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Comparison of Minimally Invasive Drainage and Craniotomy in the Treatment of Epidural Hematoma Caused by Brain Trauma

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Abstract: *Objective:* To compare and analyze the clinical efficacy of craniotomy compared to minimally invasive drainage in treating patients with traumatic brain injury and epidural hematoma. *Method:* 60 patients with traumatic epidural hematoma due to traumatic brain injury admitted to our hospital from August 2019 to August 2022 were selected as study subjects. The patients were divided into a control group and an observation group, with 30 cases in each group. The patients in the control group underwent craniotomy, whereas the patients in the observation group underwent minimally invasive drainage. The general indexes of the operation and the incidence of postoperative complications were compared between the two groups. *Results:* There was no difference in the hematoma clearance rate between the two groups ($P > 0.05$). The operation duration, tube placement time, incision length, and duration of hospital stay of the observation group were shorter than those of the control group. Besides, the intraoperative blood loss of the observation group was lesser than that of the control group, and the postoperative complication rate of the observation group was also lower than that of the control group ($P < 0.05$). *Conclusion:* Compared with craniotomy, minimally invasive drainage has a shorter operation time and can improve postoperative recovery of patients with epidural hematoma. It offers a hematoma clearance rate with craniotomy, with a smaller intraoperative blood loss and a lower risk of postoperative complications. Therefore, this treatment regimen should be popularized in clinical practice.

Keywords: Minimally invasive drainage; Craniotomy; Traumatic brain injury; Epidural hematoma

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1. Introduction

Epidural hematoma is one of the common complications of traumatic brain injury, which requires early surgical intervention due to its high incidence and rapid progression. Otherwise, there would be a high risk of brain hernia [1]. Craniotomy has been the primary choice when it comes to treating epidural hematoma due to its many advantages. However, this procedure is more traumatic and time-consuming, resulting in postoperative infections and other complications, which are not conducive to the patients' recovery [2]. In recent years, minimally invasive surgery has been widely promoted in clinical practice, and this procedure has been developing rapidly, resulting in more treatment options for critically ill patients. An example of minimally invasive surgery is minimally invasive drainage, which is less invasive than open craniotomy but is still able to remove hematoma efficiently. This procedure reduces the occurrence of stress reactions and accelerates the postoperative recovery of the patient. However, this procedure demands a high level of skill and requires clearly defined indications for the patient's operation; otherwise, it will be difficult to obtain the ideal clinical efficacy [3]. The purpose of this study was to compare and analyze the clinical value of craniotomy and minimally invasive drainage to explore which treatment plan is more conducive to improving the prognosis of patients with traumatic brain injury with epidural hematoma. A total of 60 cases were selected as the study sample, and the details are described below.

2. Information and methods

2.1. Data

A total of 60 cases of traumatic brain injury with epidural hematoma were enrolled in this study, all of which were admitted between August 2019–August 2022). The patients were divided into a control group and an observation group, with 30 cases in each group.

The patients in the control group underwent craniotomy, whereas the patients in the observation group underwent minimally invasive drainage. In the control group, there were 18 males and 12 females with ages ranging from 24 to 68 years (mean age: 46.55 ± 5.98 years). The bleeding volume ranged from 50 to 82 mL, with a mean value of 66.32 ± 7.14 mL. The hematoma sites involved the temporal parietal region in a ratio of 12:9:9 for frontal, and occipital regions. The reasons for injury were traffic accidents, falls from height, and percussion injuries, with a ratio of 12:10:8. In the observation group, there were 16 males and 14 females, with ages ranging from 25 to 65 years (mean age: 45.96 ± 5.81 years). The bleeding volume ranged from 50 to 84 mL, with a mean value of 66.39 ± 7.18 mL. The distribution of hematoma sites was temporoparietal: frontal: occipital = 11:10:9. The reasons for injury were traffic accidents, falling from a height, and striking injuries, with a ratio of 11:11:8. There were no significant differences in the baseline data between both groups ($P > 0.05$).

Inclusion criteria: (1) Diagnosed with craniocerebral trauma according to the criteria listed in the "China Surgical Guidelines" [4]; (2) confirmation of the disease by clinical symptoms, imaging and other examinations; (3) complete medical records; (4) met the indications for surgery; (5) signed the consent form.

