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Technical Note

A Modified Mini-Pterional (Subfrontal-Suprapterional) Approach to MCA Bifurcation Aneurysms with Minimal Dissection of the Temporal Muscle

Athanasios K. PETRIDIS*, Suzin JUNG*, Azad CHEKO, Martin SCHOLZ

Sana Kliniken Duisburg, Department of Neurosurgery, Duisburg, Germany

*These authors contributed equally to this work.

ABSTRACT

There are a number of different surgical approaches in middle cerebral artery (MCA) aneurysm surgery. Evolution from the classical pterional approach towards smaller modified approaches took place over the years. In the present report, we describe a new modified approach in the treatment of MCA aneurysms, which is almost exclusively subfrontal.

A modified approach was used on three patients with MCA bifurcation aneurysms. Craniotomy was subfrontal and suprapterional with minimal dissection of the temporal muscle and no drilling of the pterion. In all three cases, after establishing proximal control and dissecting the M1 carefully, retraction of the frontal lobe elevated the sylvian fissure and allowed opening of the fissure. The aneurysm could be identified easily and clips were applied. There was no infection and complete aneurysm clipping was achieved in all 3 patients.

The described minimal craniotomy to the MCA through a subfrontal-suprapterional approach allows dissection of peripheral MCA bifurcation aneurysms without any problems.

KEYWORDS: Pterional approach, Middle cerebral artery aneurysm, Subfrontal approach

INTRODUCTION

There are several approaches for the treatment of Middle Cerebral Artery (MCA) aneurysms. Yasargil´s pterional craniotomy is one of the most frequent surgical approaches used for those purposes (21-23). Besides its common use to treat aneurysms and many other lesions of the brain, this approach has also disadvantages. That includes the reduced safety of retraction of the frontal lobe through a wide-stretched preparation of the sylvian fissure, MCA dissection trauma and broad bone removal with low satisfying cosmetic outcome (17). Another complication could be that the frontalis branch of the facial nerve can be affected through orbitotomy approaches (1,5,9,11,18). There are also disadvantages related to dissection of the temporal muscle. Figueiredo et al. and Caplan et al. reported that the minipterional craniotomy provides comparable surgical exposure to that offered by the pterional craniotomy with less muscle injury. Advantages of the minipterional approach include reduction of tissue trauma and bony removal, a decrease in surgical time, and improved cosmetic outcomes (3,6,7,8,20). The minipterional craniotomy is a worthwhile alternative to the standard pterional craniotomy, which offers similar microsurgical corridors, with a substantially shorter incision, less muscle dissection, and a smaller craniotomy flap (3). Another alternative is provided by Hernesniemi et al. who described the lateral supraorbital approach as an alternative to the classical pterional approach (10).

Corresponding author: Suzin JUNG
E-mail: suzin.jung@sana.de

In terms of the disadvantages of the standard pterional approach, we are forced to develop and improve approach techniques that are less invasive with at least the same optimal microsurgical views needed to treat unruptured MCA aneurysms. In this report, we only dissect the temporal muscle on its attachment to the superior temporal line and remove the bone flap without drilling the pterion.

SURGICAL TECHNIQUE

We performed the reported approach in three patients with unruptured MCA bifurcation aneurysms. We describe the method in the following cases.

The patient is positioned as for the classical pterional approach (rotation of the head 45-60° contralateral, 20° reclined, body elevated 15°). Mannitol (20%, 125 ml) is administered immediately before skin cut. A 5 cm skin cut is performed as shown in Figure 1A, B; and the periosteum is dissected free. It is very important to put two sutures temporarily during surgery on the edges of the skin cuts since strong retraction of the skin could lead to tearing of the skin.

The temporal muscle is identified and only a very small part of the muscle is cut (superior) and dissected (Figure 1 C). Two burr holes are performed and a 2.5 cm craniotomy over the pterion is performed. The pterion is not drilled (Figure 1 D-F).

