Evaluation of Short-Term Efficacy and Safety of Neuroendoscopy in The Treatment of Patients with Brain Abscess

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Abstract

Background: Brain abscess remains a challenging clinical problem with a substantial fatality rate.

Objective: The purpose of current study was to analyze the short-term efficacy and safety of neuroendoscopic therapy in patients with brain abscesses.

Methods: A retrospective, uncontrolled, single-center study was conducted using a cohort of 61 patients with brain abscesses who were admitted to Renmin hospital of wuhan university between October 2016 and October 2021. The patients were divided into three groups based on the surgical approach used, including 12 cases of neuroendoscopic drainage or abscess resection, 20 cases of burr-hole drainage, and 29 cases of craniotomy abscess resection. SPSS 24.0 was used to analyze and compare clinical data, surgical efficacy, postoperative complications, and follow-up indicators. Data were compared via one-way analysis of variance and the chi-square test, and $p < 0.05$ was considered statistically significant.

Results: Compared with the burr-hole drainage group and the craniotomy group, the neuroendoscopy group had the highest rate of effective surgery ($p = 0.020$). In that same group the mean postoperative hospital stay was the shortest ($p = 0.040$), the mean total hospitalization cost was the lowest ($p = 0.017$), the number of intracranial complications was the lowest ($p = 0.035$), and the mean 28-day follow-up Glasgow Outcome score was the highest ($p = 0.046$).

Conclusion: Neuroendoscopic treatment of brain abscess is associated with definite curative effects, few complications, and rapid post-operative recovery, and may thus represent the optimal treatment in some patients.

Introduction

A brain abscess is a cavity formed by purulent bacteria, fungi, or parasites [4] that invade the brain and cause local brain tissue infection and destruction [1]. It is a serious intracranial infectious disease [3], with an annual incidence of 0.4–0.9 per 100,000 people [4] and a mortality rate of 20% within 1 year [3]. In recent years, with the continuous development of diagnostic imaging technology, a gradual increase in the detection rate of microorganisms, and the rational use of effective antibiotics, the diagnosis and treatment of brain abscess has improved substantially [4,12]. Notably, however, traditional craniotomy abscess resection may not be performed when the patient’s general condition is poor and there are accompanying serious lesions in other organs. Burr-hole drainage has the disadvantages of deep abscesses, incomplete drainage of multi-chamber abscesses, and an inability to open up the separation of abscesses under direct vision, making surgical intervention one of the difficult problems faced by neurosurgeons [22]. Advances in neuroendoscopy technology and its wide clinical application have resulted in better surgical options for the treatment of brain abscess [9,23,26]. The current study retrospectively analyzed clinical data from 61 patients with brain abscesses treated at a single hospital, and assessed the short-term efficacy and safety of neuroendoscopy.

Materials And Methods

2.1 General information

The study was approved by the institution’s Joint Research Ethics Committee in November 2021, and the requirement for informed consent was waived. Data from 61 patients with brain abscesses treated at a single hospital from October 2016 to October 2021 were retrospectively analyzed, and the patients were divided into three groups based on the surgical methods used to treat them. Twelve patients who underwent transneuroendoscopic puncture drainage or abscess resection were assigned to a neuroendoscopy group, 20 patients who underwent transcranial puncture and drainage were assigned to a burr-hole drainage group, and 29 patients who underwent traditional craniotomy abscess resection were assigned to a craniotomy group. The mean diameter of all abscesses was 3.11 ± 1.47 cm. The mean Glasgow Coma Scale (GCS) score of all patients on admission was 13.37 ± 1.65. There were 56 cases of single-locular abscess, and 5 cases of multilocular abscess. There were no significant differences in any of the baseline data assessed between the three groups(Table 1).

2.2 Inclusion criteria

Age ≥ 15 years, all brain abscesses in the brain parenchyma confirmed by surgery and pathology, and complete clinical data.

