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Impact of Introducing Endovascular Treatment on Acute Phase of Subarachnoid Haemorrhage Outcome

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Abstract

Introduction: Ruptured intracranial aneurysm is an urgent diagnostic and therapeutic condition. Occlusion with coils is the first line treatment for ruptured aneurysms and also should be used to prevent re-rupture, potentially causing severe brain damage. Most aneurysms are subject to this type of treatment. The risk of intraoperative thromboembolic and haemorrhagic complications during treatment with coils is very low. Endovascular treatment with coils is therefore a safe and effective method that can prevent short and long-term haemorrhage. Short and long-term haemorrhage is achieved by early recanalization of cases with neuro-visualisation. **Methods:** In this article we present a retrospective analysis of the results of endovascular embolization of 137 patients, from 2017 to the present time, in three hospitals of Georgia country (Evex hospitals, New hospitals, New-vision University Hospital) with a diagnosis of acute subarachnoid haemorrhage. **Results:** In our study, overall postoperative mortality was reported to be 29.9% (41/137 patients). In 45 patients presenting with Hunt-Hess IV-V, the mortality rate was 51.1% (23/45). According to Raymond-Roy Scale, complete occlusion of aneurysm occurs in 66% of cases, residual occlusion of neck in 26%, and partial occlusion in 6%. **Conclusion:** Aneurysm rupture is an urgent clinical condition requiring rapid diagnosis and treatment. To prevent aneurysm re-rupture, operative intervention should be performed quickly. The recommended time interval is within 72 hours, and, if possible, within 24 hours after aneurysm rupture. Given the spasms typical of subarachnoid haemorraghe endovascular coiling of ruptured aneurysms is a first-line treatment that depends on the angioarchitecture and localization of the aneurysm. The

main technique of endovascular treatment is occlusion by coils with or without remodeling balloon assistance. Generally, in acute periods, only aneurysms with coils are associated with relatively high rates of recanalization, so further observation and possible surgical treatment are recommended.

Keywords

Anurisms, Sah, Coiling, Rupture, Acute Phase

1. Background

Subarachnoid haemorrhage due to intracranial aneurysm rupture is an urgent condition that involves a multidisciplinary approach to diagnosis and treatment by neuroradiologists, neurosurgeons, and neurologists. The annual incidence of aneurysmal subarachnoid haemorrhage is approximately 10/100,000. The United States reports about 21,000 - 33,000 new cases [1] of subarachnoid haemorrhage each year. It is noteworthy that the disease is more common in the population of working age, within average patient age of 55 years. The risk of subarachnoid haemorrhage is 1.6 times higher in women than in men. Compared to Caucasians, the risk of haemorrhage is higher in Afro and Latin Americans, at 1.6/1.3, respectively [2] [3] [4]. The timely occlusion of ruptured aneurysm allows us to avoid its subsequent re-rupture. The mortality rate in clinic is 26.3% and within 30 days of the disease is 16% - 38% [2] [3]. Most cases of recurrent aneurysm rupture occur within 2 weeks of haemorrhage, including 61% within the first 48 hours [5] [6] [7]. Prehospital mortality as a result of posterior circulation aneurysm rupture is three times more common than in anterior circulation aneurysm patients [5] [8].

Technological advances, such as 3D angiography and neuro-navigation have made the endovascular treatment of aneurysms more effective.

Treatment of aneurysmal subarachnoid haemorrhage in the acute period mainly involves endovascular treatment—coiling. Depending on the case, aneurysm coiling may be performed with stent or balloon assistance coiling (Neqstent).

FDs are flexible stent systems that redirect blood flow from aneurysms and eliminate the need for coil occlusion. They are effective, though they require long-term anti-aggregation therapy, which makes them difficult to use in the acute hemorrhagic phase. Studies have shown that they are effective in the case of bifurcation and wide-neck aneurysms. However, it should be noted that their long-term effects have not yet been studied.

The following article illustrates the indications, risks, and consequences of endovascular treatment in cases of ruptured intracranial aneurysms.

2. Indications

Ruptured untreated aneurysms have the highest risk of re-bleeding. Recurrent

bleeding usually develops within a few days of the first bleeding. The risk of re-bleeding is time-dependent. The risk of recurrent haemorrhage developed without surgery is 40% within 4 weeks. Also, recurrent haemorrhage is predictably severe, with high mortality and disability rates. 59% of patients die from recurrent bleeding.

