Keyhole Evacuation for moderate basal ganglia Hematoma superior than Craniotomy

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Research article

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Abstract

Background: Spontaneous intracerebral hemorrhage (SICH) is the most devastate kind of stokes. For basal ganglia hematoma with volume ranged from 30 to 60 ml, different surgical procedures have been recommended by different neurosurgeons. This study aimed to compare the clinical outcomes and hospitalization cost between keyhole surgery and craniotomy for basal ganglia intracerebral hemorrhage.

Methods: A retrospective analysis was performed on clinical data of 63 cases of keyhole procedure and 56 cases of craniotomy procedure. Hematoma evacuation rate, infection rate, re-bleeding, operation time, hospitalization cost and outcome were recorded.

Results: The evacuation rate was similar in keyhole group and craniotomy group ($P > 0.05$), and infection rate was lower in keyhole group compared to craniotomy group ($P < 0.05$). Mean operation time and hospitalization cost were less in keyhole group than in craniotomy group ($P < 0.05$). Mortality rate between two groups showed no significant differences. The patients operated within 6h had better outcome than those operated between 6-24h ($p < 0.05$).

Conclusion: For patients with basal ganglia hematoma ranged from 30-60 ml, keyhole surgery is safe and feasible, and operation within 6 h can improve the prognosis of the patients.

Background

Spontaneous intracerebral hemorrhage (SICH) is the most devastate kind of stokes. It was estimated that SICH affects over 1 million people worldwide every year with a mortality rate of more than 50% [1, 2]. Only 12–39% of the survivors could live independently after 6 months [3–5]. The most common cause of SICH is hypertension, and about 60% of SICHs occur at the basal ganglia region [6, 7]. Currently, the treatment of hematomas within the basal ganglia continues to be a matter of debate among neurologists and neurosurgeons [7–9]. The hematoma with small volume (< 30 ml of supratentorial) can be treated with conservative therapies, while larger hematoma (> 30 ml of supratentorial) is often removed through surgery.

Previous studies showed that the removal of hematoma might reduce nervous tissue damage, possibly by relieving local ischemia and removing noxious chemicals [6–8]. However, different surgical procedures have been recommended by different neurosurgeons, such as craniotomy, endoscopy operation, stereotactic aspiration, and keyhole evacuation [8–10]. In this study, we present our series of cases of basal ganglia hematoma with volume ranged from 30 to 60 ml who underwent keyhole evacuation or traditional craniotomy, and compared the safety and effectiveness of keyhole surgery with traditional craniotomy.

Methods

Ethical permission

This study was approved by Institute Ethics Committee and all patients signed written informed consent.

Patients

Patients enrolled in this study met the following inclusion criteria: 1) Aged 35-70 years; 2) computed tomography (CT) confirmed basal ganglia hemorrhage; 3) Hematoma volume between 30 to 60 ml; 4) Surgery performed within 24 hours from the onset of clinical symptoms. Patients were excluded if they had tumor bleeding, posttraumatic intracerebral hematomas, arteriovenous hemorrhage or aneurysmal, bleeding caused by uremia, liver cirrhosis, or anticoagulation therapy.

The keyhole group consisted of 63 consecutive adult patients admitted between July 2017 and July 2019. Traditional craniotomy group consisted of 56 consecutive patients treated by craniotomy at our department between July 2017 and July 2019. Clinical characteristics of the patients were recorded.

Traditional craniotomy

An arch incision about 20 cm long was made at the frontal temporal region, and a bone window about 6×8 cm was made with milling cutter. After opening the dura, the hematoma cavity was entered via a transcortical channel through the middle temporal gyrus or inferior temporal gyrus approach with a cortex incision about 1 cm. After evacuation of hematoma, the dura was sutured and the bone flap was replaced to its position. Usually drainage tube was put in the hematoma cavity and kept draining for 3 days.

Keyhole operation

The procedure was performed as described previously [10-12]. Briefly, 4-cm skin longitudinal straight incision was made about 3 cm posterior and 3 cm superior the pterion dot area as shown in Fig. 1a. A bone flap 2.5 cm in diameter was drilled (Fig. 1c). Sylvian fissure was dissected using the microsurgical technique. Sylvian veins and arteries had always been protected during surgery. A small insular cortex incision about 1 cm was made parallel to sylvian fissure, and hematoma on putamen was exposed after splitting the insular cortex. Hematoma evacuation was performed using suction and hemostasis with bipolar cautery. Usually drainage tube was put in the hematoma cavity and kept draining for 3 days.

