Scientific Research Publishing

Open Journal of Emergency Medicine, 2021, 9, 49-59
https://www.scirp.org/journal/ojem
ISSN Online: 2332-1814
ISSN Print: 2332-1806

Analysis on Emergency Microsurgical Treatment for Cerebral Hernia Caused by Intracranial Anterior Circulation Aneurysm with Intracranial Hematoma

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How to cite this paper: Yang, G., Lv, J.J., Yang, S.J., Gu, C., Wang, C.B., Weng, L.L. and Ding, F. (2021) Analysis on Emergency Microsurgical Treatment for Cerebral Hernia Caused by Intracranial Anterior Circulation Aneurysm with Intracranial Hematoma. *Open Journal of Emergency Medicine*, **9**, 49-59.
https://doi.org/10.4236/ojem.2021.93007

Received: June 2, 2021
Accepted: July 2, 2021
Published: July 5, 2021

Abstract

Objective: This study is to discuss CT performances and direct surgical strategy as well as therapeutic effect of patients who have rupture hemorrhage of intracranial anterior circulation aneurysm with complications of intracranial hematoma and cerebral hernia. **Methods**: CT performances and treatment of 14 patients who have rupture hemorrhage of intracranial anterior circulation aneurysm with complications of intracranial hematoma and cerebral hernia in our hospital from March, 2019 to March, 2021 were reviewed. The relationship between hematoma caused by intracranial anterior circulation aneurysm and position of the aneurysm was analyzed. Besides, surgical processing keys were discussed. **Results**: For all selected patients, intracranial hemorrhage is proved to be caused by rupture of aneurysm. Among them, there are 2 cases of anterior communicating aneurysms, 3 cases of posterior communicating aneurysms, and 9 cases of middle cerebral aneurysms. According to exploration, we found 1 case of multiple aneurysm, which is the combination of a middle cerebral aneurysm (the responsible aneurysm) and ipsilateral posterior communicating aneurysm. There were two cases of intraoperative rupture. In this study, 3 patients died. According to GOS grading at 3 months after the operation, there were 1 case of V-grade (good recovery), 3 cases of IV-grade (self-maintenance), 5 cases of III-grade (severe disabled), 2 cases of II-grade (persistent vegetative state) and 3 cases of I-grade (died). **Conclusions**: Emergency microsurgical treatment can lower the death rate of cerebral hernia caused by intracranial anterior circulation aneurysm with intracranial hematoma and recover the neurological functions to the maximum extent.

Keywords

Anterior Circulation Aneurysm, Intracranial Hematoma, Cerebral Hernia, Microsurgery

1. Introduction

For subarachnoid hemorrhage (SAH), 70% - 80% of cases are caused by rupture of intracranial aneurysms [1]. Some are caused by the combination of rupture hemorrhage of aneurysm and intracerebral hematoma. These mainly belong to Hunt-Huss 4 - 5 grades and cause the higher disability rate and fatality rate than rupture of simple subarachnoid hemorrhagic aneurysm. If the conservative therapy is implemented, patients who have the relatively high Hunt-Hess grade, high hematoma volume and cerebral hernia may die for the worsening conditions and lose the opportunity of treatment [2]. Whether early diagnosis and reasonable therapy in early stage can influence the prognosis significantly? In this study, 14 patients who had emergency microsurgical treatment for intracranial anterior circulation aneurysm with cerebral hernia in our hospital were reviewed.

2. Data Methods

1) General information

A total of 14 patients, including 6 males and 8 females, were chosen as the research objects. These patients aged from 36 to 82, averaging at 61.5. They all have cerebral hernia and consciousness disorder before the operation. Specifically, 6 cases were in mild coma, 5 cases were in moderate coma and 3 cases in deep coma. Among them, 3 patients had bilateral mydriasis. According to Hunt-Hess grading, 14 patients were divided into 8 cases of IV-grade and 4 cases of V-grade.

2) Imageological Examinations

In this study, preoperative head computed tomography (CT) showed that all patients had SAH. Meanwhile, they have complications of intracranial hematoma with a volume of 25 - 75 mL, averaging in 46.3 mL. There were 2 cases of frontal lobe hematoma, 3 cases of frontal lobe and temporal lobe hematoma, 8 cases of temporal lobe hematoma, 1 case of subdural hematoma and 5 cases of combined intraventricular hemorrhage. Specifically, 12 cases of patients had three-dimension computed tomography angiography before operations. It found 8 cases of middle cerebral artery bifurcation aneurysm, 2 cases of posterior communicating aneurysms and 2 cases of anterior communicating aneurysms.

