

# Research Paper: Surgical Protocol and Outcome of 60 Cases With Intracranial Aneurysm



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## ABSTRACT

**Background and Aim:** This study aimed to present the results of early and delayed operation on patients with ruptured brain aneurysms. In addition to comparing the results and rates of morbidity and mortality in the surgical procedure and identifying the effective factors, this study aimed to provide methods to improve the treatment of brain aneurysm.

**Methods and Materials/Patients:** This was a retrospective study on 60 patients with a definitive diagnosis of brain aneurysm admitted to Neurosurgery Ward of Poursina Hospital, Rasht, Iran from 2009 to 2013.

**Results:** Seven (11.7%) patients on the first 3 days and 37(61.7%) patients on the days 4-14 and 16(26.7%) after 2 weeks and underwent surgery selectively. In total, 11.7% of patients died and 15% developed severe complications. In the group that underwent surgery on the first 3 days, 2(28.5%) patients died and 2 experienced severe complications. In the second group (underwent surgery on 4-14 days), 4(10.8%) patients died and 5(13.5%) suffered from severe complications, and in the group with delayed surgeries (16 patients), 1(6.2%) patient died and 2(12.5%) suffered from severe complications. Neurological grading and operation time were important factors in complications and mortality of patients.

**Conclusion:** This study showed that Hunt and Hess neurological grading score has a direct relationship with increased morbidity and mortality rates, while delayed operation is associated with a reduction in morbidity and mortality. Given the complications of early aneurysm surgery (during the first 3 days) compared with delayed surgery, and also most of these patients die due to vasospasm or recurrent hemorrhage before the onset of a delayed phase, performing early surgery in these patients requires further evaluation. According to this study, the reduction of each episode of occlusion with temporary clipping will result in fewer complications.

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## Highlights

- Brain aneurysm is a bubble-shaped sacs out of brain vascular walls.
- Treatment of this disease is the closure of aneurysm necks that is very delicate and with high complications .
- Hunt and Hess neurological grading score has a direct relationship with increased morbidity and mortality rates.
- Delayed operation is associated with a reduction in morbidity and mortality.
- Reduction of each episode of occlusion with temporary clipping will result in fewer complications.

## Plain Language Summary

Brain aneurysm is referred to as a bubble-shaped sacs out of brain vascular walls. This disease is common and very dangerous and requires surgical intervention. Treatment of this disease is the closure of aneurysm neck by using metal clips or blocking it by intravascular methods such as endovascular coiling. This surgery is very delicate and with high complications. In this study, 60 patients with this disease underwent anesthetic clipping surgery. Complications of this disease and surgery are closure of the brain vascular (vasospasm) and recurrent hemorrhage, which depends on various factors. The results of this study are similar to those of other studies. These studies are aimed at using methods to reduce their complications. Preoperative care, surgeons' skill, and development of intravascular methods should be taken into consideration.

### 1. Introduction

**S**ubarachnoid hemorrhage caused by spontaneous aneurysm rupture is a common and complicated neurological disorder [1]. Cerebral aneurysm is congenital in most cases, in which one part of the artery wall is dilated like a balloon and highly prone to spontaneous rupture. Lesions may occur in different forms, but the saccular form is the most common type [2, 3].

Microsurgical clipping treatment of aneurysm is among the main measures to reduce complications and mortality in these patients. Such operations have advanced a lot during the last two decades [4, 5]. Significant advances in microsurgery and endovascular treatments and other modern medical treatments have significantly reduced the morbidity and mortality of these patients [6, 7], but rehemorrhage and vasospasm are still the causes of unfavorable outcomes [8, 9]. Even these patients need to have a long follow-up because patients with history of aneurysmal Subarachnoid Hemorrhage (aSAH) suggest that is an ongoing development of aneurysms during life [10]. Several epidemiological studies have investigated whether management outcome for patient with aSAH has improved [11].

In order to present the surgical treatment outcomes of ruptured brain aneurysms in Guilan Province, Iran, we at-

tempted to compare the results and rates of morbidity and mortality in the surgical procedure along with a general review of patients with this type of lesion in medical journals of Iran and the world. The relationship between temporary clip duration and the complications of the patients were also investigated in recent studies conducted worldwide and in Iran, which well highlights the importance of this study.

### 2. Methods & Materials/ Patients

This was a retrospective descriptive study. The subjects included all patients who had been admitted to the Neurosurgery Ward of Poursina Hospital in Rasht during a 4-year period (2009-2013) with a definitive diagnosis of aSAH. This study was conducted based on hospital data and patients' neurological grading of Hunt and Hess scale (which is one of the best methods for determining the patients' condition after ruptured cerebral aneurysms, through which patients are categorized based on grades 1 to 5).

