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Clinical Application of New-Type Stereotaxic Apparatus-Assisted Transfrontal Puncture Drainage in Treatment of Hypertensive Intracerebral Hemorrhage in the Basal Ganglia

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Abstract

Objective: To investigate the efficacy of new-type stereotaxic apparatus-assisted transfrontal puncture drainage in the treatment of hypertensive intracerebral hemorrhage in the basal ganglia.

Methods: A retrospective analysis was performed on the clinical data of 60 patients with hypertensive intracerebral hemorrhage in the basal ganglia who received disposable new-type stereotaxic apparatus-assisted transfrontal insertion with soft tunnels for hematoma aspiration drainage in our hospital from August 2017 to September 2019. The treatment efficacy was analyzed.

Results: All patients were successfully punctured at one time. The puncture surface was 5~6.5 cm on the basement plane, where the hematoma surface was the largest. The puncture angle was 10°~14°, and the puncture depth was 9~11.5 cm. Fifteen patients were operated within 6 h of hemorrhage, and the intraoperative hematoma clearance rate was about 25%; 40 patients were operated 6~24 h after hemorrhage, and the hematoma clearance rate was about 20%; 5 patients were operated one-3 d after hemorrhage, and the hematoma clearance rate was as high as 30%. The first postoperative re-check CT showed that 51 patients had ideal position of the drainage tube, 2 were too deep, one was too shallow, 2 were below the position, 2 were above the position, one was inside the position, and one was outside the position. The GCS scores of the patients on 3rd d of operation (9.88±3.998) were significantly higher than those of the patients before operation (6.24±3.159, $P<0.05$). One month after the operation, GOS showed that 20 patients (33.3%) returned to normal, 28 (46.7%) had mild disability, 7 (11.7%) had severe disability, 3 (5.0%) had plant survival, and 2 (3.3%) died.

Conclusion: The disposable new type stereotaxic apparatus-assisted transfrontal puncture drainage is easy to be conducted and practicable with a reasonable design, accurate positioning, minimal surgical traumas and satisfactory curative effect.

Keywords: Hypertensive Intracerebral Hemorrhage in the Basal Ganglia; Disposable New-Type Stereotaxic Apparatus; Transfrontal Puncture Drainage

Introduction

Hypertensive intracerebral hemorrhage is a disease with high morbidity, high mortality and high morbidity rates, which often occurs in the basal ganglia, accounting for 70% ~80%. .If the hemorrhage amount exceeding 30 mL easily leads to cerebral hernia that threatens lives [1], so there is a need to apply various surgical programs to remove hematoma as soon as possible. Timely evacuation of hematoma and control of intracranial pressure increase are currently the most effective treatment methods in clinical practice [2]. If the treatment is not timely, patients are prone to multiple complications of neurological impairment, resulting in severe disability, and even threatening lives [3]. The routine craniotomy evacuation of hematoma lasts for a long time with huge traumas and more postoperative complications, thus reducing the due operation results. The minimally invasive method can quickly and effectively lower the intracranial pressure, so hematoma puncture and aspiration drainage is increasingly recognized by more neurosurgeons [4]. According to the principle of stereotactic, Neurosurgery Department of Weifang people's hospital has developed a new type of stereotactic instrument with accurate positioning. Assisted by the stereotactic instrument, trans frontal puncture drainage is effective and safe in the treatment of hypertensive basal ganglia cerebral hemorrhage. We now retrospectively analyze the clinical data of these patients, summarize the treatment experience, in order to provide experience for clinical workers.

Objects and Methods

General Data

From August 2017 to September 2019, 60 patients with hypertensive basal ganglia intracerebral hemorrhage were treated with frontocentesis and drainage assisted by a new disposable stereotactic instrument in Department of Neurosurgery, Weifang people's Hospital. There were 36 males and 24 females, aged (56±10) years old, ranging from 35 to 84 years old; 15 cases were operated within 6 hours after bleeding, 40 cases were operated within 6 ~ 24 hours after bleeding, and 5 cases were operated within 1 ~ 3 days after bleeding; preoperative Glasgow Coma Scale (GCS) score was (6.240 ± 3.159), ranging from 5 to 15 points.

The inclusion criteria of the subjects were as follows: (1) having a history of hypertension, excluding basal ganglia hemorrhage caused by cerebral vascular malformations and intracranial aneurysms by CTA or DSA; (2) aged 30-90 years; (3) the amount of bleeding showed by CT in the hospital was 20-80 ml. Exclusion criteria: (1) patients with coagulation dysfunction; (2) patients with severe diseases or important organ dysfunction.

