

# Outcomes of Microsurgical Clipping in Middle Cerebral Artery Aneurysms

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## Abstract

**Objective:** Surgical or endovascular treatment is used in the treatment of intracranial aneurysms. Recent studies have suggested that the of endovascular treatment are superior to surgery Middle cerebral artery (MCA) aneurysm is the third most common bleeding aneurysm after anterior communicating artery and internal carotid artery aneurysms. We aimed to retrospectively evaluate the microsurgical outcomes of cases operated for MCA aneurysm.

**Methods:** Twenty cases with MCA aneurysm who accepted the microsurgical treatment option were included in this study. Data were obtained by retrospectively reviewing the clinical, radiological, and intraoperative findings, as well as postoperative morbidity and mortality of the cases.

**Results:** In total, 23 MCA aneurysms were detected in 20 cases. In 2 cases, MCA aneurysm was detected incidentally. Microsurgical clipping was performed in 23 aneurysms. In the study, the total mortality rate was 10% and the morbidity rate was 20% in MCA aneurysms.

**Conclusion:** It was observed that the incidence of calcification or thrombosis within the aneurysm increased and the Glasgow outcome scores at the 3rd month decreased as the width and length values of the aneurysm sac increased. In addition, presence of calcification in the aneurysm wall or thrombosis in the sac was found to be positive and strongly correlated with mortality and morbidity.

**Key words:** Middle cerebral artery, aneurysm, microsurgery

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## Introduction

Surgical or endovascular treatment is used in the treatment of intracranial aneurysms. Recent international studies have suggested that the outcomes of endovascular treatment are superior to surgery (1,2). However, microsurgical clipping is the first treatment option in most centers since middle cerebral artery (MCA) aneurysms have a wide neck and middle cerebral artery branches come out of the base or body of the aneurysm (2,3).

MCA aneurysms constitute 18%–36% of all intracranial aneurysms (3). It is the third most common bleeding aneurysm after anterior communicating artery and internal carotid artery

aneurysms (2). This study retrospectively evaluated the microsurgery results of 23 MCA aneurysms detected in 20 cases. Demographic findings, morphological structure of the aneurysm, calcification in the wall and thrombosis in the sac the effect of on outcome were evaluated.

### Methods

We retrospectively evaluated consecutive cases operated for MCA aneurysm performed by a single surgeon (M.S). (Ethics committee number: 74-2021). Inclusion criteria for the study; rupture and non-rupture MCA aneurysm was detected and microsurgery was applied. Exclusion criteria were those who did not accept surgery for an MCA aneurysm and had endovascular treatment. Of the cases, 18 presented to the emergency department with symptoms of subarachnoid hemorrhage (SAH) that developed after rupture of the aneurysm. Incidental MCA aneurysm was detected on MRI in 2 patients who presented to the outpatient clinic with headache. In cases of SAH and incidental detection of MCA aneurysm, computed tomographic angiography and/or digital subtraction angiography were used to evaluate the morphology and location of the aneurysm (Fig. 1). We measured and recorded the largest width and height values of the aneurysm sac. Patients who presented following SAH were admitted to the intensive care unit.

### Statistical analysis

Statistical analysis was performed using the SPSS version 25.0 for Windows (Armonk, NY: IBM Corp.). The normality of the distribution of the data was analyzed by the Shapiro Wilk test. The relationship between variables was evaluated using the Spearman correlation analysis. The results were presented as numbers (percentages) and mean  $\pm$  standard deviation. Results with a p value less than 0.05 were considered statistically significant.

### Results

The cases comprised 12 women and 8 men. The mean age was  $53.2 \pm 12.9$ , with the youngest and the oldest patient being 14 and 70 years old, respectively. The bilateral MCA aneurysm was found in 3 cases with SAH (Fig. 2). Morphologically; 17 aneurysms

were small in size (smaller than 15 mm), one aneurysm was large ( $20 \times 23$  mm), 2 aneurysms had a giant size ( $48 \times 34$  mm and  $30 \times 34$  mm) and partial thrombosis, and 2 aneurysm walls had calcified. Clinical, radiological, intraoperative findings, postoperative morbidity, and Glasgow outcome scale (GOS) at 3 months are shown in Table-1. Emergency surgery was performed in one patient with a large temporal hematoma. Other patients were operated under the earliest elective conditions to prevent the possibility of re-bleeding.

### Surgical treatment:

ECG, invasive artery and central catheters were used in each patient for intraoperative anesthesia monitoring during aneurysm surgery. Pental was used for providing neuroprotection in cases where temporary clips were used. Surgery was performed in the form of classical pterional craniotomy in cases with thrombosed giant aneurysm and hematoma, and in the form of osteoplastic pterional craniotomy in uncomplicated cases. The patient was laid in the supine position and induced general anesthesia. Next, the head was fixed in a head holder and rotated approximately 30–45 degrees to the opposite side and a pterional skin incision was performed such that the malar eminence was in the uppermost position. The dura was opened with a C-shaped incision and topped to the front side. Then, starting from the medial Sylvian fissure and leaving the vein group on the temporal side, dissection was performed from the frontal side to reach the internal carotid artery bifurcation. Later, after M1 was prepared for proximal control, the aneurysm was dissected distally and the aneurysm was clipped using a temporary clip when necessary (Fig. 3). Thrombectomy was performed in cases where the aneurysm was thrombosed. After clipping, the proximal and distal MCA branches were checked with a micro-Doppler probe, and papaverine-impregnated gel sponges were placed in the vascular bed. The dura was sealed watertight, and then primary closure was performed of the other layers. In patients with bilateral aneurysm, a second surgery was performed one month later for non-rupture contralateral MCA aneurysm.

