



Intraoperative High-resolution Imaging System to Simultaneously Visualize Visible Light and Near-infrared Fluorescence for Indocyanine Green Angiography

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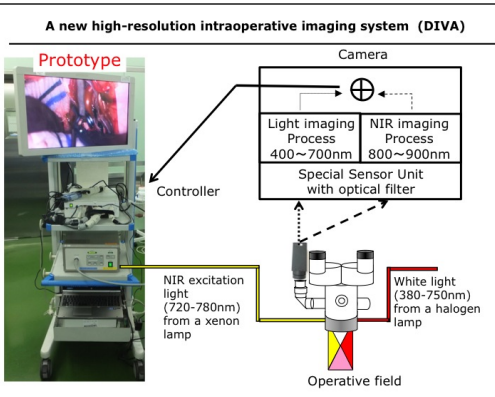
Introduction

Observation of blood flow is important for checking aneurysm obliteration and intact parent and perforating arteries, ensuring bypass patency, and understanding the structures of feeders and drainers of arteriovenous malformations or arteriovenous fistulas.

Intraoperative indocyanine green videoangiography (ICG-VA) has been widely used in vascular surgeries. Vessels are clearly shown as white in black background. However, we cannot observe the other structures during ICG-VA. We developed a new high-resolution intraoperative imaging system (dual image VA, DIVA) to simultaneously visualize both visible light color image and near-infrared (NIR) fluorescence image of ICG-VA.

Methods

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 camera 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. In the control system, grayscale NIR image can be changed to a designated color from a palette of more than 256 visible colors. We selected green because green was a non-biological color. DIVA was used in a total of 20 patients who were undergoing neurovascular surgeries. We adopted DIVA into an operating microscope.



Standard ICG-VA (left) and DIVA (right)



DIVA visualizes both visible light color images and NIR fluorescence-enhanced vessels in green.

Results

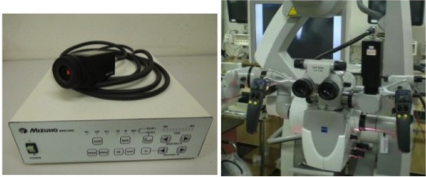
Our system clearly visualized the color operative field together with the enhanced blood flow. In aneurysm surgeries, clipping with neck remnant or remnant flow into the aneurysm was confirmed. In the cases of arteriovenous malformation, feeding arteries and draining veins were easily distinguished.

Conclusions

Using our system, we can observe the color operative field and the enhanced blood flow by ICG in real-time. Our system could facilitate various types of vascular surgeries.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of preservation of the blood flow, 2) Discuss, in small groups, usefulness and limitation of the ICG-VA, 3) Identify an effective treatment using our system.



We adopted DIVA into an OPMI PENTERO 900 operating microscope (OPMI PENTERO 900, Zeiss, Germany).

Introduction to microscope

Micro scope	A	B	C	D	E
DIVA	○	○	○	×	○

Unable to connect some microscopes without external connection.

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References

Sato T, Suzuki K, Sakuma J, et al. Development of a new high-resolution intraoperative imaging system (dual-image videoangiography, DIVA) to simultaneously visualize light and near-infrared fluorescence images of indocyanine green angiography. *Acta Neurochir.* 2015;157:1295-1301.

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