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A Case Report and Literature Review of Complications of Acute Intracranial Aneurysm Rupture

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Abstract

Intracranial aneurysm is pathological dilatation of the intracranial arteries with the risk of rupture, because the wall is not strong enough to withstand hemodynamic pressure. The current treatment of intracranial aneurysms is mainly divided into endovascular treatment and craniotomy clipping treatment. However, the complications after treatment are still an important part that cannot be ignored, such as postoperative vasospasm, intracranial infection, pulmonary infection, cerebral infarction, cerebral hematoma, and secondary hemorrhage. And there are many complications after the rupture of an intracranial aneurysm. This review reports a patient with subarachnoid hemorrhage from a ruptured left posterior communicating aneurysm that eventually died of cardiac and respiratory failure. It is concluded from the analysis of this disease case that in the acute stage of intracranial aneurysm rupture, the patient's general condition should be evaluated before surgery to examine whether the patient can benefit from surgery, prevent adverse reactions as soon as possible, truly improve the quality of life of the patient and prolong the survival of the patient.

Keywords: Intracranial aneurysm; Acute phase; Treatment; Complications

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Introduction

Intracranial aneurysm is a common intracranial disease with rapid onset, fast development, high mortality [1,2], and its incidence is second only to cerebral vascular rupture. Subarachnoid hemorrhage due to a ruptured aneurysm accounts for approximately 5% of strokes [3]. There are numerous factors that affect the formation of aneurysms, including blood hemodynamics [4], inflammatory factors, trauma and infection [5]. Moreover, it is very easy to rupture suddenly under stress, fatigue and other factors, thereby causing subarachnoid hemorrhage [6]. If there is a hardly timely and effective treatment, the mortality rate of patients will greatly increase [7], which is a serious threat to the safety of patients' lives. At present, surgery is the most important method. This article describes a case of a ruptured aneurysm that underwent interventional surgery. The patient underwent successful surgery, but died one month later. This case made us reflect that in addition to successful surgery, the comprehensive evaluation of the patient's systemic condition should not be ignored, and it is equally important to pay attention to the management of postoperative complications as well as surgery. Therefore, we subsequently introduced the treatment methods and common complications of cerebral aneurysm, and the medical report is as follows.

Case Presentation

An 86-year-old female patient was admitted to the neurosurgery hospitalization with dizziness and vomiting for 4 h. The patient developed dizziness and vomiting without obvious incentive 4 h ago, for example, she took a ship, or the vomitus was stomach contents. During the course of the disease, there was no headache, unconsciousness, no fecal incontinence, and no history of falls. The family members sent the patient to the emergency department of the local hospital for treatment. The emergency head CT examination showed subarachnoid hemorrhage. The blood biochemical indicators showed that the glucose was 13.07 mmol/L, and the other blood indicators were normal. Subsequently, the patient was transferred to the emergency department of our hospital for treatment. A neurological examination showed that she was conscious, but she was not vigorous. The pupils are equal in size and round, with a diameter of 2 mm, sensitive to direct and indirect light reflex, bilateral frontal lines are symmetrical, nasolabial folds are symmetrical, pronunciation is normal, gag reflex (+), tongue protruding in the middle, and limb muscle strength and muscle

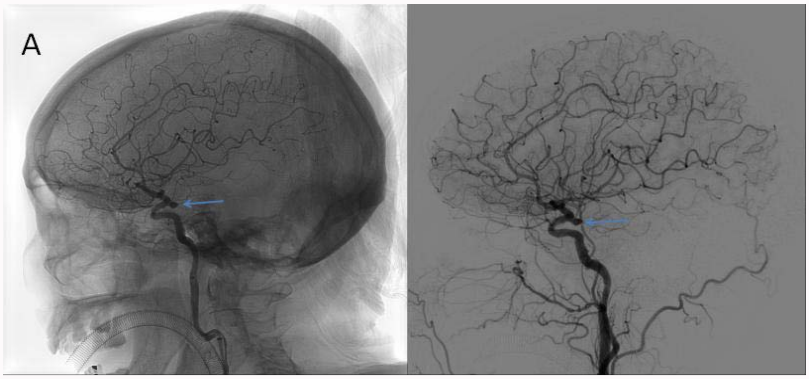

Figure 1: The left posterior communicating artery aneurysm is about 5.2 mm × 3.9 mm in size and 1.2 mm in the neck.

