Indocyanine green videoangiography for tumor

see Indocyanine green videoangiography for brain tumor

Indocyanine green videoangiography for pituitary neuroendocrine tumor

Indocyanine green videoangiography for spinal cord tumor

Indocyanine green videoangiography for hemangioblastoma.

Several groups have experimented with an near-infrared (NIR) dye, indocyanine green (ICG), administered intravenously minutes before resection. However, this approach has failed to provide value as a means of localizing tumor margins. Although ICG provides vascular enhancement at the surface of the tumor, the dye rapidly clears and leaves significant background noise.

Lee et al., has been studying an alternative approach. They have been studying a technique called “Second Window ICG” as a means to delineate tumor margins during surgery. In this technique, they administer intravenous ICG. They call it Second Window ICG to differentiate it from the standard ICG videoangiography bolus of 25 mg just before visualization. ICG for Second Window ICG is solubilized in a higher concentration using sodium chloride and administered 24 hours before imaging. ICG has a peak excitation of 780 to 790 nm and emission spectra of 805 to 820 nm in animal and human tissues. These make ICG an ideal fluorescent contrast agent within this spectral window, because other tissue components (water, hemoglobin-oxygen, deoxyhemoglobin, melanin) do not interfere with the excitation source [1].

Over 24 hours, the dye accumulates in the tumor tissue because of the enhanced permeability and retention (EPR) effect. This effect explains delivery in that small molecules may pass through a disrupted tumor blood-brain barrier and be retained because of a relative lack of drainage (by lymphatics, for example) [2].

Prior work has demonstrated that accumulation within may occur because of the relatively hypoxic microenvironment [3].

As a molecule, ICG is amphiphilic; it has 2 ringed groups (1 with positive charge) and 2 negatively charged sulfonate groups. At high concentrations and at extreme temperatures (>60°C) when dissolved in vitro, chains may form based on noncovalent interactions between individual molecules. These aggregations (termed J-aggregates) can have different fluorescent properties. At the dose injected at the time of constitution, ICG does not form J-aggregates; this has been verified in our laboratory. In circulation, the fluorescent compound is unlikely to form these aggregations given the relatively large plasma volume compared with the volume injected. Rather, Lee et al. hypothesize that the amphiphilic properties of ICG may contribute in part to retention once delivered within the tumor microenvironment. Current tissue-processing methods limit the ability to support whether or not this mechanism contributes to retention within tumors [4] [5].

The Second Window ICG technique allows neurosurgeons to deliver NIR optical contrast agent to human glioblastoma patients, thus providing real-time tumor identification in the operating room. This nonspecific tumor accumulation of ICG within the tumor provides strong signal to background contrast, and is not significantly time dependent between 6 hours to 48 hours, providing a broad plateau for stable visualization. This finding suggests that optimal imaging of the “Second Window of ICG” may be within this plateau period, thus providing signal uniformity across subjects [6].

Case series

Between May 2011 and December 2017, all cases in which indocyanine green videoangiography and FLOW 800 analysis were used at least one time before, during, or after the tumor resection, and in which surgical videos were available, were retrospectively reviewed. Results of the histological analysis were analyzed together with the intraoperative ICG-VA with FLOW 800 in order to investigate the tumor-related videoangiographic features.

Seventy-one patients who underwent surgery for cerebral and spinal tumors were intraoperatively analyzed using ICG-VA with FLOW 800, either before or after tumor resection, for a total of 93 videoangiographic studies. The histological diagnosis was meningioma in 25 cases, glioma in 14, metastasis in 7, pineal region tumor in 5, hemangioblastoma in 4, chordoma in 3, and other histological types in 13 cases. The authors identified 4 possible applications of ICG-VA and FLOW 800 in CNS tumor surgery: extradural surveys allowed exploration of sinus patency and the course of veins before dural opening; preresection surveys helped in identifying pathological vascularization (arteriovenous fistulas and neo-angiogenesis) and regional venous outflow, and in performing temporary venous clipping tests, when necessary; postresection surveys were conducted to evaluate arterial and venous patency and parenchymal perfusion after tumor removal; and a premyelotomy survey was conducted in intramedullary tumors to highlight the posterior median sulcus.

They found ICG-VA with FLOW 800 to be a useful method to monitor blood flow in the exposed vessels and parenchyma during the microsurgical removal of CNS tumors in selected cases. In particular, a preresection survey provides useful information about pathophysiological changes of brain vasculature related to the tumor and aids in the individuation of helpful landmarks for the surgical approach, and the postresection survey helps to prevent potential complications associated with the resection (such as local hypoperfusion or venous infarction) [7].

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