**Table-1:** Patient demographics, characteristics of the aneurysms, and clinical outcomes.

No	Age (years)	Gender	Side	Size (mm)	Calcification on / Thrombosis	Localization	Hunt&Hess	SAH	GOS 3 <sup>rd</sup> month	Morbidity
1	70	Female	Left	8x4	-	Bifurcation	Grade 1	-	5	-
2	57	Female	Left	7x5	-	Bifurcation	Grade 1	+	5	-
3	14	Female	Right	5.5x4	-	M3	Grade 1	+	5	-
4	63	Female	Right	5.8x7.7	-	Bifurcation	Grade 1	+	5	-
5	65	Female	Right	6.5x5.1	-	Bifurcation	Grade 1	+	5	-
6	70	Female	Right	7x6	-	Bifurcation	Grade 1	-	5	-
7	54	Female	Right	11x10	Calcification	Bifurcation	Grade 1	+	4	Left hemiparesis
8	53	Male	Left	7.3x4.9	Calcification	Bifurcation	Grade 1	+	4	Right hemiparesis
9	54	Male	Bilateral	6.5x4 R	3.3x2.2 L	- Bifurcation	Grade 2	+	5	-
10	60	Female	Bilateral	6x5 R	6.4x4.5 L	- Bifurcation	Grade 2	+	5	-
11	35	Female	Left	5.2x5	-	Bifurcation	Grade 2	+	5	-
12	62	Male	Left	6.3x4	-	Bifurcation	Grade 2	+	5	-
13	43	Female	Right	4.1x4	-	M2	Grade 2	+	5	-
14	52	Male	Bilateral	5.2x3.4 R	1.6x1.3 L	- Bifurcation	Grade 2	+	5	-
15	63	Male	Right	48x34	Thrombosis	Bifurcation	Grade 3	+	5	Hydrocephaly
16	43	Male	Right	6x4	-	Trifurcation	Grade 3	+	5	-
17	45	Female	Left	30x34	Thrombosis	Bifurcation	Grade 3	+	5	Aphasia
18	35	Male	Right	20x23	-	Bifurcation	Grade 3	+	1	Fatal
19	63	Female	Right	5.6x4.3	-	Bifurcation	Grade 4	+	5	-
20	56	Male	Right	11.8X10	-	Bifurcation	Grade 5	+	1	Fatal

GOS: Glasgow outcome scale; L: left; R: right; SAH: subarachnoid hemorrhage.

### Surgical Outcomes:

In a total of 20 patients, 23 MCA aneurysms were clipped. One patient with a wide hematoma and Hunt & Hess stage 3 died due to vasospasm, and another patient with a large aneurysm (size 11.8 × 10 mm) and Hunt & Hess stage 5 died due to vasospasm-related ischemic causes. In our case of giant thrombosed aneurysm located in the left MCA, transient aphasia resolved in the third month. Hydrocephalus developed during the first postoperative month in the other case with giant thrombosed MCA aneurysm. The hydrocephalus was treated with a ventriculoperitoneal (VP) shunt. Hemiparesis developed in 2 patients with MCA aneurysm with a calcified part. Both patients were able to mobilize without aid 3 months later with the support of physical therapy. In the study, the total mortality rate was 10% and morbidity rate was 20% in MCA aneurysms. The relationship between the

demographic characteristics of the patients, the radiological characteristics of aneurysms, and the surgical outcomes are presented in Table-2. Age and SAH incidence were found to be negatively correlated in the cases. ( $r = -0.490$ ;  $p = 0.018$ ) It was observed that Hunt & Hess stages were higher ( $r = 0.433$ ;  $p = 0.039$ ) in the male gender. As the measured values of width and length of aneurysms increased, the incidence of calcification or thrombosis within the aneurysm increased ( $r = 0.571$ ,  $p = 0.004$  for width;  $r = 0.498$ ,  $p = 0.016$  for height) and GOS scores at the 3rd month decreased ( $r = -0.507$ ,  $p = 0.014$  in width;  $r = -0.431$ ,  $p = 0.040$  for height), and mortality and morbidity were more common ( $r = 0.747$ ,  $p < 0.001$  in width;  $r = 0.679$ ,  $p < 0.001$  for height). In addition, the presence of calcification or thrombosis in the aneurysm sac as found to be positive and strongly correlated with mortality and morbidity ( $r = 0.772$ ;  $p < 0.001$ ).