To perform this, at first, the hospital records of patients with primary diagnosis of subarachnoid hemorrhage and Intracerebral Hemorrhage (ICH) were prepared and the cases diagnosed with definite aneurysm were selected. Then, the data regarding the time of bleeding, clinical signs and symptoms, hospitalization time, primary CT findings, time of CT angiography and its findings, type

and time of treatment (surgical and medical), and complications during hospitalization were recorded.

### Statistical analysis

Descriptive statistics and frequency distribution tables were used to describe the data. The Chi-square test was used to analyze the data in SPSS (V. 19). P values less 0.05 were considered significant.

### 3. Results

Of 135 patients, 60 were entered in the study and the rest were excluded due to their incomplete records. Out of those, 36(60%) patients were females and 24(40%) were males. The oldest age group was 50-60 years. The mean age of males and females were 51 and 55 years, respectively, while the total mean age of the patients was 53 years. The mean duration of hospitalization for all patients was 19.5 days. The interval between the onset of symptoms and hospitalization were within the first 24 h for 28(46.7%) patients, after 24 h for 16(26.7%) patients, after 48 h for 5(8.3%) patients and after 72 h for 11(18.3%) patients. In total, more than 80% of the patients were admitted to the hospital within the first 3 days after aSAH. The most common symptoms were sudden headache, nausea,

vomiting, and loss of consciousness. According to Hunt and Hess scale, 11(18.3%) patients were classified in grade 1, 25(41.7%) in grade 2, 20(35%) in grade 3, and 3(5%) patients in grade 4 (Table 1).

The most common risk factors included hypertension (43%), smoking (10%), opium addiction (9%) and diabetes (5%). Early study data of CT scan showed that 46(76.7%) patients had aSAH and 13(21.7%) patients had ICH and Intraventricular Hemorrhage (IVH). According to CT brain angiography, the location of aneurysm was anterior communicating artery in 23(38.3%) patients, the middle cerebral artery in 19(31.7%) patients, the anterior cerebral artery in 5(8.3%) patients, the posterior communicating artery in 4(6.7%) patients, the posterior circulation in 3(5%) patients, and the internal carotid artery, the ophthalmic artery and the clinoid artery in 3 patients, respectively. There was also a case of middle cerebral artery giant aneurysm. In addition, there were 54 patients with single aneurysm and 6 patients with multiple aneurysms. In 6 cases, 2 aneurysms were diagnosed in 2 different locations (Table 2).

In 59 patients, the aneurysm underwent microsurgical clipping (closing the aneurysm by inserting the clip in its neck) and wrapping was performed in patients,

**Table 1.** Characteristics of 60 patients with aneurysmal subarachnoid hemorrhage admitted to the Neurosurgery Ward of Poursina Hospital from 2009 to 2013

Variable	No., or Value	%	
Gender	Men	24	40
	Women	36	60
Mean age, y	53		
Oldest age group	50-60		
The interval between onset of symptoms and hospitalization	First day	28	46.7
	Second day	16	26.7
	Third day	5	8.3
	After the third day	11	18.3
Patients' grading based on Hunt & Hess Scale	Grade 1	11	18.3
	Grade 2	25	41.7
	Grade 3	20	35
	Grade 4	3	5

**Table 2.** Characteristics of 60 patients brain aneurysm treated in Neurosurgery department , Poursina Hospital in 2009-2013

Variable		No., or Value	%
Location of aneurysm	Internal carotid artery	1	1.7
	Middle cerebral artery	19	31.7
	Anterior communicating artery	23	38.3
Anterior cerebral artery		5	8.3
Posterior communicating artery		4	6.7
Posterior circulation		3	5
Ophthalmic artery		1	1.7
Clinoid artery		1	1.7
Time of operation	First 3 days	7	11.7
	Days 4 <sup>th</sup> -14 <sup>th</sup>	37	61.7
	After 2 weeks	16	26.7
Outcome	Death	7	11.7
	Severe complication	9	15
	Complete recovery	44	73



(covering the aneurysm wall). Seven (11.7%) patients on the first 3 days and 37(61.7%) patients on days 4-14 and 16(26.7%) patients after 2 weeks underwent elective surgery. Of these patients, 7(11.7%) were subject to External Ventricular Drain (EVD) or shunt surgery, due to hydrocephalus. Moreover, vasospasm was experienced in 9(15%) patients after the operation; 1(1.6%) patient during the first 3 days, 6(10%) patients on days 4 to 14, and 2(3.3%) patients 14 days and more after the operation. Therefore, vasospasm was mostly prevalent in groups that underwent surgery on days 4-14, after the onset of bleeding .

