Clinical Neuroscience Research, 2024, Volume 2, Issue 2
http://ojs.bbwpublisher.com/index.php/CNR

Evaluation of the Effectiveness and Efficiency of Minimally Invasive Craniotomy in the Treatment of Cerebral Hemorrhage

Yi Zhang*

Weinan Second Hospital, Weinan 714000, Shaanxi Province, China

***Corresponding author:** Yi Zhang, sxzy888vip@163.com

Abstract: *Objective*: To investigate the clinical effect of minimally invasive craniotomy in the treatment of patients with cerebral hemorrhage. *Methods*: 58 samples of patients with cerebral hemorrhage admitted to the hospital were extracted, and the enrollment time was from January 2023 to December 2023. The patients were grouped into an observation group (n = 29) and a control group (n = 29) by using the random draw method of the numerical table. Patients in the control group underwent traditional craniotomy, while patients in the observation group underwent minimally invasive craniotomy, comparing the clinical effectiveness rate, operation time, hematoma clearance rate, rebleeding rate, hospital stay, and various functional scores between the two groups. *Results*: The clinical efficiency of the observation group was higher than that of the control group ($P < 0.05$); the operation time and hospital stay of the observation group were lower than that of the control group ($P < 0.05$); there was no significant difference in the hematoma clearance rate and rebleeding rate of the two groups ($P > 0.05$); the neurological impairment score of the observation group was lower than that of the control group after the operation, and the Barthel index of daily living score, cognitive functioning score (HDS), dementia scale score of the observation group were lower than that of the control group ($P > 0.05$). Dementia scale scores (HDS) were higher than those of the control group ($P < 0.05$). *Conclusion*: Minimally invasive craniotomy is effective in the treatment of patients with cerebral hemorrhage, which can shorten the operation time and hospital stay, improve the recovery of neurological function and daily living ability, and is suitable to be promoted and applied in medical institutions.

Keywords: Minimally invasive craniotomy; Cerebral hemorrhage; Effective rate

Online publication: July 22, 2024

1. Introduction

Cerebral hemorrhage mainly refers to non-traumatic factors triggered by bleeding in the brain parenchyma, and its main causes are hypertension, small arteriosclerosis, aneurysm, and so on. The main clinical symptoms of the patients are dizziness, headache, limb weakness, dyskinesia, numbness of the face or limbs, and others, and with the increase in the amount of bleeding, the clinical symptoms are aggravated, and the patient's lives can be endangered [1]. Surgery is the main solution for the clinical treatment of cerebral hemorrhage, traditional craniotomy operation is relatively simple, the surgical field of vision is clear, and the hematoma can be effectively removed. However, if the surgical trauma is more serious, the incidence of postoperative complications is higher, and the hospital stay is longer. A minimally invasive craniotomy with a small bone window is a brand-new solution for the clinical treatment of cerebral hemorrhage. Its main features are slight surgical trauma, thorough removal of hematoma, short postoperative recovery time, and so on [2]. In this study, 58 patients with cerebral hemorrhage were selected as samples to explore the clinical effects of minimally invasive craniotomy.

2. Information and methods

2.1. General information

A sample of 58 cases of cerebral hemorrhage patients admitted to the hospital was taken, and the enrollment time was from January 2023 to December 2023. The patients were grouped into an observation group (n = 29) and a control group (n = 29) by using the numerical table random draw method. There were 18 males and 11 females in the observation group, with a statistical age range of 52–71 years old, mean 61.58 ± 3.79 years old, a statistical hemorrhage volume range of 35–80 ml, mean 49.26 ± 4.73 ml, and hemorrhagic sites including the basal ganglia in 12 cases, the subcortex in 7 cases, the thalamus in 6 cases, and the ventricles in 4 cases. In the control group, there were 17 males and 12 females, the statistical age range was 54–70 years old, with an average of 61.64 ± 3.74 years old, and the statistical hemorrhage volume ranged from 38–77 ml, with an average of 49.38 ± 4.65 ml, and the sites of hemorrhage included the basal ganglia in 14 cases, the subcortical in 6 cases, the thalamus in 5 cases, and the ventricles in 4 cases. The results of the comparison of the general information of the two groups did not have any significant difference (P > 0.05).