This study meets the requirements of the Helsinki Declaration (www.wma.net/en/30publications/10policies/b3/index. Html) revised in 2013.

Clinical Manifestations

There were 50 cases of headache, 52 cases of emesis, 50 cases of hemiplegia, 52 cases of hemidysesthesia, 35 cases of aphasia and 10 cases of meningeal irritation sign. Before operation, there were 10 cases of cerebral hernia, 5 cases of awareness, 35 cases of drowsiness, 6 cases of light coma and 4 cases of moderate coma.

Imageological Examination

Hemorrhages were located on the left side of the basal ganglia in 36 cases and on the right side in 24 cases. The hemorrhage amount was 20-30 mL in 18 cases, 31-60 mL in 40 cases, and larger than 61-80 mL in 2 cases.

Surgical Treatments

Disposable New-Type Stereotactic Instrument and its Principle: The disposable new-type stereotactic instrument is made of polystyrene. The two side arms and the goniometer are in the same plane. The two side arms ensure that the main board of the goniometer is in the puncture plane. The radian and length of the two side arms are asymmetric (because the puncture point of the forehead is either right or left), it can ensure that both arms are close to the scalp, and the round point at the bottom of the goniometer is at the puncture point (Figure 1). The principle of disposable new stereotactic instrument is to change "three-dimensional positioning" into "two-dimensional positioning", that is to say, the problem of three-dimensional space is simplified into a problem in plane, as long as the puncture angle and depth measured in the puncture plane determined by preoperative brain CT images are used for puncture.

Figure 1: Disposable new-type stereotaxic apparatus.

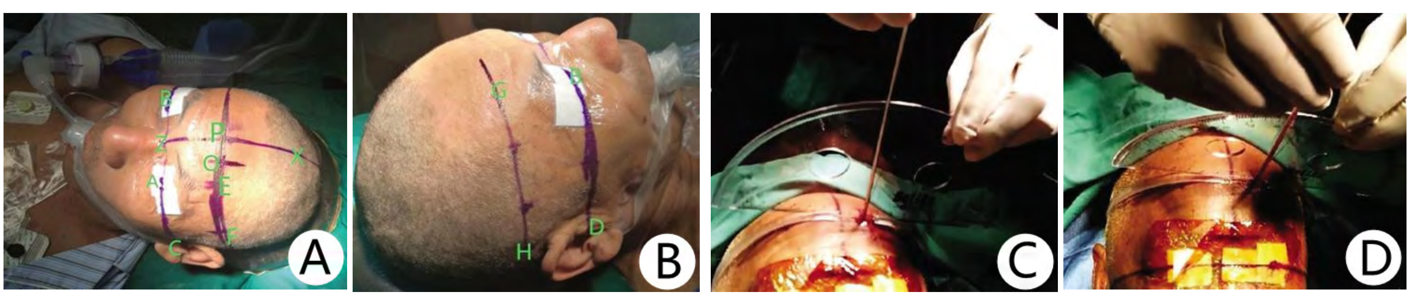
Positioning Methods: Patients underwent preoperative examinations immediately after admission. After the head skin was prepared, the maximum axial layer of hematoma was selected based on the preoperative cranial CT [scanning according to the "orbitomeatal (OM) line"]. Straight line AB was the standard midline, and straight line CD was perpendicular to straight line AB and close to the forehead skin.

A: It is a point on the midline (vertical line) of brain CT film; B: another point on the midline of brain CT film; C: a point on the vertical line (horizontal line) of midline AB, with the horizontal line close to the scalp; D: a point on the vertical line (horizontal line) of midline AB; E: a point on the reverse extension line of puncture passage OF; F: the farthest end of hematoma; G: a point on the vertical line GH, with GH perpendicular to the horizontal line CD, with vertical point O; X: The intersection of vertical line AB and horizontal line CD; O:The puncture point is a point on the horizontal line CD, and the line XO is 1.5 cm; Z: the intersection of the puncture path OF and the hematoma

Figure 2: CT positioning mark line of one patient.

Point X was the intersection point of straight line AB and straight line CD, line segment XO length was 1.5 cm, ray FE passed point O, point F was the most distal end of hematoma, line ZF was the maximum longitudinal axis of hematoma, and FE was the insertion direction of the puncture drainage tube. Angle EOG was the puncture inclination angle, which was generally 10 ~ 14 °, and line segment OF was the distance from the puncture point to the most distal end, which was generally 9.0 ~ 11.5 cm. Straight line GH was parallel to straight line AB crossing point O (Figure 2).

