscope after hematoma removal can avoid insertion of the brain tissue or injury of the arachnoid, leading to cerebrospinal fluid entering the hematoma cavity after surgery.

However, neuroendoscope removal of a subdural hematoma by small bone window also has its disadvantages. Because CSDH patients are mostly elderly patients, the risk of general anesthesia craniotomy is relatively high. The selection of cases should be considered comprehensively, and the relevant preparation before the operation should be improved. The observation and treatment scope of rigid neuroendoscopy is limited by the bone window. Therefore, the intraoperative bone window should be more than 2 cm × 3 cm to achieve the purpose of observation and operation. To restore the bone flap, it is fixed by a titanium plate and titanium nails, and the charge is higher.

Compared with burr hole drainage, small bone window craniotomy for hematoma removal under neuroendoscope can remove a hematoma more thoroughly[25,28]. Combined with neuroendoscopy on the basis of small bone window craniotomy for the removal of hematoma, hemostasis and removal of internal adherent substances of the hematoma can be performed under direct vision to avoid the recurrence of hematoma. Meanwhile, the insertion of a drainage tube under endoscope can prevent the injury of the brain tissue or arachnoid of patients[25-27].

We compared the speed of re-expansion of brain tissue and complications after small bone window surgery under neuroendoscopy with that after traditional burr hole drainage surgery. In the neuroendoscopy group, the brain tissue re-expanded quickly, and the incidence of recurrence and complications was lower after the 3 mo follow-up compared to the traditional burr hole drainage group, showing statistical significance (Table 4). There were no complications such as low cranial pressure or tension pneumocephalus in either groups. In our opinion, the removal of subdural hematoma under neuroendoscope is simple, safe and minimally invasive and can stop bleeding thoroughly and reliably under direct vision, thus enabling the brain tissue to rapidly re-expand.

### Limitation

This is a 4-year case study at a single center. Despite the small number of cases, we were satisfied by the results of this study. They prompted us to carry out further research, study the corresponding technology, summarize the indications and provide support for better clinical work. In the future, we will apply for further multicenter studies.

## CONCLUSION

Compared with traditional burr hole drainage, neuroendoscopy has a clear vision and safe operation under direct intraoperative vision, can effectively stop bleeding and can guide the placement of the drainage tube. The complete removal of hematoma at the early stage promotes the early expansion of brain tissue after surgery, which enables the patients to relieve clinical symptoms quickly, with a low recurrence rate and fewer complications. Neuroendoscopy for the treatment of CSDH is a practical minimally invasive surgical method, which is worthy of clinical promotion.

## ARTICLE HIGHLIGHTS

### Research background

Chronic subdural hematoma (CSDH) is a common disease in neurosurgery. The traditional treatment methods include burr hole drainage, bone flap craniectomy and other surgical methods. Complications include recurrence, pneumocephalus, infection and so on. With the promotion of neuroendoscopic technology, its treatment effect and advantages need to be further evaluated.

### Research motivation

At present, neuroendoscopic technology has been applied in many neurosurgical operations, and it has certain advantages in the treatment of CSDH, which has been gradually carried out in many units. Its treatment effect and advantages need to be further evaluated.

### Research objectives

To study the clinical effect of endoscopic small bone approach in CSDH.

### Research methods

A total of 122 patients with CSDH admitted to our hospital from August 2018 to August 2021 were randomly divided into two groups using the digital table method: the neuroendoscopy group ($n$ = 61 cases) and the burr hole drainage group ($n$ = 61 cases). The clinical treatment effect of the two groups of patients with CSDH was compared.

### Research results

At the early postoperative stage (1 d and 3 d), the proportion of 1/2 re-expansion of the brain tissue in the hematoma cavity and the proportion of complete re-expansion was higher in the neuroendoscopy group than in the burr hole drainage group, and the difference between the two groups was statistically significant ($P$ < 0.05). The recurrence rate of hematoma in the neuroendoscopy group was lower than that in the burr hole drainage group, and the difference between the two groups was statistically significant ($P < 0.05$). No intracranial hematoma, low cranial pressure, tension pneumocephalus or other complications occurred in the neuroendoscopy group.

### *Research conclusions*

The neuroendoscopic approach for the treatment of CSDH can clear the hematoma under direct vision and separate the mucosal lace-up. The surgical effect is apparent with few complications and definite curative effect, which is worthy of clinical promotion and application.

### *Research perspectives*

This is a 4-year case study at a single center. The number of cases was small, but we were satisfied with the results of this study, which gives us the confidence to carry out further research studying the corresponding technology, summarizing the indications better and providing support for better clinical work. In the next step, we will apply for further multicenter studies.

## FOOTNOTES

**Author contributions:** Wang XJ and Cui ZM conceived of and designed the trial; Wang XJ and Wang ZF collected the data; Sun C and Yin YH and Wang XJ analyzed the data; Wang XJ and Zhang Y wrote the manuscript; All authors contributed to the article and approved the submitted version.

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**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at 6841441@163.com.

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