Inclusion criteria: CT examination was consistent with the Diagnostic Criteria for Hypertensive Cerebral Hemorrhage. The time from onset to surgery was less than 24 hours. Glasgow Coma Score (GCS) <8 points. The patients themselves or their families signed the informed consent for the study.

Exclusion criteria: Combined with cardiac, hepatic, renal, and other major organ dysfunction. Combined intracranial or systemic infection, coagulation dysfunction. Brain stem hemorrhage, hematoma involving the brain stem, aneurysm, or arteriovenous malformation.

2.2. Methods

Both groups of patients underwent basic treatment such as controlling blood pressure, disinfecting, lowering intracranial pressure, maintaining acid-base and electrolyte balance, and so on. The patients in the control group underwent traditional craniotomy, the anesthesia program was general anesthesia, a CT examination was performed, the location of the hematoma was determined and then set up horseshoe shaped surgical incision, the cranium was opened routinely to observe cerebral hemorrhage, and a blood clot was sucked out using a suction device. If there was an active hemorrhage within the brain tissues, electrocoagulation was performed to stop the hemorrhage. The dura was treated with a reduction suture, based on the dura. If there is active bleeding in the brain tissue, electrocoagulation will be performed to stop bleeding, and the dura mater will be treated with a tension-reducing suture. According to the damage to the brain tissue, bone flap reset or bone flap decompression treatment will be adopted, and the drainage tube will be left in place at the end of the operation to ensure smooth drainage.

The patients in the observation group underwent minimally invasive craniotomy, with general anesthesia as the anesthesia plan, CT examination, selecting the center of the largest hematoma level as the target point, and completing the positioning by using a ruler, to avoid damage to the important functional areas of the brain tissues and cortical blood vessels during the surgical operation. A longitudinal straight incision was made in the skin tissue nearest to the hematoma, the skull was drilled, and the bone window was enlarged to 3 cm x 3 cm with bone forceps after the operation was completed. The dura mater was cross-cut and suspended, the cortex was cut in the non-functional and non-vascular areas of the brain tissue, the suction device was placed in the direction of the puncture channel, and the hematoma was slowly and gently suctioned out. The operation was performed to avoid pulling the brain tissue, and the hematoma was protected with cotton pads. The puncture channel was protected by cotton pads, and the hematoma cavity was flushed with saline several times. The patient's head position and microscope angle were adjusted during the operation. Electrocoagulation was performed in case of active hemorrhage. At the end of the operation, a drainage tube was left in place and the surgical incision was closed. Postoperatively, 2 ml of saline mixed with 20,000–50,000 U of urokinase was injected into the hematoma cavity, clamped for 30 min, and then released.

2.3. Evaluation criteria

Evaluate the clinical effective rate of the two groups in 7 days after surgery. If the patient's GCS score rises by more than 90% after treatment, it is very effective; if the patient's GCS score rises by 45%–89% after treatment, it is effective; if the patient's GCS score rises by less than 45% after treatment, it is ineffective.

Statistics on operation time, hematoma clearance rate, re-bleeding rate, and hospital stay of the two groups were recorded.

Neurological deficit scores (NIHSS), daily living ability (BI) scores, and cognitive function Hasegawa dementia scale (HDS) scores were assessed in the two groups before surgery and 1 month after surgery. The NIHSS scores were 42 out of 42, with the higher scores being the more severe neurological deficit; BI scores were 100 out of 100, with the higher scores being the better daily living ability; HDS scores were 40 out of 40, with the higher scores being the better cognitive ability.