Exclusion criteria: (1) Presence of contraindications to surgical procedures; (2) unstable vital signs; (3) dysfunction of the liver, kidney, or other important organs; (4) coagulation disorders or immune system diseases; (4) death or withdrawal from the study.

2.2. Methods

Upon admission to the department, both groups underwent standardized interventions such as hemostasis, anti-inflammation, and dehydration based on their individual conditions. Subsequently, different surgical treatments were implemented for each group according to their respective interventions.

The patients in the control group underwent craniotomy, which involved utilizing CT examination to determine the hematoma's location. Surgical incisions, such as straight, horseshoe, or curved incisions, were designed based on the lesion's location. After confirming the access plan, general anesthesia was administered accordingly. Once in full effect, the scalp and muscles were incrementally incised to fully expose the skull. Using a milling cutter, the skull was drilled and cut open until the dura mater was exposed. The hematoma was then effectively removed, and the operation was concluded with hemostasis and cranial closure. Postoperative antibiotics were routinely administered to prevent infection.

The patients in the observation group underwent minimally invasive drainage. Before the operation, the surgical indications for each patient were thoroughly assessed, and a brain CT was performed to determine the hematoma's location. The lower edge of the hematoma's projection was identified as the puncture point, marked, and subsequently reviewed on CT to ensure the accuracy of the puncture point.

After the surgery, a 2% lidocaine solution (Drug Administration Code: H65020295, Manufacturer: Sinopharm Xinjiang Pharmaceutical Co.) was used for infiltration anesthesia. Once the drug took effect, the large blood vessels of the meninges and relevant functional areas were avoided. A disposable hematoma puncture needle was then used for vertical puncture. During the first attempt at reaching the hematoma, the liquid was slowly withdrawn, removing approximately 3/10th of the hematoma. In case of resistance, the position of the side hole of the needle tip was adjusted appropriately. For crushed hematomas, 0.9% sodium chloride solution (5 ml) could be taken each time for flushing. Simultaneously, any active bleeding was observed, and if present, timely measures were taken to stop the bleeding. Subsequently, an appropriate amount of urokinase (Drug Administration Code: H23020109, Manufacturer: Heilongjiang Dilong Pharmaceutical Co.) was injected to liquefy the hematoma, retained for about 4 hours, and administered four times a day. The amount of drainage was monitored closely daily, guiding the adjustment of the CT and the depth of the puncture needle. In cases with more hematoma, the puncture point could be extended towards both sides to form a localized guide line. For those with less hematoma, the clot could be extracted under negative pressure, and if there was any blood outflow, norepinephrine (Drug Administration Code: H31021177, Manufacturer: Shanghai Hefeng Pharmaceutical Co.) was used to stop bleeding. This process continued until the bloody fluid was completely released. Then, the operation of flushing and drainage was carried out. If there were no abnormalities after 3 days, the drainage tube could be removed, and the incision could be sutured to complete the operation. The postoperative measures taken were the same as in the control group.

2.3. Observation indicators

(1) General indicators of surgery

The operation time, intraoperative blood loss, incision length, tube placement time, duration of hospital stay, and hematoma clearance rate of the two groups of patients were recorded, and the results were compared.

(2) Postoperative complications

The postoperative complications of the two groups were recorded, including re-bleeding, infection, epilepsy, craniocerebral injury, and so on, and their incidences was compared in a standardized manner.

2.4. Statistics

SPSS 25.0 for Windows software was used as the statistical basis for analyzing all the obtained data. For the nature of the score, if it was considered as measurement data, the results were presented as (mean ± standard deviation), and the *t*-test was employed. If the data was considered as counting data, it was presented as a percentage (%), and both the chi-square test and the final P-value were calculated. A *P-value* smaller than 0.05 was considered to indicate statistical significance.

3. Results

3.1. General surgical indicators

As depicted in **Table 1**, upon observing the general surgery indexes of both groups, all values in the observation group were lower, and the difference between the groups was statistically significant ($P < 0.05$). However, when comparing the hematoma clearance rate between the two groups, the difference was not statistically significant ($P > 0.05$).

