adjacent neurosurgical centres is a frequent obstacle, compounding transfer delays. Finally, volume and the degree of endovascular sub-specialization at the accepting neurosurgical centre are recognized as important predictors of outcome in the management of ruptured and unruptured intracranial aneurysms.21,22

Conclusions
A patient’s proximity to the treating neurological centre significantly impacts mortality after aneurysmal subarachnoid hemorrhage. The precise cause of this relationship cannot be deduced from our data. Nevertheless, these findings have important clinical and policy implications for the management, triage, and transfer of these critically ill patients. Further research is required to confirm these results and establish specific factors impacting on outcome, such as time of transfer, mode of transport, and care provided at the referring institution.

This factor can then be addressed to optimize transfer systems and minimize the potential impact of inevitable delays.

Funding
This research was supported by a research fellowship from the Heart and Stroke Foundation of Canada.

References


The usefulness of indocyanin green videangiography (ICG-VG) as a tool for intraoperative monitoring has been reported since about 1998, and its utility is particularly indicated during the neurosurgical treatment of vascular disorders.23,24,25 Indocyanin green videangiography is considered useful for confirming the patency of reconstructed brain vessels. Conversely, there have been only a few reports indicating the utility of ICG-VG in relation to tumorous lesions.26,27,28 We report herein the intraoperative ICG-VG findings for three cases of cerebral hemorrhage (GBM), and discuss the usefulness of this imaging modality.

Case 1
A 67-year-old man presented with vertigo and headaches. Magnetic resonance imaging (MRI) (Figure 1.1) and cerebral angiography led to a diagnosis of a cerebral HB with the anterior inferior cerebral artery as its feeding artery.
Craniotomy was performed via a lateral suboccipital approach. Following incision of the dura, the cisterna magna was opened and the cerebrospinal fluid was aspirated. The fluid contents of the cyst were also aspirated and the operative field was secured. The site of the lesion was confirmed from above the arachnoid (Figure 1.2). Indocyanine green (ICG), at 10 mg (25 mg/10 ml of distilled water), was intravenously infused via a peripheral blood vessel, flushing was performed with 10 ml of physiological saline, and visualization was achieved from 12 sec after ICG infusion. Visualization of the lesion (Figure 1.3) began at about the same time as the arterial phase, while the draining vein (Figure 1.4) was visualized before the venous phase but clearly after the contrast findings for the lesion. Thus, the feeding and draining vessels could be clearly distinguished. Indocyanine green videoangiography (Figure 1.5) performed following tumor resection (Figure 1.6) showed no abnormal staining that would correspond to a tumor shadow. Postoperative contrast-enhanced MRI on Day 2 after resection also confirmed that the tumor lesion had been totally removed. The post operative course was uneventful and the tumor was pathologically diagnosed as HB.

Case 2
A 29-year-old man presented with headaches. Magnetic resonance imaging (Figure 2.1) and cerebral angiography led to a diagnosis of a cerebellar HB with the posterior inferior cerebellar artery (PICA) as its feeding artery. Craniotomy and C1 laminectomy was performed via a midline suboccipital
Cranietomy was performed via a lateral suboccipital approach. Following incision of the dura, the cisterna magna was opened and the cerebrospinal fluid was aspirated. The fluid contents of the cyst were also aspirated and the operative field was secured. The site of the lesion was confirmed from above the arachnoid (Figure 1.2). Indocyanine green (ICG), at 10 mg (25 mg/10 ml of distilled water), was intravenously infused via a peripheral blood vessel, flushing was performed with 10 ml of physiological saline, and visualization was achieved from 12 sec after ICG infusion. Visualization of the lesion (Figure 1.3) began at about the same time as the arterial phase, while the draining vein (Figure 1.4) was visualized before the venous phase but clearly after the contrast findings for the lesion. Thus, the feeding and draining vessels could be clearly distinguished. Indocyanine green videoangiography (Figure 1.5) performed following tumor resection (Figure 1.6) showed no abnormal staining that would correspond to a tumor shadow. Postoperative contrast-enhanced MRI on Day 2 after resection also confirmed that the tumor lesion had been totally removed. The postoperative course was uneventful and the tumor was pathologically diagnosed as HB.

