Direct Microsurgical Embolectomy for an Acute Distal Basilar Artery Occlusion

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BACKGROUND: **Acute basilar artery occlusion is associated with high mortality rates, up to 35%–40%. Early revascularization by intravenous thrombolysis, intra-arterial thrombolysis, and endovascular mechanical embolectomy is considered the best option to date. The objective of this technical report is to present the direct microsurgical embolectomy technique for an acute distal basilar artery occlusion as an urgent life-saving revascularization procedure.**

METHODS: **A 71-year-old male patient suffered from an acute embolic basilar artery occlusion and became unconscious (Glasgow Coma Scale 4). Computed tomography angiography and MRA revealed the distal basilar artery occlusion along with an increased diffusion-weighted imaging signal in the corresponding territory. After an individual case discussion, the patient underwent a microsurgical embolectomy via a frontotemporal craniotomy and an anterior temporal approach.**

RESULTS: **Intraoperative indocyanine green and postoperative computed tomography angiography revealed complete revascularization of the previously occluded basilar quadfurcation. The patient steadily recovered and was able to walk with assistance after 4 weeks.**

CONCLUSIONS: **Microsurgical embolectomy can be an effective treatment option for acute distal basilar artery occlusion in selected cases with experienced surgeons, but a critical preoperative decision-making process is needed.**

INTRODUCTION

Acute basilar artery occlusion, by arterial embolism or local atherosclerotic occlusion, accounts for less than 1% of ischemic strokes and is associated with a high mortality rate.[1] Because there is a high rate of fatality with time to treatment being the major limiting factor, treatment should be performed in specialized stroke centers.[2] The clinical diagnosis can be aggravated by a variety of symptoms. However, early magnetic resonance imaging with diffusion-weighted imaging (DWI) provides high sensitivity for the detection of ischemic strokes in the anterior and posterior circulation.[3] Intravenous thrombolysis with recombinant human tissue plasminogen activator (rtPA) has a limited effect on basilar artery revascularization within a 4.5-hour window.[4,5] It is because of this limitation that intra-arterial thrombolysis and the endovascular mechanical thrombectomy are used increasingly to achieve basilar artery recanalization even after unsuccessful intravenous thrombolysis.[6-10] However, the best treatment modality has yet to be studied effectively.

Since the first report of an intracranial surgical embolectomy by Welch in 1956,[11] several case series of microsurgical embolectomies in the anterior cerebral circulation have been reported.[12-14] Morgan and Biggs[15] published a case of successful microcoil evacuation from the basilar bifurcation

Key words
- Basilar artery
- Basilar artery occlusion
- Embolectomy
- Ischemic stroke
- Posterior circulation

Abbreviations and Acronyms
CTA: Computed tomography angiography
DWI: Diffusion-weighted imaging
ICG: Indocyanine green
MRA: Magnetic resonance angiography
PCA: Posterior cerebral artery
rtPA: Recombinant human tissue plasminogen activator
SCA: Superior cerebellar artery

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using a longitudinal posterior cerebral artery (PCA) arteriotomy in 1992. To date, there is only one report in the literature of an acute posterior circulation embolic stroke treated by direct microsurgical proximal PCA embolectomy.[16]

The objective of this technical report is to present the microsurgical embolectomy for an acute distal basilar artery occlusion as an urgent life-saving revascularization procedure by the use of a transverse PCA postcommunicating segment arteriotomy from an anterior temporal approach.

MATERIALS AND METHODS

History and Examination

A 71-year-old man was found in his home on the ground unable to walk. The estimated time of stroke was around 5 hours before discovery; this was the last time the patient was seen without symptoms. The patient was transferred to our hospital without delay. In the emergency department, the patient's neurologic examination consisted of only left upper-extremity motor response to a painful stimulus. He was otherwise completely unresponsive with equal pupils that were nonreactive but not dilated. The initial electrocardiogram revealed a new atrial fibrillation. There was no previous history of symptoms for a vertebrobasilar ischemia.