We show now further microphotographs of the second case of a patient with an MCA bifurcation aneurysm (Figure 2A, B). The frontal lobe is retracted and proximal control by identification and dissection of the carotid artery is established (Figure 3 A-F). We follow the internal carotid artery to its bifurcation, as well as identifying the contralateral carotid artery. Lamina terminalis and basal cisterns are identified and the carotid cistern is opened (Figure 3 E, F). After dissecting the proximal part of the M1 and retracting the frontal lobe the sylvian fissure is identified and opened from proximal to distal (Figure 3G). The MCA could be dissected free (Figure 3H) and the aneurysm, which is in the MCA bifurcation, is easily identified, dissected and clipped (Figure 3 J, K). Clipping of the aneurysm and indocyanin-green (ICG)-angiography followed and showed normal perfusion of the proximal and distal MCA vessels. Intraoperative Doppler sonography was used as well.

DISCUSSION

There are many different approaches to get access to the middle cerebral artery region. The standardized pterional

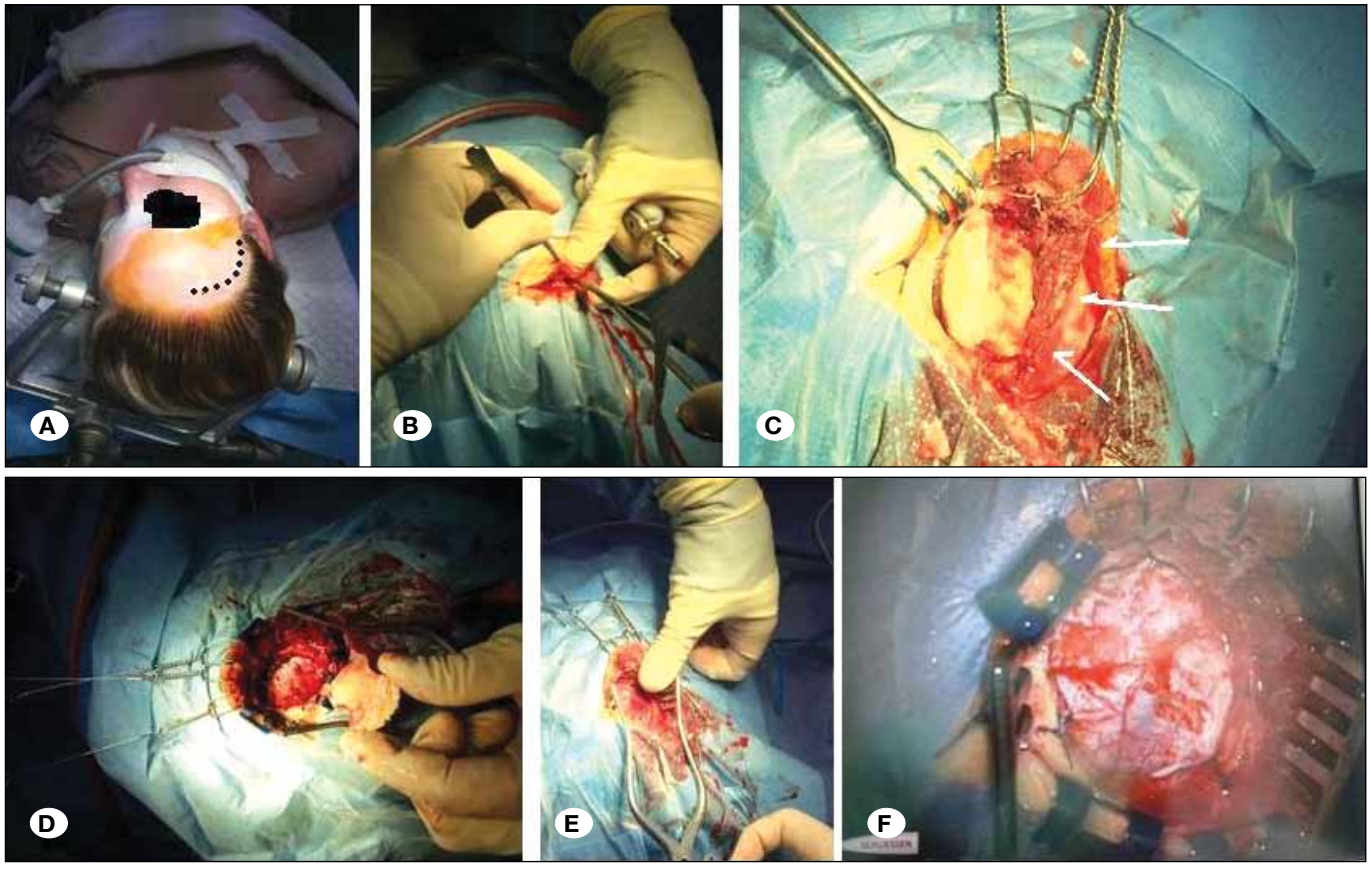

Figure 1: The subfrontal-supraperional approach (Patient 1). **A)** The skin incision is shown with the dotted line. **B)** After application of surgical drapes the skin is incised. **C)** The temporal muscle is only removed on its attachment to the superior temporal line (white arrows). **D)** A small craniotomy is now performed over the pterion and along the superior temporal line as its inferior border. **E)** A skin retractor provides additional exposure of the field. **F)** The dura is now exposed.

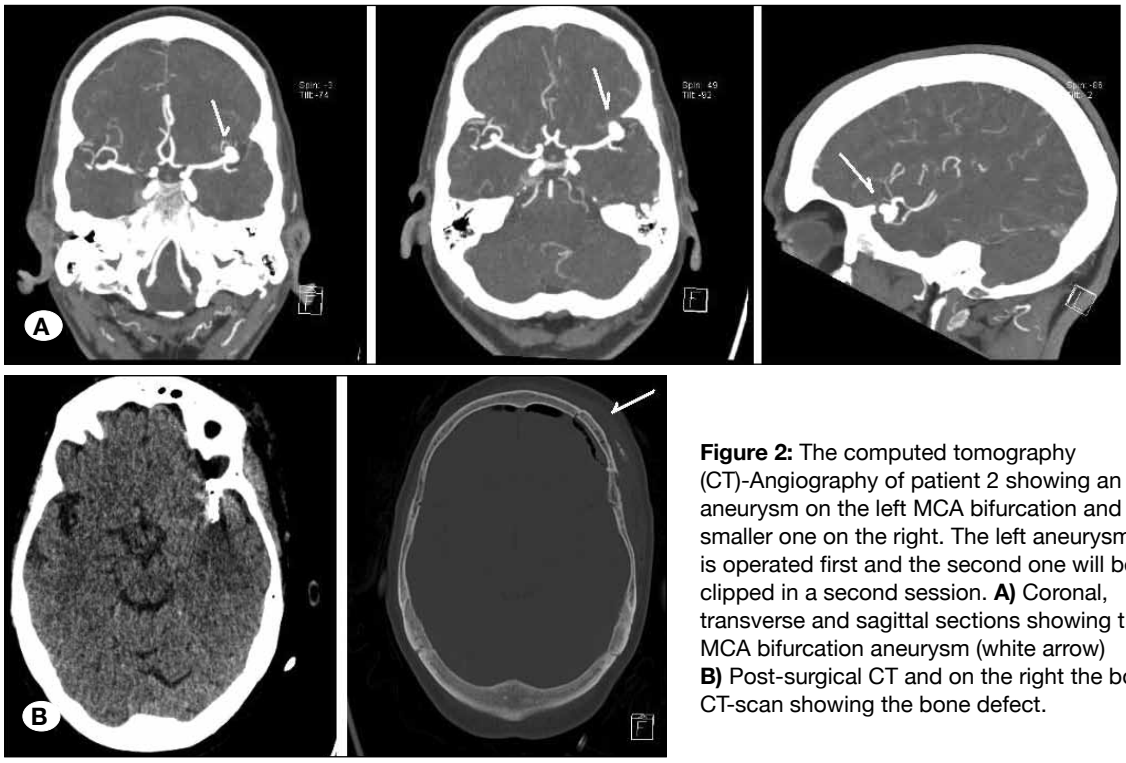

Figure 2: The computed tomography (CT)-Angiography of patient 2 showing an aneurysm on the left MCA bifurcation and a smaller one on the right. The left aneurysm is operated first and the second one will be clipped in a second session. **A)** Coronal, transverse and sagittal sections showing the MCA bifurcation aneurysm (white arrow) **B)** Post-surgical CT and on the right the bone CT-scan showing the bone defect.

