

Case Report

Intraoperative dynamic assessment of the posterior communicating artery and its branches by indocyanine green videoangiography

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Abstract

Background: True hemodynamic assessment of the posterior communicating artery (PCoA) by preoperative angiography in terms of its perforators and configuration (adult vs. fetal vs. transitional) can be challenging in the surgical treatment of aneurysms involving the PCoA, posterior cerebral artery, and basilar artery. Indocyanine green videoangiography (ICG-VA) is a widely accepted new technique in the surgical treatment of intracranial aneurysms to assess the patency of the parent artery, branches, and residual flow within the aneurysm after clipping.

Case Description: Here we report two cases in which ICG-VA was utilized to assess either the direction of flow in the PCoA or preservation of the PCoA perforators with temporary clip application before dividing the PCoA.

Conclusions: Our experience is that ICG-VA can be used to assess the main trunk, and perforating branches of the PCoA providing real-time, dynamic intraoperative information of the surgical field. Therefore we suggest that ICG-VA may increase the safety of surgical treatment of aneurysm involving PCoA.

Key Words: Aneurysm, basilar artery, indocyanine green videoangiography, perforating arteries, posterior communicating artery

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INTRODUCTION

The main goal of aneurysm surgery is the obliteration of the aneurysm with preservation of flow in the parent artery, its branches, and perforators.^[5,18] This can be achieved by applying the principles of microsurgical techniques and utilizing intraoperative adjuncts such as microdoppler ultrasonography, intraoperative angiography (IA), and indocyanine green videoangiography (ICG-VA).^[10] Since its introduction into cerebrovascular surgery, many studies have been

published regarding the reliability of ICG-VA in assessing residual aneurysm and preservation of the flow within the parent and branch arteries.^[5,12,17]

During surgical clipping of the basilar bifurcation or P1 segment of posterior cerebral artery (PCA) aneurysms, if the basilar bifurcation is quite high in relation to the dorsum sella or the posterior communicating artery (PCoA) is tethering the PCA, dividing the PCoA might allow surgeon to access the aneurysm safely, provided that PCoA is not a fetal type. Once the decision is made to divide the PCoA, extreme care must be exercised to

avoid injury to the anterior thalamoperforating arteries arising from the PComA.^[8,13]

Clipping of the PComA aneurysms has a reputation of being easy due to the fact that the aneurysm neck and the PComA origin can be included in the clip blades if the PComA is not of the fetal type. However, there are rare cases in which the assessment of dynamics, configuration, and flow direction of the PComA cannot be assessed by preoperative radiologic studies.

Here we report two cases in which ICG-VA was utilized to assess the preservation of the PComA perforators with temporary clip application before dividing the PComA to allow wider access to the basilar and posterior cerebral arteries.

CASE REPORT

Case 1

A 42-year-old female presented with Hunt and Hess grade IV subarachnoid hemorrhage (SAH), which improved to grade III after placement of a ventriculostomy. Computed tomography (CT) and CT angiography revealed a diffuse SAH and ruptured basilar tip aneurysm [Figure 1a]. Digital subtraction angiography (DSA) confirmed the diagnosis of a basilar bifurcation aneurysm with a wide neck and shallow dome [Figure 1b]. Due to its unfavorable neck/dome ratio, endovascular obliteration of this aneurysm was thought to be high risk. The basilar bifurcation was noted to be quite high in relation to the dorsum sella [Figure 1c]. A right cranio-orbital approach was used for the clipping of the aneurysm in this patient. After wide opening of the Sylvian fissure and arachnoid cisterns, the PComA, and the P1 and P2 segments of the PCA were isolated.

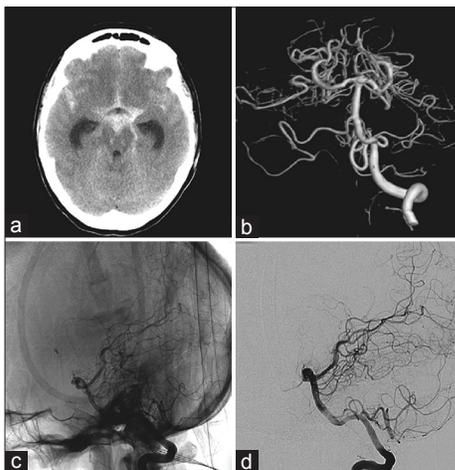


Figure 1: (a) Computed tomography revealing diffuse subarachnoid hemorrhage. (b) 3D-reconstruction of digital subtraction revealing a broad base small aneurysm of the basilar tip. (c) Digital subtraction angiography revealing quite high basilar tip in relation to the dorsum sella. (d) Postoperative digital subtraction angiography revealing the total obliteration of the aneurysm

