Article

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Real-time patency verification during clipping aneurysm and STA-MCA by-pass with dual-image videoangiography

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Abstract: The dual-image videoangiography (DIVA) is a new tool which helps identify ves-sels and surrounding structure. This method is based on use of indocyanine green video angiography (ICG-VA) technology on real time microscopic operative image. In this two case, we report of using DIVA in STA-MCA bypass surgery of 46 years old, female patient of stenosis of right MCA. And using DIVA during clipping ICA paraclinod aneurysm of 35 years old, female. During surgery, it helped in identifying temporal and frontal branches of the STA and there careful selection. After anastomosis, DIVA was used to refine vessel patency and functioning of the anastomosis. DIVA has the potential to replace ICG-VA as a tool for checking the patency of graft during bypass procedures and obliteration of aneurysm along with surgical procedures for AVM and d-AVF. DIVA allows visualization of vessels against a background of normal brain and has better visualization at greater depth and high magnification. This is particularly important during bypass surgery, which very often is performed in deep surgical fields and high magnification.
Key words: DIVA, ICG, STA-MCA bypass, aneurysm

Introduction

During microvascular surgery, it is of utmost importance to observe blood flow for checking complete occlusion of aneurysm, intact flow through the parent vessels and non-occlusion of perforating arteries, ensuring patency of bypass vessels and understanding the microsurgical anatomy of arteriovenous malformations (AVM) and dural arteriovenous fistula (dAVF) [1–3]. Neurovascular surgeon has various modalities in his armamentarium like Doppler ultrasonography, indocyanine green video angiography (ICG-VA), conventional angiography and endoscopic visualization. The latest addition in this field is Dual Image videoangiography by Sato et al.[4]. It enables the simultaneous visualization of both light and near-infrared (NIR) fluorescence images of ICG-VA. We used DIVA during bypass surgery on a patient with MCA arteritis, and during clipping aneurysm on patient with ACoA aneurysm, and we evaluated its potentials as an adjunct to conventional ICG-VA.

Materials and methods

Microscope and DIVA system:

The OPMI PENTERO Flow 800 intraoperative microscope (Carl Zeiss Meditec, Jena, Germany) was used for the operations. The near-infrared color camera MINIRC-2000K (Mizuho, Japan. 48mm x 48mm x 119mm; 0.3kg) was mounted on the PENTERO microscope in order to visualize DIVA during surgery. The operative field was illuminated via an operating microscope by halogen and xenon lamps with a filter to eliminate wavelengths over 780 nm. In the cam-era unit, visible light was filtered to 400–700 nm and NIR fluorescence emission light was filtered to 800–900 nm using a special sensor unit with an optical filter. Light and NIR fluorescence images were simultaneously visualized on a single monitor. We bolus injected ICG 0.3 mg/kg body weight systemically.

Case Report

First case - 46-year-old female patient was admitted to our Department be-cause of a transient ischemic attack with left paresthesia and facial paralysis. The neuroradiological workup as suggestive of MCA arteritis (Figure 1). She suffered three transient ischemic attacks (TIA) involving right MCA territory in last one year. CT and MRI angiography confirmed stenosis of the right MCA. An STA-MCA bypass surgery was therefore scheduled for revascularization of the right hemisphere. She underwent surgery - right side STA-MCA bypass after informed consent. DIVA initially was used during surgery to identify temporal and frontal branches of the STA and there careful selection. After the craniotomy, right MCA branches (M4) - frontal and temporal were identified and prepared. Then the two branches of STA were anastomosed with frontal and temporal branches of MCA individually. DIVA was used to refine vessel patency and functioning of the anastomoses. It revealed insufficient blood flow in the arteries of the donor. We did mechanical restoration of blood flow by milking of STA branches without switching off the DIVA mode (Figure 2). Postoperatively MRI angiography con-firmed the patency of anastomoses (Figure 3). The patient's neurological symptoms regressed in the early postoperative period and patient was discharged without any complications.

Second case - 35-year female patient came with complaint of headache. The CT-AG detected unruptured ICA paraclinoid aneurysm. She was operated by left pterional craniotomy and transsylvian approach. After distal dissection of lateral fissure, we used DIVA to visualize ICA and optic nerve (Figure 4). It helped in identifying relation between aneurysm and left optic nerve. After clipping aneurysm, we used DIVA again for checking patency of artery and decompression of optic nerve from aneurysm (Figure 5). There was no postoperative complication.

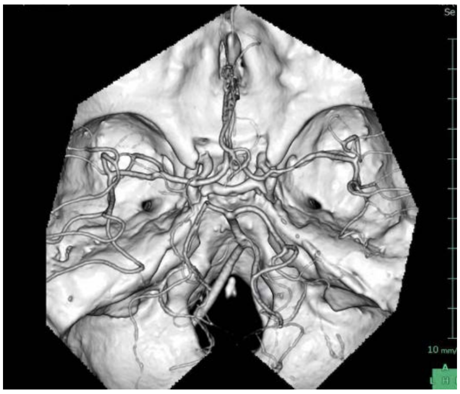

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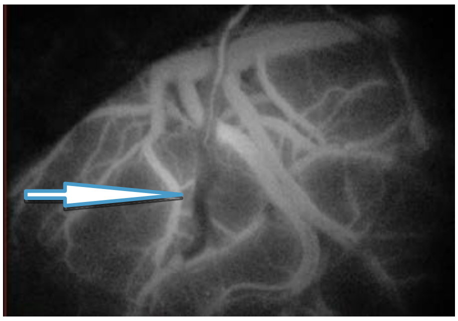
Figure 1 - Preoperative 3D CT-AG show stenosis right MCA M1