tone are normal. Head CTA examination, the results suggest: Left posterior communicating aneurysm, subarachnoid hemorrhage. The patient was recommended for surgical treatment, and the patient was admitted to the neurosurgery ward at 00:21 on November 21st, 2021.

The patient has had a history of type 2 diabetes for 15 years. She usually takes metformin 0.5 g bid + Humulin 70-30 22U in the morning and 22U in the evening. The blood sugar is controlled normally. The patient denies coronary heart disease, cerebral infarction, malignant tumor and other medical histories. And the patient had no history of smoking.

On the first day of admission (November 21st, 2021), intracranial aneurysm embolization was performed for the patient at 9:00 a.m. The patient was in a supine position, the right inguinal artery was punctured, the 6F arterial sheath was ligated, and a positive pressure instillation was maintained. Whole brain angiography was performed by placing a 5F single-curved angiography tube. After angiography, an aneurysm in the posterior communicating segment of the left internal carotid artery was seen, with a size of about 5.2 mm × 3.9 mm and a neck of 1.2 mm. Bilateral vertebral arteries and right internal carotid arteries were not found and other intracranial vascular malformations were present, and bilateral P1 was present. The long sheath and 6F NAVIE intermediate catheter were replaced, and the left internal carotid artery was inserted. The left internal carotid artery was subjected to spiral 3D angiography with non-ionic iodine contrast agent. The double microcatheter was shaped and placed into the posterior communicating aneurysm. Moreover, the catheter was placed in the middle and lower 1/3 of the aneurysm and the Johnson & Johnson hydrolyzed coils 4 mm × 12 mm, 3 mm × 6 mm, 3 mm × 6 mm, Axium 3 mm × 4 mm, and Axium 2 mm × 3 mm were filled into it. After the filling was completed, the angiography was rechecked, and it was found that the aneurysm embolization was denser, with no extravasation of contrast agent, no fluctuation of blood pressure and heart rate, ending aneurysm embolization surgery.

At 23:30 on the first day of admission, the patient's blood oxygen saturation decreased suddenly, with a minimum of 78%, shortness of breath, and the patient complained of chest tightness. The blood gas analysis showed that the arterial blood pH value was 7.28, the carbon dioxide partial pressure was 33.3 mmHg, and the arterial blood oxygen partial pressure was 33.3 mmHg to 57.1 mmHg, residual base 10 mmol/L, oxygen saturation 88%, non-invasive ventilator assisted ventilation, but blood oxygen saturation was always maintained at 94% to 96%. Three results of myocardial infarction showed that troponin continued to rise, and an electrocardiogram showed that for myocardial ischemia, acute coronary syndrome and heart failure were considered after consultation with the Department of Cardiology and Pulmonary, and symptomatic cardiotonic coronary dilation was given successively with isosorbide mononitrate and levosimendan.

On the eleventh day of admission (December 1st, 2021), a bedside ultrasound was performed for the patient, suggesting bilateral pleural effusion. On the same day, a right thoracic drainage was performed, and about 800 ml of pale-yellow clear fluid was drained successively.

On the twelfth day of admission (December 2nd, 2021), the patient underwent a tracheotomy and ventilator-assisted ventilation was used. A chest scan was conducted for the patient on the same day, and the results indicated that firstly during tracheal intubation, chronic bronchitis with extensive inflammation of both lungs, and pulmonary edema cannot be excluded, which should be considered with the clinic results. Secondly, the left pleural effusion is with local pulmonary insufficiency, and a small amount of fluid builds up. Symptomatic tigecycline and meropenem were given for anti-infective treatment.