The shortest time to use the temporary clip was 1 minute in 19(31.7%) patients and the longest time was 22 minutes in 1(1.7%) patient, with the mean applying time of 6.5 minutes in all patients. The patients were divided into 2 groups. A temporary clip placement time lasted less than 7 minutes in the first group and more than 7 minutes in the second group. The second group experienced (12.3%) more complications. The total duration of temporary clip placement was significantly longer in this group ( $P=0.001$ ).

The total duration of clipping was associated with the rate of complications in this group. The shortest perma-

nent aneurysm clip was 4 mm, used in one patient and the longest one was 18 mm, while the mean size of the clips was 8.1 mm in 22(36.7%) patients. On the whole, 11.7% of patients died and 15% developed severe complications. In the group undergoing surgery in the first 3 days, 2(28.5%) patients died and 2 experienced severe complications. In the group who underwent the operation during days 4-14, 4(10.8%) patients died and 4(13.5%) suffered from severe complications. In this group, 28 patients recovered completely after the surgery.

In patients who had underwent surgery late (16 patients), 1(6.2%) died and 2(12.5%) suffered from severe complications. Overall, 44(73%) patients had complete recovery, 9(15%) developed severe complications and 7(11.7%) died (Table 2). Logistic regression showed a significant relationship between the factors involved in severe complications and postoperative death in patients through Hunt and Hess grading ( $P=0.008$ ) and early or late surgery time ( $P=0.01$ ). The higher Hunt and Hess grading scores were positively correlated with increased complications and death of patients, but other factors like diabetes mellitus did not have a significant relationship with the rate of complications and death.

#### 4. Discussion

Recently, the treatment of aSAH has been significantly changed [12]. This knowledge about the risks of brain aneurysm will help in planning, screening and prevention strategies and in predicating the prognosis of individual patients [13]. Advances in treatment and microsurgical techniques for brain aneurysm improved surgical results and reduced mortality and surgical complications of brain aneurysm [14]. In general, mortality rate was 40% in the patients, on the first 30 days, and only 25% of these patients had good functional outcomes. Rebleeding and vasospasm were the adverse outcomes and important causes of the disease [15]. Studies have shown that recurrent hemorrhage occurs in 15%-30% of patients in the first 2 weeks after ruptured aneurysm, and the highest incidence happens on the first 3 days, which leads to death in 50% of cases [16].

Early treatment of aneurysms with endovascular detachable coils is effective in preventing recurrent hemorrhage [17]. The results of this study and few studies in the field of brain aneurysms in Iran indicate that this disease is one of the most important causes of death and disability of patients in the hospitals. A comparison of the studies by Hernesniemi [17] in Canada and Cesarini [5] in Sweden, with recent published studies in Iran, shows that the epidemiological factors such as the gender (more prevalence in women), age range (high prevalence of ruptured aneurysms in people aged 50-60 years), location of the aneurysm (the anterior arteries and middle cerebral arteries and carotid arteries), and risk factors such as hypertension, smoking and diabetes are the same as in these studies [2, 3, 5, 10, 11].

There is a significant difference in some cases, including therapeutic management, interval between the icus to the patients admission and aneurysm clipping on the first 3 days, which depend on the availability of the country's healthcare facilities [3]. Factors such as the rate and severity of bleeding, grading of patients before surgery, the clinical situation of patients before the aneurysm rupture, and the size and location of the aneurysm, as well as the surgical procedure time, surgeon's experience and skills, and surgical techniques are effective in the prognosis of these patients [18].

In this study, factors such as the duration of hospitalization, time of surgery, grading, location and number of aneurysms, postoperative vasospasm and complications, were investigated using the Chi-square test. In addition, the duration of clipping along with the number

and length of the permanent clips were also examined in the study patients. A total of 7(11.7%) patients died and 9(15%) had severe complications, with no significant difference between sex and mortality ( $P=0.09$ ). Thus, compared with other studies, 13.6% of study patients died and 10.7% had severe complications. The most important factor influencing the mortality of the patients was the time of surgery.

Of 7 patients operated on the first 3 days, 2(28.5%) died and 2 patients had severe complications. Of 37 patients operated on days 4-14 after bleeding onset, 4(10.8%) died and 5(13.5%) developed complications. In cases of delayed surgery, 16(6.2%) patients died and 2(12.5%) suffered from severe complications. The Chi-square test revealed a significant difference between the mortality rate of patients and early and late surgery ( $P=0.01$ ). The prevalence of vasospasm and cerebral ischemic events in various studies was reported between 1% and 14% [19, 20]. In this study, vasospasm was seen in 9 (15%) patients, with no clear differences, compared to the other studies.

In this study, most cerebral vasospasm occurred on days 4-14 after rupturing aneurysm, which has been confirmed by other studies. Therefore, in order to microsurgical aneurysm clipping, surgery should not be performed during this period, because the surgery increases the severity of vasospasm. At intervals, surgical treatment is only required in patients who need immediate surgery to evacuate hematoma, or in case of loss consciousness and increased severity of neurological symptoms, in which the surgical intervention might save the patient, although performing surgery in this period increases the severity of vasospasm.