Transfrontal Puncture and Drainage: After local anesthesia at the transcranial point with a frontal cone, the scalp was cut approximately 3 mm with a sharp blade, an electric cranial cone bur drilled through the skull, the left and right arms of the new-type stereotaxic apparatus were respectively overlapped with the scalp marking lines EF and GH, the midpoint (origin) of the base edge of the gauge was aligned to point O, and a meningeal piercing needle was taken to break the dura at the angle of puncture with the assistance of the goniometer. A drainage tube with a guiding core is removed and punctured through the drilled bone hole with the assistance of a directional instrument at an angle (∠EOG) that is measured preoperatively, the catheter is slowly advanced, and the depth of puncture is determined by the preoperative measurement (the length of the line of OF), to which the guiding core is removed after hematoma and the dark black liquid component and semisolid bloody fluid are drawn, indicating that the puncture is successful and the drainage tube is inside the hematoma. If herniation occurs preoperatively, up to 1 / 3 of the volume of the hemorrhage may be removed without aspiration if there is resistance to aspiration (Figure 3).



A: The plane of puncture and the point of puncture were marked on the scalp; B: points G,H are points in the plane of puncture, GH⊥basal plane ABCD. C: The dura was punctured with a meningeal needle according to the “puncture angle” with the assistance of new-type stereotaxic apparatus. D: The drainage tube was placed into the human hematoma according to the “puncture angle” with the assistance of new-type stereotaxic apparatus.

Figure 3: Images during new-type stereotaxic apparatus-assisted transfrontal puncture drainage.

Postoperative Treatment: Patients were reviewed for cranial CT after surgery to see whether the drainage tube position was ideal, whether postoperative rebleeding occurred, and whether bleeding occurred in the puncture tract. The preoperative and postoperative residual hematoma volumes were calculated separately by combining the Coniglobus formula, and the intraoperative hematoma evacuation rate was further calculated [intraoperative hematoma evacuation rate = (preoperative hematoma volume - postoperative residual hematoma volume) / preoperative hematoma volume × 100%].

After surgery, liquefied fluid (urokinase) of human hematoma was injected into the intracerebral hematoma cavity every day, which was 30000 ~ 100000 u, 1 ~ 2 times / D, with low drainage, reducing the application of dehydrating drugs such as mannitol. Dehydrating drugs were discontinued postoperatively in some patients to facilitate evacuation of the hematoma .After the obvious reduction of hematoma via drainage, the dosage of urokinase can be reduced, generally with 50000 u per time. At the same time, the change of coagulation function of the patient was dynamically monitored, so as not to show bleeding from the puncture tract or rebleeding at the original hematoma caused by the application of urokinase. Dynamic cranial CT review, timely adjusts the depth of drainage tube according to the results. The GCS score was adopted to evaluate the coma level of patients on the 3rd postoperative day. 3 ~ 6 d after operation, as shown by cranial CT, the intracerebral hematoma has completely absorbed; only visible drainage tube, can be removed. As shown by cranial CT, the intracerebral hematoma cavity is significantly smaller, its density becomes isodense, at this time, and drainage needs to be continued. In addition, it is necessary to actively control blood pressure, prevent infection, and prevent complications.

Follow Up Time and Methods: The patients were followed up for 4 ~6 months after discharge, and the cranial CT was reviewed 1 month after operation to record the recovery of limb movement and language function, and the Glasgow Outcome Scale (GOS) score was used to determine the efficacy of the patients, with specific criteria: (1) the patients were cured well: gos score 5 points, returned to normal life despite mild defects; (2) mild disability: gos score 4 points, Mild disability, but can live independently and can work under protection; (3) severe disability: gos score 3 points, severe disability awake and disabled, needs care in daily life; (4) vegetative survival: gos score 2 points, vegetative survival, only minimal response (eg, eyes can open with the sleep / wake cycle); (5) death: gos score 1 points.

Statistical Processing

Statistical analyses were performed using spss22.0.Normally distributed metrology data were expressed as mean±standard deviation ($\bar{x}$±s), and comparisons between 2 groups were performed by t-test. $P < 0.05$ was taken as statistically significant.

Result

Surgical Outcomes

All patients in this group had successful first puncture and satisfactory puncture accuracy. The operative time was (30±5) min. The puncture plane was 5.0 ~ 6.5 cm on the basal plane, and this plane had the largest hematoma plane. The puncture angle was 10 ~ 14°and the puncture depth was 9.0 ~ 11.5 cm. The intraoperative hematoma evacuation rate was approximately 25% in 15 patients within 6 h of hemorrhage, 20% in 40 patients between 6 and 24 h after hemorrhage, and up to 30% in 5 patients between 1 and 3 d after hemorrhage. Patients with intracerebral hemorrhage 20 ~ 30 ml used 1 ~ 3 times urokinase postoperatively, patients with hemorrhage 31~ 60 ml used 3 ~ 5times urokinase postoperatively, and patients with hemorrhage 61 ~ 80 ml used 5 ~ 6 times urokinase postoperatively.