**Table-2:** Correlation coefficients of the variables.

	Male	Right / Left	Width	Height	Calcification / Thrombosis	Hunt&Hess	SAH	GOS 3 <sup>rd</sup> month	Morbidity / Mortality
Age (years)	$r$ -0.239 $p$ 0.273	-0.040 0.855	0.274 0.206	0.194 0.376	-0.052 0.814	-0.246 0.257	-0.490 0.018*	0.223 0.307	-0.172 0.432
Gender (male)	$r$ - $p$ -	0.016 0.944	0.033 0.881	-0.260 0.230	0.060 0.784	0.433 0.039*	0.271 0.212	-0.310 0.149	0.278 0.199
Right / Left	$r$ - $p$ -	- -	-0.067 0.761	-0.251 0.248	0.102 0.643	-0.142 0.518	-0.069 0.755	0.153 0.487	-0.071 0.749
Width (mm)	$r$ - $p$ -	- -	- -	0.759 0.000**	0.571 0.004**	0.077 0.727	-0.221 0.310	-0.507 0.014*	0.747 0.000**
Height (mm)	$r$ - $p$ -	- -	- -	- -	0.498 0.016*	0.107 0.627	0.012 0.958	-0.431 0.040*	0.679 0.000**
Calcification / Thrombosis	$r$ - $p$ -	- -	- -	- -	- -	0.000 1.000	0.142 0.519	-0.341 0.112	0.772 0.000**
Hunt&Hess	$r$ - $p$ -	- -	- -	- -	- -	- -	0.369 0.083	-0.117 0.596	0.292 0.176
SAH	$r$ - $p$ -	- -	- -	- -	- -	- -	- -	-0.141 0.521	0.183 0.402
GOS 3 <sup>rd</sup> month	$r$ - $p$ -	- -	- -	- -	- -	- -	- -	- -	-0.769 0.000**

GOS: Glasgow outcome scale; SAH: subarachnoid hemorrhage. \* $p < 0.05$ ; \*\* $p < 0.01$ .

## Discussion

The most important results of the present study are as follows. It was determined that the incidence of calcification or thrombosis in the aneurysm increased, the GOS scores at the 3rd month decreased, and mortality and morbidity were more common as the measured width and height values of the aneurysms increased. In addition, thrombosis in the aneurysm sac and calcification in the aneurysm wall were found to be positive and strongly correlated with mortality and morbidity.

Surgery for MCA aneurysm has been performed for a long time. While aneurysm occlusion at a rate of above 90% and good results at a rate of 88%–100% after surgery have been reported in nonbleeding aneurysms, results have been variable in bleeding aneurysms. There are still question marks and confusion as to the selection of the treatment method for MCA aneurysms (4). The International Subarachnoid Aneurysm Trial (ISAT) has reported that endovascular treatment is superior in the treatment of ruptured and no ruptured aneurysms (1). Microsurgical treatment comes to the fore in cases where the MCA aneurysms have a wide neck, are of dysmorphic shape, are located in the trifurcation, have MCA branches coming out of their base or body, are easily accessible surgically, and there is hematoma accompanying the ruptured aneurysm (2,4).

Ruptured aneurysms are associated with serious morbidity and mortality rates, around 60% (5,6). In the literature, the mortality rate due to microsurgical clipping ranges from 0.3% to 13% (4,7). In our study, the mortality rate was 10% when evaluated according to the number of patients, and 8.6% when evaluated according to the number of surgeries performed. The rate of major complications in MCA aneurysm surgery is between 2% and 25% (6). In this study, morbidity was 20% based on the number of cases, and 13.0% based on the number of surgeries.

In the present study; thrombosis in the aneurysm sac, large size, and calcification in the aneurysm wall are identified as risk factors leading to morbidity and mortality. In a study by Ulutaş reporting the results of intracranial aneurysm surgery; it was reported that multiple aneurysms, high Hunt & Hess stage, and presence of intracerebral hematoma affected morbidity and mortality (8). In our study, the lack of correlation between high Hunt & Hess stage and morbidity and mortality was attributed to the low number of patients in high stage. Similar to the results of the study by Ulutaş, the Hunt & Hess stage was found to be high in male patients in the present study.

In our series, no mortality or morbidity was observed in patients with multiple aneurysms with bilateral MCA aneurysm. Flamm et al. reported that morbidity is high in complex aneurysms with large size and wide neck, and calcification in the aneurysm wall (9). In our study, calcification of the aneurysm wall was detected intraoperatively in both the patients who developed postoperative hemiparesis. We believe that the difficult and long duration of clip application due to calcification contributed to the development of ischemia and hemiparesis. The patient's condition following aneurysm rupture, presence of calcification in the aneurysm wall, intraluminal thrombus, and surgical accessibility are important in determining the treatment option in MCA aneurysm (10). In addition to evacuation of intraparenchymal hematoma during microsurgical clipping, it also allows decompressive hemicraniectomy when necessary (4,11,12).

The limitations of this study were the limited number of patients since it only included patients with MCA aneurysm and the failure to standardize postoperative intensive care follow-ups because it was not a controlled study.

## Conclusion

In conclusion, large size of the aneurysm, presence of thrombosis in the aneurysm sac, and calcification in the aneurysm wall were found to be positive and strongly correlated with mortality and morbidity.

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