Effect and prognosis of endoscopic intracranial hematoma removal and hematoma puncture and drainage in patients with hypertensive intracerebral hemorrhage

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Abstract

Introduction: *Hypertensive intracerebral hemorrhage is one of the most serious complications of hypertension. The treatment focuses on reducing bleeding damage and promoting functional recovery.*

Aim: *This study investigated the efficacy and prognosis of endoscopic intracranial hematoma removal (EIHR) and hematoma puncture and drainage (HPD) in treating hypertensive intracerebral hemorrhage (HICH).*

Material and methods: *Ninety-two patients admitted to our hospital for EIHR and HPD between September 30, 2021 and September 30, 2022 were enrolled, including 14 cases of EIHR (endoscopy group) and 78 cases of HPD (puncture group). The efficacy of the two surgery modes in treating HICH patients was compared. Univariate logistic regression (ULR) and multivariate logistic regression (MLR) were employed to analyze the influences of different treatment methods on the prognosis of patients with HICH.*

Results: *The average hematoma clearance rate (HCR) of all patients was 80.52%, and the patients in the endoscopy group had a higher HCR than those in the puncture group (73.00% vs. 86.00%) ($p < 0.001$). The good prognosis rate (GPR) shown by the Glasgow Outcome Scale (GOS) score in the endoscopy group was 69.23%, and that in the puncture group was 40.38%, a large but statistically non-significant difference ($p > 0.05$).*

Conclusions: *The HCR of EIHR was greatly higher based on that of HPD, but showed no great difference in prognostic effect. The higher the GCS score on admission, the lower the likelihood of poor prognosis.*

Key words: *endoscopy, endoscopic intracranial hematoma removal, hematoma puncture and drainage, hypertensive intracerebral hemorrhage, efficacy, prognosis.*

Introduction

Hypertensive intracerebral hemorrhage (HICH) is a very dangerous neurological disease with extremely high rates of death and disability. Globally, there are about 4.02 million new cases every year, and the median mortality within 30 days of onset is 41% [1]. Common surgical methods in HICH are endoscopic intracranial hematoma removal (EIHR) and hematoma puncture and drainage (HPD). The application of EIHR is the most extensive. It can remove a deep intracranial hematoma under direct vision, and the hemostatic effect is quite strong. However, this operation has a long time, more bleeding, greater trauma to the surrounding brain tissue, a strong postoperative edema reaction, and more postoperative complications [2]. Therefore, minimally invasive surgery with less erosion and fewer complications is more likely to be applied clinically. In recent years, neuroendoscopic minimally invasive surgery and minimally invasive HPD

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have achieved excellent clinical therapeutic effects in the treatment of HICH. Neuroendoscopic minimally invasive treatment of HICH has less trauma, more thorough removal of the hematoma, more reliable hemostasis, and a lower postoperative intracranial infection (II) rate [3]. Most of the survivors had severe neurological, physical and speech impairments. However, in this case, only about 13% of survivors can live independently after 90 days and have mild disabilities, which will bring a certain burden to the family and society [4]. Because our country population is large, the incidence of cerebrovascular diseases is very high. In addition, with the continuous progress of economic society, people's way of life has also undergone drastic changes. The aging population brings a great threat to the development of society, thus greatly increasing the incidence and quantity of hypertensive cerebral hemorrhage, which seriously affects our economic and social development [5]. At present, although a lot of time and energy has been invested in the treatment of HICH patients, little effect has been achieved in China. How to improve the prognosis of patients has become an important issue of concern for scholars at home and abroad. In terms of neurosurgery, the commonly used treatment methods for HICH patients are surgery, including traditional removal of bone flap hematoma, removal of small bone window hematoma, neuroendoscopic surgery, and minimally invasive HPD [6]. According to the pathogenesis of cerebral hemorrhage, some scholars believe that hematoma causes irreversible damage to peripheral nerves after 24 h, so early surgical removal of the hematoma can effectively improve the prognosis of patients. At present, surgical treatment is commonly used in the treatment of HICH, but there is still a great debate on the surgical treatment of HICH and the timing of the operation [7].