The first postoperative CT examination showed that the drainage tube position was ideal in 51 cases, too deep in 2 cases, too shallow in 1 case, position biased down in 2 cases, position biased up in 2 cases, position biased inside in 1 case, and position biased outside in 1 case; postoperative rebleeding was observed in 5 cases, including two cases of puncture tract bleeding and three cases of primary bleeding site. The blood loss did not reach the indication for craniotomy, and all improved after continuing to stay the drainage tube and reducing the amount of urokinase.

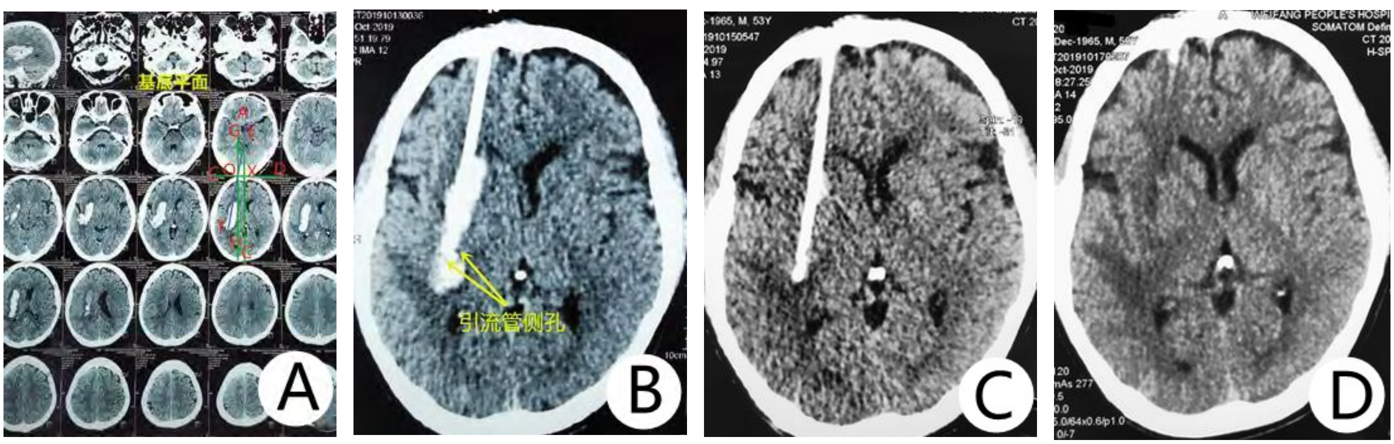
Time to extubation in our group was (3.5±1.5) d, range 1 ~ 7 d; liquefed fluid from hematoma was injected (5±3) times, range 2 ~ 10 times).The GCS score of patients on the 3rd postoperative day [(9.880 ± 3.998) points] was higher than that of patients before surgery [(6.240±3.159) points], and the difference was statistically significant ($t = 5.446$, $P=0.010$).

Follow up Results

Median follow-up time after patients' discharge was 4.6 months. The GOS score at 1 month after surgery showed that the prognosis was good in 20 cases (33.3%), light residues in 28 cases (46.7%), heavy residues in 7 cases (11.7%), vegetative survival in 3 cases (5.0%), and death in 2 cases (3.3%).

Typical Cases

The patient was male, 53 years old, chief complaint: sudden left-sided limb immobility for about 2 admission physical examination: somnolence, physical examination was less cooperative, question and words were not answered, right limb muscle strength was grade 5, muscle tone was normal, physiological reflexes were normal, pathological reflexes were negative, left limb muscle strength was grade 2, muscle tone was slightly low, pathological reflexes were positive. Auxiliary examination: cranial CT showed cerebral hemorrhage in the right basal ganglia region, volume about 35 ml, right lateral ventricle compression narrowing, mild left shift of the midline, annular cistern unclear. On day 1 after admission, the cranial CT was reviewed, the cranial CT films were reconstructed, and the lenses of both eyes and bilateral tragus were simultaneously presented in a plane according to the approximate "OM line " scan, which was the basal plane, the plane of puncture was determined, and the angle and depth of puncture were measured. On day 2 after admission, the drainage was performed by transfrontal puncture under the assistance of new-type stereotaxic apparatus under general anesthesia, the puncture plane and the puncture point were marked on the patient's scalp before operation, after the success of the intraoperative cone cranial drilling, the dura was punctured with a meningeal needle under the assistance of a goniometer according to the measured angle, and the drainage tube was placed intracranially under the assistance of new-type stereotaxic apparatus according to the same angle, and the surgical procedure was smooth (Figure 3). Review of cranial CT on postoperative day 1 showed that the intracerebral hematoma was significantly reduced, the drainage tube position was satisfactory, 1 ml of urokinase (100000 U) solution was injected into the hematoma through the drainage tube, 2 h after clamping the drainage tube, open drainage tube, low drainage, 1 time / D, the change of drainage fluid trait was observed. Review of cranial CT on postoperative day 3 showed that the hematoma disappeared, the puncture tract did not bleed, the brain tissue around the original hematoma did not show obvious edema, and the midline was reset. On postoperative day 5, a review of cranial CT after removal of the drainage tube showed that the hematoma drainage was clean completely disappeared, no obvious brain edema, and the midline was centered (Figure 4). Postoperatively, the patient's left limb muscle strength improved significantly and approached grade 4, which was treated with rehabilitation and he was discharged from the hospital with the ability to walk unassisted inferiorly.