**Case 2**

A 29-year-old man presented with headaches. Magnetic resonance imaging (Figure 2.1) and cerebral angiography led to a diagnosis of a cerebellar HB with the posterior inferior cerebellar artery (PICA) as its feeding artery. Cranietomy and C1 laminectomy was performed via a midline suboccipital approach.
intravenously infused via a peripheral blood vessel, and flushing was performed with 10 ml of physiological saline. A dilated and tortuous abnormal vessel was confirmed on the cerebellar surface (Figure 3.3). IBR sec after ICG infusion, and the tumor location gradually became stained and defined. Prior to ICGVAG, the extent of tumor was not confirmed, however, post-ICGVAG, extent of tumor was clearly indicated. The delayed phase of ICGVAG (Figure 3.4) suggested the position of the

Case 3
A 56-year-old man presented with headaches. Magnetic resonance imaging (Figure 3.1) and cerebral angiography led to a diagnosis of a cerebellar HB with the PCA as its feeding artery. Craniotomy was performed via a midline suboccipital approach. Ventricular drainage was performed prior to incision of the dura. Following dural incision, the location of the tumor from the surface of the cerebellum was unclear (Figure 3.2). ICG, at 12 mg (25 mg/10 ml of distilled water), was intravenously infused via a peripheral blood vessel, and flushing was performed with 10 ml of physiological saline. A dilated and tortuous abnormal vessel was confirmed on the cerebellar surface (Figure 3.3). IBR sec after ICG infusion, and the tumor location gradually became stained and defined. Prior to ICGVAG, the extent of tumor was not confirmed, however, post-ICGVAG, extent of tumor was clearly indicated. The delayed phase of ICGVAG (Figure 3.4) suggested the position of the

Case 3
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approach. Ventricular drainage was performed prior to incision of the dura. Following dural incision, the general location of the lesion was confirmed from above the arachnoid (Figure 2.2). ICG, at 12 mg (25 mg/10 ml of distilled water), was intravenously infused via a peripheral blood vessel, flushing was performed with 10 ml of physiological saline, and visualization was achieved from 22 sec after ICG infusion. Visualization of the lesion (Figure 2.3) began at about the same time as the arterial phase. The draining vein ran along the top of the tumor body, and was therefore confirmed as a filling defect. The delayed phase of ICGVAG (Figure 2.4) suggested the position of the draining vein. ICGVAG (Figure 2.5) performed following tumor resection (Figure 2.6) revealed no abnormal staining that would correspond to a tumor shadow. Postoperative contrast-enhanced MRI on day 43 after resection also confirmed complete removal of the tumor lesion. The postoperative course was uneventful and the tumor was pathologically diagnosed as HB.

Case 3
A 56-year-old man presented with headaches. Magnetic resonance imaging (Figure 3.1) and cerebral angiography led to a diagnosis of a cerebellar HB with the PCA as its feeding artery. Craniotomy was performed via a midline suboccipital approach. Ventricular drainage was performed prior to incision of the dura. Following dural incision, the location of the tumor from the surface of the cerebellum was unclear (Figure 3.2). ICG, at 12 mg (25 mg/10 ml of distilled water), was intravenously infused via a peripheral blood vessel, and flushing was performed with 10 ml of physiological saline. A dilated and tortuous abnormal vessel was confirmed on the cerebellar surface (Figure 3.3). 18 sec after ICG infusion, and the tumor location gradually became stained and defined. Prior to ICGVAG, the extent of tumor was not confirmed, however, post-ICGVAG, extent of tumor was clearly indicated. The delayed phase of ICGVAG (Figure 3.4) suggested the position of the...
draining vein. Postoperative contrast-enhanced MRI on Day 1 after resection confirmed complete removal of the tumor lesion. The postoperative course was uneventful and the tumor was pathologically diagnosed as HB.

**Discussion**

In 2003, Raabe et al. reported their clinical experience with ICGAV as an intraoperative image diagnostic technique for evaluating cerebral perfusion. In particular, with regard to its usefulness in comparison with intraoperative cerebral angiography, ICGAV is reported to be an easy, rapid, and inexpensive modality. With respect to intracranial lesions, ICGAV is useful in cases including aneurysm, vascular reconstructive surgery, and cerebral infarction. There have also been reports of the utility of this imaging modality in a small number of patients with cavernous lesions.