Relevant studies showed that in most patients bleeding stopped after 2 h, and neuronal apoptosis could be observed around the hematoma within 3–6 h, but neuronal damage and metabolic disorders were not significant. Six to 7 h later, edema began to appear around the hematoma, and the apoptosis rate of nerve cells was accelerated [8, 9]. By observing the computed tomography (CT) findings of patients with cerebral hemorrhage, researchers found that a few patients still continued to bleed after 6 h, so 6 h was proposed as the time node for hemostasis. However, a day later, the patient's condition is likely to deteriorate due to aggravated edema and other reasons [10]. The main cause of death in patients with cerebral hemorrhage is cerebral hernia, which is caused by a hematoma occupying the space and the compression of the brain stem leading to the failure of the nervous central system. Therefore, it is very important to remove the hematoma and relieve compression through surgery. Early surgery is considered to be the best way to reduce brain tissue damage and prevent deterioration of brain edema. Many researchers recommend early surgery. Although ultra-early surgery eliminates the mass within 3 h and helps restore brain function, postoperative bleeding and mortality are greatly higher than those in other periods [11]. The curative effect of preoperative surgical treatment of HICH is not ideal, but the treatment of HICH is still worth exploring. The clinical application of traditional EIHR is threatened due to iatrogenic injury. Small bone window surgery is an improved surgical method developed on the basis of traditional craniotomy, which is mainly used to treat superficial intracranial hematomas. However, due to limited access to deep hematomas, further observation cannot be made, which is the limitation of this operation in the treatment of cerebral hemorrhage [12]. In recent years, due to the deepening understanding of minimally invasive techniques, the application of minimally invasive hematoma puncture in the treatment of cerebral hemorrhage has gradually attracted people's attention. The surgical methods for HICH's resection of intracranial hematoma mainly include resection of intracranial hematoma with a traditional large bone flap, resection of intracranial hematoma, and resection of intracranial hematoma under a neuroendoscope [13]. This study aimed to investigate the efficacy and prognosis of EIHR and HPD in treating patients with HICH.

Aim

The aim of our study was to investigate the efficacy and prognosis of EIHR and HPD in treating HICH.

Material and methods

Research objects

Between September 30, 2021 and September 30, 2022, 92 patients who underwent EIHR (endoscopy group, 14 cases) or HPD (puncture group, 78 cases) were admitted to our hospital.

The patients could be enrolled if they satisfied all the following conditions: I. the cause of intracerebral hemorrhage in patients was spontaneous intracerebral hemorrhage caused by hypertension; II. the hemorrhage was located in supratentorial, subtentorial, and cerebral parenchyma; III. bleeding time less than 72 h; IV. the amount of blood loss above and below the tentorium ≥ 30 ml and 10 ml; and V. complete clinical data.

The patients had to be excluded if they had any of the following conditions: I. cerebral hemorrhage not caused by hypertension; II. it was not parenchymal hemorrhage; III. accompanied by severe coagulation dysfunction; IV. the patient had cerebral herniation or brain death, or was accompanied by other important organ failure; and V. the patient's family refused surgical treatment.

This study was approved by the Medical Ethics Committee of Qixingguan District People's Hospital, and the families of the patients included in the study signed the informed consent form.

Methods

The EIHR was performed as follows. A preoperative CT scan was performed to locate the hematoma, mark the hematoma site, and select the best surgical approach. The patient was sheathed and admitted to the operating room in a supine position. Routine endotracheal intubation was performed under general anesthesia. After successful anesthesia, the patient wore a headband and turned the head to the healthy side. The location of the hematoma was determined again to avoid deviation. With the incision as the center, it was cut into 3.2–4.3 cm straight. A mastoid retractor was utilized to open the incision. The bone hole was drilled out and a milling cutter was employed to make a small bone window 3.2 cm by 3.2 cm. The dural membrane was "+" incised and suspended, then a puncture needle with a flexible tube was inserted into the central area of the hematoma, and the minimally invasive surgical cannula was inserted along the puncture tunnel to pull out the inner core and establish the operating channel. The hematoma was aspirated under a microscope, and the surgical cannula was rotated and retracted to remove additional hematoma. During the operation, bipolar hemostasis and saline irrigation can be adopted to ensure a clear visual field. There was no need to remove the hematoma forcibly if there was a clot that was closely connected to the brain tissue and could not be completely sucked out. The hematoma can be absorbed by itself in the later stage, and the residual hematoma around the hematoma cavity can be checked repeatedly. After the hematoma was completely removed, it was rinsed with normal saline repeatedly. If the fluid in the operative cavity is clear, hemostatic gauze should be placed, the surgical cannula should be withdrawn, a drainage tube should be placed, the bone flap should be reset and fixed, and the scalp should be sutured layer by layer, gauzed, and fixed.

