Fully Endoscope-Controlled Clipping Bilateral Middle Cerebral Artery Aneurysm Via Unilateral Supraorbital Keyhole Approach

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Abstract: Clipping bilateral middle cerebral artery (bMCA) aneurysms via unilateral approach in a single-stage operation is considered as a challenge procedure. To our knowledge, there is no study in surgical management of patients with bMCA aneurysms by fully endoscope-controlled techniques. The author reported a patient with bMCA aneurysms who underwent aneurysms clipping via a unilateral supraorbital keyhole approach by endoscope-controlled microneurosurgery, and the patient had an uneventful postoperative course without neurologic impairment and complication. Furthermore, the author discussed the advantages and adaptation of endoscope-controlled clipping bMCA aneurysms via unilateral supraorbital keyhole approach.

Key Words: Bilateral middle cerebral artery aneurysms, endoscope-controlled microneurosurgery, supraorbital keyhole approach

METHODS

Patient

A previously healthy 62-year-old male presented with a 9-day history of severe headache and vomiting. On admission, his neurologic examination was normal, except for a stiff neck. The patient was judged clinically to be Hunt and Hess grade I. The brain computed tomography (CT) revealed subarachnoid hemorrhage (SAH) prominently occupying the right sylvian fissure and suprasellar cisterns. Cerebral Angio-CT revealed 2 aneurysms arising from the bMCA bifurcations (Fig. 1A). The CT and Angio-CT findings indicated that the right MCA aneurysm was probably responsible for the SAH. A decision of clipping aneurysms was made to operate the patient.

Operation Procedure

A standard right supraorbital keyhole approach with small posterior extension for frontobasal lateral burr hole is used for bMCA aneurysm clipping. The patient is positioned supine, and the head fixed in a Mayfield frame is slightly titled backward and rotated 20° away from the right side. Mannitol is administered at the start of the operation for brain relaxation. An approximately 5-cm skin incision was made in the upper half of right eyebrow starting from the midpupillary line to behind the frontal process of the zygomatic bone. The temporalis muscle was cut approximately 1.5 cm in the lateral part of the incision, and exposed for a frontobasal lateral burr hole posterior to the temporal line. The minicraniotomy (approximately 3 × 3 cm) is performed in the frontal bone. The dura is then opened in a curved fashion with its base toward the roof of orbital providing a 2.5 cm opening. With the use of a narrow brain spatula, the right frontal lobe was gently retracted. To avoid frontal lobe contusion spatula creeping technique was adopted until the optic nerve, chiasmatic, lamina terminalis, and internal carotid artery (ICA) cistern are encountered, at which point the cisterns are opened to achieve brain relaxation and frontal lobe retraction. The 30° endoscope was then placed along the bottom of frontal lobe, and fixed by a holding device allowing bimanual manipulation during the surgical procedure. Subsequently, arachnoid attachments between the frontal lobe and olfactory nerve are dissected to avoid postoperative anodinia. After the right ICA and sylvian cisterns are opened, the right ICA bifurcation was identified, and then dissection is continued by following M1 until the right aneurysm was encountered. After careful dissection of aneurysm neck free of adhesions to the surrounding vascular and neural structures, the right aneurysm was clipped (Fig. 2A-B). During this procedure the angle of endoscopy was multiplied adjusted to avoid wrong clipping. Afterward, the endoscopy was adjusted to the left side and anterior communicating artery complex and the left optic nerve was identified, and the dissection is continued to contralateral ICA bifurcation by following the contralateral A1 segment. The left ICA and sylvian cisterns are then opened, and finally the contralateral M1 segment is identified. Dissecting along the M1 from medial to lateral direction, the left aneurysm and
The procedure of clipping bMCA aneurysms: (A) intraoperative picture of the right sylvian cisterns dissection, (B) intraoperative picture of clipping the right aneurysm, (C, D) contralateral progression of the dissection the left ICA bifurcation and sylvian fissure, (E) intraoperative picture of clipping the right aneurysm, and (F) intraoperative picture of clipping the right aneurysm. A1, anterior cerebral artery; Car. A., internal carotid; M1, 2, middle cerebral artery segment M1, 2; Optic. N., optic nerve.

FIGURE 2. The procedure of clipping bMCA aneurysms: (A) intraoperative picture of the right sylvian cisterns dissection, (B) intraoperative picture of clipping the right aneurysm, (C, D) contralateral progression of the dissection the left ICA bifurcation and sylvian fissure, (E) intraoperative picture of clipping the right aneurysm, and (F) intraoperative picture of clipping the right aneurysm. A1, anterior cerebral artery; Car. A., internal carotid; M1, 2, middle cerebral artery segment M1, 2; Optic. N., optic nerve.

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FIGURE 1. Angio-CT of pre- and postoperation: (A) cerebral Angio-CT revealed 2 aneurysms arising from the bMCA bifurcations, and (B) postoperative Angio-CT confirmed good occlusion of the bilateral aneurysms.

the 2 M2 branches were visualized. The aneurysm was clipped without temporal clipping of the M1 (Fig. 2C-F).