3) Surgery

The time from morbidity to surgery of all selected patients ranged 1 - 13 h. All patients had emergency craniotomy to explore the occlusion of closed aneurysm

and eliminate hematoma. All surgeries had incisions through the expanded transpterional approach and tried to remove the sphenoid ridge window to expose the anterior-middle cranial fossa. The hematoma removal and aneurysm processing were all finished under a microscope. When eliminating the hematoma, the hematoma subject enters from the cerebral cortex into hematoma cavity. When the hematoma is below the gyrus rectus of the frontal lobe bottom, the frontal lobe is lifted up and it enters into the hematoma cavity through the bottom cortex of the frontal lobe. When the hematoma is at the temporal lobe, cut the shallowest cortex of hematoma directly to enter into the hematoma cavity. Firstly, hematoma is eliminated partially and intubation was applied for extracranial drainage and opening. After the brain pressure decreases to a satisfying level, the lateral fissure cistern, internal carotid cistern and optic chiasm cistern were separated. The cerebrospinal fluid (CSF) was released to further decrease the intracranial pressure. Subsequently, the arterial aneurysm is investigated, separated and closed. The hematoma is further eliminated after the aneurysm processing. In this study, there were 2 cases intraoperative rupture hemorrhage. Whether bone flap is eliminated is determined after comprehensive considerations to hematoma volume, intraoperative intracranial pressure improvement and age. Nine cases have a hematoma volume of over 40 mL, weak postoperative brain beats and encephalocele, all of which had bone flap removal to decrease the pressure. All patients had intubation brain drainage before the craniotomy or after finishing the craniotomy. Five patients had intubation of lumbago cistern drainage tube after finishing the surgery.

4) Postoperative treatment

Conventional anti-infection, preventive cerebral angiospasm and intracranial pressure control therapy were performed. The conventional head CT was reexamined 24 h after the operation. The tracheotomy was performed as early as possible if necessary. The open external ventricular drainage or lumbar drainage was applied. Patients who have hydrocephalus in the late stage received ventriculoperitoneal shunt.

5) Therapeutic effect and follow-up visits

3D-CTA or DSA (digtal subtraction angiography) was performed at 2 weeks after the operation to examine closure conditions of aneurysm. The prognosis of patients was evaluated according to Glasgow outcome scale (GOS) at 3 months. Five grades were divided: V-grade (good recovery), IV-grade (self-maintenance), III-grade (severe disability), II-grade (persistent vegetative state) and I-grade (died). The V-grade and IV-grade had satisfying effect.

3. Results

In this study, intracranial hemorrhage is caused by rupture hemorrhage of aneurysm in all patients. Among them, there are 2 cases of anterior communicating aneurysms, 3 cases of posterior communicating aneurysms, and 9 cases of middle cerebral aneurysm. According to exploration, we found 1 case of mul-

tiple aneurysm, which is the combination of a middle cerebral aneurysm (the responsible aneurysm) and ipsilateral posterior communicating aneurysm. According to postoperative reexamination of CT, the hematoma clearance of all patients is higher than 70%. There are another two cases of intraoperative rupture hemorrhage. One case had disposal surgical closure of multi-aneurysm. In all 14 cases, the aneurysm diameter ranged from 3 to 15 mm, 5.6 mm in average. According to postoperative DSA, all aneyrysms have satisfying closure. Among 14 patients, 5 cases had complications of communicating hydrocephalus, who had ventriculoperitoneal shunt surgery. In this study, three patients died for out of control over postoperative intracranial pressure, bilateral mydriasis and brainstem failure. According to GOS at 3 months after the operation, all patients were divided into 1 case of V-grade (good recovery), 3 cases of IV-grade (self-maintenance), 5 cases of III-grade (severe disability), 2 cases of II-grade (persistent vegetative state) and 3 cases of I-grade (died). The V-grade and IV-grade had satisfying effect, reaching 28.6%.

Imageological data before and after the operation of typical patients

The patient is an 81-year-old woman who was hospitalized for "3 h of sudden conscious disturbance". According to physical examination, the patient was in a coma and GCS score shows E1VTM4, Hunt-Hess IV-grade. The bilateral pupil diameter was 3 mm and she lagged in response to lights. According to emergency head CT, it shows subarachnoid hemorrhage (SAH) as well as left temporal lobe and lateral cleft hematoma. According to 3D-CTA, it indicates the left posterior communicating aneurysm (Figure 1-4).