A: Preoperative cranial CT showed cerebral hemorrhage in the right basal ganglia region, taking the plane with the largest cross-sectional area of the hematoma as the puncture plane, point O as the puncture point, line segment OX was 1.5 cm in length, point F was the furthest point of the hematoma, connecting OF, and line segment OF as the predetermined puncture path, the puncture depth was the length of segment OF, straight GO was perpendicular to the straight CD at point O, point E was a point on the reverse extension line of segment OF, and the angle of EOG was the puncture angle; B: On postoperative day 1, cranial CT showed that the drainage tube position was satisfactory, just reached the most distal end of the hematoma, and the intracerebral hematoma was significantly reduced; C: on postoperative day 3, cranial CT showed that the hematoma disappeared after perfusion of urokinase, low drainage, no bleeding from the puncture tract, and the midline was reset; D: on postoperative day 5, cranial CT showed that the hematoma disappeared after the drainage tube was removed, without significant brain edema, and the midline was centered.

Figure 4: Preoperative and postoperative brain CT images of one patient.

Discussion

Advantages of Disposable New-Type Stereotaxic Apparatus Assisted Puncture and Drainage Procedure

The puncture and drainage procedure with the assistance of brain stereotaxic instrument and neuronavigation can precisely puncture the target of intracerebral hematoma, but it is limited to be popularized and applied in primary hospitals because of the tedious preoperative preparation, high requirements, complicated equipment structure and expensive price. CT real time guided puncture can always review cranial CT, to understand the position of the puncture drainage tube, residual hematoma volume, with or without rebleeding, reducing the risk of the surgical procedure and improving the success rate of the procedure, but it needs to occupy expensive medical equipment intraoperatively and is difficult to achieve in hospitals with more patients. The simplest technique and currently the most widely used surgical method for performing puncture according to the positioning of cranial CT slices, which also requires positioning cranial CT (with a marker on the scalp) examination again preoperatively, is associated with poor puncture accuracy. To this end, there are clinicians who design and utilize a positioning ruler to improve the precision of puncture for intracerebral hematoma targets, by choosing the puncture point at the scalp closest to the intracerebral hematoma, but this puncture method has the potential to damage blood vessels in the sylvian fissure and its surrounding area, triggering rebleeding.

The disposable new-type stereotaxic apparatus assisted puncture method adopted by our group of patients has the characteristics of being simple, practical, and safe, and effective, while making up for the deficiencies of the above surgical methods. The side arms of this new-type stereotaxic apparatus were made of polystyrene and exhibited certain resilience and toughness, similar to hairpins worn by women. The localization accuracy of our method is 1~2 mm, which is suitable for basal ganglia ICH and cortical hemorrhage. When patients with intracerebral hemorrhage need urgent cranial CT examination, patients who cooperate can be scanned according to the routine "OM line"; patients who do not cooperate can be subjected to computerized 3D reconstruction to achieve the effect of scanning according to the "OM line". This positioning method has a certain requirement for the scan baseline, and it is not necessary to perform positioning CT scan again before operation, which is very suitable for emergency surgery and greatly shortens the preoperative preparation time. Before operation, the puncture plane, puncture point, puncture depth and puncture angle were determined by accurate measurement according to different CT films of basal ganglia hemorrhage [5].

