



ENDOVASCULAR OBLITERATION OF INTRACRANIAL ANEURYSMS IN ACUTE PHASE OF SPONTANEOUS SUBARACHNOID HEMORRHAGE

FANARJYAN R.V.*, KHACHATRYAN M.K., SARGSYAN N.A.,
KOCHARYAN S.A., KHACHATRYAN T.K.

Neurosurgery and Comprehensive Stroke Center, Yerevan State Medical University, Yerevan, Armenia

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ABSTRACT

Early diagnosis and appropriate treatment of acute stroke including acute subarachnoid hemorrhage due to aneurysm rupture remains one of the most actual problems in modern neurosurgery. Aneurysmal acute subarachnoid hemorrhage is an acute life-threatening condition, which requires urgent medical attendance and operative intervention.

Taking into account the importance of the problem, a study was conducted directed to the optimization of intracranial aneurysms' treatment strategy. The aim of the study is to analyze the importance and effectiveness of aneurysm obliteration in acute phase of aneurysmal acute subarachnoid hemorrhage.

A total of 160 patients with 194 intracranial aneurysms were treated in the Department of Neurosurgery and Comprehensive University Stroke Center from June 2010 to March 2015. The patients' mean age was 52 years. 65% of them were males (n=104), while 35% were females (n=56). Clinical and neurological condition was evaluated using Hunt & Hess Scale (3.8 on average). Radiological assessment was performed by Fishers' Scale (3.2 on average).

Aneurysms were located in the territory of anterior communicating artery (37%), middle cerebral artery (26%), posterior communicating artery (15%) and internal carotid artery (13.4%). 34.5% of aneurysms were located on the right side (n=67), and 25.8% (n=50) on the left.

External ventricular drainage was placed in 72 cases of intraventricular hemorrhage. The number of patients who underwent endovascular coil-embolization was 76.25% (n=122), 12 of them were with stent-assistance. A clipping of aneurysm was performed in 23.75% (n=38).

Symptomatic cerebral vasospasm was developed in 25 patients (15.6%). Ultra-high doses of Verapamil (in medium 75mg/hour, from 25 to 160mg/hour) were intra-arterially selectively performed for the treatment of this complication.

Ventricular extrasystoles that disappeared immediately after the injection was stopped were found only in two cases, as complication. Balloon-angioplasty was used in 7 symptomatic vasospasm cases, 6 of which were combined with ultra-high dose of Verapamil injection. Repeated digital cerebral angiography was performed in survived patients in 3 and 9 months after endovascular obliteration. The enlargement and repeated blood filling of the aneurysm was diagnosed in 6 patients (3.75%). In this regard, 4 patients underwent recoiling of aneurysm, and 2 of them – aneurysm clipping.

The neurological status was evaluated by Modified Rankin Scale (MRS) in 9 months after discharge, according to which in 77.1% of patients the index was – MRS ≤ 2 , in 2.5% – MRS 3, in 5.8% – MRS ≥ 4 and 14.6% of our operated patients died (MRS 6).

KEYWORDS: aneurysm, subarachnoid hemorrhage, obliteration, clipping, verapamil, balloon angioplasty.

INTRODUCTION

Early diagnosis and appropriate treatment of acute stroke including acute subarachnoid hemorrhage due to aneurysm rupture remains one of the

most actual problems in modern neurosurgery. Aneurysmal acute subarachnoid hemorrhage is an acute life-threatening condition, which requires urgent medical attendance and operative intervention.

Several authors note that intracranial aneurysms are found in 3.2% of general population. C.G. Drake mentioned that aneurysms are detected in 5% of people during autopsy and those under 2 mm – in

ADDRESS FOR CORRESPONDENCE:

Yerevan State Medical University after M. Heratsi
2 Koryun Street, Yerevan 0025, Armenia
Tel.: (+37460) 62-14-10
E-mail: rvfanar@yahoo.com

17% of population. Most commonly aneurysms are diagnosed in individuals at a mean age of 50-56 years [Drake C, 1977; Bohnstedt B et al., 2015; D'Andrea G et al., 2015].

