2) Intraoperative Imaging

“Intraoperative imaging helps surgeons capture real-time views of the brain during surgery, allowing them to remove the tumor more safely and reduce the chances of needing a second operation.” (Dr. Vitaly Siomin, MD, Neurosurgery, on behalf of Baptist Health South Florida)[1].

This procedure can help physicians ensure that they remove as much of the tumor as possible, being able to continue the surgery in case there is still diseased tissue.

This technology has brought CT, MRI and PET into the operating rooms as additions to ultrasound and X-ray (C-arm) devices. These imaging modalities extend or replace direct visualisation. Furthermore, Mass Spectroscopy devices can further help the surgical decision-making process.[2]

Issues that arise in these cases are that the gantry has to accommodate the OR table, and that the cleanliness of the environment has to be properly maintained. The imaging systems are often movable, so the machine travels to the patient, and not vice-versa.

CT

Intra-operative CT Systems can glide into the OR as fast as 30 seconds. Special devices, such as Visius and Brain Lab's Airo [3] have been developed to provide past iCT images. Low-dose CT and CT-guided interventions can be carried out [4]. The advantages of CT are that we obtain a true image, making registration easy and providing a suitable base for navigation. This technique is often used for skull-based tumours and intra-cranial tumours. With the help of iCT, the surgical procedure can be re-planned as needed due to changes in brain and skull anatomy due to cuts.

MRI

When carrying out Image Guided Surgeries (when resection planning is made based on previous imaging data), surgeons have to consider the brain shifts that happen intra-operatively upon opening up the skull and after the leakage of CSF. In order to be able to follow the anatomy of tissue, serial MRI imaging can be carried out (e.g. with a 0.5 T MRI from GE, the patient does not even have to be moved[5], or with setups where the OR table with patient is moved to an MRI machining).

Apart from MRI, MRS is often also carried out during brain tumour resection to get information on remaining unhealthy tissue.

Ultrasound for intraoperative imaging is performed routinely in the neurological practice. In comparison with the methods previously explained, US allows the differentiation of more structural details within tissue compartments, a crucial point in neuroimaging. Also it is possible to distinguish between healthy tissue and necrosis.

The fact of being quick, real-time, easy to handle in every operating scenario and relatively cheap, makes a big advantage from other intraoperative imaging methods. However, gliomas are not as well defined in US imaging as in CT or MRI.

Fluoroscopy

Fluoroscopy guided surgery is one the rapidly emerging methods of personalised surgery. The main objective is the accurate visualization of brain tumours and residual tumour cells during the surgery for brain tumour resection. In human neurosurgical procedures, the main fluorescence probes are fluorescein sodium, indocyanine green (ICG) and 5-aminolevulinic acid (5-ALA), although not all of them are approved in all countries.

One of the most important characteristics of the probes is their ability to accumulate in tumour tissues in high concentrations. In the case of brain tumours, the blood-brain barrier (BBB) influences the delivery of probes that are not lipophilic or have a molecular weights higher than 400-600 kDa. Photons with longer wavelengths in the NIR spectrum have greater tissue penetration and thus are better for visualize obscure residual tumour tissue or cells.

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