Imaging

The computed tomography angiography (CTA) reconstruction (**Figure 1A**) identified an occlusion of the distal basilar artery with an inflow interruption at the proximal superior cerebellar artery (SCA) and PCA. This distal basilar occlusion is more specific for an embolic occlusion than for atherothrombosis. No calcified atherosclerotic plaques were found at the intracranial vessels on computed tomography/CTA. Preoperative computed tomography perfusion imaging was performed. The infarct penumbra affected the right SCA territory, the midbrain, and the thalamus on both sides. DWI revealed a perfusion defect in the left thalamus (**Figure 1B**). Therefore, the actual affected area was small compared with the estimated territory at risk.

Indication

Emergent revascularization was deemed the only potential life-saving treatment option based on the patient's deteriorating clinical condition and the basilar occlusion with corresponding increased DWI signal. The angiography suite was not available, and the decision was made to perform an open microsurgical embolectomy based on the institutional experience with microsurgical treatment of vascular lesions in the posterior circulation.

Positioning, Craniotomy, and Graft Preparation

The patient was placed in the supine position with the head rotated 30° to the right and secured with a MAYFIELD headholder (Integra, Plainsboro, New Jersey, USA). The head was slightly elevated above the heart. A curved frontotemporal skin incision was performed. The temporal muscle was retracted caudally, followed by a frontotemporal craniotomy.

Intracranial Dissection

After the sphenoid wing subfrontally, the carotid cistern was opened at the level of the posterior communicating artery segment of the internal carotid artery and cerebrospinal fluid was released to obtain more working space. Thereafter, the proximal portion of the Sylvian fissure was dissected carefully and the superficial Sylvian veins were detached from the cortex of the frontal lobe and mobilized towards the temporal lobe. The temporal Sylvian veins were detached from the

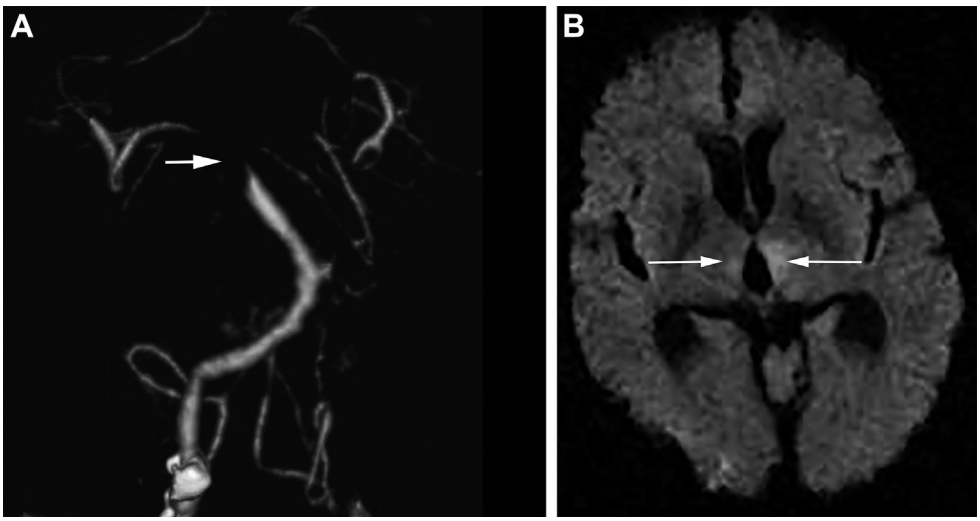

Figure 1. (**A**) The preoperative, 3-dimensional computed tomography angiography shows an occlusion (*arrow*) of the upper basilar artery trunk. (**B**) The preoperative diffusion-weighted imaging (axial) shows a small affected area (*arrows*) in the left posterior thalamus.