The aneurysmal acute subarachnoid hemorrhage is on the second place after traumatic hemorrhage, and on the first place among spontaneous acute subarachnoid hemorrhages. Aneurysmal acute subarachnoid hemorrhage is the third most frequently occurring stroke after cerebral embolism and hypertensive intracerebral hemorrhage [Ji C, Chen G, 2016]. It should be mentioned that one third of hemorrhages occur during the sleep.

According to literature data female sex is thought to be a risk factor for aneurysm formation and for acute subarachnoid hemorrhage occurrence, especially after menopause, which testifies about the protective function of sex hormones. It is established, that the incidence and mortality are confirmed to be higher in females, however they elucidated no clear differences in the functional state among survivors after acute subarachnoid hemorrhage [Turan N et al., 2016].

Although intracranial aneurysms are diagnosed mostly after rupture, there are symptoms mentioned in literature that may give a clue to the existence of aneurysm. According to Walsh M.E. (2014), 11-15% of unruptured aneurysms appeared with such symptoms as convulsions, unilateral disorder of cranial nerve function, vision loss, headache and ischemia. Convulsions can be accompanied with speech disorders, sensation of fear, parasthesia, tonic-clonic seizures.

Taking into account the importance of the problem, a study was conducted directed to the optimization of intracranial aneurysms' treatment strategy. The aim of the study is to analyze the importance and effectiveness of aneurysm obliteration in acute period of aneurysmal acute subarachnoid hemorrhage.

MATERIALS AND METHODS

All patients admitted to the Neurosurgery and Comprehensive University Stroke Center in Yerevan from June 2010 to March 2015, were included in the study. All patients underwent detailed clinical and neurological examination, which was estimated using Hunt & Hess scale. The level of consciousness was assessed using Glasgow coma scale. Computed tomography scan of the brain was performed in all pa-

tients. The results were estimated using Fisher's scale. CT-angiography was performed for the determination of the source of hemorrhage and the method of surgical interference if the patient also had intracerebral and intraventricular hemorrhage. Digital cerebral angiography was the gold standard which was performed in all patients. It helps to determine the exact number of aneurysms, localization, size, neck width and the method of urgent surgical interference such as endovascular obliteration of aneurysms' coiling or open clipping. Any surgical intervention was contraindicated in terminal conditions (Glasgow coma scale – 3-4). These patients received intensive therapy in the intensive care unit under the supervision of neurosurgical staff, and the indications for operation were discussed only in case of improvement of general and neurological condition.

A total of 160 patients with 194 intracranial aneurysms were treated in the Department of Neurosurgery and Comprehensive University Stroke Center from June 2010 to March 2015. During the admission the main complaint was headache with various degrees of consciousness disorder. The hemorrhage was manifested by convulsions in 2 patients. The patients' mean age was 52 years. 65% of them were males (n=104), while 35% were females (n=56). Clinical and neurological condition was evaluated using Hunt & Hess Scale (3.8 on average). The level of consciousness was assessed using Glasgow coma scale and was 9.6 on average. Radiological assessment was performed by Fishers' Scale (3.2 on average). Patient's mean age, sex distribution, aneurysm location was estimated during the study.

External ventricular draining was performed in case of intraventricular hemorrhage. The duration of drainage which was to a maximum of 10 days in order to avoid infectious complications. If repeated drainage was necessary, the drainage was placed in the opposite side. The external ventricular drainage helped to drain hemolyzed blood from ventricles and to control intracranial pressure.

Calcium channel blockers, statins, hemodilution and hyperdynamic therapy were appointed from the moment of patient admission to prevent cerebral vasospasm. The methods of balloon angioplasty and superselective intra-arterial injection of antispasmodics were used in case of symptomatic vasospasm development. The complications of those manipulations were estimated.

Repeated digital cerebral angiography was performed in survived patients in 3 and 9 months after surgery, which allowed evaluating the effectiveness of previous operation and the necessity of the new one.

The outcome was evaluated by Modified Rankin Scale in 9 months after discharge.