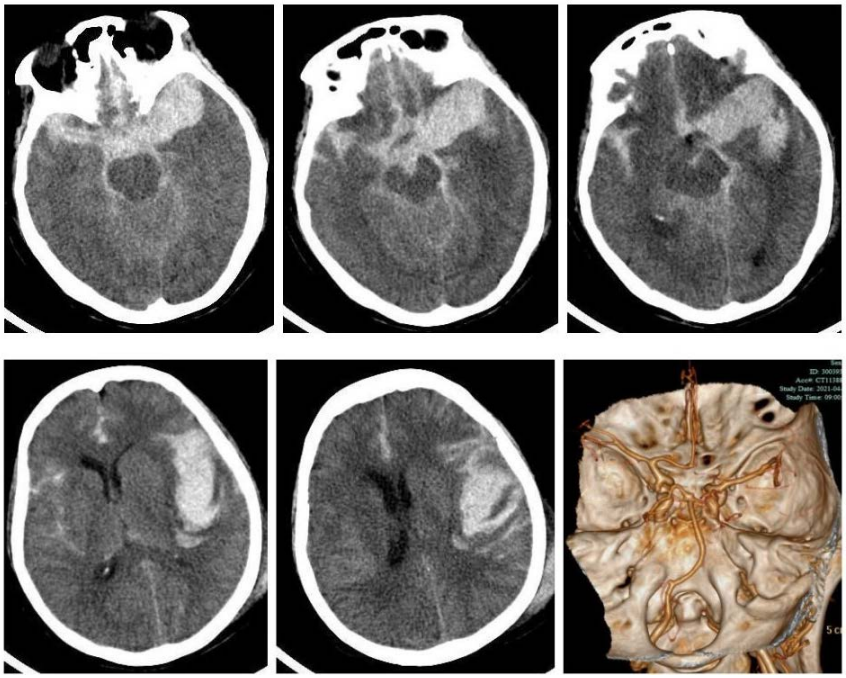

Figure 1. Subarachnoid hemorrhage (SAH) as well as left temporal lobe and lateral cleft hematoma. According to 3D-CTA, it indicates the left posterior communicating aneurysm.

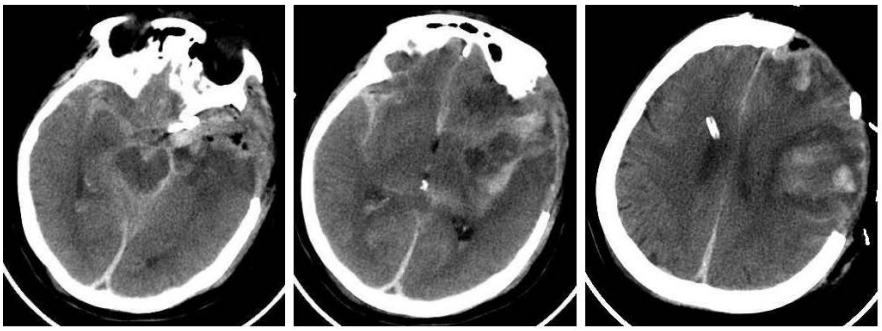

Figure 2. Head CT reexamination at 12 h after the operation, the aneurysm was closed, and most hematoma at the left temporal lateral cleft had been eliminated. The bone flap was removed to decrease pressure.

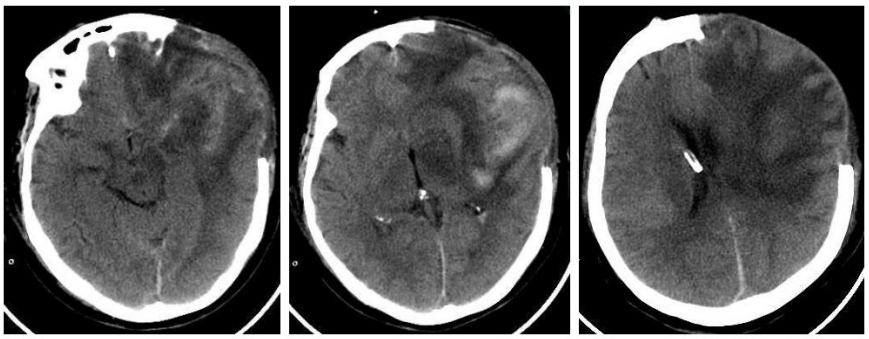

Figure 3. Head CT reexamination at 6 d after the operation indicates that the intracranial pressure was controlled effectively.