On the seventeenth day of admission (December 7th, 2021), the patient suffered sudden cardiac arrest at 19:48, with undetectable blood pressure and oxygen saturation of 90%. Chest compressions, 3 mg epinephrine bolus, and electric shock defibrillation were conducted. After cardioversion, the atrial fibrillation rhythm was 70 beats/min, the blood pressure rose to 90/50 mmHg, and the oxygen saturation increased. The patient's blood pressure was maintained at 110/50 mmHg after norepinephrine booster therapy. The patient suffered from frequent atrial premature death and paroxysmal atrial fibrillation, but her vital signs were temporarily stable.

On the eighteenth day of admission (December 8th, 2021), after consulting the hospital, she asked the director of the ICU of Shanghai First People's Hospital for expert consultation. Consultation opinion: Heart failure is still considered according to the condition of the patient's mother. It was recommended to control the intake and maintain a negative fluid balance. Additionally, oral ACEI drugs should be taken, nitroglycerin should be injected intravenously, blood pressure should be monitored, electrolytes should be examined and anticoagulation therapy should be continued.

On the thirty-first day of admission (December 21st, 2021), the patient's heart rate decreased again at 1:15, and the blood pressure could not be measured. After intravenous injection of epinephrine and electrical defibrillation, there was no obvious improvement. At 1:50, the patient's breathing and heartbeat cessation, and carotid

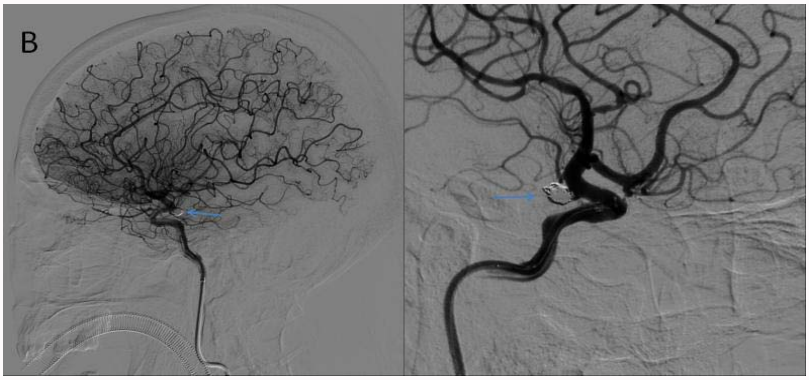

Figure 2: After the aneurysms were embolized with double microcatheters and coils, they were tightly embolized without extravasation of contrast medium.

pulse disappeared, and clinical death was declared.

Discussion

In this case, the patient suffered from an acute rupture of the left posterior communicating aneurysm. The patient's focal blood vessels can be clearly seen from the cerebral angiography image of the patient (Figure 1). The operation used double microcatheter-assisted coils to embolize the aneurysm. On cerebral angiography images after embolization, the embolization of the aneurysm was relatively dense and there was no extravasation of the contrast medium (Figure 2). However, the patient is old and the organ function is poor. During the endovascular treatment, a large amount of fluid replacement was required through the treated blood vessel to fully ensure smooth operation, but it caused the burden on the patient's heart to increase. Therefore, heart failure, pleural effusion, and pulmonary infection occurred after surgery, and the symptom of this patient is mainly heart failure. After active treatment, the desired effect was not achieved, and the patient eventually died of complications. The risk of death may be greatly reduced if the patient's fluid rehydration is strictly restricted during surgery and the patient's blood pressure is stabilized after surgery while the cardiovascular dilator is administered prophylactically. From this case, it could be inferred that in the acute stage of intracranial aneurysm rupture, the patient's general condition should be thoroughly assessed while actively treating the patient. Besides this, the patient and her family should be informed of the complications and risks of treatment. Furthermore, a preventive plan to avoid complications should be formulated according to the particular condition of the patient.