The blood supply in the basal ganglia originates from the lenticulostenotic arteries in the M1 segment of the middle cerebral artery. The hemorrhagic spot is usually located in the anterior and posterior regions of the hematoma. Temporal puncture may cause damage to the superficial veins, middle cerebral artery branches and the brain pool in the lateral fissures. Although the transfrontal puncture path is longer than temporal puncture path, the former can effectively avoid the interference to the hemorrhagic spot and reduce the chance of hemorrhage during aspiration and drainage since the puncture pathway avoided the blood vessels in the lateral fissure area, and it penetrated from the anterior and posterior directions of the hematoma to the lower part of the hematoma. Patients lie in the supine position for most of the time. When the forehead is punctured, the distal end of the drainage tube is located at the lowermost end of the hematoma in the brain. When the hematoma gradually liquefies, it first flows to the lowermost end of the hematoma cavity due to gravity and will be drained out of the body via the side hole in the head end of the drainage tube, which greatly shortens the drainage time, improves the surgical effect, but this effect cannot be achieved through temporal puncture.

In trans frontal puncture through free hands, the puncture angle is difficult to be controlled, so and the head end of the drainage tube may be largely deviated after a long path. However, the puncture plane is determined according to the preoperative cranium CT scan, the puncture plane and the puncture point are marked on the scalp, and puncture is performed according to the outward-inclination angle and puncture depth in the plane determined by preoperative CT scan slices using the self-designed simple stereotactic apparatus, thus effectively ensuring the puncture accuracy. This avoids not only the tedious surgical procedure of stereotactic surgery but also the risk of corticospinal tract injury and vascular injury using the trans frontal stereotactic approach. Due to minimal injury and low cost, this method is easy to be accepted by the family and more suitable for elderly patients and those with poor health, oral administration of anticoagulant drugs for a long time or renal failure. In this group, the head end of the drainage tube was in the hematoma cavity, thus reducing the risk of hemorrhage caused by repeated punctures. Besides, the puncture accuracy of this method was satisfactory, which ensured adequate drainage of hematoma while reducing the risk of rehaemorrhagia triggered by injection of urokinases into the hematoma cavity. The general intracerebral hematoma is 40 ~ 60 mL, and 3 ~ 6 times of postoperative urokinase infusion can achieve good drainage effects.

During the trans frontal puncture, the intracerebral hematoma was gradually decreased until it disappeared. The puncture drainage tube would shift to the outside (away from the midline) as the compressed brain tissues, especially the midline structure, were reset, which would not cause secondary damage to brain tissues. However, during the temporal hematoma puncture in the basal ganglia, the too deep puncture would again damage the inner brain tissues of the hematoma cavity, especially the inner capsule and the hind limb. After the hematoma gradually disappeared, the hematoma cavity would gradually narrow and the compressed brain tissues, especially the midline structure, would be gradually reset. The length of the drainage tube did not change in the intracranial segment, causing the distal end of the drainage tube to penetrate into the brain tissue inside the hematoma cavity and resulting in unnecessary secondary injuries. If the internal capsule or thalamus was damaged, the consequences would be more serious. This indicates that the trans frontal puncture of intracerebral hemorrhage in the basal ganglia is superior to the temporal puncture. It has been reported that drainage via frontal puncture can reduce the injury to corticospinal tract [6-8].

Curative Effect of Puncture and Drainage Assisted by a Disposable New-Type Stereotaxic Apparatus

The average operation time for patients in this study was 30 min. With the increasing experience of surgeons, the operation time will be shortened after mastering the use of disposable new-type stereotaxic apparatus. Although only partial hematoma was removed during surgery, it played decisive roles in reducing intracranial pressure and preventing cerebral hernia. As the hematoma is gradually drained, the surgical removal of hematoma as soon as possible can relieve the pressure of brain tissues in the early stage, reduce brain edema, prevent the further increase of intracranial pressure, prevent the aggravation of secondary damage of brain tissue and improve the prognosis of the patients. In general, most of the hematomas can be drained in about 2 to 3 days. Therefore, the hematoma can be removed before the peak of edema, eliminating the space occupying effect, reducing the use of dehydrating agents, and avoiding the secondary brain damage caused by the release of toxic substances after the decomposition of the hematoma. Early hematoma drainage is beneficial to protecting important structures, and trans frontal operative approach evades the damage to the corticospinal tract 7-9. At present, most scholars believe that the hematoma is formed when hypertensive intracerebral hemorrhage lasts 20 to 30 minutes. However, some patients with high blood pressure or those with larger blood pressure fluctuations after antihypertensive therapy may continue to bleed for 3 ~ 5 h after the incidence, and those with rehaemorrhagia at 6 h after the incidence usually are rare. For patients in the early stage of cerebral hernia, the effects of ultra-early surgery within 6 h after hemorrhage are good. Studies have shown that when perforation and drainage are used to treat hypertensive intracerebral hemorrhage, 7~24 h is the optimal time window for operation, and intraoperative rehaemorrhagia rate is high within 7 h [9]. Many studies have revealed that neurological deficits of patients with moderate cerebral hemorrhage in the basal ganglia (30~50mL) undergoing minimally invasive puncture hematoma drainage are significantly alleviated, and surgical removal of hematomas within 8 h can improve the efficacy of treatment [10-12]. The patients in this study were aged 36~84 years old, and some of them also had more serious internalmedicine diseases. However, except for 4 cases of rehaemorrhagia, there were no serious complications and no direct surgical deaths, and 80% of patients had good curative effects. In general, for hematoma in moderate size (30 ~ 50ml), puncture drainage is the best treatment method when patients have different levels of disturbance of consciousness but no cerebral hernia occurs. Since the mechanism of puncture drainage is to remove the hematoma slowly and gradually, for patients with large hematoma, we should refer to the patient's consciousness, limb activity, whether there are basic diseases and other specific conditions to decide which operation to use. Stereotactic drilling and drainage is generally feasible for patients with cerebral hernia who have developed unilateral mydriasis if the time of cerebral hernia is short. If the time of cerebral hernia is too long, craniotomy and hematoma clearance can be generally selected.