RESULTS

The results of appropriate studies revealed that aneurysms were located in the territory of anterior communicating artery (37%), middle cerebral artery (26%), posterior communicating artery (15%) and internal carotid artery (13.4%); 34.5% of aneurysms were located on the right side (n=67), and 25.8% (n=50) on the left.

External ventricular drainage was placed in 72 cases of intraventricular hemorrhage. The maximum duration of drainage was 10 days. The drainage was installed before digital cerebral angiography and aneurysm obliteration; however the drainage was kept closed, before the performance of surgical interference in order not to allow the sharp decrease of intracranial pressure and rebleeding from the aneurysm. External ventricular drainage allows removing cerebrospinal fluid and hemolyzed blood from the ventricles, reducing the intracranial pressure, improving brain blood supply and controlling the level of intracranial pressure. For the avoidance of ventriculitis the drainage was removed on the 10th day and if needed was replaced from the opposite side.

The next step is to perform digital cerebral angiography, which allows assessing the number, shape, size and localization of the aneurysm, choosing the way of surgical manipulation. 76.25% (n=122) of patients underwent endovascular coil-embolization, 12 of them were with stent-assistance. In 23.75% (n=38) clipping was performed. Aneurysm wasn't found in 3 patients with acute diffuse of subarachnoid hemorrhage and severe vasospasm according to digital cerebral angiography. Only super selective intra-arterial injection of antispasmodics (Verapamil) allowed the visualization of aneurysms and appropriate treatment. However, the injections of antispasmodics may increase the risk of intraoperative rupture of unsecured aneurysm.

All operated patients were under the careful neurological and radiological monitoring. The cerebral vasospasm was followed-up using transcranial dopplerography – monitoring. Symptomatic

cerebral vasospasm was developed in 25 patients (15.6%). Ultra-high doses of Verapamil (in medium 75mg/hour, from 25 to 160mg/hour) were intra-arterially selectively performed for the treatment of this complication.

Ventricular extrasystoles that disappeared immediately after the injection was stopped were found only in two cases, as complication. Balloon-angioplasty was used in 7 symptomatic vasospasm cases, 6 of which were combined with ultra-high dose of Verapamil injection. Repeated digital cerebral angiography was performed in survived patients in 3 and 9 months after surgery. The enlargement and repeated blood filling of the aneurysm was diagnosed in 6 patients (3.75%). In this regard, 4 patients underwent recoiling, and 2 of them – aneurysm clipping.

The neurological status was evaluated by Modified Rankin Scale in 9 months after discharge, according to which in 77.1% of patients the index was – Modified Rankin Scale <2, in 2.5% – Modified Rankin Scale 3, in 5.8 % – Modified Rankin Scale >4 and 14.6% of our operated patients died (Modified Rankin Scale 6).

DISCUSSION

Over the last 40 years scientists require intensive efforts to investigate pathological, etiological, pathogenetic, and hemodynamic aspects of aneurysmal acute subarachnoid hemorrhage, to describe the course of the pathology, complications and outcomes.

Heit J. and co-authors (2015 a,b) mentioned that aneurysms most commonly arise from the supraclinoid internal carotid artery (22%), the middle cerebral artery (18%), and the anterior communicating artery (13%). In present study the aneurysms of anterior communicating artery were majority (37%).

The annual mortality rate in Scandinavian countries is 15.6% for patients with ruptured aneurysms and 2.7% for patients with unruptured aneurysms [Lindekleiv H et al., 2015]. Approximately 10.5/10 million cases of subarachnoid hemorrhage caused by are annually diagnosed in China. Aneurysmal subarachnoid hemorrhage leads in mortality rate amounting 67 %, and, because of the sudden onset of this disease, approximately 12-15% of patients die before they receive effective treatment. Two-third of mortality caused by acute subarachnoid

hemorrhage occurs within 48 hours, mainly as a result of early brain injury [Ji C, Chen G, 2016]. The initial hemorrhage causes death in approximately 25% of patients, with most subsequent mortality being attributable to delayed cerebral ischemia in the USA [Lominadze G et al., 2016]. Overall rupture rate per year was 0.76%. The size of aneurysm ≥ 5 mm significantly increases the risk of rupture in a comparison with small aneurysms of 2-to 4-mm size. It is noted that full recovery wasn't observed in patients with large or giant aneurysms, and the mortality rate after rupture was 69%. For aneurysms sized < 5 mm, the mortality rate was 18% [Murayama Y et al., 2016].