2.3 Exclusion criteria

Age < 15 years, scalp abscess involvement, subdural abscess involvement, epidural abscess involvement, pituitary abscess involvement, and lost to follow-up.

2.4 Methods

In accordance with guideline recommendations [24], empirical antimicrobial therapy (vancomycin combined with anti-monas cephalosporins or carbapenems) was initiated after admission, and targeted antibiotics were administered based on the results of pus culture after surgery. The course of treatment was 4–6 weeks, or until computed tomography or magnetic resonance imaging depicted absorption of the lesion [6].

2.4.1 Neuroendoscopy group

A Karl Storz neuroendoscope was used (hard endoscope, 0°, hard lens length 15 cm, outer diameter 4 mm). The procedures performed included rigid neuroendoscopic abscess drainage under general anesthesia (Figure 1 a–f) and abscess resection (Figure 2 a–d). Neuroendoscopic abscess drainage was performed to introduce the neuroendoscope into the abscess cavity, suck and remove the pus under direct vision, and clean up the foreign body in the abscess cavity and the pus coating on the abscess wall. At the same time the cavity partition was opened and gentamicin in normal saline was used to repeatedly rinse the area until the solution was translucent, and the drainage tube was placed into the lesion cavity

(Figure 1 e). Abscess resection was performed to remove the abscess after it was separated along the edema around the abscess wall under neuroendoscopy. In some cases in which the abscess was large, part of the abscess was punctured and aspirated to reduce some of the cerebral pressure prior to removal (Figure 2 b–c).

2.4.2 Burr-hole drainage group

Burr-hole drainage was performed under general anesthesia, and computed tomography or magnetic resonance imaging were used to locate the puncture point and plan the puncture path before the operation. Patients were placed in a supine or lateral recumbent position, and a straight incision approximately 3–5 cm in length was made on the scalp in accordance with the positioning point. The skull was drilled, the dura was opened, and the first puncture was made with a long needle in accordance with the originally set position and direction. Extraction was then performed after entering the abscess cavity, to obtain pus for culturing. The drainage tube was inserted into the abscess cavity via a guide core, the remaining pus was extracted, gentamicin in normal saline was used to rinse the abscess cavity, and lastly the drainage bag was connected and the drainage tube was fixed to suture the wound.

2.4.3 Craniotomy group

Computed tomography or magnetic resonance imaging were performed before surgery. The surgical approach was selected based on the preoperative position, the skin was cut, the bone flap was milled out, the dura mater was cut, then the cortex was cut—avoiding the functional area—and the abscess area was reached. In cases in which the abscess was large, some of the pus was released to avoid it spilling and contaminating the brain tissue. After the pus was completely aspirated, the abscess was carefully peeled off along its outer wall, and the surrounding edema brain tissue was removed under a microscope.

2.5 Surgical timing, postoperative reexamination, and follow-up

In patients with severe illness, rapid progression, and a Glasgow coma scale(GCS) score ≤ 8 the operation was performed within 72 h. Conversely, in patients with stable condition and a GCS score > 8 the operation was postponed to 72 h after onset (mean 4.86 ± 0.87 days). Computed tomography or magnetic resonance imaging were reviewed 24 h, 2 weeks, and 28 days after discharge. Routine outpatient follow-up was performed 28 days after discharge, and non-outpatient follow-up was performed by telephone. Glasgow Outcome Score (GOS) was evaluated based on follow-up.

2.6 Surgical efficacy indicators

The size of the brain abscess cavity before and after the operation was compared using head imaging acquired within 2 weeks after the operation. If the diameter of the abscess cavity was reduced by > 80% and the compression and space-occupying effects of the abscess had resolved, the results were considered significant. If the diameter of the abscess was reduced by > 30% and the intracranial symptoms were controlled to an extent, the operation was considered effective. If the abscess diameter was reduced by < 30% or the abscess was enlarged, and postoperative symptoms were not controlled, the operation was considered ineffective. Significantly effective + effective = total effective. Recurrence of brain abscess refers to the appearance of a new abscess at the same location as the original brain abscess.