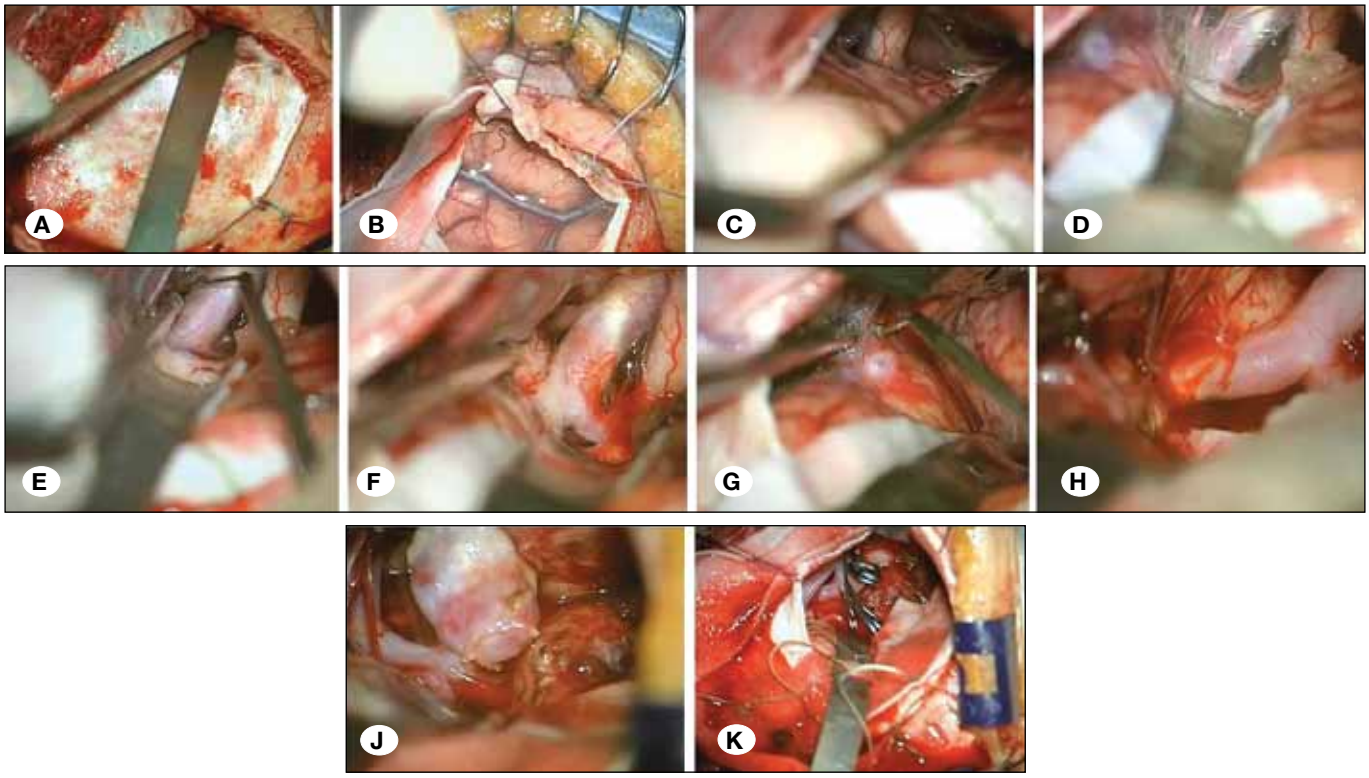

Figure 3: Intraoperative photographs of MCA aneurysm clipping through the subfrontal suprapterional approach. **A)** After craniotomy, the dura can be seen. The retractor is placed under the frontal lobe and the bone at this region is drilled to allow a comfortable subfrontal dissection. **B)** The dura is opened and dura stitches are applied. **C)** Retraction of the frontal lobe and identification of the optic nerve. **D)**The carotid artery is identified. **E)** Opening the carotid cistern relaxes the brain significantly through release of cerebrospinal fluid. **F)** Further dissection of the carotid allows identification of the posterior communicating artery, anterior cerebral artery and MCA. **G)** Proximal opening of the sylvian fissure. **H)** Following the MCA distally. **J)** Aneurysm dissection. **K)** Aneurysm application with 3 clips.

approach is the most popular way to get access to the aneurysms of the medial artery circulation (21-23).

