Red Light

Intrinsic optical imaging is a functional imaging modality where the reflectance of red light indicates active portions of cortex, as developed by Grinvald et al. is a powerful technique for monitoring neural function in the in vivo central nervous system. The advent of this dye-free imaging has also enabled us to monitor human brain function during neurosurgical operations.

The objective of a study was to detect 5 aminolevulinic acid (ALA)-induced tumor fluorescence from glioma below the surface of the surgical field by using red-light illumination.

To overcome the shallow tissue penetration of blue light, which maximally excites the ALA-induced fluorophore protoporphyrin IX (PpIX) but is also strongly absorbed by hemoglobin and oxyhemoglobin, a system was developed to illuminate the surgical field with red light (620-640 nm) matching a secondary, smaller absorption peak of PpIX and detecting the fluorescence emission through a 650-nm longpass filter. This wide-field spectroscopic imaging system was used in conjunction with conventional blue-light fluorescence for comparison in 29 patients undergoing craniotomy for resection of high-grade glioma, low-grade glioma, meningioma, or metastasis.

Although, as expected, red-light excitation is less sensitive to PpIX in exposed tumor, it did reveal tumor at a depth up to 5 mm below the resection bed in 22 of 24 patients who also exhibited PpIX fluorescence under blue-light excitation during the course of surgery.

Red-light excitation of tumor-associated PpIX fluorescence below the surface of the surgical field can be achieved intraoperatively and enables detection of subsurface tumor that is not visualized under conventional blue-light excitation. Clinical trial registration no.: NCT02191488 (clinicaltrials.gov) [1].

1)
Roberts DW, Olson JD, Evans LT, Kolste KK, Kanick SC, Fan X, Bravo JJ, Wilson BC, Leblond F, Marois M, Paulsen KD. Red-light excitation of protoporphyrin IX fluorescence for subsurface tumor detection. J Neurosurg. 2017 Aug 4:1-8. doi: 10.3171/2017.1.JNS162061. [Epub ahead of print] PubMed PMID: 28777025.