Near Infrared Optical Imaging

Although real-time localization of gliomas has improved with intraoperative image guidance systems, these tools are limited by brain shift, surgical cavity deformation, and expense.

Tumor Paint BLZ-100, a tumor ligand chlorotoxin (CTX) conjugated to indocyanine Green (ICG), has shown potential to be a targeted contrast agent. There are many infrared imaging systems (NIR) in use, but they are not optimized to the low concentration and amount of ICG

BLZ-100 has a very high affinity toward human gliomas. They also describe a small, cost-effective, and sensitive NIR system for visualizing brain tumors tagged using BLZ-100. Butte et al. hope that the use of BLZ-100 along with near infrared optical imaging imaging will be useful to delineate the brain tumors in real-time and assist surgeons in near-complete tumor removal to increase survival and reduce neurological deficits [1].

Lee et al., propose a novel method to perform near-infrared (NIR) imaging during glioma resections based on preclinical and clinical investigations, in order to localize tumors and to potentially identify residual disease.

Fifteen patients were identified and administered a Food and Drug Administration-approved, NIR contrast agent (Second Window indocyanine green [ICG], 5 mg/kg) before surgical resection. An NIR camera was utilized to localize the tumor before resection and to visualize surgical margins following resection. Neuropathology and magnetic resonance imaging data were used to assess the accuracy and precision of NIR fluorescence in identifying tumor tissue.

NIR visualization of 15 gliomas (10 glioblastoma multiforme, 1 anaplastic astrocytoma, 2 low-grade astrocytoma, 1 juvenile pilocytic astrocytoma, and 1 ganglioglioma) was performed 22.7 hours (mean) after intravenous injection of ICG. During surgery, 12 of 15 tumors were visualized with the NIR camera. The mean signal-to-background ratio was 9.5 ± 0.8 and fluorescence was noted through the dura to a maximum parenchymal depth of 13 mm. The best predictor of positive fluorescence was enhancement on T1-weighted imaging; this correlated with signal-to-background ratio (P = .03). Nonenhancing tumors did not demonstrate NIR fluorescence. Using pathology as the gold standard, the technique demonstrated a sensitivity of 98% and specificity of 45% to identify tumor in gadolinium-enhancing specimens (n = 71).

With the use of Second Window ICG, gadolinium-enhancing tumors can be localized through brain parenchyma intraoperatively. Its utility for margin detection is promising but limited by lower specificity [2].

1)
Butte PV, Mamelak A, Parrish-Novak J, Drazin D, Shweikeh F, Gangalum PR, et al: Near-infrared imaging of brain tumors using the Tumor Paint BLZ-100 to achieve near-complete resection of brain tumors. Neurosurg Focus 36(2):E1, 2014

2)
Lee JY, Thawani JP, Pierce J, Zeh R, Martinez-Lage M, Chanin M, Venegas O, Nims S, Learned K, Keating J, Singhal S. Intraoperative Near-Infrared Optical Imaging Can Localize Gadolinium-Enhancing Gliomas During Surgery. Neurosurgery. 2016 Oct 11. PubMed PMID: 27741220.