Due to the high riding basilar bifurcation, dissection of the basilar bifurcation was restricted by the PComA, which was tethering the PCA. Because the PComA was not a fetal type, the decision was made to divide the PComA. However, before dividing it in its perforator-free segment, we performed ICG-VA with a temporary clip on the perforator-free segment, and demonstrated that both perforators were filling from both the PCA and the internal carotid artery (ICA). The PComA was divided between the proximal and distal perforators. Another ICG-VA was performed and this showed that the perforators were still filling. The aneurysm was then clipped (see video, Supplemental Video 1, which demonstrates the surgery, 3 min 18 s, and 71.8 MB). Postoperatively the patient's clinical status improved and she was extubated on the 7th postoperative day with intact speech and was able to follow verbal commands. A postoperative angiogram showed the total obliteration of the aneurysm [Figure 1d]. Two days after the removal of the external ventricular drainage, the patient suffered a rapid decline because of right intraventricular hemorrhage. Emergency evacuation of the hematoma was performed. She eventually made a good recovery and was discharged to a rehabilitation center. On postoperative 3rd month follow-up she was neurologically intact.

Case 2

A 47-year-old female presented with headache. CT angiography and a four-vessel angiogram revealed a PComA-PCA junction aneurysm on the right hemisphere and P1 segment aneurysm on the left side [Figure 2a and b]. The patient elected to undergo coil embolization of both aneurysms. Although the right-sided P1-PComA junction aneurysm was successfully coiled the left-sided P1 aneurysm was not

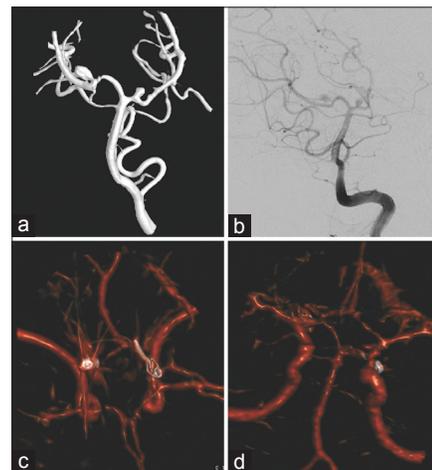


Figure 2: Preoperative computed tomography-angiography (a) and digital subtraction angiography (b) revealing right posterior communicating artery-posterior cerebral artery and left P1 segment aneurysms. Postoperative intravenous-digital subtraction angiography (c, d) revealing the total obliteration of the aneurysm with presentation of the P1 perforating branch

amenable to safe coiling due to its broad neck involving the P1 posterior thalamoperforating artery. Therefore, the patient underwent a cranio-orbital approach for the clipping of the left P1 aneurysm. After wide splitting of the arachnoid cisterns, the ICA, PComA, PCA and basilar bifurcation were all exposed. The aneurysm was originating from the P1 segment of the PCA in relation to the P1 perforating artery. The tethered PComA was obstructing the view of the aneurysm neck and origin of the P1 perforator. Preclipping ICG-VA was performed to lay out the vasculature. Although few clip options were exercised, it was felt that without dividing the PComA, safe clipping would not be possible. As such, a temporary clip was placed along the distal P1 vessel and then ICG-VA performed to ensure that there was flow through the PComA perforators. After this was confirmed, the distal portion of the PComA was divided. The aneurysm was then dissected free and good clip purchase was provided. Postclipping ICG-VA revealed no flow through the aneurysm dome and persistent flow in the P1 perforator and rest of the P1 (see video, Supplemental Video 2, which demonstrates the surgery, 3 min 18 s, and 97.5 MB). The patient refused to undergo postoperative arterial DSA, so intravenous-DSA was performed and revealed the total obliteration of the aneurysm [Figure 2c and d]. The postoperative course was uneventful and the patient was discharged home in stable and neurologically intact condition.

DISCUSSION

The ICG-VA has been widely used in cerebrovascular surgery and the reliability of ICG-VA has been previously demonstrated in aneurysm, arteriovenous malformation, and dural arteriovenous fistula surgeries.^[1,6,10,12] ICG-VA provides real-time, dynamic, and high-resolution intraoperative images to assess the blood flow in the surgical field.

