

Clinical Characteristics and Surgical Treatment of Patients with Distal Middle Cerebral Artery Aneurysms

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ABSTRACT

Objective : Middle cerebral artery (MCA) aneurysm is a common source of aneurysmal subarachnoid hemorrhage, but distal MCA aneurysms are rare. This present study was conducted to evaluate the clinical characteristics of the distal MCA aneurysms and the optimal treatment for a good outcome. **Methods :** Among 3323 patients underwent aneurysmal surgery from 1975 to 2007, 21 patients with distal MCA aneurysm was identified. The clinical, radiological and operative records of 21 patients with distal MCA aneurysms who underwent surgical management were reviewed retrospectively. The clinical outcomes were evaluated according to the Glasgow Outcome Scale. **Results :** The clinical analyses of 21 patients with distal MCA aneurysms has following characteristics. (1) Mean aneurysm size of 5.3mm (range 2-8mm). (2) All lesions were considered to be saccular except one case. (3) The location being M2 in one patient, M2-3 junction in 12, M3 in 3, and M4 in 5 patients. (4) In 7 of 21 patients, initial CT scan revealed intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH). (5) All patients underwent surgical treatment for aneurysm; the procedures were clipping in 17 patients, trapping in 2 patients, trapping and end-to-end anastomosis in 1 patient, and direct vessel suture in 1 patient. (6) All patients without ICH had a good recovery. However, the patient with ICH had a different prognosis. Of the 7 patients with ICH, 4 patients had a good recovery and 2 patients had a moderate disability. 1 patient died due to severe brain swelling. **Conclusion :** The patients with distal MCA aneurysm were relatively young, and there was no female predominance. The aneurysms have high rates of cardiac problems such as infective endocarditis or mitral valve prolapse, attributing to be developed infectious aneurysm. Ruptured distal MCA aneurysms are rare and can cause life-threatening ICH with SAH. However, the appropriate surgical treatments can obtain a favorable outcome. (Kor J Cerebrovascular Surgery 10(3):508-512, 2008)

KEY WORDS : Intracranial aneurysm · Middle cerebral artery · Subarachnoid hemorrhage · Surgical treatment

Introduction

Middle cerebral artery (MCA) aneurysm is a common source of aneurysmal subarachnoid hemorrhage (SAH). Because ruptured distal MCA aneurysms are rare,

constituting 1.1% to 5% of MCA lesions, there are few reports about ruptured distal MCA aneurysms and the clinical characteristics and management outcome is not obvious.^{3,8,11)} Some authors reported that ruptured distal MCA aneurysms cause poor outcomes due to the combination of SAH and intracerebral hemorrhage (ICH).⁵⁾ Even with successful aneurysm occlusion, an ICH can result in a life-threatening situation due to direct mass effect or aggravation of brain swelling. Therefore, the present study was conducted to evaluate the clinical characteristics of the distal MCA aneurysms and the optimal treatment for a good outcome.

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Patients and Methods

From September 1975 through March 2007, there were 3323 patients with intracranial aneurysms treated surgically at our institution. Among these patients, there were 627 patients (18.9%) with a MCA aneurysm. Twenty one of 627 patients (3.3%) were identified to have distal MCA aneurysms according to the classification of Gibo et al.²⁾ Their locations were the M2 (insular segment), M2-3 junction, M3 (opercular segment), and M4 (cortical segment). There were 11 male and 10 female and the mean age was 41.9 years (range from 13 to 64 years).

Medical records and radiological imaging studies such as CT and cerebral angiography of the 21 patients were reviewed retrospectively. The preoperative neurological status was assessed using the Hunt-Hess (H-H) grade and the preoperative radiological status was evaluated using Fisher classifications.

All patients with a distal MCA aneurysm underwent craniotomy via a pterional approach. After dural opening, aneurysm dissection was carefully performed via a transsylvian or transcortical approach. Temporary clipping

of parent artery was performed intentionally because of a high risk of premature when adhesions of the aneurysm to the surrounding blood vessels or brain tissue. Direct aneurysmal clipping should be done if possible, but in case of high risk of parent artery occlusion, trapping and subsequent anastomosis was performed. The blood flow of the distal MCA was inspected before and after the aneurysm was clipped by using intraoperative microvascular Doppler. Postoperatively, the patients were managed in the neurosurgical intensive care unit in the special attention of vasospasm and increased intracranial pressure (IICP).

The outcomes, at the time of discharge and follow-up, were recorded using the Glasgow Outcome Scale (GOS) as a good recovery, moderate disability, severe disability, vegetative state or death. A good clinical outcome included patients with good recovery or moderate disability and a poor outcome in patients with severe disability, a vegetative state or death.