The intracranial HPD was performed as follows. Skin preparation was performed before surgery. The patient was placed in a supine position with the head in the head ring and tilted to the healthy side. With the maximum hematoma level shown in the preoperative CT scan as the target, the puncture location was determined according to the location of hematoma, and the puncture direction was selected. A 2.2–3.2 cm incision was made on the scalp, each scalp layer was cut open to expose the skull, bone holes were drilled to expose the dura mater, electrical coagulation was stopped, the dura mater was cut open with a sharp knife, and then a hose puncture needle was used according to pre-CT positioning to reach the predetermined depth. Dark red blood could be observed and the needle core was removed. The hematoma was aspirated gently and slowly with a 9 ml syringe, usually no more than 32 ml for the first time. The drainage tube was fixed subcutaneously, the scalp was sutured, and sterile gauze was fixed to cover the bandage.

Observation indicators

General data of patients were collected, including age, gender, hematoma site, preoperative blood loss (PBL), Glasgow Coma Scale (GCS) score on admission, duration from onset to operation (duration), and hematoma clearance rate (HCR). Postoperative complications included pulmonary infection (PI), II, gastrointestinal bleeding, intracranial rebleeding (IRB), and length of stay (LOS). Outcome evaluation data referred to the Glasgow Outcome Scale (GOS) score 3 months after surgery. It was scored as 1 point: death; 2 points: vegetative state with minimal response; 3 points: conscious but severely disabled with permanent need for assistance with activities of daily living; 4 points: mild disability, able to live independently, can carry out corresponding work under protection; and 5 points; good recovery, can live normally, may be accompanied by mild defects.

One point meant death; 2–3 points meant the patients had a poor prognosis, and 4–5 points suggested that the patients had a good prognosis.

Statistical analysis

SPSS21.0 was utilized to perform a statistical analysis of all data. The measurement and count data were expressed as $\bar{x} \pm s$ and percentage, being subjected to t and χ^2 tests, respectively. $P < 0.05$ was considered statistically significant. The mean activities of daily living (ADL) value in the endoscopy group was 58.63, while that in the puncture group was 47.59, with the standard error (SE) of 6.28. For the bilateral test $\alpha = 0.05$ and power = 0.9 were set. Power Analysis and Sample Size (PASS) was utilized to calculate the sample size of each group, with at least 8 cases in each. A logistic regression model was used to analyze the prognostic factors of hypertensive encephalopathy patients.

Results

Preoperative general data of patients

The hospital data of 92 HICH patients were collected; of these, 14 (15.22%) and 78 (84.78%) were included in the endoscopy group and puncture group, respectively. Those in the endoscopy group were on average 56.88 ±14.15 years old, with males accounting for 64.39%. The average age of patients in the puncture group was 57.32 ±12.18 years, and males accounted for 66.77%. Therefore, the average age and male/female ratio showed no great difference for patients in different groups ($p > 0.05$). The GCS score of patients in the endoscopic group at admission was 8.02 ±2.01, while in the puncture group it was 6.10 ±2.13, with a highly significant difference ($p < 0.001$). The duration of patients in the endoscopy group was 14.12 ±5.76 h, and that in the puncture group was 8.34 ±4.62 h, exhibiting a significant difference with $p < 0.001$. The above data are presented in Table I.

Table I. Preoperative general data of patients

Variables	Endoscopy group (*n* = 14)	Puncture group (*n* = 78)
Gender (male/female)	9/5	52/26
Age [years]	56.88 ±14.15	57.32 ±12.18
PBL [ml]	38 ±9.5	42 ±6.4
GCS score on admission	8.02 ±2.01	6.10 ±2.13
Duration [h]	14.12 ±5.76	8.34 ±4.62

PBL – preoperative blood loss, GCS – Glasgow Coma Scale.

Postoperative data of patients

The HCR was 95.00% (91.00%, 95.56%) in the endoscopy group, which was much higher than that in the puncture group (80.52% (73.00%, 86.00%)), showing a significant difference ($p < 0.001$), as demonstrated in Figure 1.