2.7 Clinical efficacy indicators

Clinical efficacy indicators included the time to symptom relief, the time until inflammatory indicators returned to normal, days of postoperative hospitalization, total cost of hospitalization, the duration of the operation, and GOS at discharge.

2.8 Postoperative complications and 28-day follow-up indicators

Postoperative intracranial and extracranial complications were assessed, as were 28-day discharge survival rate, abscess recurrence rate, and GOS.

2.9 Statistical analysis

Data were analyzed using SPSS 24.0 software. All quantitative data were normally distributed, and are expressed as mean ± standard deviation. Means of multiple groups were compared via one-way analysis of variance. The least significant difference test was used for pairwise comparisons between multiple groups. All qualitative data conformed to a normal distribution, and are represented as frequencies and percentages. The chi square test or Fisher’s exact probability test were used to compare rates between groups. Partitions derived via the chi square method were used for pairwise comparisons between multiple groups. The Bonferroni method was used for correction. $p < 0.05$ was considered statistically significant.

Results

3.1 Comparison of baseline data in the three groups

There were no significant differences in age, gender, clinical symptoms, source or location of infection, pathogen type, abscess diameter, Acute Physiology and Chronic Health Evaluation Ⅱ (APACHE Ⅱ) score, or GCS score between the three groups (Table 1).

3.2 Comparison of surgical effects in the three groups

There were no significant differences in effectiveness, ineffective rate, or recurrence rate between the three groups (Table 2). There was a significant difference between the total effective rates in the neuroendoscopy group (100%), the craniotomy group (97%), and the burr-hole drainage group (95%) (p = 0.020).

3.3 Comparisons of clinical efficacy and perioperative indexes in the three groups

The neuroendoscopy group exhibited the most rapid relief of headache and vomiting, the fastest recovery of leukocyte count, the shortest postoperative hospitalization time, and the lowest total hospitalization cost ($p < 0.05$). Operation times were long in that same group however, which may be related to the proficiency of the operator. There were no significant differences in GOS between the three groups (Table 3).

3.4 Comparisons of postoperative complications and 28-day follow-up indexes in the three groups

There were no significant differences in the incidence of postoperative extracranial complications between the three groups ($p > 0.05$), but the incidence of total intracranial complications was highest in the craniotomy group, followed by the burr-hole drainage group, then the neuroendoscopy group. The patients were followed up for 28 days after discharge, and all the patients in the neuroendoscopy group survived well. Two patients in the burr-hole drainage group died from basic conditions (coronary heart disease and lung cancer), and two patients in the craniotomy group also died; one from multiple myeloma and the other from chronic renal failure. There was only 1 case of recurrence, in the burr-hole drainage group, and the abscess was removed after craniotomy and the prognosis was good. Reexamination computed tomography indicated that the abscesses continued to shrink, and part of the abscess wall disappeared. GOS 28 days after discharge were greatest in the neuroendoscopy group, followed by the craniotomy group then the burr-hole drainage group, and the difference was statistically significant ($p = 0.046$) (Table 4).

Discussion

In the current single-center retrospective cohort study investigating the surgical treatment of patients with brain abscesses, compared with a burr-hole drainage group and a craniotomy group, the total effective rate of minimally invasive neuroendoscopic surgery was higher, postoperative headache and vomiting were relieved more quickly, postoperative leukocyte counts recovered quickly, and postoperative hospital stays were short, which greatly reduced hospitalization costs. There were also fewer postoperative complications and more rapid recoveries in the neuroendoscopic surgery group, which greatly improves the quality of life and renders patients able to return to society as soon as possible.