Measurements

Hematoma volume was estimated by the following equation: $V = \text{length} \times \text{width} \times \text{thickness} / 2$. The length, width and thickness were measured on CT images. The hematoma evacuation rate (%) was defined as $(\text{preoperative volume} - \text{postoperative volume}) / (\text{preoperative volume}) \times 100\%$. Re-bleeding was identified as postoperative CT volume greater than preoperative volume. The primary endpoint was re-bleeding and surgical complications and/or death. Outcome variables included hematoma evacuation rate, mean Glasgow Coma Scale (GCS) score at day 3 after operation, and Glasgow Outcome Scale (GOS) score 3 months after operation.

Statistical analysis

SPSS version 13.0 was applied for all statistical analyses. Statistical analysis was carried out using t test or χ^2 test. $P < 0.05$ was considered significant.

Results

63 cases of keyhole group and 56 cases of craniotomy group were evaluated in this study. All patients had altered consciousness with or without local neurologic deficit. Their characteristics are summarized in Table 1. The male ratio was 71.4% and 60.7% and the mean age was 48.5 and 50.5 years in two groups, respectively. 42 cases in keyhole group and 34 cases in craniotomy group had surgery within 6 hours after symptom onset, respectively. The mean hematoma volume was 46.7 ml in keyhole group and 48.5 ml in craniotomy group, respectively. There were no significant differences in hematoma volume and age between these two groups.

The evacuation rate in keyhole group ranged from 60–99%, while the evacuation rate of craniotomy group was from 30–99%. The mean evacuation rate of two groups was 78.4% and 80.6%, respectively without significant difference ($p = 0.325$). There was no difference in GOS score between two groups 3 months after surgery ($P = 0.156$, Table 2). The median operation time was significantly shorter in Keyhole group than in craniotomy group (116.4 vs. 143.7 minutes, $p = 0.001$). Only one case died of intracerebral infection in craniotomy group, mortality rate was 0% in keyhole group and 3.57% in craniotomy group, without significant difference ($P > 0.05$). ICU stay of keyhole group ranged from 0 to 9 days with the mean of 3.3 days. ICU stay of craniotomy group ranged from 0 to 12 days with the mean of 4.5 days, with significant difference between two groups. There was significant difference in hospitalization costs between two groups ($p = 0.001$, Table 2).

Total 76 cases received surgery within 6 hours after symptom onset (42 cases in keyhole group and 34 cases in craniotomy group), among them 52 cases had good prognosis with GOS more than 3. In contrast, only 25 cases had good prognosis among all cases received surgery after 6 hours after symptom onset (Table 3). However, there was no significant difference in re-bleeding incidence between ultra-early group (within 6 hours) and early group (> 6 hours) (3.22% vs. 5.56%; $P = 0.245$, Table 3).

Discussion

In clinical practice, hematoma with small volume (< 10 ml) can be treated with conservative measures and functional exercises for rehabilitation [7, 8]. On the other hand, for large hematoma more than 30 ml which could threaten life or cause neurological dysfunction, surgery is essential [9, 14]. However, different groups have recommended different surgical procedures [3, 7, 10]. To moderate volume basal ganglion hematoma ranging from 30 to 60 ml, there are several surgical procedures available, such as endoscopy operation, craniotomy, stereotactic aspiration and keyhole evacuation [9]. In this study, we introduced keyhole operation for moderate basal ganglion hematoma, and compared the complications and outcome with craniotomy.