Preoperative, Intraoperative and Postoperative Precautions

For preoperative positioning, head positioning was performed fully with the help of the binocular lens and the tragus of both ears as body surface markers, and the lines were not too thick when positioning the marks to improve the accuracy of positioning. While calvarial taper, the periosteum can be first peeled away with hemostats, then the calvarial bone surface is slowly drilled perpendicular to the bone surface using an electric cranial cone bur at the localization, until the groove in the bone surface appears, then gradually incline the electric cone cranial bur on one side and the electric cranial cone on one side so that the inclination of the bone hole approaches the puncture angle designed preoperatively. In order to adjust the inclination angle to a greater extent when puncturing the bur, an electric cranial cone bur can be used to enlarge the outer and inner ostia of the bone canal. After the perforation of the bone hole, in general, the dura does not break through, and the drainage tube whose forehead is the blind end cannot break through the dura into the hematoma. Before tube placement, we punctured the dura mater, arachnoid membrane, leptomeninges, and cerebral cortex using a meningeal needle under the assistance of a disposable new-type stereotaxic apparatus at the puncture angle designed preoperatively, which would reduce the chance of epidural hematoma, subdural hematoma, and intracerebral hematoma. Dural stripping is reduced when a meningeal needle pierces the dura. Meningeal needling, when breaking the arachnoid, reduces the chance of pulling on the pontine vein. When the leptomeninges and cerebral cortex are punctured, the cortical vessels can be allowed to "dodge " and avoid injury. Before catheter placement, the drain can be bathed in epinephrine solution (1mg adrenaline + 0.9% sodium chloride injection 500ml), which reduces the chance of puncture tract bleeding. During needle placement, the guide core steel bars inside the drains should be of sufficient hardness to avoid migration of the drains through the dura mater, cerebral cortex, hematoma surface, ensuring that the drains are placed in accordance with the designed needle placement. When urokinase is perfused through the drain postoperatively, sterile gas (drawn from within the fluid of the plastic bag) can be utilized to push the urokinase solution inside the drain into the hematoma cavity like a piston, the amount of gas can be measured preoperatively using sterile saline, and the gas cannot be excessive, preventing the development of intracranial gas.

Measures to Reduce Surgical Risk

Puncture drainage is not an operation under direct vision, so there are inherent defects such as inability to avoid blood vessels and inability to stop bleeding. How to reduce the risk of postoperative rehaemorrhagia to the lowest level is a question that doctors who perform paracentesis to treat cerebral hemorrhage must seriously consider.

Excessive systolic blood pressure or fluctuating postoperative blood pressure is a common cause of postoperative rebleeding after drainage of hypertensive intracerebral hemorrhage. The amplitude of postoperative patient blood pressure fluctuation was positively correlated with the probability of postoperative rebleeding. Many studies at home and abroad have reported that the causes of rebleeding after drainage of hypertensive intracerebral hemorrhage (ICH), such as high and fluctuating preoperative BP with drainage, ultra early surgery, excessive intraoperative aspiration, and suboptimal BP control [13,14]. Aiming at the analysis of etiological factors leading to rebleeding, early aggressive preventive measures can reduce the occurrence of rebleeding.