Results

There were 11 male and 10 female and the mean age was 41.9 years (range from 13 to 64 years). One aneurysm was

Table 1. Clinical summary of 21 patients who suffered for distal middle cerebral artery aneurysms

| | Sex/Age | H-H | Fisher | ICH(cc) | Location | Size (mm) | Shape | Operation | GOS |
|----|---------|-----|--------|---------|----------|-----------|----------|--------------------------|------|
| 1 | F/52 | 2 | 3 | | R.M2-3 | 6.0 | Saccular | Clipping | GR |
| 2 | F/35 | 3 | 4 | 45 | L.M4 | 7.0 | Fusiform | Trapping | GR |
| 3 | M/23 | 3 | 4 | 25 | R.M4 | 3.2 | Saccular | Clipping | GR |
| 4 | F/64 | 3 | 4 | 10 | R.M2-3 | 5.0 | Saccular | Clipping | GR |
| 5 | F/13 | 5 | 4 | 35 | R.M4 | 6.0 | Saccular | Clipping | GR |
| 6 | M/38 | 3 | 1 | | L.M3 | 5.0 | Saccular | Trapping and anastomosis | GR |
| 7 | M/30 | 2 | 2 | | L.M2-3 | 5.0 | Saccular | Clipping | GR |
| 8 | M/37 | 3 | 3 | | L.M2-3 | 5.0 | Saccular | Neck open and suture | GR |
| 9 | M/40 | 2 | 2 | | R.M2-3 | 8.0 | Saccular | Clipping | GR |
| 10 | F/40 | 2 | 2 | | R.M2 | 3.0 | Saccular | Clipping | GR |
| 11 | M/48 | 1 | 1 | | R.M4 | 6.0 | Saccular | Trapping | GR |
| 12 | M/29 | 4 | 4 | 44 | R.M3 | 8.0 | Saccular | Clipping | MD |
| 13 | F/55 | 3 | 3 | | L.M2-3 | 5.0 | Saccular | Clipping | GR |
| 14 | F/43 | 4 | 2 | | R.M2-3 | 3.0 | Saccular | Clipping | GR |
| 15 | M/47 | 2 | 2 | | R.M2-3 | 5.0 | Saccular | Clipping | GR |
| 16 | F/36 | 4 | 4 | 36 | R.M4 | 5.0 | Saccular | Clipping | MD |
| 17 | F/39 | 1 | 1 | | L.M2-3 | 5.0 | Saccular | Clipping | GR |
| 18 | M/57 | 4 | 4 | 55 | L.M2-3 | 3.0 | Saccular | Clipping | Dead |
| 19 | M/33 | 2 | 2 | | R.M3 | 2.0 | Saccular | Clipping | GR |
| 20 | M/61 | 2 | 3 | | L.M2-3 | 6.0 | Saccular | Clipping | GR |
| 21 | F/60 | 3 | 2 | | R.M2-3 | 4.0 | Saccular | Clipping | GR |

GOS : Glasgow Outcome Scale, GR ; Good recovery, MD ; Moderate disability.

located in the M2 segment, 12 at the M2-3 junction, three in the M3 segment, and five in the M4 segment (Fig. 1). The preoperative clinical and radiological findings are listed in Table 1. The initial H-H grades were variable; Grade 1 in 2 patients, Grade 2 in 7 patients, Grade 3 in 7 patients, Grade 4 in 4 patients, and Grade 5 in 1 patient. The initial Fisher grades were as follows; Grade 1 in 3 patients, Grade 2 in 7 patients, Grade 3 in 4 patients, and Grade 4 in 7 patients. In Fisher Grade 4, the mean volume of the ICH was 35.7mL (range from 10 to 55mL). The insular cortex was mostly affected and temporal rather than frontal lobe hematoma was also observed. The aneurysm sizes ranged from 2 to 8mm (mean 5.3mm). There was no statistical correlation between aneurysm size and volume of ICH. The shape of all aneurysms was saccular except one that was fusiform.

Sixteen patients had true aneurysm and 5 patients had infectious one. Among 5 infectious aneurysms, 3 patients were associated with cardiac problems such as infective endocarditis or mitral valve prolapse. There was no experience of preoperative rebleeding in all patients.

All patients underwent surgical treatment for aneurysm; the procedures were clipping in 17 patients, trapping in 2 patients, trapping and end-to-end anastomosis in 1 patient, and direct vessel suture in 1 patient. In patients with ICH, three patients underwent hematoma removal via a transylvian approach and remainder via a transcortical approach. All patients without ICH had a good recovery. However, the patient with ICH had a different prognosis. Of the 7 patients with ICH, 4 patients had a good recovery and 2 patients had a moderate disability. 1 patient died due to severe brain swelling.