Table 1. Comparison of observations of general surgical indicators (mean ± standard deviation)

Group	Cases	Operation duration (min)	Intraoperative blood loss (mL)	Incision length (cm)	Intubation time (d)	Duration of hospital stay (d)	Hematoma clearance (*n* [%])
Control group	*n* = 30	165.52 ± 31.41	355.58 ± 58.65	14.41 ± 4.58	7.45 ± 3.22	12.82 ± 5.54	27 (90.00)
Observation group	*n* = 30	61.42 ± 18.44	56.25 ± 16.78	3.12 ± 1.05	3.98 ± 1.49	6.14 ± 2.54	28 (93.33)
t	-	15.654	26.876	13.160	5.357	6.003	0.218
P	-	0.001	0.001	0.001	0.001	0.001	0.640

3.2. Postoperative complication rate

As can be seen from **Table 2**, after the observation of the total value of postoperative complications in the two groups, the results shown in the observation group were 6.67%, which was lower than that of the control group (26.67%), and the difference between the groups was statistically significant, with a $P < 0.05$.

Table 2. Comparison of observations of postoperative complications (*n* [%])

Group	Case	Re-bleed	Infection	Epilepsy	Cranial injury	Total
Control group	*n* = 30	3 (10.00)	3 (10.00)	1 (3.33)	1 (3.33)	8 (26.67)
Observation group	*n* = 30	1 (3.33)	1 (3.33)	0 (0.00)	0 (0.00)	2 (6.67)
χ^2	-	-	-	-	-	4.320
P	-	-	-	-	-	0.038

4. Discussion

Traumatic brain injury is a serious clinical trauma, characterized by visible trauma of the head caused by external objects, and its clinical manifestations may vary depending on the nature of the injury, whether it is focal or diffuse [5]. Epidural hematoma is one of the critical complications of traumatic brain injury which can occur within a short time after the injury, and is often manifested by symptoms such as headache, drowsiness, retardation, memory loss, etc. Individuals can be accompanied by delirious motor excitement, optic papillae edema, and other symptoms. In severe cases, it can lead to dementia, brain herniation and other adverse outcomes, so it is important to remove hematomas from the brain promptly. Therefore, hematoma removal is the first principle of this disease, but the specific choice of intervention is a major challenge [6].

Craniotomy is a conventional surgical procedure that involves opening the patient's skull using specific surgical instruments. This allows for the direct removal of hematoma and associated necrotic brain tissue under direct vision. However, the procedure requires a large incision, resulting in a relatively lengthy operation time and posing a certain risk of damaging normal brain tissue. Additionally, there is an increased risk of infection during the operation, leading to less favorable prognoses for a significant portion of patients [7]. The results of this study showed that the hematoma clearance rates of the two groups were 90.00% and 93.33%, respectively, suggesting that the two types of surgery can achieve a relatively satisfactory clinical treatment efficiency. However, compared with the control group, the observation group's operation duration, tube placement time, incision length, and hospitalization time were shorter, intraoperative blood loss was smaller, and the total value of postoperative complications was lower, suggesting that minimally invasive drainage resulted in a better prognosis of patients. Our results also suggest that minimally invasive drainage has higher shortens the treatment, accelerates postoperative recovery, and reduces the incidence of related complications. The reasons for this are that minimally invasive drainage does not need to open the skull, and the hematoma can be effectively drained out by precise puncture and repeated drainage operations based on the clear location of the hematoma, which is a relatively simple operation procedure, and the urokinase applied during the operation can continuously liquefy the hematoma. The procedure is relatively simple, and the urokinase used in the operation can continuously liquefy the hematoma, so the overall effectiveness and safety of the treatment are relatively guaranteed [8-9]. However, it should be noted that whether minimally invasive drainage can ultimately achieve satisfactory clinical results depends on whether the patient's surgical indications are strictly mastered, whether the operator's business ability is at a high level, and whether the drainage flow and nature of the drainage process are closely observed, and once abnormal changes in the color of the drainage fluid are detected, it should be changed to a craniotomy in time, so as not to jeopardize the patient's life safety [10]. Once abnormal changes in the color of the drainage fluid are found, it should be changed to craniotomy in time to avoid jeopardizing the life of the patient [10].

5. Conclusion

In conclusion, both craniotomy and minimally invasive drainage are effective methods for treating traumatic brain injury with epidural hematoma, achieving a relatively satisfactory hematoma clearance rate. However, minimally invasive drainage stands out with its shorter operation time, tube placement time, and hospitalization duration. Moreover, it is less likely to cause serious postoperative complications. Therefore, it is more conducive to promoting the body's recovery and improving the prognosis. It is recommended to prioritize minimally invasive drainage when conditions permit.

Disclosure statement

The authors declare no conflict of interest.

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