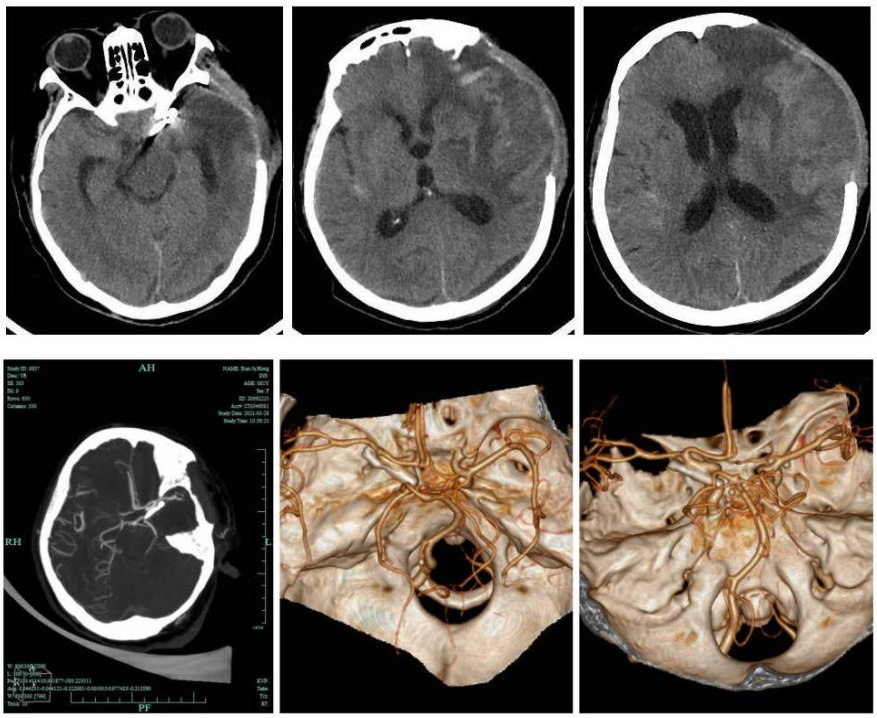

Figure 4. Head CT reexamination at 12 d and 3D-CTA. The aneurysm was closed completely and GOS at 3 month after the operation was evaluated III-grade.

4. Discussions

The aneurysmal subarachnoid hemorrhage is a common neurosurgical emergency disease. The high-level aneurysm has critical conditions and progresses quickly. The fatality rate reaches as high as 60% - 90%. Yasargil *et al.* believed that advanced arterial aneurysm was not applicable to have surgery in early stage due to diffusive brain swelling and high difficulties in surgery and anesthesia. However, the advanced arterial aneurysm had the high probability of recurrent hemorrhage and vasospasm in early stage. It often caused poor prognosis and even deaths of patients. The clinical treatment of advanced arterial aneurysm has been a controversial topic. According to traditional opinions, the advanced arterial aneurysm has critical conditions and the acute hemorrhage might be not stopped. The intracranial hypertension and diffusive brain swelling still exist, thus resulting in the high surgical risk. As a result, it often chooses conservative therapy and then surgery after improvement of the disease. Recently, scholars found that conservative therapy or delayed surgery cannot improve prognosis of patients. Moreover, many patients may die for vasospasm and secondary aneurysm rupture when they are waiting for surgery. In recent years, surgery has been accepted in the early stage (within 3 d after the primary hemorrhage) and super-early stage (within 24 h after the primary hemorrhage) after aneurysm rupture. At the early stage of aneurysm rupture of Hunt-Hess IV - V grade at hospitalization, intracranial pressure is increased and vasospasm occurs subsequently. Some patients may have acute hydrocephalus, which requires emergency treatment. When rupture of aneurysm causes intracranial hematoma, fisher's grade is high and the clinical grade is poor, which is easy to cause recurrent hemorrhage. It often progresses quickly and has poor prognosis [3]-[8]. After hospitalization, patients shall have emergency surgery immediately.