2.4. Statistical methods

SPSS 23.0 software was used to analyze the research data, a *t*-test was used for the measurement data (mean ± SD), the x^2 test was used for the count data %, and $P < 0.05$ was used for the existence of differences at the statistical level.

3. Results

3.1. Clinical efficiency of patients in two groups

As shown in **Table 1**, the clinical effective rate of the observation group is higher than that of the control group ($P < 0.05$).

Table 1. The clinical effective rate of patients in the two groups (n/%)

Groups	Very effective	Effective	Ineffective	Overall effective rate
Observation group (n = 29)	19	8	2	27 (93.1)
Control group (n = 29)	15	6	8	21 (72.4)
x^2 value				4.350
P value				0.037

3.2. Operation time, hematoma clearance rate, rebleeding rate, and hospital stay of patients in two groups

As shown in **Table 2**, the operation time and hospital stay of the observation group were lower than that of the control group ($P < 0.05$), and there was no significant difference in the comparison of hematoma clearance rate and rebleeding rate between the two groups ($P > 0.05$).

Table 2. Operation time, hematoma clearance rate, rebleeding rate, hospital stay of patients in two groups

Groups	Operative time (min)	Hematoma clearance rate	Rebleeding rate	Hospitalization time (d)
Observation group (*n* = 29)	91.28 ± 8.75	28 (96.6%)	1 (3.4%)	12.35 ± 1.79
Control group (*n* = 29)	118.35 ± 14.96	26 (89.7%)	2 (6.9%)	18.96 ± 2.85
t/x^2 value	8.411	1.074	0.351	10.577
P value	0.000	0.300	0.553	0.000

3.3. Functional scores of patients in the two groups

As shown in **Table 3**, the NIHSS of the observation group was lower than that of the control group after surgery, and the BI score and HDS score were higher than that of the control group ($P < 0.05$).

Table 3. Various functional scores of patients in the two groups (mean ± SD)

Groups	NIIHSS score		BI score		HDS score	
	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative
Observation group (*n* = 29)	20.48 ± 2.75	8.94 ± 1.69	61.83 ± 6.92	79.24 ± 8.65	14.98 ± 1.82	28.97 ± 3.06
Control group (*n* = 29)	20.55 ± 2.81	11.38 ± 2.27	61.77 ± 6.86	70.62 ± 4.43	15.04 ± 1.73	21.96 ± 1.74
t value	0.096	4.643	0.033	4.777	0.129	10.724
P value	0.924	0.000	0.974	0.000	0.898	0.000

4. Discussion

Cerebral hemorrhage, also known as spontaneous cerebral hemorrhage, accounts for about 20%–30% of all types of cerebrovascular disease, with the main site of the cerebral hemispheres, and a small number of patients with hemorrhage of the cerebellum or brainstem [3]. The main cause of cerebral hemorrhage is high blood pressure, and the patients mostly show symptoms such as dizziness, headache, limb weakness, difficulty in walking, and so on. This disease has a high rate of disability and mortality, so it is necessary to take an appropriate treatment plan as early as possible [4].

The results of this study show that the clinical effectiveness rate of patients in the observation group is higher than that of the control group, suggesting that the treatment effect of minimally invasive craniotomy in patients with cerebral hemorrhage is better than that of traditional craniotomy. Analysis of the specific reasons shows that traditional craniotomy is widely used in clinical applications, its main feature is that the operation is relatively simple. The craniotomy can be observed to determine the location of the hematoma, and removing the hematoma can achieve the role of decompression. However, this procedure is completed by expanding the wing point of the craniotomy, so the invalid craniotomy is larger in scope, the surgical trauma is relatively serious, it is easy to damage the facial nerve and the temporal muscle, and it can cause a certain degree of damage to the healthy brain tissue, which in turn affects the effect of surgical treatment. This causes damage to the healthy brain tissue, thus affecting the effect of surgical treatment [5]. Minimally invasive craniotomy is a brand new solution for clinical treatment of cerebral hemorrhage, in which the hematoma is located by CT before surgery, a small bone window is set up for access, and the hematoma is precisely removed by the physician under the microscope, which can rapidly reduce the compression of the hematoma on the brain tissue and magnify the observation of the fine anatomical structures in the hindbrain tissue to determine the small penetrating vessels around the hematoma, which can avoid damaging the healthy brain tissue [6]. Compared with traditional craniotomy, minimally invasive craniotomy removes hematoma more thoroughly and can identify tiny bleeding points with good hemostasis, and with slight surgical trauma, it can avoid damaging healthy brain tissues and important brain functional areas, which can significantly improve the surgical outcome [7].