Less invasive with comparable surgical exposure to that offered by the pterional trepanation is the minipterional approach. The advantages of this approach include reduction of tissue trauma and bony removal, a decrease in surgical time, and improved cosmetic outcomes (3,6-8,20).

Brock et al. described 1978 a new approach for the elective microsurgical treatment of aneurysms of the rostral part of the circle of Willis, including those arising from the carotid siphon. This small frontolateral approach is performed through a craniotomy of 3.5 cm in diameter and provides an operation field of 1x1 cm. It is less invasive through a small and merely osteoplastic craniotomy with protection of the sylvian fissure (2).

Transorbital keyhole accesses to anterior circulation aneurysms were also described. It is a small osteotomy that provides more ventral access than the supraorbital approaches, and the complex of the anterior communicating artery can be controlled by preparation of the basal region of the interhemispheric fissure, but it requires additional effort and time (18). Especially the frontalis branch of the facial nerve can be affected through this approaches' techniques (1,5,9,11,18).

Hernesniemi et al. describe another modified approach as a lateral supraorbital approach. This approach is subfrontal anterior and is less invasive as well as fast because of a smaller bone flap, but it is limited for temporal exposure, particularly giant MCA aneurysms and lower positioned basilar tip artery aneurysms, as well as for MCA aneurysms with a large temporo-parietal intracerebral hematoma (10).

Another "minimally invasive" approach to the anterior communicating artery region is called the "modified unilateral subfrontal" approach. It provides bilateral view of bilateral structures, minimized temporal lobe exposure and sylvian fissure dissection, easier access to the interhemispheric fissure and better visualization of superiorly projecting aneurysms and quick access to both A1 vessels when there is no arterial side dominance (17).

In time of quick advance of microsurgical cerebrovascular techniques, neurosurgical approaches have become less invasive. Therefore, keyhole craniotomies have become more popular. They are alternative approaches with minimal invasive surgery towards cerebral aneurysms, which dramatically minimize iatrogenic trauma to normal tissues, and still enable complete obliteration of aneurysms (1,4,14-16,19). Such approaches are the supraorbital keyhole craniotomies (SOKC) and the mini-pterional keyhole craniotomies (MPKC) to name the most commonly used keyhole approaches. Studies of Kang et al. show that the MPKC offers a larger surgical exposure than the SOKC with similar length of skin incision. It supports a direct sylvian approach. An MCA aneurysm is the best candidate for the MPKC. The MPKC provides a wide surgical window and the shortest distance to reach the target. It exposes both the frontal and temporal lobes, and there exists sufficient space for utilization of brain retractors in cases of difficult sylvian dissection. It can be used when treating posteriorly directed internal carotid artery (ICA) terminal aneurysms. The surgical field can be additionally enlarged by proximal sylvian dissection. Kang et al. showed there are superior working angles and depths with the MPKC then the SOKC (12).

The SOKC approach offers a more anteromedial and basal view. The main limitation of this approach is, as described in other studies, the treatment of MCA aneurysms (13,14,16). The trajectory line from the craniotomy window toward the MCA bifurcation is far laterally deviated, and it becomes even worse if the M1 segment is too long. This distorted surgical view is responsible for the narrow working angle. The best indications for this approach are anterior communicating artery aneurysms and laterally directing ICA terminal aneurysms (12).

On the other hand, we were surprised to see how far laterally the MCA can be reached by the minimal approach used in our report. There are cosmetic advantages, since we left the temporal muscle completely intact with exception of a small dissection on its superior border.

Without further mobilization of the muscle, the 2-3 cm (diameter) craniotomy was performed without the need of drilling the pterion that shows also postoperatively a cosmetically superior outcome. There was even enough space to use retractors. The retractor (subfrontal) elevated the sylvian fissure and allowed us to dissect the MCA and the aneurysm. Of course, more peripheral aneurysms, like M3 MCA aneurysms, cannot be approached by the reported technique.

CONCLUSION

We recommend the modified minipterional (subfrontal-suprapterional) approach to the MCA bifurcation to treat MCA aneurysms with a size up to 7 mm. Because of minimal dissection of the temporal muscle and no drilling of the pterion, postoperative cosmetic outcomes are improved, compared to pterional craniotomies. Through this approach, there is a limited view for peripheral aneurysms like M3 MCA aneurysms.

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