The average LOS values in the endoscope group and the puncture group were 19 days and 14 days, respectively, showing no significant difference ($p > 0.05$). The numbers of patients with PI, II, stress ulcer (SU), and IRB were 12 (91.67), 1 (7.14), 3 (21.43), and 3 (21.43) in the endoscopy group, respectively. The numbers of subjects with PI, II, SU, and IRB in the puncture group were 71 (91.03), 7 (9.21), 11 (6.41), and 4 (5.15), respectively. All the above indicators of patients in different groups exhibited no significant differences ($p > 0.05$).

Prognostic analysis of different surgical methods

The GOS score of patients in the endoscopy group was 4.05 ±1.13, and that in the puncture group was 3.11 ±0.89, showing no significant difference ($p > 0.05$), as illustrated in Figure 2. The good prognosis rate (GPR) revealed by the GOS score was 69.23% and 40.38% in the endoscopy and puncture groups, respectively, presenting no significant difference ($p > 0.05$), as demonstrated in Figure 3.

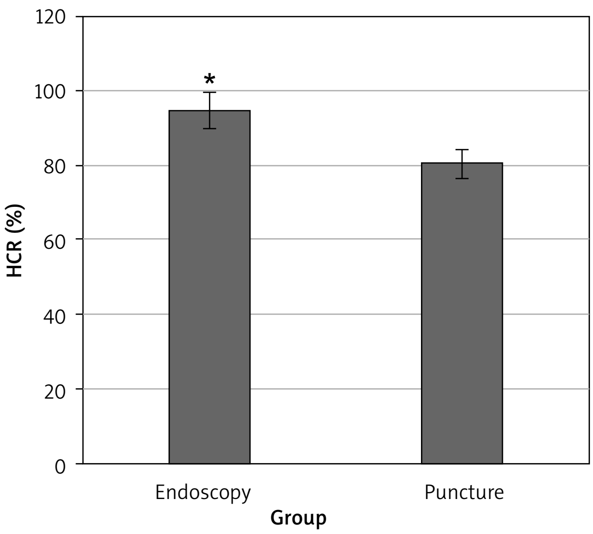

Figure 1. Hematoma clearance rate (HCR) of patients in the endoscopy and puncture groups

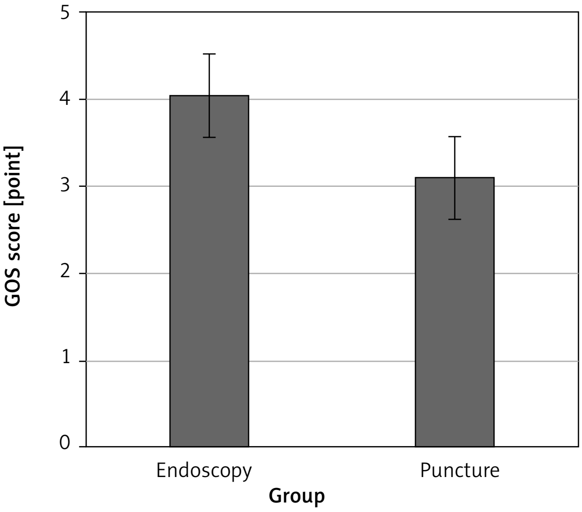

Figure 2. Glasgow Outcome Scale (GOS) scores of patients in different groups

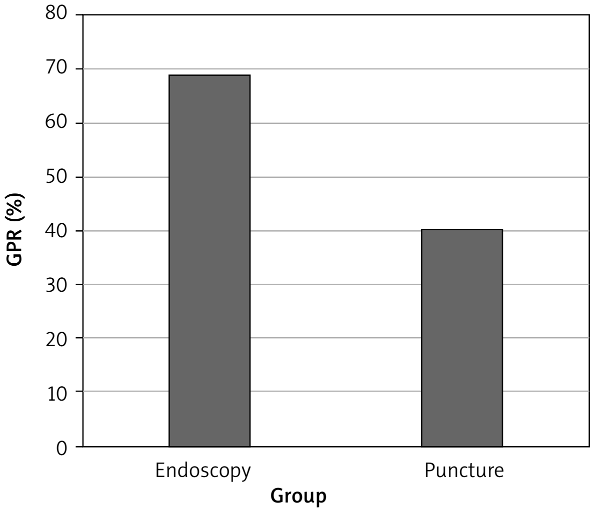

Figure 3. Good prognosis rates (GPRs) revealed by GOS of patients in various groups