The choice of surgical approach for brain abscess has been controversial[4,5,11,17,19]. The advantage of traditional craniotomy is that it can completely remove the abscess wall and reduce recurrence and resect the abscess while reducing intracranial pressure by removing bone flap, especially for patients with cerebral hernia or pre-cerebral hernia, however, there is more trauma and brain tissue damage[26]. The advantage of burr hole drainage is that it is easy to operate and less invasive. It is particularly beneficial for very unstable patients who may not withstand the stress of long procedures like a craniotomy[20]. However, it has the disadvantages of insufficient drainage and recurrence of abscess[21]. The advantage of neuroendoscopy is that it can effectively protect the brain nerve function while removing the lesion,and the trauma is less[4,16,18]. However, the endoscopic technique is more difficult, and part of the operation is limited[9].

With respect to experimental design, the patients in the current study were divided into three groups based on the surgical methods used, which differs from other case series reports [9,22-23,26]. The results of the present study are consistent with those of previous retrospective studies indicating that neuroendoscopic treatment can be used as an alternative to stereotactic puncture [13-14,18].It is especially suitable for patients with deep-seated abscess, multilocular abscess and abscess located in functional area[9,18], at the same time, it is also suitable for patients with monocular brain abscess, superficial brain abscess, non-functional brain abscess and repeated puncture ineffective brain abscess who can obtain good therapeutic effect by neuroendoscopic treatment[26]. In a series of reports on 52 patients who received surgical treatment for intracranial infection, Kural et al. [15] suggested that neuroendoscopic surgery is feasible, safe, and effective, and endoscopic navigation technology provides full visualization of an abscess, which can facilitate sufficient drainage and opening of the fibrous septum as well as complete removal of the abscess wall and electrocoagulation of small blood seepage points. These considerations support our conclusion that neuroendoscopy is effective and results in a high survival rate in the treatment of brain abscess. In a prospective study of 24 cases of brain abscess treated via neuroendoscopy, Yadav et al. [25] reported that 23 patients were completely cured, without recurrence or complications, which was similar to the results in other endoscopic series reported by Fritsch et al. [10]. In the current study patients in the neuroendoscopy group recovered more rapidly postoperatively, which may be related to less damage to nerve tissue and a slight postoperative inflammatory reaction as detected via direct endoscopic vision [8].

The results of this study showed that the total incidence of intracranial complications after brain abscess in the craniotomy group was higher than that in the neuroendoscope group ($p = 0.035$), which was inconsistent with the conclusions reported in the previous literature[5,11,27]. It may be related to the following factors: First, The rate of emergency craniotomy abscess resection in the craniotomy group was as high as 24.14%, and these patients had higher APACHEII score, lower GCS score and more complicated previous medical history before operation. Although the abscess had been removed, it was easy to be complicated with intracranial infection due to poor autoimmune condition, greater surgical trauma, prolonged drainage tube retention and ICU stay. Second, two patients in the craniotomy group were complicated with ventriculitis, which may be related to the location of the abscess close to the ventricle. Third, in the craniotomy group, two patients were complicated with cerebral hemorrhage possibly related to basic diseases (thrombocytopenic purpura, coagulation dysfunction caused by hepatitis B cirrhosis). Postoperative complications are considered to be a strong predictor of increased medical costs[7], mainly due to prolonged hospitalization or re-hospitalization caused by postoperative complications[2], which supports the conclusion of this study that neuroendoscopic treatment of brain abscess has less postoperative complications and short hospitalization time, resulting in lower total hospitalization cost.

The present study had some limitations. The sample size was small, which may have biased the results. The study was retrospective and single-center, and some confounding factors are difficult to control; thus the results need to be verified with large sample, multicenter, prospective studies. Lastly, the follow-up time of the study was short, which may underestimate the time of real events.

Conclusion

Neuroendoscopy for the treatment of patients with brain abscesses has curative effects, and is associated with less trauma, less complications, and rapid postoperative recovery compared to other methods. It may be the preferred treatment in many patients, and warrants promotion in the clinic.