Surgery and intravascular interventional treatment are optional to low-grade aneurysmal subarachnoid hemorrhage. For rupture aneurysm of secondary intracerebral hematoma, emergency craniotomy was performed under the existence of cerebral hernia. It not only eliminates hematoma, but also is close the aneurysm. This is the optional choice [9] [10] [11] [12] [13]. Surgery is not considered to preoperative Hunt-Hess V-grade patients who are in deep coma, bilateral mydriasis, decorticate rigidity, agonal stage and brain stem functional failure. If patients don't have brain stem functional failure, surgery shall be performed positively. This study demonstrated that most patients will achieve good effects after immediate therapy even though the preoperative clinical symptoms are serious. According to GOS grading at 3 months after the operation, all patients were divided into 1 case of V-grade (good recovery), 3 cases of IV-grade (self-maintenance), 5 cases of III-grade (severe disability), 2 cases of II-grade (persistent vegetative state) and 3 cases of I-grade (died). The V-grade and IV-grade had satisfying effect, reaching 28.6%.

For acute critical patients with rupture of aneurysm, a diagnosis can be gained through CT and 3D-CTA. Since the 3D-CTA has quick imaging and it is non-

invasive without general anesthesia, the emergency and imageological examination can be finished in the same time to save time to the maximum extent. The sensitivity and specificity of intracranial aneurysm are close to DSA [14] [15]. In this study, 2 cases had secondary hemorrhage during 3D-CTA. During 3D-CTA, high pressure contrast media were injected into the body to cause sudden increase of blood pressure, which will cause secondary hemorrhage. Subsequently, we implemented necessary analgesia and sedation during 3D-CTA, which prevented the secondary hemorrhage. According to CTA scanning, patients stood on the image workstation to rebuild images, and they rotate for cutting and measurement according to needs. Fast solving information of position, size, morphology, top orientation and relations of aneurysm with peripheral sclerotin and blood vessels can provide important guidance to formulate the therapeutic schedule of aneurysm, prevent intraoperative aneurysm rupture and effective occlusion of neoplasia neck.

Under allowable disease conditions, 3D-CTA shall be perfected as much as possible. Getting familiar with imageological data can lower surgical risk to some extent. If the disease progresses quickly and cerebral hernia is formed, surgery can be performed according to CT characteristics of aneurysm hemorrhage. In this study, 2 patients had formed hernia before the craniotomy. According to head CT performances, these two patients were diagnosed as rupture hemorrhage of middle cerebral artery aneurysm. Since the condition is emergent, it has not time for head CTA and received emergency microsurgical treatment, which achieved satisfying effect. The direct head CT examination is blind to some extent. Instead, indications shall be mastered strictly.

In this study, all patients had extremely high intracranial pressure after craniotomy. When lowering the intracranial pressure effectively, it is necessary to disclose the trunk blood vessels and it is the key in surgical operation of closed aneurysm. In this study, the improved transpterional approach or the expanded transpterional approach were applied. The bone window shall be close to the anterior-middle cranial fossa as much as possible. The sphenoid ridge is eliminated and the anterior clinoid process is eliminated according to specific conditions. The approach for aneurysm closure shall be chosen after comprehensive considerations to blood volume in arachnoid cavity, hematoma volume, hematoma position, brain swelling degree, intraventricular blood volume, aneurysm position and orientation. We have experiences: 1) hematoma lobe approach (it is applicable to hematoma which has great volume and is close to cortex as well as middle cerebral aneurysm); 2) Hematoma lobe approach combined with lateral cleft approach (it is applicable to hematoma which has moderate volume and is close to cortex, middle cerebral aneurysm or posterior communicating aneurysm); 3) Lateral cleft approach combined with end-plate fistulization (it is applicable to frontal lobe hematoma, anterior communicating aneurysm or posterior communicating aneurysm with ventriculomegaly); 4) Direct forehead bottom approach is applied to open the optic chiasma cistern and internal carotid cistern, make reverse separation of lateral cleft, eliminate hematoma and process

aneurysm (it is applicable to middle cerebral aneurysm which has a small volume of hematoma or posterior communicating aneurysm); 5) If patients have serious brain swelling and cerebral pressure cannot be relieved after hematoma removal, temporal pole or frontal pole can be eliminated. Meanwhile, it is suggested to open the temple angle or frontal angle to release cerebrospinal fluid to lower the intracranial pressure.