Britz et al. and Hansen et al. reported that ICG may provide visual enhancement of tumor margins in a rat glioma model, thus aiding radical resection. However, there have been no clinical reports regarding the application of ICGAV in patients with HB. Indocyanin green videoangiography has been indicated during the surgical resection of cerebral arteriovenous malformations (AVMs). Hemangioblastomas are angiographically similar to such malformations; therefore, it is likely that ICGAV can be conveniently applied to the surgical removal of HB. In the present cases, ICGAV findings clearly visualized the HB, feeding artery and draining veins, thus aiding clarification of tumor borders and decreasing the extent of necessary resection.

Hemangioblastoma lesions are more frequently seen as mural nodules located close to the brain surface, rather than presenting as cysts. HB lesions are more often found as mural nodules located close to the brain surface. The lesion is partially exposed on the cerebellum surface, and the tumor blood vessels form an abnormal vascular network on the brain surface directly above. These anatomical characteristics explain why ICGAV is convenient for intraoperative examination of HB. In the case of AVM, which are often located deep in the brain, it is necessary to employ cerebral angiography, which is a radiographic test capable of seeing through the brain. In comparison with cerebral angiography, ICGAV, which is a fluorescence test, is unable to depict the lesion site if the light is blocked by the brain parenchyma. Therefore, a lesion in the brain parenchyma can be difficult to distinguish in the differential diagnosis of imaging findings, and the present cases provide important examples of intraoperative ICGAV imaging of HB.

In addition to confirming the location of the tumor body, successful resection of HB requires differentiation between the feeding and draining vessels and evaluation of the presence of residual tumor tissue. Wang et al. reported that their surgical principle for HB is similar to that for AVM: selective division of feeding arteries, preservation of the main draining veins, and protection of vessels across the tumor surface. If significant resection is carried out for total tumor resection, clamping of the main draining veins, which are extremely dilated, should be carried out at the last moment. Jogeshan et al. also reported that care should be taken to coagulate and sharply transect vessels individually as they enter or leave the tumor capsule, and that vessels supplying the tumor should be

**References**

draining vein. Postoperative contrast-enhanced MRI on Day 1 after resection confirmed complete removal of the tumor lesion. The postoperative course was uneventful and the tumor was pathologically diagnosed as HB.

**DISCUSSION**

In 2013, Raabe et al. reported their clinical experience with ICGVAG as an intraoperative image diagnostic technique for evaluating cerebral perfusion. In particular, with regard to its usefulness in comparison with intraoperative cerebral angiography. ICGVAG is reported to be an easy, rapid, and inexpensive modality. With respect to intracranial lesions, ICGVAG is useful in cases including aneurysm, vascular reconstructive surgery, and cerebral infarction. There has also been reports of the utility of this imaging modality in a small number of patients with GBM lesions. According to Britz et al. and Hansen et al., ICGVAG may provide visual enhancement of tumor margins in a rat glioma model, thus aiding radical resection. However, there have been no clinical reports regarding the application of ICGVAG in patients with HB. Indocyanine green videoangiography has been indicated during the surgical resection of cerebral arteriovenous malformations (AVM) and hemangioblastomas are angiographically similar to such malformations; therefore, it is likely that ICGVAG can be conveniently applied to the surgical removal of HB. In the present three cases, ICGVAG findings clearly visualized the HB feeding artery and draining veins, thus aiding clarification of tumor borders and decreasing the extent of necessary resection.

Hemangioblastoma lesions are more often present as mural nodules located close to the brain surface, as opposed to cystic interiors. As with ICGVAG findings, the lesions are more often found as mural nodules located close to the brain surface. The lesion is partially exposed on the cerebellar surface, and the tumor blood vessels form an abnormal vascular network on the brain surface directly above. These anatomical characteristics explain why ICGVAG is convenient for intraoperative examination of HB. In the case of AV, which are often located deep in the brain, it is necessary to employ cerebral angiography, ICGVAG, which is a fluorescence test, is unable to depict the lesion site if the light is blocked by the brain parenchyma. Therefore, a lesion in the brain parenchyma can be detected by ICGVAG with less pain. In the present cases, ICGVAG findings clearly visualized the HB feeding artery and draining veins, thus aiding clarification of tumor borders and decreasing the extent of necessary resection.

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