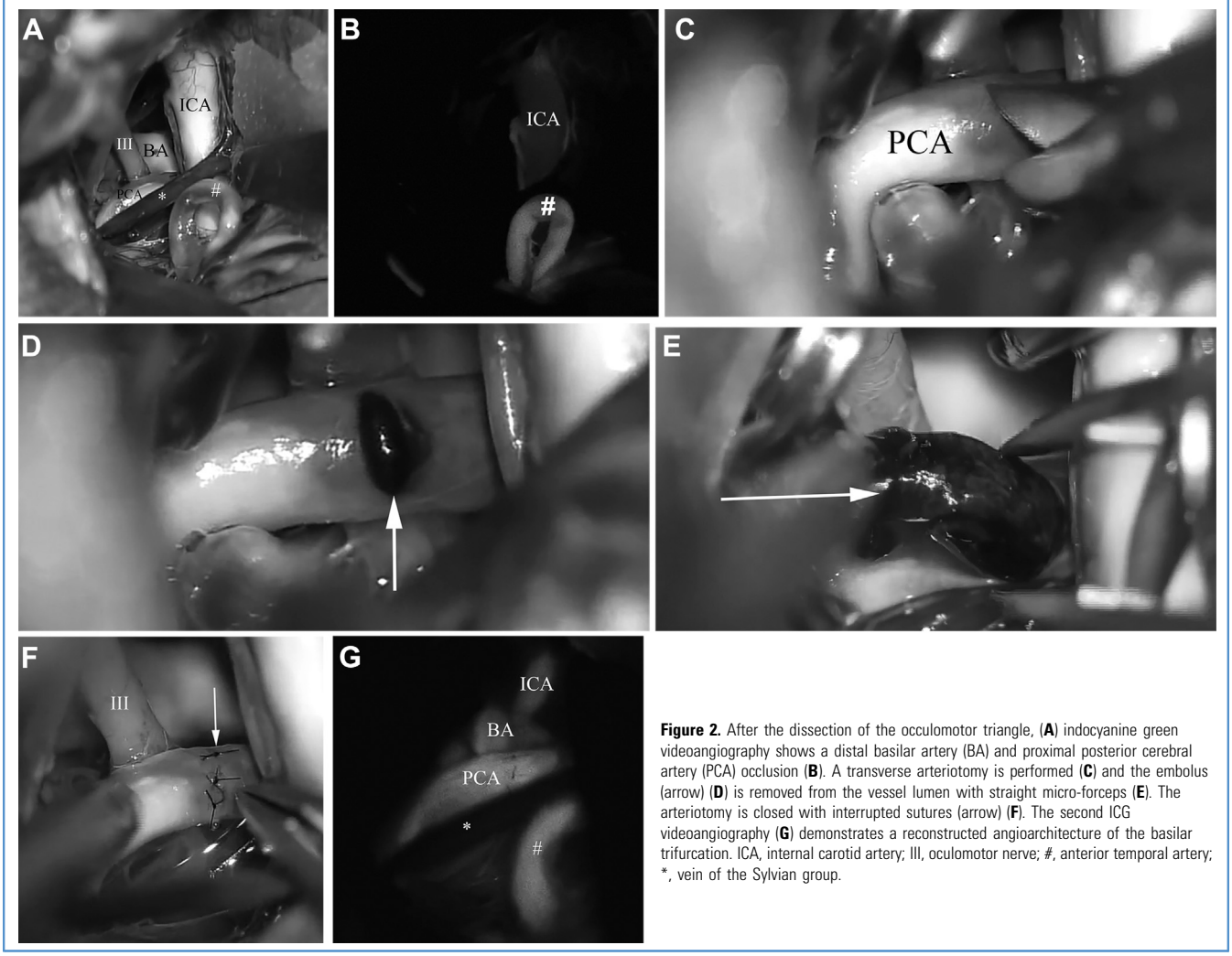

Figure 2. After the dissection of the occulomotor triangle, (**A**) indocyanine green videoangiography shows a distal basilar artery (BA) and proximal posterior cerebral artery (PCA) occlusion (**B**). A transverse arteriotomy is performed (**C**) and the embolus (arrow) (**D**) is removed from the vessel lumen with straight micro-forceps (**E**). The arteriotomy is closed with interrupted sutures (arrow) (**F**). The second ICG videoangiography (**G**) demonstrates a reconstructed angioarchitecture of the basilar trifurcation. ICA, internal carotid artery; III, oculomotor nerve; #, anterior temporal artery; *, vein of the Sylvian group.

temporal lobe, which was then retracted laterally. The P2 segment of the PCA then became visible within the carotid-oculomotor triangle (Figure 2A). This segment was further mobilized from the attached arachnoid to allow for postembolectomy temporary clipping to facilitate suturing of the arteriotomy. After we opened the interpeduncular arachnoid, the distal portion of the basilar artery became visible. Indocyanine green (ICG) videoangiography was performed, which revealed sufficient anterior circulation perfusion and the known occlusion of the distal basilar artery, SCAs, and PCAs (Figure 2B).