This study confirms that the operation time and hospital stay of the observation group are lower than that of the control group, and there is no significant difference in the hematoma removal rate and rebleeding rate of the two groups, suggesting that minimally invasive craniotomy can shorten the operation time and hospital stay, and there is no significant difference in the effect of hematoma removal and rebleeding rate between minimally invasive craniotomy and traditional craniotomy. Compared with traditional craniotomy, minimally invasive craniotomy has a clear field of vision, and the surgeon can complete the hematoma removal and hemostasis-related operations under direct vision, thus avoiding damage to the major blood vessels and functional areas of the brain tissue, and the intraoperative hemostasis and decompression are sufficient, which can rapidly relieve cerebral edema, promote neuron function recovery, and avoid secondary brain damage. The minimally invasive craniotomy has a small area of the bone window, so the skull does not need to be repaired after the surgery, which can shorten the surgical time, and avoid the cerebral bleeding caused by traditional craniotomy. Avoiding complications such as softening and swelling of brain tissue caused by traditional craniotomy can significantly shorten the postoperative recovery time [8]. The results of this study showed that the NIHSS of the observation group was lower than that of the control group, and the BI score and HDS score were higher than those of the control group, suggesting that minimally invasive craniectomy treatment for cerebral hemorrhage patients can reduce the degree of neurological deficits, and improve the daily life ability and cognitive function of the patients. Analyzing the specific reasons, it can be seen that traditional craniotomy can completely remove the hematoma, with a large surgical trauma area, and the intraoperative operation is very easy to damage the healthy brain tissues, which affects the recovery effect of the postoperative neurological function [9]. Minimally invasive craniotomy with a small bone window can reduce surgical trauma based on ensuring hemostasis and hematoma removal, and the surgeon can rapidly complete the removal of the hematoma, avoiding its continuous compression of the surrounding brain tissues, effectively reducing the intracranial pressure, and avoiding the neurological deficits from worsening continuously. At the same time, a minimally invasive craniotomy incision is small and can reduce the damage to the scalp region of the nerves, blood vessels, and muscles, allowing access process away from the important nerves and blood vessels. The intraoperative use of a microscope to complete the operation, so that the pull on the brain tissue is small, can reduce the side injury caused by surgical operation, and significantly improve the patient's postoperative recovery effect [10].

The analysis of this study concluded that minimally invasive craniotomy can achieve relatively satisfactory therapeutic effects in patients with cerebral hemorrhage, can be applied to the treatment of mild and moderate basal ganglia hemorrhage, and can also be applied to the elderly, people with basic diseases and other patients with a low degree of surgical tolerance. Minimally invasive craniotomy also has certain defects, since the intraoperative bone window area is small if the patient is combined with cerebral hernia or there is obvious midline displacement, then it cannot effectively achieve decompression. To ensure the therapeutic outcome of patients with cerebral hemorrhage, physicians need to assess the patient's state of consciousness, underlying disease, age, bleeding volume, hematoma status, bleeding site, and depth before surgery, and to choose an appropriate surgical plan. During the minimally invasive craniotomy, physicians need to master the operation process, use imaging to determine the location of the hematoma, accurately complete the operation of hemostasis and hematoma removal, and monitor the changes in the patient's signs after the operation, and deal with the abnormalities promptly, to ensure the effectiveness of surgical treatment.