Main Treatments for Intracranial Aneurysms

According to the above-mentioned intracranial cerebral aneurysm, as the most common intracranial disease, its prognosis is poor, and the current treatment methods mainly include endovascular interventional therapy and surgical craniotomy clipping. Endovascular treatment is a relatively common treatment method. The endovascular treatment of an aneurysm mainly undergoes three research stages, which are parent artery and aneurysm occlusion, aneurysm endovascular embolization, and parent artery reconstruction, respectively [8].

Intracranial parent artery and aneurysm occlusion have been widely used since the 1970s. At present, this method is still used to occlude the giant aneurysm parent artery and terminate the blood flow in the aneurysm cavity, but the disadvantage is that it significantly affects the intracranial blood flow dynamics, and would increase the incidence of cerebral ischemia in the long term. However, for refractory aneurysms such as large/giant aneurysms or posterior circulation vertebral artery dissecting aneurysms and distal dissecting aneurysms of their subsidiary branches, occlusion of parent arteries and aneurysms with coils or liquid glue still remains a treatment option [9].

The treatment methods of intracranial aneurysm embolization can be mainly divided into simple coil embolization, the use of blood flow devices in the tumor cavity, balloon and liquid embolizing agent, and stent-assisted coil embolization technique. Simple endovascular coil embolization is safe and effective, which can reduce the early rebleeding rate and long-term mortality rate. However, simple endovascular coil packing cannot effectively complete the endothelialization of the tumor neck. For wide-necked aneurysms, long-term rebleeding rate and recurrence rate are higher than those of surgical clipping [10]. Intraluminal blood flow devices, for example, braided intraluminal bridge devices, interrupt blood flow in the aneurysm from the level of the aneurysm, and are suitable for wide-neck and bifurcation aneurysms. Moreover, mid-term follow-up clinical evidence shows that this method has better embolization rates than stent Auxiliary coils, but the long-term effect still needs clinical evidence [11]. The embolization rate of liquid embolic agents is high, and the embolization rate of this technique is high. Whereas, there are complications of extravasation and perforator vessel occlusion [12]. Based on the high long-term retreatment rate of simple coil embolization mentioned above, various assisted embolization techniques to improve embolization rate and reduce recurrence rate have been gradually developed, including microcatheter, microguide wire assisted embolization technology, balloon-assisted embolization technology, and stent-assisted coil packing technology. Presently, stent-assisted coil packing technology is used increasingly for acute ruptured intracranial aneurysms. This technology could improve the embolization rate of aneurysms, reduce the recurrence rate, and reshape the aneurysm neck, which is beneficial to the endothelialization of the aneurysm neck. Reconstruction of the tumor neck, but this technique is prone to thromboembolic events, so it requires long-term antiplatelet therapy, whose long-term risks and benefits require further study [13].

Common Complications

Although surgery is a common treatment for intracranial aneurysms, some complications would inevitably occur during and after surgery, such as cerebral vasospasm, intracranial infection,

pulmonary infection, cerebral infarction, cerebral hematoma, and secondary hemorrhage.