Declarations

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Conflict of interest The authors declare that they have no conflict of interest.

Code availability Not applicable.

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki.

the study was granted exemption by the Ethics Committee of Renmin Hospital of Wuhan University (Date 2021.12.02 / No WDRY2021–KS064).

Consent to participate According to the local institutional review board, for this type of retrospective study, informed consent is not required.

Consent for publication All authors agreed with the publication of this study.

Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Long Zhou, Zhiyang Li, Wenju Wang, Hangyu Wei, Pan Lei and Qianxue Chen. The first draft of the manuscript was written by Li Cheng, Ping Song, WenHui Bai, Daofa Sun and Qiang Cai. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1: Comparison of baseline data in the three groups

Project	Neuroendoscopy group (n = 12)	Burr-hole drainage group (n = 20)	Craniotomy group (n = 29)	F/c^2 value	p
Age (years)	53.67 ± 10.79	47.30 ± 16.79	51.00 ± 13.87	1.096	0.341
Male / female (cases)	8/4	10/10	17/12	0.887	0.642
Clinical manifestation [n (%)]					
Fever	5 (41.7)	9 (45.0)	12 (41.4)	0.069	0.966
Headache	9 (75.0)	13 (65.0)	18 (62.1)	0.633	0.729
Vomiting	4 (33.3)	12 (60.0)	12 (41.4)	1.914	0.384
Focal symptoms	7 (58.3)	12 (60.0)	18 (62.1)	0.044	0.978
Source of infection [n (%)]					
Traumatic	1 (8.3)	1 (5.0)	2 (6.9)	0.146	0.929[a]
Rhinogenic	2 (16.7)	3 (15.0)	2 (6.9)	1.161	0.559[a]
Otogenic	1 (8.3)	2 (10.0)	3 (10.3)	0.040	0.980[a]
Hematogenous	2 (16.7)	6 (30.0)	7 (24.1)	0.725	0.696
Cryptogenic	6 (50.0)	8 (40.0)	16 (55.2)	1.094	0.579
Site of infection [n (%)]					
Frontal lobe	6 (50.0)	5 (25.0)	6 (20.7)	1.047	0.306
Temporal lobe	2 (16.7)	8 (40.0)	8 (27.6)	2.061	0.357
Basal ganglia	2 (16.7)	1 (5.0)	4 (13.8)	1.297	0.523[a]
Parietal lobe	1 (8.3)	2 (1.0)	5 (17.2)	0.844	0.656[a]
Occipital lobe	1 (8.3)	3 (15.0)	3 (10.3)	0.398	0.820[a]
Cerebellum	2 (16.7)	2 (10.0)	5 (17.2)	1.620	0.445[a]
Single room abscess	10 (83.3)	19 (95.0)	27 (93.1)	1.481	0.447[a]
Multilocular abscess	2 (16.7)	1 (5.0)	2 (6.9)	1.481	0.447[a]
Type of					

pathogenic bacteria [*n* (%)]					
G+	4 (33.3)	8 (40.0)	10 (34.5)	0.205	0.903
G-	1 (8.3)	1 (5.0)	2 (6.9)	0.146	0.929[a]
Anaerobic bacteria	2 (16.7)	3 (15.0)	5 (17.2)	0.044	0.978[a]
Other	2 (16.7)	3 (15.0)	4 (13.8)	0.057	0.972[a]
Average abscess diameter [cm]	3.17 ± 0.93	2.67 ± 0.65	3.38 ± 1.47	1.397	0.256
APACHE II (points)	8.67 ± 2.67	8.85 ± 2.11	9.14 ± 1.20	0.231	0.794
GCS (points)	13.83 ± 1.19	13.25 ± 2.45	13.14 ± 2.48	0.406	0.668

G^+, gram-positive; G^-, gram negative; APACHE II, Acute Physiological and Chronic Health Evaluation II; GCS, Glasgow Coma Score