Many authors reported that PComA can be safely divided or occluded when needed in aneurysm surgery,^[2,7,9,18] although the safety of this procedure is highly dependent upon preservation of the perforating arteries originating from the PComA.^[7,13] Regli *et al.*^[13] reported that dividing the PComA during clipping of a basilar bifurcation aneurysm resulted in neurological deficits caused by tuberothalamic infarct, despite protecting the perforating arteries. The authors concluded that the combination of the division of the PComA and cerebrovascular risk factors of the patient were probably responsible for the postoperative infarct. Sugita *et al.*^[16] reported one case in a series of 32 aneurysms of the basilar artery in whom the PComA was divided at the junction of P1 segment. Postoperatively, the patient deteriorated progressively due to severe vasospasm, and it was assumed that circulatory disturbance would have been better if the PComA had

been preserved. Inao *et al.*^[7] presented four cases of basilar bifurcation aneurysms where the PComA was divided. One of these four patients had suffered from an anterior thalamic infarct, which was thought to be due to the injury of thalamoperforating arteries from the PComA. In his series of 50 cases, Yaşargil reported that the PComA was divided in 11 cases to allow better access to the basilar tip aneurysms; in these 11 cases, no morbidity related to the dividing the PComA was observed.^[18] Lawton also indicated that a small PComA that tethers P1 or compromises the view can be safely divided, providing that its anterior thalamoperforating branches can be preserved.^[9] However, when present as the fetal type PComA or if permanent clipping is expected to compromise antegrade flow in the P1 segment, the PComA cannot be sacrificed.^[9]

All of these previous reports were presented before the ICG-VA era, and the vascular integrity had been assessed visually. In this present report, we suggest that ICG-VA provides safe and real-time assessment of the flow and the perforating arteries. In this technique, the first ICG-VA is performed to assess the normal anatomy of the PComA and perforators. Temporary clip is then applied for mimicking the division of the PComA. Under temporary clipping a second ICG-VA is performed to prove the patency of the PComA perforators and the direction of the flow. If the PComA is divided, another ICG-VA is performed to verify the final situation after division.

Anatomical studies showed that most of the PComA perforating arteries seldom arise from the posterior half of the vessel.^[4,11,14] Also, the largest perforating branch of the PComA, the premamillary artery, rarely emerges from the posterior third of the PComA.^[3] In contrast, the normal direction of flow through the PComA is thought to be from the ICA.^[15] Thus, dividing a PComA near to the PCA would be safer than dividing it near the ICA.^[3,7] Although the normal flow through the PComA is thought to be from ICA, the exact opposite may occur, as in our second case, and this can be easily assessed intraoperatively by ICG-VA.

The basilar artery aneurysm surgery is still a challenging procedure for neurosurgeons because these aneurysms are closely related to perforating arteries of the PCA. During an approach to the basilar tip, the PCA may be tethered by the PComA and cannot be mobilized. Also, the PComA may interfere with visibility and manipulation around the aneurysm neck.^[3,9,18] In such situations, the surgeon may be obliged to divide the PComA. In our first case, we decided to divide the PComA because of tethering, and the patency and filling of these perforators were confirmed by ICG-VA. After we were certain that all perforators were preserved, the PComA was then divided.

To assess vessel patency, numerous intraoperative techniques have been developed, such as intraoperative

DSA, microvascular Doppler ultrasonography, and ICG-VA. Of these, IA is the most sensitive and the gold standard.^[17] However, IA is expensive, technically complex and invasive, involves ionizing radiation, and carries the risk of causing neurological deficit. Microscope-based ICG-VA is simple and provides real-time information about the perforating vessels. The studies that compare ICG-VA to IA suggest that the concordance rate between these two methods is 90–100%.^[5,12,17] Despite ICG-VA being widely used in cerebrovascular surgery, to our knowledge, this is the first report where ICG-VA is used to assess either the direction of flow in the PComA or preservation of the PComA perforators to evaluate if PComA can be safely divided or not.

CONCLUSION

In this study, we report our experience utilizing ICG-VA in assessing the main trunk and perforating branches of the PComA providing real-time, dynamic intraoperative information about the surgical field. Therefore, we believe that ICG-VA may increase the safety of the clipping procedure in the treatment of PComA, PCA, and basilar tip aneurysms.

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