In this study, given preoperation grading and prioritizing the level of consciousness in relation to its effect on the prognosis, the patients with better grading showed lower complications and better prognosis ( $P=0.01$ ), which indicates that neurological grading is a strong predictor. Examination of the effects of aneurysm location on prognosis showed no significant differences in the prevalence of aneurysms and mortality in patients ( $P=0.52$ ), which is in line with the results of Mashhadinejad [3].

The results of this study are comparable with other studies. Mashhadinejad reported that 85.7% of the patients undergoing surgery in the first 2 weeks suffered from severe complications or died. Shabehpour [12] reported that 54% of the patients with same time condition suffered from severe complications, while Bor-

zouyeh [21] reported a rate of 55.2% for the same condition. Of all study patients undergoing surgery in the first 2 weeks, 28.5% developed severe complications or died. Therefore, studies indicate that the complications and vasospasm are associated with the surgical time and possibly be related to the surgical technique [8]. The overall incidence of complications was lower in groups with the duration of temporary clips with less than 7 minutes. Shorter duration of total period of clipping and increased experience of the surgeons could influence the lower complications in this group.

The microsurgical clipping treatment of aneurysm and its removal from the brain's circulatory pathway is the only definitive method of preventing recurrent hemorrhage and its adverse effects. Vasospasm is an important factor in determining the prognosis of patients after the third day, yet it might be reduced by removing blood circulation aneurysm as well as vasospasm prevention and treatment methods, using calcium channel blockers and triple-H therapy (hemodilution, hypervolemia, hypertension) or angioplasty and intra-arterial papaverine [22, 23].

Early treatment of brain aneurysms with microsurgical clipping and endovascular coiling on the first 3 days, especially in patients with good clinical grades (grades 1 and 2) and, in some cases, with grade 3 has started since 2 decades ago [16, 22-24]. Although endovascular coiling treatment in ruptured aneurysms has been proven to have a lower mortality rate besides preventing complications due to early surgery, it is also effective in preventing recurrent hemorrhage [25].

In physiopathology, the primary injury and secondary events in subarachnoid hemorrhage, due to aneurysm like brain stroke are believed to be caused by ruptured aneurysm. Thus, by taking comprehensive care of the patients in specialized units and effective treatments, secondary complications and injuries due to the hemorrhage associated with aneurysm might be reduced. The high mortality rate in this disease requires improvement in the treatment strategy and the quality of special care units [5].

## 5. Conclusion

In this study, factors such as hypertension, diabetes mellitus and smoking did not have a significant relationship with the complications and morbidity of patients. However, there was a significant relationship between patient's grading and the surgical time. Higher grades associate with increase in the mortality and morbidity

rates of the disease. The mortality rate also reduces in patients who underwent delayed surgery.

This study showed that Hunt and Hess neurological grading had a direct relationship with increased morbidity and mortality, while delayed surgery was associated with a reduction in morbidity and mortality. Considering the complications of early aneurysm surgery (the first 3 days), compared with delayed surgery, and that most of these patients die due to vasospasm or recurrent hemorrhage before the onset of a delayed phase, performing early surgery in these patients requires further evaluation.

The duration of the total occlusion increases with higher number of temporary clips used during surgery; however, the aneurysm clipping surgery is more effective. Temporary clipping with a shorter duration of time can reduce the overall complications of the patients.

Based on the results, we recommended training more experienced personnel in the specialized field of neurovascular fellowship; providing medical equipment, including angiography devices for endoscopic intervention in special care units; establishing neurovascular special care units, at least in the major academic and referral centers, to provide diagnostic and therapeutic procedures at the earliest time possible.

In this study, 60 patients were examined and the rest were unfortunately excluded from the study due to their incomplete records. Unfortunately, about half of our cases were missed, therefore, the results might have been corrupted. Thus, failure to record and maintain the patients' information caused this problem. Also, the lack of a special care unit for patients with brain aneurysm can increase the poor prognosis of postoperative patients.

## Ethical Considerations

### Compliance with ethical guidelines

The patients' data were extracted from patients' files and this information remained confidential.

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### Authors Contribution

The authors contributions are as follows: Conception and design: Babak Alijani, Mohammadreza Emamhadi;

Data collection: Seyfollah Jafari, Amin Naseri; Drafting the manuscript: Shahrokh Yosefzadeh-Chabok, Seyfollah Jafari, Amin Naseri; Critical revision of the manuscript: All authors; Reviewing the submitted version of manuscript: All authors; Approving the final version of the manuscript.

### Conflict of interest

The authors certify that they have no affiliation with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials dismissed in this manuscript.

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