Vasospasm

Vasospasm is one of the most common complications of intracranial aneurysm rupture, and it is also the main cause of disability and death [14,15]. Vasospasm can lead to a decrease in blood flow to the brain tissue in the nutritional area, insufficient oxygen supply, resulting in swelling and necrosis of brain tissue, increased intracranial pressure, and reduced cerebral microcirculation, thereby aggravating cerebral insufficiency and forming a vicious circle [16]. The incidence rate is as high as 30% to 60%, and once it occurs, the situation is difficult to reverse [17]. Currently, its pathogenesis is not yet clear, and the mainstream theories tend to be related to oxyhemoglobin, nitric oxide, endothelin, immune inflammatory response and changes in calcium ion channels, and there is no specific treatment, only symptomatic treatment [18]. Therefore, cerebral vasospasm with a ruptured intracranial aneurysm should be actively treated early to protect brain tissue. Nowadays, the treatment methods mainly include drug therapy, hyperbaric oxygen therapy and surgical treatment. In addition, drug therapy is the most important treatment method. The classic treatment methods mainly include three-high therapy (hypertension, high blood volume, and high blood dilution) [19], but there is still some controversy [20]. There are studies that found that hyperbaric oxygen, as a physical method, can reduce the damage to the nerve and vascular cell function caused by spasticity and improve prognosis. This is related to the mechanism that hyperbaric oxygen can rapidly increase blood oxygen partial pressure, increase blood oxygen content, capillary oxygen diffusion distance, improve vascular smooth muscle oxygen supply, improve vascular elasticity, promote fibroblast transformation, and rapidly regenerate capillaries [21]. Additionally, there were scholars found that rapid rehabilitation technology can also reduce the incidence of cerebral vasospasm, improve cerebral vascular blood supply, and improve prognosis [22].

Intracranial infection

Surgical craniotomy clipping is a common operation for the treatment of cerebral aneurysms, mainly through a craniotomy to clip cerebral aneurysms. However, craniotomy is traumatic to the body, and it is prone to cause intracranial infection. The consequence of intracranial infection is serious, since the development of it is rapid, and the treatment is difficult, which is not only not conducive to the recovery of the patient's neurological function but also seriously threatens the life of the patient. Its occurrence might be closely related to factors such as longer exposure time of brain tissue, hyperglycemia, intraoperative aneurysm rupture, postoperative cerebrospinal fluid leakage, and intraoperative blood loss [23,24]. Studies have shown that 2.6% to 30.0% of patients may be complicated by intracranial infection after surgery, and the mortality rate is higher than 30.0% [25,26]. Cerebrospinal fluid puncture is the gold standard for clinical diagnosis of intracranial infection [27], but it is often limited in clinical practice because of its invasive operation, high cost and low patient tolerance. There were studies that found inflammatory response is crucial in intracranial infection, for instance, IL-8 and WBC, which might be effective early-period diagnostic indicators of intracranial infection [28-30]. Therefore, early and timely diagnosis and treatment are of great significance to the occurrence, development, and prognosis of intracranial infection.

Pulmonary infection

Due to the disease, patients with intracranial aneurysms need to stay in bed for a long time, and there are conditions such as confusion and coma. Moreover, when the intracranial aneurysm is complicated by bleeding, the patient would be in serious condition, and various invasive operations are required, which might easily lead to the occurrence of pulmonary infections. There are studies suggesting that the irrational application of postoperative antibiotics in patients with an intracranial aneurysm is also a significant factor for postoperative pulmonary infection. In addition, a high-grade intracranial aneurysm can easily lead to an increase in intracranial pressure, vomiting, reflux, and aspiration. In other cases, it could also increase the risk of lung infection [31]. A pulmonary infection would prolong the hospitalization time for patients, and severe pulmonary infection would aggravate the disease, increase the mortality rate, and affect the prognosis of patients [32]. Studies have shown that the incidence rate can be as high as 20% to 30%, and the mortality rate due to pulmonary infection is as high as 25% to 35% [33]. Thus, early active treatment to control pulmonary infection can effectively improve the prognosis of patients. In a study, it was found that teaching patients to pursed lips and abdominal breathing can promote effective sputum excretion and reduce the incidence of lung infection [22]. Therefore, according to the causes of pulmonary infection, targeted treatment measures should be taken, for instance, rational use of antibiotics could reduce the occurrence of drug resistance, and decrease the incidence of nosocomial infection. Besides this, timely suction, turnover, and pat on the back could maintain airway patency. Moreover, the removal of phlegm in time could improve lung function. Additionally, providing nutritional support timely could enhance the patient's immunity and improve the patient's tissue repair ability.