In view of the above statistics, it is important to timely remove these aneurysms from the blood circulation via clipping or coiling. Given that the risk of recurrent bleeding after rupture is 4.1%. Timely endovascular treatment is indicated. According to modern guidelines, with given general condition of the patient, aneurysms should be removed from the circulation within 72 hours, or, at best, within 48 hours.

The International Study of Aneurysm Subarachnoid Hemorrhage (ISAT) reveals the benefits of endovascular treatment over open surgery. 2143 patients with subarachnoid haemorrhage participated in this study [8]. The 1-year mortality rate was lower in the endovascular group than in the surgical group (23.5/30.9%); They estimated that endovascular treatment is considered the first-line treatment in a large group of intracranial aneurysms (WFNS I or II).

A meta-analysis published in 2013 shows low rates of mortality and morbidity (9% - 23%) as a result of endovascular treatment. In the first year after treatment, 66% of patients were fully recovered and returned to their usual rhythm of life. In 87% of cases, aneurysm occlusion was complete or partial [5].

Aneurysm rupture can cause large intracranial haemorrhage, compressing the surrounding area. The main type of treatment is a combination of emergency coiling of aneurysm and evacuation of haematoma.

3. Methods

In this series we present a retrospective analysis of the results of endovascular embolization of 137 patients, treated from 2017 to the present time, with a diagnosis of acute subarachnoid haemorrhage.

82 patients underwent endovascular treatment within 48 hours of subarachnoid haemorrhage, 29 patients within 48 - 72 hours, and 29 patients within 72 hours.

The sex distribution was female—77 patients (56%) and male—60 (44%). Age ranged from 3 to 82 years.

Aneurysm localization was distributed as according to localization: anterior communicating artery—70 (51.1%); Internal carotid artery—47 (34.5%); Middle Cerebral Artery—7 (4.4%); Vertebro-Basil Pool—13 (10%).

The first-line diagnostic study was computed tomography/computed tomography with angiography, which primarily diagnoses subarachnoid haemorrhage as well as presence of aneurysm, determining its size, shape and localization. In most of the cases this type of examination is enough to determine appropriate treatment tactics (clipping/coiling). The gold standard in determining the appropriate tactics and techniques for endovascular treatment of aneurysmal sub-

arachnoid haemorrhage is digital angiography. In some cases the aneurysm diagnosis proceeded digital angiography to endovascular intervention- the aneurysm coiling.

Endovascular coiling was performed under general anaesthesia. The right femoral artery was usually punctured, however, in exceptional cases, the approach might be done from the brachial or radial artery or through direct puncture from the neck to the carotid artery. In our cases most of approaches were performed from the femoral artery.

A microcatheter with the help of a microwire was inserted into the aneurysm, through which the aneurysm was completely filled out with descending size coils.

Endovascular treatment of aneurysm involves coiling of aneurysm with micro-coils (complex, bare coils, hydrogel) under general anesthesia. Coiling was performed with balloon assistance in 16 patients, and without balloon assistance in the remaining 121 patients. Every endovascular treatment was done by us in several hospitals of Georgia country (Evex Hospitals, New hospitals, New-vision University Hospital). The average duration of endovascular treatment was 45 minutes (Figure 1).

When the aneurysm has a wide neck, coils are inserted into the aneurysm lumen with the assistance of a balloon catheter. The balloon forms a temporary wall at the aneurysm neck, after which the aneurysm cavity is filled out with coils. This technique is widely used in cases of complicated aneurysms (Figure 2).

Figure 1. Endovascular coiling of posterior inferior cerebellar artery (PICA) aneurysm. (A) Preoperative cerebral angiography; (B) Postoperative cerebral angiography.