Postoperative Management
The patient was admitted to intensive care unit for the first 24 hours after operation. Calcium channel blockers (Nimodipine) had been given at 4 mL per hour via venous pump, and 3H therapy (hypertension, hypervolemia, and hemodilution) was adopted to elevate systolic blood pressure to 150 to 160 mm Hg, to maintain intravenous infusion volume 200 mL per hour, and to keep hematocrit ≤35%. The patients underwent brain CT examination after anesthetic recovery, and postoperative Angio-CT 5 days after operation.

RESULTS
Surgical procedure was uneventful, and the patient had an excellent postoperative course without neurologic impairment and complication. Postoperative Angio-CT confirmed good occlusion of the bilateral aneurysms (Fig. 1B). The patient was discharged home in good condition 2 weeks later.

DISCUSSION
Cerebral aneurysms occur with an incidence of 1/10,000 per year. Approximately 7% to 34% of the patients harbor multiple intracranial aneurysms, and the aneurysms are bilateral in 20% to 40% of these patients.\(^1,16\) The incidence of bMCA aneurysms aneurysms has been reported approximately 1% of all intracranial aneurysms.\(^6\) Middle cerebral artery aneurysms are generally not suitable for endovascular treatment, due to their often complex configuration and/or broad neck. Therefore, surgical treatment is still the first choice in many patients with MCA aneurysms. The bilateral craniotomies are traditional therapies to clip those aneurysms. The contralateral approach can be considered as a useful procedure to clip bMCA aneurysms; its use is not widely spread because of technical difficulty, the long dissecting distance, limiting view, and impaired the brain tissue. Oshiro et al\(^14\) previously described the contralateral exposure for the most common sites of anterior circulation aneurysms. Several authors have reported clipping of bilateral aneurysms via unilateral craniotomy successfully in case series and clinical reports.\(^12,15,16\)

Surgical management of bMCA aneurysms is still controversial and considered a challenge procedure, although clipping all aneurysms in a single-stage operation is more preferred.\(^5,5\) The unilateral approach presents some important advantages comparing 1- or 2-stage operations: avoiding a second craniotomy, shorter operation time, shorter hospitalization, reducing the cost of treatment, and less cosmetic defect due to single craniotomy. In addition, the most important advantage of 1-stage operation is elimination of the risk of rebleeding from unruptured aneurysms, due to 3H treatment for vasospasm may carry a potential risk of rupturing an untreated aneurysm in the postoperative period.\(^17\)

The recent keyhole approaches have been made possible by technological advances such as by three-dimensional CT angiography guidance, by the use of endoscopes, and by the manufacturing of dedicated microsurgical instruments. The supraorbital keyhole approach is a minimally invasive approach, and both the ipsilateral and contralateral MCA aneurysms can be approached from proximal to distal. The side of approach was preferentially chosen as the side of the suspected bleeding source in all patients with SAH, in patients without SAH it was based on morphologic characteristics but not on speech dominance.\(^13\) Factors for successful clipping of the contralateral aneurysm are as follows: the severity of cerebral edema, total length of the contralateral (A1 + M1) segments, configuration of the contralateral aneurysm, contralateral ICA bifurcation angle, and projection of the contralateral aneurysm.\(^18\)

Compared with microscope in bMCA aneurysms clipping via supraorbital keyhole approach, with the endoscope better visualization and ability to operate freely on the contralateral anterior cerebral artery, ICA, M1, and origin of M2 were achieved. The direction of the contralateral aneurysm is very important during bMCA aneurysms clipping surgery via supraorbital keyhole approach. Aneurysms pointing inferior are more difficult to clip from the contralateral approach because the MCA regularly covers the neck region of an aneurysm and visualization of the perforating branches is poor. Aneurysms pointing in lateral, anterior, or posterior directions are also more difficult to clip from the contralateral side because further inferior extension of the neck may be difficult to recognize. In these situations endoscope-controlled microneurosurgery help to enhance the pathoanatomic situation.\(^13\) Endoscope-controlled techniques have the following advantages: deep surgical field brightness can be increased and allow pathologic anatomy in a short distance to extend view angle and a clear descriptive. According to surgical need to change the depth the angle of the endoscope, and a different perspective of the endoscope can increase vision information, so as to achieve complete clipping the aneurysm, to avoid the occurrence of mistaken clipping.

Fully endoscope-controlled clipping intracranial aneurysms were rarely reported.\(^19\) In this study, we reported a case of bMCA aneurysms endoscope-controlled clipping via unilateral
supraorbital keyhole craniotomy. We believed that fully endoscope-controlled clipping bMCA aneurysms was a practically feasible method, which combined advantages of both unilateral supraorbital keyhole approaches and endoscopic technology. Because of the limited operative space and relative deep location, the surgery should be performed by experienced neurosurgeons. Fully endoscope-controlled clipping bMCA aneurysms may be a safe and effective application to increase the quality of treatment.

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