Cerebral infarction

Cerebral infarction is the most common complication after vascular interventional embolization and craniotomy clipping [1], with an incidence of 6.7% to 10% [34] and 0.9% to 45.3%, respectively [35-37]. Large-scale cerebral infarction can cause severe neurological dysfunction and is also the main reason for poor postoperative prognosis [38]. Studies have shown that cerebral infarction after vascular interventional embolization may be closely related to factors such as vasospasm, stent thrombosis, cardiogenic thrombus shedding, and deep vein thrombosis shedding caused by intraoperative intravascular operation [39]. Cerebral infarction with surgical craniotomy clipping might be associated with risk factors such as larger aneurysm diameter, irregular carotid aneurysm, and temporary occlusion of the parent artery [40-42]. In addition, studies have found that the degree of cerebral vasospasm is positively correlated with the occurrence of cerebral infarction [36,43]. Doppler ultrasound and neurological function testing have been found by scholars that can effectively monitor cerebral blood flow [44] and reduce the incidence of postoperative cerebral infarction. Consequently, effective prevention of cerebral infarction is a key factor for postoperative prognosis. Strengthening intraoperative monitoring of cerebral blood flow and neurological function can help reduce the incidence of postoperative cerebral infarction.

Cerebral hematoma

Rupture and hemorrhage of intracranial aneurysm are often manifested as subarachnoid hemorrhage, intracerebral hematoma, and intraventricular hemorrhage, leading to cerebral vasospasm, and producing toxic substances to damage brain tissue, and

causing coma [45]. The degree of coma in patients with internal hematoma is associated with brain parenchymal damage, and the more intraventricular hemorrhage, the worse the prognosis [46]. Furthermore, if it is not treated in time, the morbidity and mortality rates are extremely high [47], and the effect of conservative treatment is unsatisfactory, with a fatality rate of 80% [48]. Presently, intracranial aneurysm complicated with cerebral hematoma is mostly treated by surgery [49], which can not only remove the hematoma, and improve intracranial hypertension, but also prevent aneurysm rebleeding.

Secondary bleeding

Intracranial aneurysm rupture is the main cause of subarachnoid hemorrhage [50], and it is also the main cause of disability and death [51], while aneurysm rupture and rebleeding are more common in patients with high-grade aneurysmal subarachnoid hemorrhage [52]. Some scholars have discovered that high-grade aneurysmal subarachnoid hemorrhage is associated with severe brain swelling and brain injury after the onset [53]. In addition to preoperative rebleeding, intraoperative or postoperative rebleeding is also more common. Studies have shown that the incidence of intraoperative bleeding or rebleeding within 1 year after embolization is 1% and 0.90% to 2.70%, respectively, and the mortality rate can be as high as 80% [54-57], which seriously affects the prognosis of patients. Hence, active treatment of rebleeding is of great significance to improve the success rate of surgery and improve postoperative quality of life.

Conclusion

The patient mentioned in this case received vascular interventional therapy at the acute stage of intracranial aneurysm rupture. The whole operation was smooth, but the patient unfortunately died of serious complications in the end. Therefore, while focusing on the updating of therapeutic materials and the effect of surgical treatment, we should evaluate the overall situation of the patient, and consider from the perspective of the patient how much benefit the operation can bring to the patient, whether it can improve the quality of life of the patient and prolong the life of the patient. Conservative treatment can also be an effective treatment if the comprehensive assessment results in a higher risk of complications and death after surgery.

Intracranial aneurysm is a serious brain disease involving many complicated factors, and its incidence is second only to cerebral vascular rupture. Intracranial aneurysm rupture is the most common cause of spontaneous subarachnoid hemorrhage. Currently, the treatment methods for acute rupture mainly include endovascular treatment, and craniotomy and clipping. The materials and methods of endovascular treatment are constantly updated, so the research on its complications should be studied in more standardized and long-term controlled follow-up studies. However, craniotomy and clipping surgery is relatively less used, since it might increase the incidence of ischemic events.

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