[a]Fisher’s exact probability test

Table 2: Comparison of surgical effects in the three groups

Surgical effects [*n* (%)]	Neuroendoscopy group (*n* = 12)	Burr-hole drainage group (*n* = 20)	Craniotomy group (*n* = 29)	c^2	*p*
Significantly effective	11 (100.00)	15 (75.00)	27 (93.10)	3.704	0.157[b]
Effective	1 (8.33)	0 (0.00)	1 (3.45)	1.647	0.439[b]
Ineffective	0 (0.00)	4 (20.00)	1 (3.45)	5.643	0.060[b]
Recurrence	0 (0.00)	1 (5.00)	0 (0.00)	2.084	0.353[b]
Total effective	12 (100.00)	15 (95.00)	28 (96.55)[a]	7.829	0.020[b]

[a]Comparison with the neuroendoscopy group, $p > 0.05$

[b]Fisher’s exact probability test

Table 3: Comparisons of clinical efficacy and perioperative indexes in the three groups

	Neuroendoscopy group (n = 12)	Burr-hole drainage group (n = 20)	Craniotomy group (n = 29)	F value	p
Relief time of main complaint symptoms after operation (days)					
Headache	11.42 ± 4.81	13.20 ± 6.65[a]	17.51 ± 1.54	3.859	0.027
Fever	11.08 ± 5.20	14.63 ± 8.23	17.07 ± 8.15	2.612	0.083
Vomiting	9.92 ± 3.82	12.00 ± 6.18[a]	15.52 ± 8.21	3.276	0.045
Focal symptoms	12.16 ± 4.78	15.47 ± 7.82	17.03 ± 8.01	1.823	0.171
Recovery time of postoperative inflammatory indexes (days)					
Leukocyte count	14.00 ± 6.05[b]	11.81 ± 6.16	17.81 ± 7.45	4.15	0.021
C reactive protein	17.81 ± 7.45	12.50 ± 11.72	21.97 ± 47.81	1.393	0.260
Procalcitonin	12.50 ± 11.72	11.38 ± 14.59	16.28 ± 9.63	0.702	0.502
Postoperative hospital stay (days)	19.42 ± 6.01	26.60 ± 6.95[a]	27.86 ± 11.95	3.412	0.040
Total hospitalization expenses (10,000 yuan)	9.46 ± 4.61	13.04 ± 5.31[a]	14.54 ± 4.96	4.348	0.017
Operation time (minutes)	151.25 ± 16.57[b]	85.40 ± 24.35	158.52 ± 38.87	30.949	< 0.001
GOS at discharge (points)	4.50 ± 0.67	4.10 ± 1.02	4.03 ± 0.82	1.263	0.290

GOS, Glasgow Outcome Score

[a]Comparison with the neuroendoscopy group, $p > 0.05$

[b]Comparison with the craniotomy group, $p > 0.05$

Table 4: Comparisons of postoperative complications and follow-up indexes in the three groups

Project	Neuroendoscopy group (n = 12)	Burr-hole drainage group (n = 20)	Craniotomy group (n = 29)	F/c^2 value	p
Total intracranial complications [n (%)]	1 (8.33)	3 (15.00)[b]	12 (41.38)[a]	6.729	0.035[c]
Cerebral hemorrhage	0 (0.00)	1 (5.00)	2 (6.90)	0.864	0.649[c]
Ventriculitis	0 (0.00)	1 (5.00)	2 (6.90)	0.864	0.649[c]
Hydrocephalus	0 (0.00)	0 (0.00)	2 (6.90)	2.282	0.320[c]
Intracranial infection	1 (8.33)	1 (5.00)	6 (20.69)	2.857	0.240[c]
Total extracranial complications [n (%)]	2 (16.67)	4 (20.00)	6 (20.69)	0.086	0.956[c]
Pulmonary infection	1 (8.33)	3 (15.00)	4 (13.79)	0.315	0.854[c]
Lower extremity venous thrombosis	1 (8.337)	1 (5.00)	2 (6.90)	0.146	0.929[c]
28-day follow-up [n (%)]					
Survival	12 (100.00)	18 (90.00)	27 (93.10)	1.234	0.539[c]
Abscess recurrence	0 (0.00)	1 (5.00)	0 (0.00)	2.084	0.353[c]
Computed tomography indicates abscess continues to shrink	12 (100.00)	19 (95.00)	27 (93.10)	0.864	0.649[c]
GOS (points)	4.67 ± 0.50	3.95 ± 0.89	4.21 ± 0.77[a]	3.252	0.046