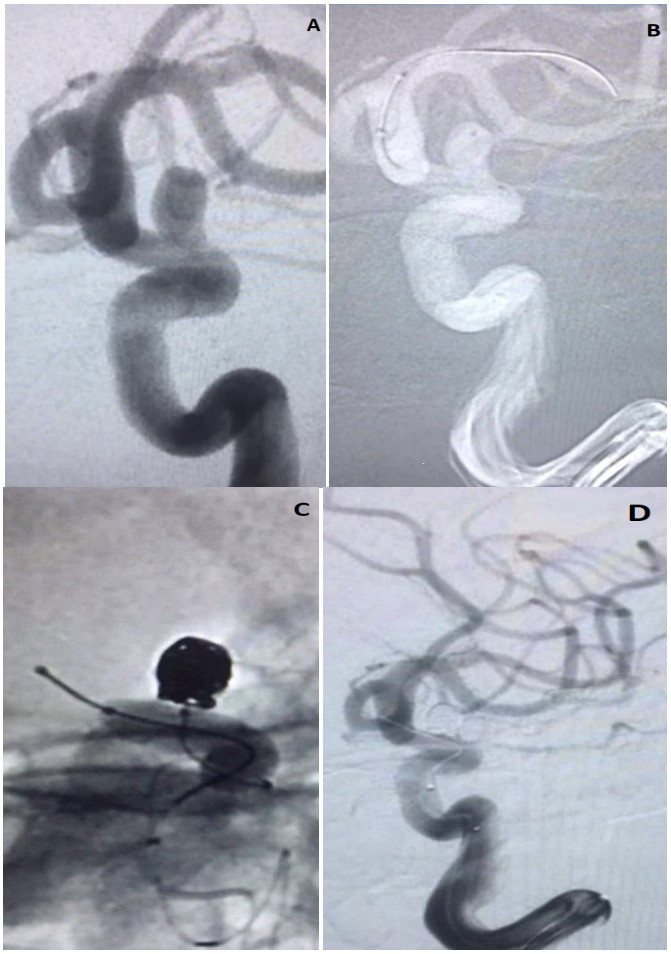

Figure 2. Endovascular coiling of internal carotid artery aneurysm with a wide neck with balloon assistance. (A) Preoperative digital angiography—internal carotid artery aneurysm with a wide neck; (B) Intraoperative angiography—the microcatheter benchmark is visualized at the base of the aneurysm. Balloon-catheter benchmark is also visualized in carotid artery; (C) Intraoperative angiography—aneurysm is completely removed from the bloodstream by balloon assist technique; (D) Postoperative angiography—the aneurysm is not contrasted.

FDs are flexible stent systems that redirect blood flow from aneurysms and eliminate the need for coil occlusion. They are effective, though they require long-term anti-aggregation therapy, which makes them difficult to use in the acute hemorrhagic phase. Studies have shown that they are effective in the case of bifurcation and wide-neck aneurysms. However, it should be noted that their long-term effects have not yet been studied.

There are two main complications of endovascular treatment during acute subarachnoid hemorrhage: thromboembolic complication and vascular spasm.

Anti-coagulation and anti-aggregate therapy is mainly used to manage thromboembolic complications. In our series, a nimotope infusion (8 ml nimotope/500 ml physiological solution) was performed throughout the operation, both in the guide catheter and in the microcatheter. If the intervention lasted more than one hour, 5000 units of heparin were given intravenously.

4. Outcome

Of the 137 endovascular procedures we performed, intraoperative thrombosis developed in 8 (5.8%). Mechanical thrombectomy was performed in all these cases (Figure 3). 10 patients developed total Progressive vasospasm.

Intraoperative aneurysm rupture occurred in three cases. In all cases, the aneurysm was timely removed from the bloodstream. It is noteworthy that intraoperative rupture did not affect clinical outcome (Figure 4).

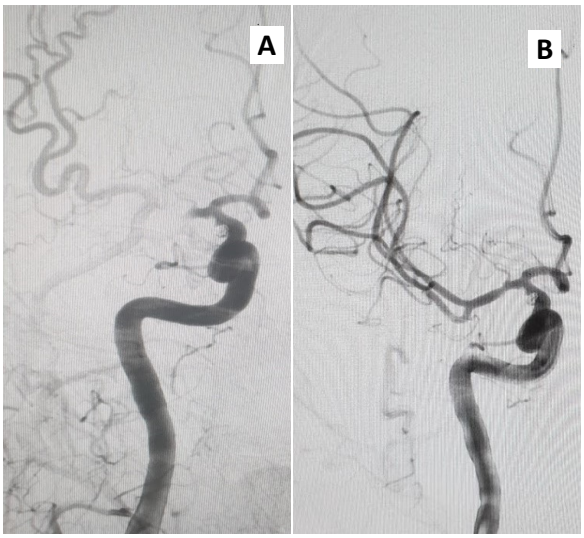

Figure 3. Endovascular coiling of right internal carotid artery aneurysm complicated by right middle artery thrombosis. (A) Intraoperative angiography—aneurysm occluded endovascularly. Middle cerebral artery thrombosis is visualized; (B) Intraoperative angiography—post-mechanical thrombectomy—blood flow to the middle artery is restored.

