Efficacy of indocyanine green videography and real-time evaluation by FLOW 800 in the resection of a spinal cord hemangioblastoma in a child

Case report

TETSUYA UEBA, M.D., HIROSHI ABE, M.D., JUNTAO MATSUMOTO, M.D., TOSHIHIKO HIGASHI, M.D., AND TORU INOUE, M.D.

Department of Neurosurgery, Faculty of Medicine, Fukuoka University, Fukuoka, Japan

A 19-month-old child was gradually suffering from gait disturbance and was referred by his pediatrician to the authors' institution. Spinal MRI showed Gd-enhanced spinal cord tumor and congestive myelopathy. Intraoperatively the lesion was seen to be a hemangioblastoma. Because discrimination of the arterialized draining veins from the feeding arteries was difficult, indocyanine green videography was conducted to differentiate them. Real-time evaluation by FLOW 800 revealed that the slope of the average signal intensity in the feeding artery was steeper than that of the arterialized veins. The tumor was successfully resected, and postoperative indocyanine green videography showed total removal of the tumor as a signal-negative region; the circulation time between the feeding artery and the main draining vein was prolonged from 2.5 to 5.5 seconds. Indocyanine green videography and real-time evaluation by FLOW 800 were objective and effective for the excision of a tumor retaining the arteriovenous shunt. The patient recovered from congestive myelopathy and gait disturbance.


KEY WORDS • hemangioblastoma • child • spinal cord • indocyanine green • FLOW 800 • spine • oncology

Indocyanine green videography has been introduced into neurosurgical fields for intraoperative assessment of vascular flow after clipping of cerebral aneurysms and for cortical perfusion measurements in moyamoya disease. The dye helps visualize perforating arteries 1 mm in diameter or smaller and the architecture of arteriovenous malformations. We adapted the use of ICG videography and real-time evaluation using FLOW 800 to discriminate the vascular structure and assist in the resection of a spinal cord hemangioblastoma in a child. In the present report we show the efficacy of ICG videography, emphasizing the significance of the slope of average intensity and the circulation time by FLOW 800 visualization in pediatric spinal cord hemangioblastoma.

Case Report

This 19-month-old child had gradually suffered from gait disturbance and was referred by his pediatrician to the Department of Neurosurgery at Fukuoka University. Spinal MRI showed a Gd-enhanced spinal cord tumor and congestive myelopathy (Fig. 1A). A T5–L2 laminectomy was performed, and the dural sac was opened following exposure of the hemangioblastoma. Because the recommended dose of ICG (Pulsion Medical Systems) for video angiography is 0.2–0.5 mg/kg, we provided a standard dose of 5.0 mg intravenously. In the darkened operating room, the intravascular dye was then visualized using an operating microscope (OPMI Pentero, Carl Zeiss Meditec) equipped with an additional fluorescent light source (wavelength 700–850 nm), and we assessed the slope of average intensity and the circulation time using the FLOW 800 system (Carl Zeiss Meditec). Real-time FLOW 800 evaluation revealed that the slope of

Abbreviations used in this paper: DSA = digital subtraction angiography; ICG = indocyanine green.
average signal intensity in the feeding artery and tumor was 50.0 average intensity (AI/second), the slope in the arterialized draining veins was 22.2 AI/second (Fig. 2), and the circulation time between the main feeder and the main drainer was 2.5 seconds. Resection of the tumor was successfully performed without any bleeding events. Postoperative ICG videography showed total removal of the tumor as a signal-negative region, and we observed a circulation time prolonged from 2.5 to 5.5 seconds. One month after surgery, spinal MRI revealed an absence of congestion and no enhanced lesion in the spinal cord (Fig. 1B). The patient’s gait disturbance resolved.

**Discussion**

Spinal cord hemangioblastoma in a child represents a rare clinical entity. The majority of intramedullary spinal cord tumors in children are low-grade glial tumors. The goal of complete resection is often, but not always, achieved using microsurgical techniques. Excessive blood loss, severe adhesions, and ill-defined margins have been reported as reasons limiting a complete resection.

In the present case ICG videography helped delineate the extent of the lesion and identify the feeding artery and the arterialized draining veins. The keys to success in the surgical treatment of a spinal cord hemangioblastoma are identification of the arterialized medullary vein that drains the tumor and differentiation of this arterialized medullary vein from the artery feeding the spinal cord. Use of FLOW 800, which calculated the subtle difference of the slope of average signal intensity and the circulation time between the feeding artery and the arterIALIZED draining veins, facilitated the discrimination of the arterialized medullary veins in this case. This information may facilitate intraoperative planning and resection of the lesion while minimizing trauma to remaining areas of the spinal cord. Furthermore, by defining the extent of the lesion with use of ICG, we may minimize the risk of entering the lesion inadvertently and contributing to massive blood loss or an incomplete resection. Moreover, this imaging modality improved the simplicity and speed of the procedure. There was no need to move the microscope from the surgical field or to interrupt the operation. The results of ICG videography were obtained within several minutes. Indocyanine green videography may be a simple tool for intraoperative quality control and documentation of surgical outcomes.
Intraoperative DSA is also effective as an alternative intraoperative modality. However, occlusion of the femoral artery has been reported as a complication of intraoperative DSA in children.\textsuperscript{17} Compared with intraoperative DSA, another advantage of ICG videography is its high spatial resolution, which allows the surgeon to observe the patency of all vessels within the surgical field of view, including small perforating or cortical arteries of submillimeter diameter.\textsuperscript{12,16}

The toxicity of ICG is possibly a major concern, especially in children. Indocyanine green, which has been approved by the US FDA, has been widely used in medical diagnoses since 1956\textsuperscript{3} and has excellent safety records with very few side effects.\textsuperscript{4} The combination of near-infrared spectroscopy and ICG to estimate cerebral blood flow has been described in adults\textsuperscript{8} and in newborn infants undergoing cardiopulmonary bypass.\textsuperscript{2} Measurement of the blood flow index as noninvasive, bedside estimation of cerebral blood flow has also been performed safely in the infant.\textsuperscript{19} However, in Japan, ICG is off label in this clinical setting. The incidence of systemic allergic reactions has been reported as approximately 1:250,000. Indocyanine green may not have an unlimited nontoxic range because photosensitizing properties have been reported following large intravenous ICG boluses of 4 mg/kg combined with high-power infrared skin illumination at 3 W/cm.\textsuperscript{18} Although the incidence of ICG toxicity is low in our setting, the patient should be observed carefully.

Recently application of ICG videography to spine surgery has been reported.\textsuperscript{5,13} In this report, we suggest ICG videography and real-time analysis by FLOW 800 can be useful and objective in discriminating the vascular structure.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Ueba, Inoue. Acquisition of data: Abe, Matsumoto, Higashi. Drafting the article: Ueba. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Ueba.

**References**


Real-time evaluation of the arterialized draining veins


Manuscript submitted July 5, 2011. Accepted December 22, 2011.
Please include this information when citing this paper: DOI: 10.3171/2011.12.PEDS11286.
Address correspondence to: Tetsuya Ueba, M.D., Department of Neurosurgery, Fukuoka University, 7-45-1 Nanakuma, Jonan-ku, Fukuoka-city, Fukuoka 814-0180, Japan. email: tueba@fukuoka-u.ac.jp.