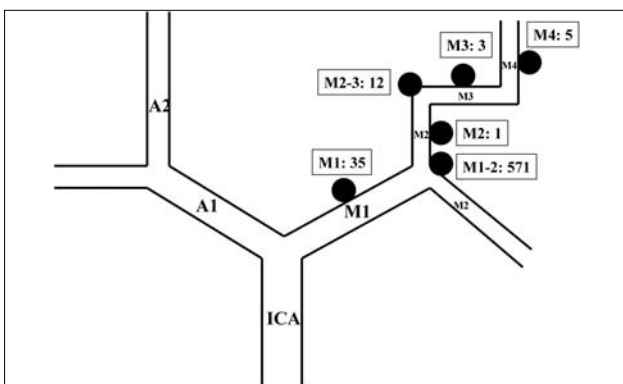


Fig. 1. Diagram shows the location of 627 ruptured MCA aneurysms. The numbers indicate the number of aneurysms in each location according to Gibo.

Illustrative cases

Patient 2 (Fig. 2). This 35-year-old female patient admitted to our hospital with sudden, severe headache and dizziness. The initial CT scan revealed SAH, ICH and IVH, which meant Fisher Grade IV. The angiography demonstrated a fusiform aneurysm at the left M4 segment. Her electrocardiography showed abnormal pattern, so echocardiogram was performed and it revealed mitral regurgitation, mitral valve prolapse and bacterial vegetation in the left atrium. She underwent aneurysmal trapping and the outcome was good.

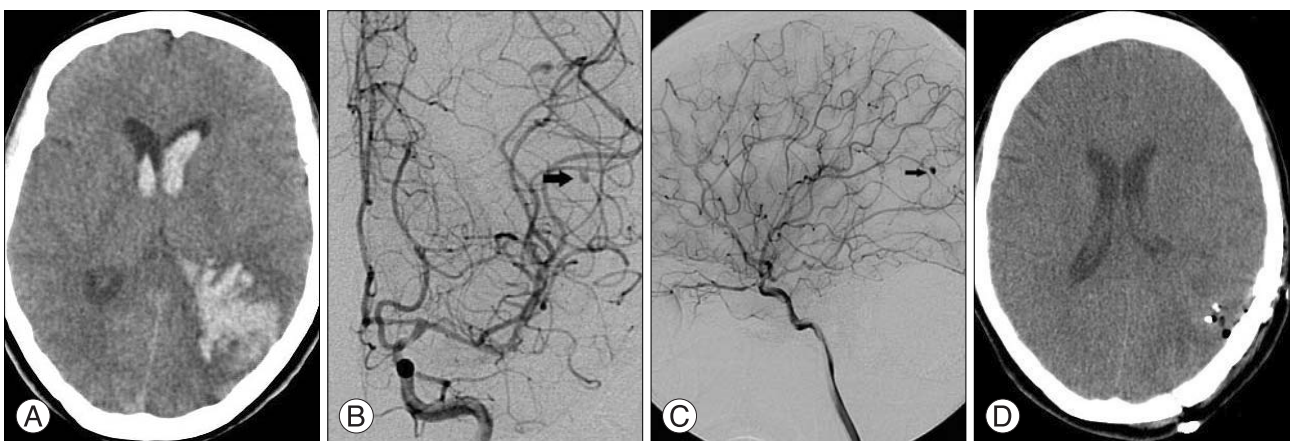


Fig. 2. Patient 2. (A) Preoperative CT scan demonstrates intracerebral hemorrhage on the left temporo-parietal lobe with intraventricular hemorrhage. Cerebral angiography (B: antero-posterior view, C: lateral view) reveal a fusiform aneurysm (arrow) at the left M4 segment. (D). After trapping of the aneurysm, CT scan demonstrates complete removal of the ICH.

Patient 3 (Fig. 3). This 23-year-old male patient was admitted with left hemiparesis and dysarthria. He diagnosed a mitral regurgitation 1 year ago. The initial CT scan revealed right frontal subcortical ICH. The angiography demonstrated right M4 saccular aneurysm. With transcortical approach, the aneurysm was clipped successfully and the outcome was good, so that the left hemiparesis and dysarthria improved.

Discussion

Since Poppen⁷⁾ first reported the distal MCA aneurysm in 1951, there have been some literatures about this lesion. Because cerebral aneurysms usually arise at the primary bifurcation or trifurcation due to hemodynamic stress or congenital factors, ruptured distal MCA aneurysms are uncommon. The incidence of distal MCA aneurysms ranged from 1.1 to 5% in previously reported studies. In our study, there are 21 patients with distal MCA aneurysms out of 3323 patients with ruptured aneurysms, and the incidence is 0.63%. The patients were relatively young, and there was no female predominance.