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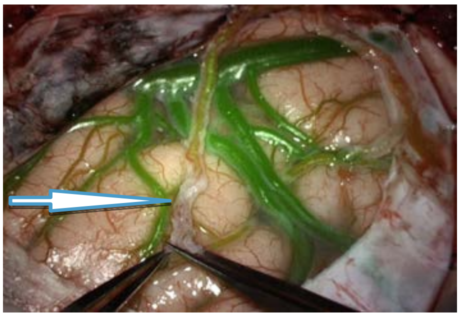


B

Figure 2 - Surgical view ICG videoangiography and DIVA at the time of operation. ICG showing black and white color, that's why the unfilled part of STA branch appears similar to brain i.e. black. While DIVA is showing unfilled part of STA branch as a normal vessel present over brain, because of ability to show colored anatomical structures

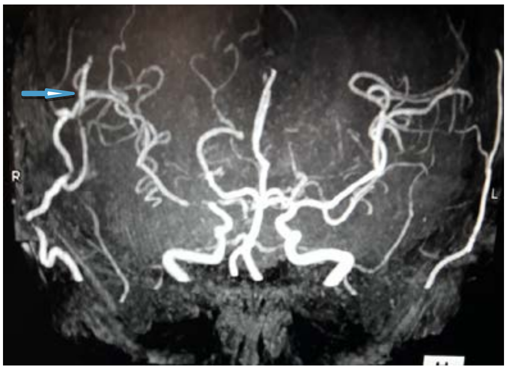
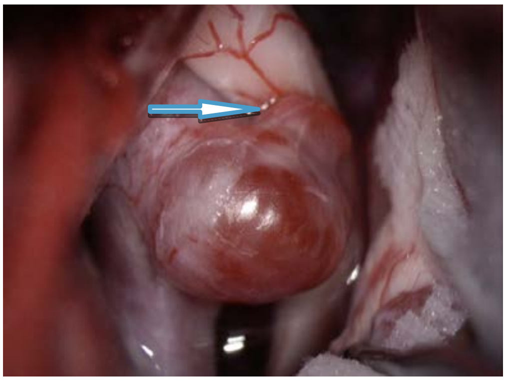


Figure 3 - Postoperative MRI-AG shows excellent patency of anastomosis and right MCA

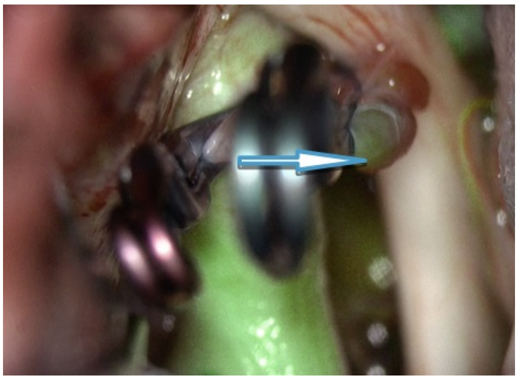


A

B

Figure 4 A - real intraoperative image shows left ICA paraclinoid aneurysm and optic nerve. **B** - DIVA image of same aneurysm showing compression of optic nerve by aneurysm (arrow)

A



B

Figure 5A - real intraoperative image shows clipped left ICA paraclinoid aneu-rysm. **B** - DIVA image of same clipped aneurysm showing no flow in aneurysm and decompression of optic nerve (arrow)

Discussion

Rabbe et al. described the utility of ICG-VA for neurovascular surgeries in 2003[1]. Subsequently there has been widespread use of ICG-VA in neurovascular surgeries throughout the world. One drawback of ICG-VA is that we cannot observe the surrounding structures including clip position as ICG-VA only gives a vision of near infra-red (NIR) fluorescence images showing the vessels in a black background. DIVA as reported by Sato et al.[4] gives normal impression of the vessels in original color initially, followed by vessels highlighted in green as the dynamics of blood flow changed from an "inflow" to "washout". Intracerebral bypass microsurgery requires not only advanced technical skills in microsuturing, but also reliable tools in order to evaluate the vessels patency.

ICG-VA is routinely used with this purpose, and has proven to be very useful in supporting the vascular neurosurgeon. Apart from the drawback of ICG-VA mentioned above, the other potential limitations of ICG-VA are suboptimal visualization in deep operative fields and high magnification [5]. Also at times, it is difficult to visualize and differentiate the deep located perforators from the aneurysm neck. DIVA as a combination of tools provides real time simultaneous visualization of vessels and surrounding structures. Green color used in DIVA, serves as a contrast for vessels which are red (arteries) and blue (veins) against a normal brain background, DIVA makes it easier to understand anatomical relations between intracranial structures. The volume of dye essentially re-mains same as that used for ICG-VA. We have recently started using DIVA during cerebrovascular surgeries. We concur with the findings of Sato et al. that DI-VA gives better resolution of vessels at depth and under high magnification, courtesy to the high-resolution video system and hence is an excellent tool for bypass procedures which is often performed at depth and under high resolution. DIVA suffers from the same limitation of ICG-VA, i.e. vascular structures not exposed in the operative field can't be visualized. Moreover, it gives a better vision of the depth of field. It can have an impact in decision-making during surgery.

Conclusion

DIVA has the potential to replace ICG-VA as a tool for checking the patency of graft during bypass procedures and obliteration of aneurysm along with surgical procedures for AVM and d-AVF. DIVA allows visualization of vessels against a background of normal brain and has better visualization at greater depth and high magnification. This is particularly important during bypass surgery, which very often is performed in deep surgical fields and high magnification.

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