GOS, Glasgow Outcome Score

[a]Comparison with the neuroendoscopy group, $p > 0.05$

[b]Comparison with the craniotomy group, $p > 0.05$

[c]Fisher's exact probability test

Figures

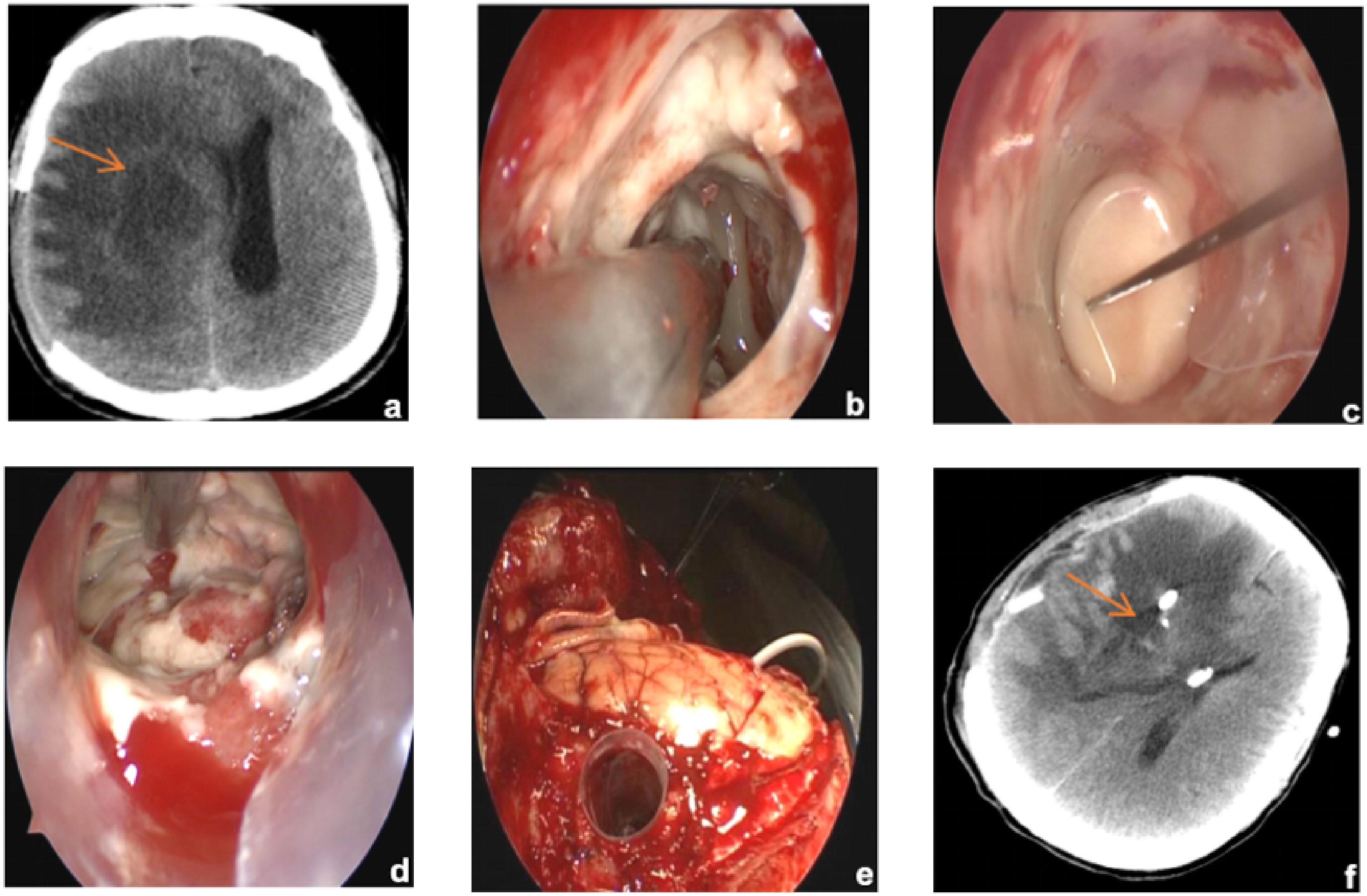

Figure 1

Neuroendoscopic puncture and drainage of the right basal ganglia brain abscess. a: Computed tomography of the head indicating a suspicious brain abscess in the right basal ganglia. b: The neuroendoscope reaches the lesion area. c: The abscess cavity can be seen via endoscopy. d: Endoscope lower puncture into the abscess cavity, depicting pus outflow. e: Indwelling drainage