Optical technology

Optical or optical technology refers to anything relating to light or vision, whether it be visible light or infrared light, that performs a specific function. … A computer mouse is an example of an optical device that uses optical technology.

The use of optic technology in skull base surgeries has the potential to revolutionize the field of medicine, particularly neurosurgery and neurology. Here, we briefly present the past, present, and future of skull-base surgery, with an emphasis on the applications of optical topography techniques. We discuss optical topography techniques such as functional near-infrared spectroscopy, optical diffusion tomography, and optical topographical imaging. Optical topography techniques are particularly advantageous when combined with other imaging methods. For instance, optical topography can be combined with techniques such as functional magnetic resonance imaging (fMRI) to combine the temporal resolution of optical topography with the spatial resolution of fMRI. Multimodal approaches will be critical to advance brain-related research as well as medicine. Structured light imaging techniques are also writing the future of 3-dimensional imaging. In short, optical topography can allow for non-invasive, high-resolution imaging that will provide real-time visualizations of the brain that are ideal for neurosurgery. From the limitations of traditional skull base surgeries to the newest developments in optical neuroimaging, here we will discuss the potential applications of optics in skull base procedures [1)].

Optics can be used for guidance in deep brain stimulation (DBS) surgery. The aim of Zsigmond and Wårdell was to use laser Doppler flowmetry (LDF) to investigate the intraoperative optical trajectory along the ventral intermediate nucleus (VIM) and zona incerta (Zi) regions in patients with essential tremor during asleep DBS surgery, and whether the Zi region could be identified.

A forward-looking LDF guide was used for the creation of the trajectory for the DBS lead, and the microcirculation and tissue greyness, i.e., total light intensity (TLI) was measured along 13 trajectories. TLI trajectories and the number of high-perfusion spots were investigated at 0.5-mm resolution in the last 25 mm from the targets.

All implantations were done without complications and with significant improvement of tremor ($p < 0.01$). Out of 798 measurements, 12 tissue spots showed high blood flow. The blood flow was significantly higher in VIM than in Zi ($p < 0.001$). The normalized mean TLI curve showed a significant ($p < 0.001$) lower TLI in the VIM region than in the Zi region.

Zi DBS performed asleep appears to be safe and effective. LDF monitoring provides direct in vivo measurement of the microvascular blood flow in front of the probe, which can help reduce the risk of hemorrhage. LDF can differentiate between the grey matter in the thalamus and the transmission border entering the posterior subthalamic area where the tissue consists of more white matter tracts [2)].

[1)]
Zagzoog N, Zadeh G, Lin V, Yang VXD. Perspective review on applications of optics in skull base surgery. Clin Neurol Neurosurg. 2021 Dec 3;212:107085. doi: 10.1016/j.clineuro.2021.107085. Epub ahead of print. PMID: 34894572.

[2]

Zsigmond P, Wårdell K. Optical Measurements during Asleep Deep Brain Stimulation Surgery along Vim-Zi Trajectories. Stereotact Funct Neurosurg. 2020 Feb 20:1-7. doi: 10.1159/000505708. [Epub ahead of print] PubMed PMID: 32079023.