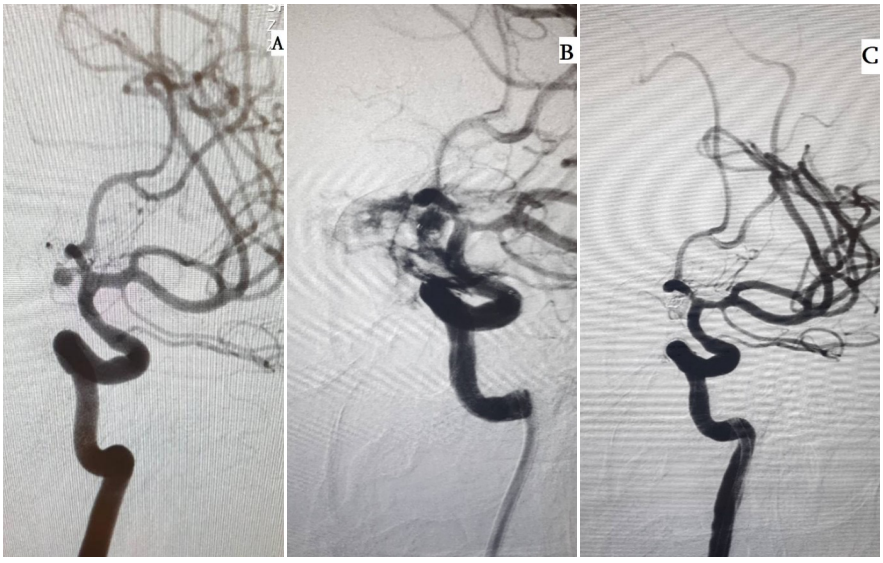

Figure 4. Aneurysm of the left internal carotid artery bifurcation. (A) Diagnostic angiography—aneurysm of the left internal carotid artery bifurcation; (B) Intraoperative aneurysm rupture—a contrast substance is over than aneurysm borders; (C) Intraoperative angiography—aneurysm is completely removed from the bloodstream.

Neurological status of patients preoperatively was evaluated using the Hunt-Hess (Table 1) scale and postoperatively using the Glasgow Outcome Scale (GOS) (Table 2).

It is noteworthy that at the time of hospitalization the majority of patients were in a severe state, approximately 60% of patients with Hunt-Hess scale I-III.

A good outcome to aneurysmal subarachnoid haemorrhage does not depend solely on successful endovascular intervention. Massive Subarachnoid Haemorrhage, degree of vascular spasm, neurological status and many other factors affect the outcome.

As stated above, the aim of our study was to provide timely endovascular intervention despite severe neurological status in cases of aneurysmal subarachnoid haemorrhage. Postoperative mortality was reported to be 29.9% (41/137 patients). In the 45 patients presenting with Hunt-Hess IV-V, the mortality rate was 51.1% (23/45).

Incomplete occlusion of an aneurysm carries the risk of re-canalization, which is more common following endovascular treatment than open surgical clipping. There are many reasons for post-coiling re-canalization, including: wide neck aneurysm and partial occlusion of aneurysm. Re-canalization can occur immediately or after several years of coiling.

In our series, a one year control angiographic study was performed on 65 patients, with complete occlusion of the aneurysm seen in 56% of cases, residual occlusion of neck in 35%, and partial occlusion in 9%, Figure 5.

5. Discussion

The main technique of endovascular treatment is occlusion of arterial aneurysm by coils with or without remodeling balloon assistance. In acute periods of ruptured intracranial aneurysms, aneurysms with coils are associated with relatively high rates of recanalization, so further observation and surgical treatment are recommended.

Table 1. Preoperative evaluation of patients (Hunt-Hess scale).

Hunt-Hess scale	Number of Patients	%
I-II	57	41.5
III	35	25.5
IV-V	45	33.0

Table 2. Patient postoperative condition per Glasgow outcome scale (GOS).