From the above analysis, it can be seen that the treatment effect of minimally invasive craniotomy for patients with cerebral hemorrhage is remarkable, which can shorten the operation time and hospital stay, and improve the recovery of neurological function and the ability of daily life, so it is suitable for promotion and application in medical institutions. In this study, few patients with cerebral hemorrhage were selected, the specific process of research and analysis was not perfect, and the specific mechanism of minimally invasive craniotomy treatment for patients with cerebral hemorrhage still needs in-depth analysis and research.

Disclosure statement

The author declares no conflict of interest.

References

[1] Cheng K, Fang XQ, Cheng B, et al., 2023, Efficacy of Minimally Invasive Neuroendoscopic Surgery Versus Standard Bone Window Craniotomy for Hematoma Removal in the Treatment of Hypertensive Cerebral Hemorrhage in the Elderly and the Effect on Inflammatory Indices. Chinese Journal of Gerontology, 43(15): 3698–3700.

[2] Wu M, 2024, Clinical Efficacy of Minimally Invasive Surgery Versus Traditional Craniotomy in the Treatment of Hypertensive Cerebral Hemorrhage in the Basal Ganglia Region. Journal of Beihua University (Natural Science Edition), 25(2): 214–218.

[3] Xu HQ, Yang Y, 2024, A Controlled Study on the Application of Ultra-Early Minimally Invasive Cerebral Hemorrhage Removal with Small Bone Window Versus Conventional Open Hematoma Removal in Hypertensive Cerebral Hemorrhage. Modern Medicine and Health Research (Electronic Edition), 8(4): 49–52.

[4] Wang G, Wang Q, Dang L, 2023, Comparison of the Efficacy of Minimally Invasive Drilling Hematoma Puncture and Drainage under Frontal Approach Compared with Traditional Craniotomy in the Treatment of Hypertensive Cerebral Hemorrhage Patients. Sichuan Journal of Physiological Sciences, 45(9): 1691–1693.

[5] Chen SD, Liu PP, 2024, Comparison of Clinical Efficacy between Minimally Invasive Neuroendoscopic Surgery and Small Bone Window Craniectomy with Hematoma Removal in the Treatment of Hypertensive Cerebral Hemorrhage. Primary Medical Forum, 28(7): 19–21 + 34.

[6] Li YK, Sha Y, 2023, Comparison of the Effects of Minimally Invasive Neuroendoscopic Surgery and Small-Bone Window Craniotomy Microsurgery in the Treatment of Supratentorial Hypertensive Cerebral Hemorrhage. Systemic Medicine, 8(1): 151–154.

[7] Luo WT, Zhao SQ, Song YH, 2023, Comparison of the Efficacy of Minimally Invasive Soft-channel Puncture Hematoma Drainage and Open Debridement Hematoma Removal in the Treatment of Hypertensive Cerebral Hemorrhage. Sichuan Journal of Physiological Sciences, 45(3): 489–491.

[8] Zhou DF, 2023, Clinical Efficacy of Minimally Invasive Treatment of Basal Ganglia Cerebral Hemorrhage and Craniotomy in Patients with Hypertensive Cerebral Hemorrhage. Clinical Research, 31(1): 19–22.

[9] Zhai XL, Zhou DZ, Liu DH, et al., 2022, A Randomized Controlled Study of Minimally Invasive Suction-assisted Undelayed Cranial Decompression for Primary Cerebral Hemorrhage with Cerebral Hernia. Journal of Practical Medicine, 38(11): 1328–1332.

[10] Zhang GL, Li SP, Li Q, et al., 2023, Clinical Effects of Minimally Invasive Neuroendoscopic Surgery and Small Bone Window Craniotomy Microsurgery for Supratentorial Hypertensive Cerebral Hemorrhage. Life Science Instrumentation, 21(2): 74.