The patients with saccular aneurysm underwent clipping of aneurysmal neck, and if the aneurysm was located at cortical segment and fusiform or if the patient artery was too small to clip, the artery was trapped. In one patient with aneurysm located at M3 segment, the aneurysm was so fragile, that the artery including the aneurysm was trapped

and end-to-end anastomosis was performed. There was another fragile aneurysm located at M2-3 junction, the neck was opened in attempting clipping. So it was sutured directly.

The causes of distal MCA aneurysms are not clear, but it has been reported that infectious aneurysms were one of the distal cerebral artery aneurysm formation.^{6,10)} And other causes were head trauma and neoplastic emboli such as cardiac myxoma.^{1,4,6,9)} In our study, although we did not perform biopsy, there were 5 patients suggesting infectious aneurysms according to their clinical history such as mitral valve prolapse or infective endocarditis.

Eighteen patients had a good recovery, two had moderate disability and one patient died. This result of our study is more favorable than one of previous studies. Rinne, et al.⁸⁾ and Joo et al.⁵⁾ reported unfavorable outcomes, and the causes of poor outcomes were accompanied ICH and severe brain swelling. However, Horiuchi et al.³⁾ reported good outcomes and it is similar with our outcomes. Seven of the 21 patients suffered from ICH (33.3%), which contributed to poor initial Hunt-Hess grade. The mean H-H grade of the patients with ICH was 3.71, in contrast, the one of the patients without ICH was 2.28. In cases with ICH, the outcomes were poorer than that without ICH. Rinne et al.⁸⁾ reported that ICH developed easily in patients with distal MCA aneurysms. In the patients with ruptured MCA aneurysms, the incidence of ICH is up to 44%. Because ICH can result in a life-threatening situation due to a mass effect

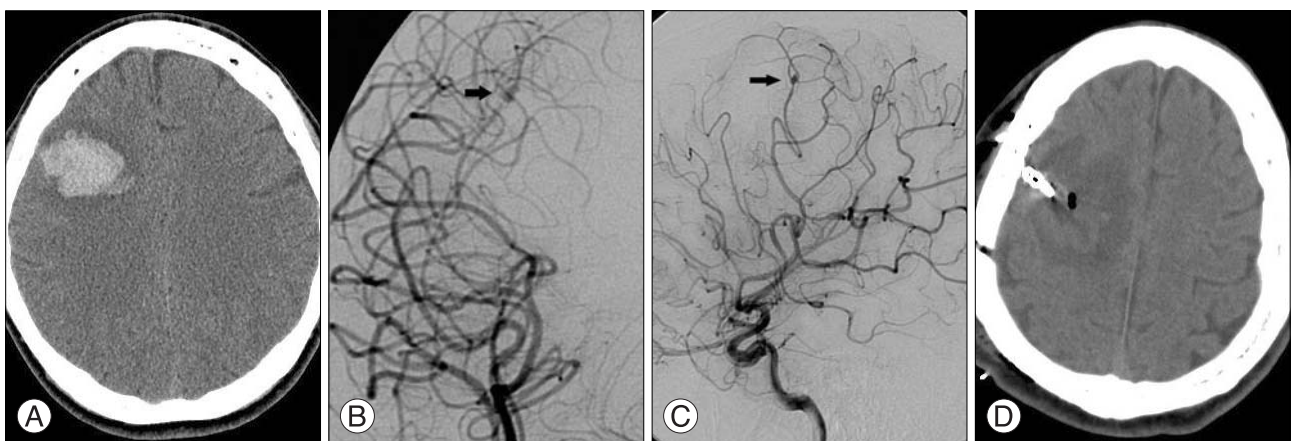


Fig. 3. Patient 3. (A) Preoperative CT scan shows intracerebral hemorrhage on the right frontal lobe. Cerebral angiography (B: antero-posterior view, C: lateral view) reveal a saccular aneurysm (arrow) at the left M4 segment. (D) After clipping of the aneurysm, CT scan demonstrates complete removal of the ICH.

or brain swelling, immediate surgical removal of ICH with aneurysm obliteration is necessary for a better clinical outcome.

In the patients with SAH or accompanied ICH, the exact locations of aneurysm and parent artery are not easy to find out. Although we did not use an intraoperative neuroimaging modality, intraoperative angiography or neuro-navigation system enables to identify a distal MCA aneurysm and its parent artery. And evacuation of intracerebral hematoma is essential to obtain an enough operative field, but the evacuation of ICH should be performed with care. Because the aneurysmal direction is pointing toward the hematoma cavity, premature rupture of aneurysm might be happened.

Conclusions

The patients with distal MCA aneurysm were relatively young, and there was no female predominance. The aneurysms have high rates of cardiac problems such as infective endocarditis or mitral valve prolapse, attributing to be developed infectious aneurysm. Ruptured distal MCA aneurysms are rare and can cause life-threatening ICH with SAH. However, the appropriate surgical treatments can obtain a favorable outcome.

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