Factors influencing the prognosis of GOS score

The GOS score was employed as the prognosis evaluation criteria. The gender, age, and other factors were analyzed by univariate logistic regression (ULR) analysis for the prognosis of poor GOS score. The results revealed that the older the age was, the more likely it was for the GOS score to show a poor prognosis, and the higher the GCS score was at admission, the less likely was a poor prognosis. No great differences were observed in the GOS score and prognosis according to lesion location, duration, surgical method, HCR, PI, II, SU, IRB, PBL, and LOS ($p > 0.05$). Table II displays the above results.

Combined with the results of multivariate logistic regression (MLR) analysis of clinical significance and prognosis of poor GOS score, the MLR analysis of GOS score prognosis was conducted by further including gender, age, GCS score at admission, PBL, surgical method, postoperative HCR, and duration. The results revealed that the higher the GCS score was at admission, the less likely was an adverse prognosis. After adjusting variables, age, gender, onset time, surgical treatment, HCR, and PBL had no great significance for GOS score and prognosis, as shown in Table III.

Discussion

In recent years, HICH surgical removal of hematomas could relieve the effects of space-occupying lesions, reduce nerve tissue damage, relieve ischemia, remove toxic chemicals, and promote the recovery of nerve function after cerebral hemorrhage. For hypertensive patients with hematoma volume between 21 and 42 ml, surgical removal of the hematoma is superior to drug treatment in reducing bleeding recurrence, shortening hospital stay and improving neurological function recovery, although there is no significant difference in mortality compared with conservative treatment [14]. In the last 30 years, although there have been many studies on the prognostic effect of HICH surgery, there is still no clear conclusion on whether surgical treatment of cerebral hemorrhage can achieve a better prognosis for patients [15]. Many prospective randomized controlled trials have been conducted to date, but most have failed to demonstrate improved outcomes for patients treated with surgery [16, 17]. The STICH trial, an international trial of intracerebral hemorrhage surgery, showed that patients with spontaneous supratentorial hemorrhage received no benefit from early surgery compared to initial conservative treatment. The STICH II trial based on subgroup analysis of the STICH test confirmed that early surgery could not reduce the mortality or disability rate within 6 months, but for patients with spontaneous supratentorial hemorrhage, there are generally significant survival conditions in terms of clinical efficacy [18]. Neuroendoscopic hematoma removal not only has the advantages of high HCR of traditional craniotomy, but also has the advantages of minimally inva-

Table II. Univariate logistic regression results of hypertensive intracerebral hemorrhage patients with poor prognosis (GOS score)

Parameter	β	SE	Wald χ^2	OR (95% CI)	*P*-value
Male	0.235	0.570	0.192	1.120 (0.450, 2.997)	0.712
Age [years]	0.039	0.011	4.533	1.403 (1.288, 1.734)	0.025
GCS score on admission	–0.889	0.425	13.818	0.414 (0.170, 0.796)	0.001
Focal location:					
Basal ganglia	Ref			1.000	
Thalamus	1.235	0.184	2.071	2.649 (0.509, 5.573)	0.314
Ventricle	0.581	0.926	0.366	1.790 (0.214, 4.916)	0.556
Surgical method:					
Endoscope	Ref			1.000	
Puncture	1.280	0.769	4.023	4.156 (0.913, 8.225)	0.063
HCR (%)	–0.053	1.044	0.770	1.210 (0.363, 2.230)	0.416
PI	0.304	1.669	0.025	1.334 (0.061, 3.445)	0.655
II	1.535	0.839	2.629	5.579 (0.502, 11.517)	0.133
SU	1.309	1.145	1.335	3.537 (0.460, 7.178)	0.271
IRB	1.426	0.915	1.250	3.708 (0.365, 8.089)	0.310
PBL [ml	0.011	0.024	1.478	0.982 (0.197, 2.226)	0.228
Duration [h]	0.017	0.455	0.155	1.134 (0.738, 2.657)	0.639
LOS (days)	0.012	0.804	0.316	0.979 (0.665, 1.306)	0.554

GCS – Glasgow Coma Scale, HCR – hematoma clearance rate, PI – pulmonary infection, II – intracranial infection, SU – stress ulcer, IRB – intracranial rebleeding, PBL – preoperative blood loss, LOS – length of stay.