In this study, two cases had intraoperative rupture hematoma. One case had posterior communicating aneurysm and temporal lobe adhesions, which is very easy to tear aneurysm by pulling the temporal lobe slightly. One case had rupture hemorrhage during separation of middle cerebral aneurysm neck. We have some experiences: blood pressure shall be controlled effectively before the operation. Mannitol dehydration was performed before cutting open the cerebral dura mater to lower the intracranial pressure. After the cerebral dura mater is cut open, the cerebrospinal fluid (CSF) is released slowly according to incracranial pressure. During operation, the incracranial pressure shall be lowered as much as possible during operation. The exposure shall start from the tumor neck rather than approaching the aneurysm from the top. Parent artery shall be exposed firstly, followed by aneurysm neck. In the separation process, trunk arteries of aneurysm shall be exposed as much as possible for the convenience of temporary blocking when the aneurysm ruptures. When hematoma occurs, the hematoma shall be eliminated firstly when it is difficult to expose. After the massive resorption is achieved, intracranial pressure can be lowered to some extent until there's some operation space. Next, parent artery and aneurysm neck are exposed clearly. Blood clots surrounding the aneurysm neck shall be eliminated as much as possible. Do not try to expose arterial aneurysm. Instead, hematocele surrounding the aneurysm shall be eliminated to expose the aneurysm clearly as well as its adjacent relations with peripheral blood vessels. Attentions shall be paid to sharp separation throughout the separation. After aneurysm neck and parent arteries close to the heart are exposed clearly, the aneurysm clip is put. Next, surrounding hematoma surrounding the aneurysm is processed. Once the aneurysm is broken in the separation process, an aspirator with a large diameter shall be chosen for resorption in the crevasse and two aspirators can be used if necessary to keep a clear field of view and block the parent arteries. Do not burn or forceps holder blindly. It is important to have proficient operation skills, gentle and accurate actions, block aneurysm arteries for temporary and effective and quick control of hemorrhage after aneurysm rupture in microsurgery of anterior circulating aneurysm under the complication of intracranial hematoma.

CT of anterior circulating aneurysm with intracranial hematoma has some laws. SAH or hematoma position after cerebral aneurysm rupture is related with position of the aneurysm, orientation of the tumor and bleeding direction after rupture of tumor [16]. SAH with hematoma formation is the major feature when there's great hematoma of aneurysm.

The position of intracranial hematoma is closely related with the position of aneurysm. The anterior communicating aneurysm is manifested as hematoma centered at gyri rectus of frontal lobe. The hematoma breaks the ventricle or hematoma is formed in front of the bottom hypothalamus of the ventriculus tertius. The posterior communicating aneurysm, pre-choroid aneurysm and middle aneurysm are manifested as temporal lobe hematoma or frontal temporal hematoma, lateral hematoma and subdural hematoma [17]. Post-cerebral aneurysm is manifested as hematoma in the occipital lobe at edges of tentorium cerebelli and the anterior aneurysm is manifested as lateral hematoma and pyocephalus [18] [19].

Most cases of anterior circulating aneurysm with great hematoma are mainly middle cerebral aneurysm. Among all 14 patients in this study, there are 9 cases of middle cerebral aneurysm, reaching 64.3%. This might be related with the fact that orientation of aneurysm is parallel to trunk arteries in brain and cerebral artery pressure can be transmitted to the top of the tumor.

The key of postoperative treatment of advanced aneurysm lies in the intracranial pressure control. In this study, 3 cases died out of control over intracranial pressure after the operation. We conclude that most advanced aneurysm patients shall eliminate bone flap to lower the pressure, together with extracranial drainage and/or lumbar drainage. Moreover, conventional therapy and drug therapy are needed to control the intracranial pressure and maintain about 70 mmHG of mean arterial pressure. Besides, cerebral perfusion shall be maintained. Hypertonic saline has some advantages to control intracranial pressure of patients with aneurysm SAH [20] [21].

5. Conclusion

Emergency microsurgical treatment can lower the death rate of patients who have intracranial anterior circulation aneurysm-induced cerebral hernia with intracranial hematoma. It can recover neurological functions to the maximum extent.

Fund-Supported Projects

Shaoxing Health Science and technology plan 2017CX025.
Zhejiang Health Development Foundation 2019ZD059.
Zhejiang Health Development Foundation 2019ZA127.
Zhejiang Medical Association Clinical research fund projects 2019ZYC-A157.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

GCS: Glasgow Coma Scale
CT: Computed Tomography
SAH: Subarachnoid Hemorrhage
3D-CTA: Three dimentional Computed Tomography Angiography
DSA: Digtal Subtraction Angiography
GOS: Glasgow Outcome Scale