Transverse PCA Arteriotomy and Embolectomy

After placing temporary clips on the contralateral PCA and the basilar trunk just proximal to the occlusion, we performed a transverse arteriotomy out at the anterior P2 segment of the PCA with the use of ultrafine sharp microscissors (Figure 2C).[4] The embolus became visible (Figure 2D) and was mobilized and removed with bayonet plateau tip microforceps (Figure 2E). After the evacuation procedure, temporary mini-clips were placed proximal and distal to the arteriotomy. The temporary mini-clips from the trunk of the basilar artery and the contralateral PCA were then removed. Thereafter, the arteriotomy was closed by 3 interrupted stitches with a 10-0 microthread (Figure 2F).

RESULTS

Intraoperative Evaluation

The blood flow in the revascularized distal portion of basilar artery, the SCA, and PCA were confirmed by Doppler ultrasound and ICG videoangiography (Figure 2G).

Operation and Temporary Occlusion Time

The in-hospital treatment time from arrival in the emergency department to revascularization of the basilar artery was 1 hour, 37 minutes (Table 1). The time between skin incision and complete revascularization of the distal posterior circulation

Table 1. Hospital Timeline

3:10 PM: Admission to the emergency department
3:21 PM: CT scan completed
3:30 PM: MRI scan completed
4:02 PM: 4D-CTA scan completed
4:10 PM: Patient in operating room
4:25 PM: Skin incision
4:47 PM: Basilar artery reperfusion
4:53 PM: Left PCA reperfusion
5:35 PM: Skin closure

CT, computed tomography; MRI, magnetic resonance imaging; CTA, computed tomography angiography; PCA, posterior cerebral artery.

was 28 minutes, 35 seconds. The total time of surgery was 1 hour, 10 minutes, skin to skin.

Postoperative Course

The patient was awoken the day after surgery. Postoperative 3-dimensional CTA revealed restored perfusion of the distal posterior circulation. (**Figure 3A**). The postoperative DWI was notable for persistent increased signal in both posterior thalami (**Figure 3B**), which is a very small region compared with the area at risk. The postoperative course was uneventful. The patient recovered steadily and was discharged 4 weeks after the surgery to a rehabilitation clinic. The early stroke rehabilitation was carried out in our institution for 4 weeks. At this time point, the patient was able to walk with assistance but bilateral oculomotor palsy interfered with activities of daily living (modified Rankin scale 3).

DISCUSSION

Acute basilar artery occlusion is associated with mortality rates up to 30%–40% and early revascularization by intravenous thrombolysis, intra-arterial thrombolysis, and endovascular mechanical embolectomy has been considered the best option to date.[1,17,18] The authors describe the first successful direct microsurgical embolectomy of an acute distal basilar artery occlusion.

Rapid pre- and in-hospital stroke management is essential if neurologic function and life are to be preserved. This includes patient transfer to the hospital, stabilization in the emergency department, and expeditious vascular imaging (**Table 1**). Therefore, prehospital diagnosis is imperative so that these patients are transferred to an experienced stroke center that is equipped to quickly execute all steps necessary to proceed with revascularization.[19]

CTA and magnetic resonance imaging/magnetic resonance angiography (MRA) are time-consuming but invaluable in the decision-making process. A small DWI lesion that correlates with a major intracranial vessel occlusion seen on angiographic studies (CTA, MRA) is considered treatable.[13] However, an embolic occlusion must be carefully distinguished from a local atherosclerotic occlusion. In particular, only up to 35% of basilar occlusions are caused by cardiac or arterial-arterial embolization.[9,20]

In general, recanalization is strongly associated with improved functional outcomes and reduced mortality.[21,22] Intravenous thrombolysis with rtPA has a limited effect on basilar artery recanalization.[6] The accepted time window for intravenous thrombolysis with rtPA is 4.5 hours.[4,5] Intra-arterial thrombolysis and endovascular mechanical thrombectomy increasingly