Table III. Multivariate logistic regression results of hypertensive intracerebral hemorrhage patients with poor prognosis (GOS score)

Parameter	β	SE	Wald χ^2	OR (95% CI)	*P*-value
Male	0.233	0.434	0.039	1.433 (0.520, 2.791)	0.663
Age [years]	0.104	0.049	1.556	0.982 (0.177, 1.365)	0.309
GCS score on admission	–0.925	0.166	10.522	0.441 (0.125, 0.773)	0.001
Surgical method:					
Endoscope	Ref			1.000	
Puncture	1.095	0.923	1.268	3.072 (0.246, 7.835)	0.416
HCR (%)	0.025	1.234	0.044	1.157 (0.443, 2.905)	0.739
PBL [ml]	0.122	0.016	0.350	0.972 (0.315, 1.591)	0.550
Duration [h]	0.065	0.504	1.991	1.263 (0.886, 1.765)	0.135

sive surgery with a small incision and less damage. The retrospective study showed that the operative time, blood loss and hemostatic time of neuroendoscopic hematomectomy were less than those of small bone window surgery. The prognosis of neuroendoscopic surgery is better than that of small bone window surgery. There was a multicenter randomized controlled trial comparing the efficacy of endoscopic hematoma removal with craniotomy in the treatment of supratentorial HICH, and the long-term prognosis of endoscopic surgery was no worse than that of craniotomy [19]. In addition, the time of endoscopic surgery is shorter, and there is no trauma or unnecessary medical costs caused by secondary skull repair surgery, so the clinical advantages are more obvious. Neuroendoscopic surgery can accurately locate the extent of the hematoma with the help of CT and other imaging examinations. With endoscopic surgery the intraoperative distribution of the hematoma can also be observed in order to remove as much of the hematoma as possible.

Minimally invasive puncture hematoma drainage is simple and can be completed under local anesthesia. It is applicable to a wider range of patients, including elderly patients and patients with serious cardiopulmonary diseases, and liver and kidney insufficiency. In addition, due to its low dependence on the instrument and simple development, it can reduce the compression effect of the hematoma by removing the hematoma in emergency situations, thus achieving the purpose of saving the life of patients. According to a study analysis of surgical treatment of HPD compared with conservative treatment, although reducing the hematoma and cerebral edema is safe and feasible, it does not show a better long-term prognostic effect [20]. Another retrospective study showed that when the blood loss was less than 52 ml, puncture hematoma drainage had a better prognosis than conventional craniotomy, with lower mortality and complication rates than conventional craniotomy [21]. However, when the blood loss was greater than 52 ml, the long-term prognosis was not greatly different between the two operation modes. This indicates that HPD, as a minimally invasive surgery, has the same effect as traditional surgery, and even better than traditional craniotomy in some aspects. It can also be observed in this study that the HCR of EIHR was much higher compared to that of HPD, while minimally invasive HPD is simple with a shorter operation time. However, the GOS score of patients after 3 months showed no great difference between the good prognosis rate and the poor prognosis rate. This indicates that the two minimally invasive procedures have advantages and disadvantages in the treatment of HICH, but no visible difference was observed in the long-term efficacy of patients. In addition, there was no significant difference in the incidence of serious complications such as PI, II, gastrointestinal bleeding, and IRB between the two groups of patients. Some studies have concluded that the older the patient, the higher the risk of death and the worse the short-term or long-term prognosis [22]. It may also suggest that the prognosis of older patients may be better than that of younger patients, possibly because the intracranial pressure due to brain atrophy in older patients is lower and the pressure on brain tissue is less than in younger patients given the same hematoma size. Therefore, postoperative tissue reperfusion and neurological function recovery are more likely in the elderly, and the prognosis is better.

Conclusions

The HCR of EIHR was greatly higher based on that of HPD, but showed no great difference in prognostic effect. The higher the GCS score was on admission, the lower was the likelihood of poor prognosis. The older the patient, and the longer the time between onset and operation, the greater was the likelihood of poor prognosis. Follow-up observation of patients will be strengthened in the future.

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Ethical approval

This study was approved by the Medical Ethics Committee of Qixingguan District People's Hospital, and the families of the patients included in the study signed the informed consent form.

Conflict of interest

The authors declare no conflict of interest.

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