tube, full drainage. f: Computed tomography indicating abscess cavity reduction 7 days after surgery.

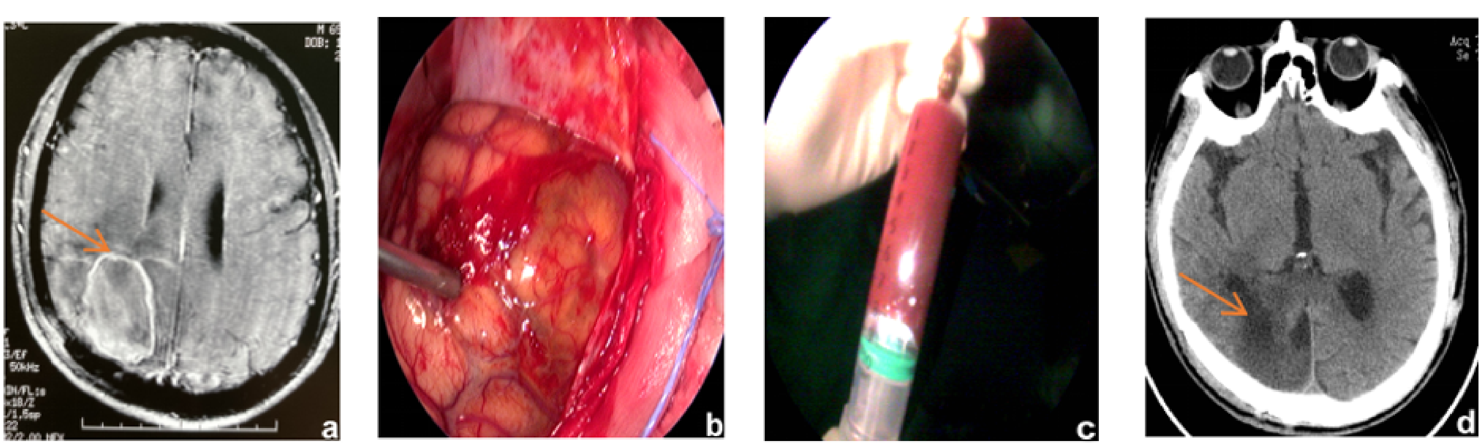

Figure 2

Neuroendoscope resection of the right occipital lobe brain abscess. a: Magnetic resonance imaging of the head depicting a suspicious brain abscess in the right occipital lobe. b: Neuroendoscope resection of the right occipital lobe brain abscess. c: Decompression of part of the pus removed during the operation. d: Computed tomography indicating abscess cavity reduction 7 days after surgery.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterial.pdf