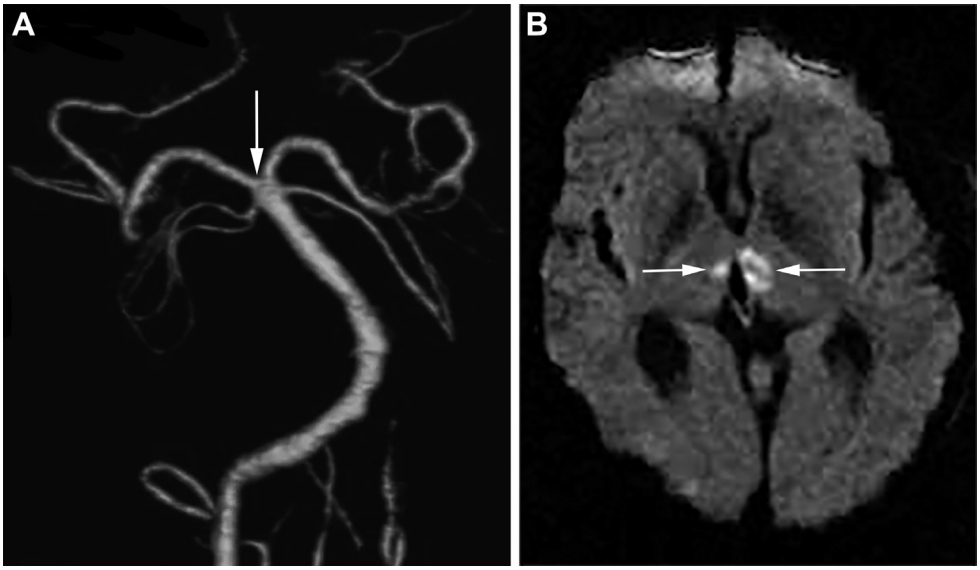

Figure 3. (**A**) The postoperative, 3-dimensional computed tomography angiography shows a reperfusion of the distal basilar artery (*arrow*) and (**B**) the postoperative diffusion weight imaging (axial) shows small bilateral thalamic infarct areas (*arrows*).

are used for basilar artery recanalization therapy in the presence of a MRA-DWI mismatch.[1,6-9,18] In particular, mechanical endovascular thrombectomy techniques allow high recanalization rates of up to 85%.[7,8]

The effectiveness of direct surgical embolectomies is well documented in other vascular areas.[23] Recent publications on the success of open microsurgical embolectomies of major intracranial vessels have allowed consideration of the same techniques to be used on easily accessible segments of the posterior circulation.[12-14,16] The rapid execution of the cranial and intracranial approach are key elements in the prevention of irreversible ischemic stroke. A standard frontotemporal approach allows fast access to the ipsilateral Circle of Willis.[24] In combination with the anterior temporal approach, a relatively wide surgical field and deep corridor for delicate instrument movements and microsutures can be obtained through the subarachnoid spaces without significant retraction of the brain tissue.[16,25-27] ICG videoangiography and Doppler ultrasound allow for immediate evaluation of recanalization.[28]

Because of the unknown time interval between the onset of stroke and the discovery of stroke in the presented case, a time window that was greater than 4.5 hours, the decision was made to perform microsurgical embolectomy without intravenous thrombolysis. In general, an open surgical procedure after unsuccessful thrombolysis is possible; therefore, the risk is only minimally increased by the half life period of rtPA.

The presented technique allowed for removal of the thromboembolus from the distal basilar artery without any technical difficulties. The transverse arteriotomy was simply closed by 3 interrupted sutures without narrowing of the vessel lumen. A complete revascularization of the distal posterior circulation was achieved, and no perioperative complications were observed.

CONCLUSIONS

Direct microsurgical embolectomy is a feasible treatment option for the recanalization of the distal basilar artery in experienced hands. Timely stroke management is a prerequisite. A critical preoperative decision-making process based on various factors such as vessel occlusion time, collateral flow, exact anatomic location, characteristics of the basilar artery, and the occluded segment and microsurgical skills is necessary.

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