Among patients in this study, 4 patients who had postoperative rehaemorrhagia underwent surgery within 3 h after incidence. Rehaemorrhagia may not be caused by puncture, but by the facts that the hematoma itself is not stabilized and that the hematoma has been excessively extracted during surgery. When hematoma is extracted during operation, it is necessary to stop extracting hematoma once there is a little resistance. The general aspiration amount is 5~15 mL, in order to ensure that the puncture drainage tube is located in the hematoma cavity. For patients who had cerebral hernia before surgery, 15 mL hematomas were extracted during surgery to ensure that the intracranial pressure was slightly reduced. The cranium CT reexamination should be conducted immediately after surgery to know the location of the drainage tube and exclude the intracranial rehaemorrhagia, which facilitated the injection of urokinases safely into the hematoma after surgery. If the degree of disturbance of consciousness of the patients after the puncture was significantly increased, the cranium CT reexamination should be conducted immediately after surgery to rule out intracranial delayed hematoma, such as acute epidural hematoma in the puncture site, puncture hemorrhage, and enlargement of original hematoma. If the epidural hematoma was large, brain tissues were significantly stressed, and the midline results were significantly shifted, craniotomy should be considered. If the epidural hematoma was not large, the pressure in brain tissues was not obvious, hemorrhage in the puncture tract was not much, the increase in the original intracerebral hematoma was not particularly obvious, and the puncture drainage tube was located in the middle of the hematoma cavity, the 1 mL hematoma liquefaction solution (1 mL 0.9% sodium chloride dissolved 100,000 units of urokinases) could be slowly injected into the hematoma cavity through a drainage tube, 2 h after which the tube was opened for drainage 1 or 2 times a day. Through the dissolution of urokinases and the pressure gradient difference inside and outside the brain, the hematoma could be drained gently. Cranium CT reexamination should be carried out every day to understand the hematoma drainage situation. Once hematoma drainage was completed, the drainage tube was removed to prevent incomplete hematoma drainage or hematoma cavity effusion and space occupying effect caused by premature removal of the drainage tube. If there is fresh hemorrhage, thrombin or epinephrine can be injected to stop bleeding. There were 2 patients with intracerebral hemorrhage in right basal ganglia in this study. On the morning of the second day after puncture drainage, the diameter of the patient's right pupil became 5.5 mm, and they were in deep coma. Craniotomy evacuation of hematoma was pre-performed. By adjusting the puncture depth of the drainage tube before surgery and slowly pulling out part of the hematoma through the drainage tube, the right pupil was significantly smaller, and the bilateral pupils were approximately equal. Intracranial pressure was reduced through light reflexes, continuous drainage and dehydration. Blood pressure was controlled to be steady, not too high, nor too low, to ensure that rehaemorrhagia or ischemia did not occur in brain tissues, and the condition was gradually improved. When there is no significant improvement in the level of disturbance of consciousness, unexplained irritability, and sudden increase in blood pressure, simple symptomatic treatment was not enough, and the possibility of rehaemorrhagia should be guarded and the brain must be reviewed via CT in a timely manner. It is not possible to judge whether there is rehaemorrhagia just by the amount of drainage, because fresh bleeding can easily clog the drainage tube. None of the 60 patients in this study had fresh active hemorrhage during surgery, but rehaemorrhagia occurred in 5 cases after surgery. Regardless of whether or not rehaemorrhagia was observed during puncture, especially for patients with ultra-early cerebral hemorrhage, it was necessary to review the cranium CT immediately after surgery to find out whether the location of the drainage tube was proper or not.

In general, for hypertensive intracerebral hemorrhage, especially with a moderate volume of hematoma (30-50 ml) in the basal ganglia, traditional craniotomy is highly traumatic with a high risk, many complications and high cost, while adopting medical conservative treatment, pending self-absorption of the hematoma, long disease course, slow recovery, poor efficacy and high complication rate and mortality. However, the treatment of hypertensive intracerebral hemorrhage by trans frontal drainage assisted by a disposable novel stereotactic instrument can remove the hematoma in a short time under a minimally invasive situation, eliminate the space occupying effect, and alleviate the secondary damage of brain tissue, resulting in significant therapeutic advantages. With this technique, 98% of the drainage tubes are punctured in place once, and the position is precise, which avoids repeated punctures and adjustment of the drainage tube position, and then reduces the chance of puncture and bleeding. The principle of this method is simple and easy to understand, precise, easy to operate, safe and reliable, less demanding surgical conditions, less trauma, and ideal results. It is a highly popular, affordable, and very promising technique for treating hypertensive basal ganglia ICH. Of course, this technique is a new technique with some deficiencies, such as problems with bur drift that may occur during intraoperative electrical bur drilling, shifting of the puncture plane by the gauge motherboard when positioning the positioner, so it also needs to be further improved in clinical practice.

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