The mortality rate of patients included in present study was 14,6% This index is attributable to various factors, such as aneurysm rupture quantity, Hunt & Hess score, Fisher's score, aneurysm obliteration in the acute period, vasospasm treatment activities.

According to the literature data female sex is thought to be a risk factor for aneurysm formation and its rupture, especially in postmenopausal age populations, suggesting the potential protective involvement of sex steroids [Turan N et al., 2016]. In contrast to literature data, in our study males were dominated, 65% vs. 35%.

Literature data confirm that the risk of rebleeding from ruptured aneurysm increased several times in comparison with non-ruptured aneurysms. This risk is especially high in the first days of acute subarachnoid hemorrhage as well as in the 7th, 14th, 21th and 28th days of hemorrhage. Sex, high arterial tension, high Fisher grade, aneurysm size larger than 10mm and poor clinical condition were independent risk factors for aneurysmal rebleeding. The importance of early aneurysm intervention and careful consideration of patient risk factors should be emphasized to eliminate the risk of rebleeding and poor outcome [Alfotih G et al., 2014]. It's obvious that disability and mortality rate can be reduced only if aneurysm obliteration performed in early stages of hemorrhage, before repeated rupture and ischemic complications. Modern neurosurgery chose less invasive surgical procedures, such as endovascular coiling.

One of the life-threatening complications of acute subarachnoid hemorrhage is cerebral vasospasm, which dramatically increases disability and mortality

risk in these patients, due to delayed cerebral ischemia [Hockel K et al., 2015]. Delayed cerebral ischemia generally occurs on post-bleed days 4th to 20th day, with maximum risk per 8-14 days [Pandey A et al., 2013; Lominadze G et al., 2016]. Vasospasm is subdivided into angiographic and symptomatic types. Angiographic spasm occurs in up to 70% of patients following acute subarachnoid hemorrhage, and approximately half become symptomatic [Weant K et al., 2010; Pandey A et al., 2013].

Despite the fact that the vasospasm pathophysiology is well known, there is no totally effective preventive treatment. With prolonged severe macrovasospasm some authors suggested continuous intra-arterial "Nimodipine" treatment, which can be applied as a rescue therapy with relative safety for more than 2 weeks to prevent secondary cerebral ischemia. It has been shown to increase the vessel diameter, although this effect is transient [Hockel K et al., 2015]. Intra-arterially administered verapamil improves angiographic vasospasm after acute subarachnoid hemorrhage when administered at 10 ± 3 mg per arterial distribution. They also mention that optimal dose, infusion rate, and retreatment interval remain to be determined [Sehy J et al., 2010]. Some neurosurgeons adopted the method of superselective intra-arterial injection of ultrahigh dose (average dose per vessel 164.6 mg, range of total dose per treatment 70-720 mg) of Verapamil into practice in recent years. Infusion time ranged from 1 to 20.5 hours (average 7.8 hours). There was no treatment-related morbidity or death [Albanese E et al., 2010]. Endovascular treatment for post-hemorrhagic cerebral vasospasm is used when medical management fails or because of complications of medical therapies. Balloon angioplasty is one of effective manipulations for vasospasm treatment. It helps to reach a persistent vasodilatation [John S et al., 2014; Heit J et al., 2015].

CONCLUSION

Thus, it can be concluded that early aneurysm obliteration is required in case of aneurysmal acute subarachnoid hemorrhage. Preference is given to endovascular obliteration of the aneurysm. This is minimally invasive surgery which effectively secures the aneurysm from rerupture at least within the first 3 months. This enables to begin active medical treatment in order to avoid secondary cerebral ischemia without the risk of rebleeding.

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