Craniotomy approach is a classical way for clearing intracerebral bleeding in basal ganglia and is widely used in clinical practice. However, craniotomy prolongs the operation and anesthesia time, and increases the risk of infection and epilepsy. Moreover, craniotomy increases the risk of damage to the speech center and the vein of Labbe, leading to increased chance of complications [9, 15]. Keyhole operation transsylvian-transinsular was performed in this study for moderate basal ganglion hematoma, and avoided the above defects of craniotomy. A challenge for keyhole operation of moderate basal ganglion hematoma is hemostasis during operation [11, 12]. The bone window of only 2.5 cm in diameter may limit hematoma cavity exposure and lead to hematoma re-bleeding postoperatively [12, 13]. In our series, there was no significant difference in re-bleeding rate of between two groups, re-bleeding rate of keyhole group was 4.76% (9 of 63 patients), similar to craniotomy group (rebleeding rate was 3.57%, 4 of 56 patients). Poor control of hypertension post-operatively may cause re-bleeding. Therefore, blood pressure control postoperatively is very important.

Importantly, we found that infection rate was lower in keyhole group compared to craniotomy group, and mean operation time and hospitalization cost were less in keyhole group than in craniotomy group. These results showed the advantages of keyhole over craniotomy. Moreover, the patients operated within 6 h after symptom onset had better outcome than those operated between 6–24 h, suggesting that early operation is important to improve the prognosis of the patients no matter which operation approach is taken.

Conclusions

Although this study has several limitations such as retrospective nature, small sample size and highly selected patients, our results suggest that keyhole surgery is safe and feasible for moderate basal ganglion hematoma. Further randomized controlled large scale studies are necessary to confirm the safety and efficacy of keyhole surgery.

Declarations

Ethics approval and consent to participate

The research protocol was approved by the Research Ethics Committee of Chongqing Medical University, China.

Consent for publication

All the patients signed the Consent for publication, and allowed to public the images and therapy data in this article without commercial interest.

Availability of data and material

The data used and/or analyzed during the current study can be obtained from the corresponding author by email.

Competing interests

No.

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Authors' contributions

GL contributed to the conception of the study. QZ, QL, YC, GL performed the experiment. LP contributed significantly to analysis and manuscript preparation. LP performed the data analyses and wrote the manuscript. QL, YC, GL helped perform the analysis with constructive discussions. All Authors read and approved the manuscript.

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Not applicable.

Abbreviations

SICH: Spontaneous intracerebral hemorrhage; GOS: Glasgow Outcome Scale; GCS: Glasgow Coma Scale; CT: computed tomography

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Tables

Table 1. General data of 49 patients with basal ganglion hematoma.

Parameter	Keyhole		Craniotomy	
	group (n = 63)		group (n = 56)	
	Value	Range or %	Value	Range or %
Age (y/o)	48.5	35–70	50.5	36–69
Sex (F: M)	18:45		22:34	
ICH volume (mL)	46.7	30–60	48.5	30–60
Initial GCS (median)	8	4–14	14	4–14
Surgery within 6 h	42	66.7	34	60.7

Table 2. Operative outcomes of 49 patients with basal ganglion hematoma.

Parameter	Keyhole		Craniotomy		
	group(n = 63)		group (n = 56)		
	Value Range or %		Value Range or %		
Median operation time (min)	116.4	80-250	143.7	120-300	0.001
Median evacuation rate (%)	78.4	60-99	80.6	60-99	0.325
Median ICU stay (d)	3.3	0-9	4.5	0-12	0.015
hospitalization expenses(¥)	32198	20921-53423	36564	25328-88723	0.001
Rebleeding (n)	9	4.76	4	3.57	0.231
Infection(n)	9	4.76	8	7.14	0.006
Mortality ^a (n)	0	0	4	3.57	0.009
GCS preoperation	8.6	6-14	7.6	6-8	0.001
Median GOS (3 mo later)	3	1-4	3	1-4	0.156
^a Cause of death: intracerebral infection.					

Table 3. Operative outcomes between <6h group and >6h group.

	< 6 h	> 6 h	p
Mortality, n (%)	0(0)	1 (5.56)	0.006
Good outcome GOS > 3, n (%)	52(68.4)	25(58.1)	0.021
Rebleeding, n (%)	3(3.94)	2(4.65)	0.245

Figures

Figure 1

Keyhole approach for basal ganglion hematoma. A. Preoperative CT. B. Postoperative CT. C. Skin incision about 4 cm in length. D. The bone scalp was about 2 cm in diameter. E. The lateral fissure was in the center of the operation field. F. View after evacuation, ICP decreased and a drainage tube was put in hematoma cavity.