GOS scale	Number of Patients	%
5	43	31.4
4	31	22.6
3-2	22	16.1
Postoperative death	41	29.9

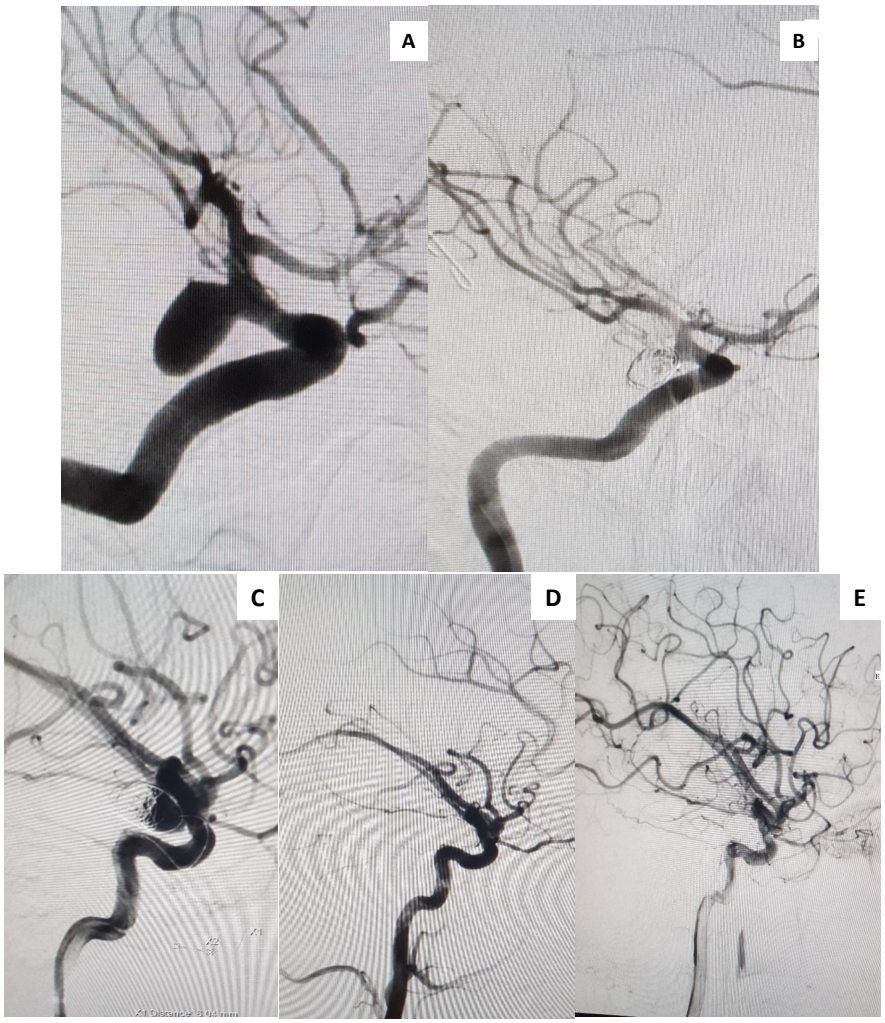

Figure 5. Large aneurysm of internal carotid artery supraclinoid segment. (A) Diagnostic Angiography—internal carotid artery supraclinoid segment aneurysm—acute subarachnoid haemorrhage; (B) Intraoperative angiography—aneurysm is occluded endovascular; (C) Diagnostic control angiography 6 months after surgery—contrasts residual part of aneurysm. Raymond-Roy—IIIB; (D) Intraoperative angiography—aneurysm is completely removed from the bloodstream; (E) Control diagnostic angiography 6 months after second surgery—aneurysm is not contraindicated.

The use of stents requires long-term anti-aggregation therapy, as it is characterized by high thrombogenicity compared to coils. Stenting has a high risk of thromboembolic and hemorrhagic complications. They are used in cases of aneurysms that are not suitable to coiling or open surgical treatment.

6. Summary

According to our cases, diagnosis and treatment of ruptured aneurysms is an urgent state. To prevent aneurysm re-rupture operative intervention should be performed quickly. The recommended time interval is less than 72 hours, and if possible less than 24 hours after aneurysm rupture. Given the spasms typical for subarachnoid hemorrhage, endovascular coiling for ruptured aneurysms is a

first-line treatment that depends on the angioarchitecture and localization of the aneurysm. The main technique of endovascular treatment is occlusion by coils with or without remodeled balloon assistance. In acute periods, only aneurysms with coils are associated with relatively high rates of recanalization, so further observation and possible endovascular treatment are recommended.

Conflicts of Interest

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

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