Editorial

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The Critical Role of Awake Brain Mapping in Glioma Surgery

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Gliomas are among the most challenging brain tumors to manage due to their infiltrative nature and frequent proximity to eloquent brain regions responsible for speech, motor, and cognitive functions. The primary goal of glioma surgery is to achieve maximal safe resection, a delicate balance between achieving extensive tumor removal and preserving critical neurological functions. Awake brain mapping has emerged as a transformative approach, enabling surgeons to delineate functional brain areas in real-time and enhancing patient outcomes.

Advancing Surgical Precision

Awake brain mapping leverages direct cortical and subcortical stimulation to identify and preserve eloquent areas during surgery. This technique provides critical feedback as patients perform tasks such as counting, naming objects, or moving specific body parts, allowing surgeons to map the functional anatomy unique to each individual. Studies have shown that awake craniotomies significantly reduce the risk of postoperative neurological deficits while maximizing tumor resection extent[1]. Professor Masazumi Fujii's work on intraoperative subcortical mapping has underscored the unique value of awake surgery in directly demonstrating the functions of white matter tracts and advancing our understanding of the neural basis of language. Although the precise role of the frontal aslant tract (FAT)—which connects the superior frontal gyrus to Broca's area—in language function remains an area of ongoing investigation, preserving this and other white matter tracts during awake procedures is crucial for reducing post-operative deficits and maintaining patients' quality of life[2]

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Enhancing Quality of Life

Beyond surgical precision, awake brain mapping plays a pivotal role in preserving long- term neurological function which directly influences patients' quality of life. Preservation of function is paramount for improving patients' quality of life post-surgery. Traditional glioma surgeries, relying solely on imaging guidance, often fail to account for brain plasticity and individual variability. Awake brain mapping addresses this limitation by tailoring the surgical approach to each patient's functional anatomy. For instance, studies have demonstrated that awake mapping improves outcomes in surgeries involving regions critical for speech and motor control, particularly in low-grade gliomas where long-term functional preservation is crucial[3]. Additionally, Professor Fujii's research on higher brain functions emphasizes the development of specific intraoperative tasks to evaluate and preserve spatial fine and higher-grade motor functions during awake surgeries[4].

Integration with Modern Imaging and Navigation

The combination of awake mapping with advanced imaging modalities such as diffusion tensor imaging (DTI) and intraoperative MRI further plays a key role in advancing neuroscientific knowledge and refines surgical strategies. DTI allows preoperative visualization of white matter tracts, while awake mapping provides real-time intraoperative confirmation of their functional significance[5]. Moreover, intraoperative MRI provides precise anatomy without influence of "brain shift" during surgery. The integration of Intraoperative DTI with a surgical navigation system is particularly valuable when electrical stimulation identifies functional fiber bundles, allowing for informed surgical decisions. This synergy enhances not only the precision of glioma resection but also deepens our knowledge of functional anatomy of the human brain.

Challenges and Future Directions

Despite its advantages, awake brain mapping awakens poses challenges, including patient selection, managing intraoperative discomfort, and ensuring adequate anesthesia to balance alertness with pain control. Addressing these challenges requires multidisciplinary coordination and the development of standardized protocols.

Emerging technologies, such as virtual reality-based preoperative simulations and augmented reality overlays during surgery, hold promise for further improving the accuracy and applicability of awake brain mapping[6]. These innovations could prepare patients preparation, enhance surgical planning, and optimize intraoperative functional assessment making awake procedures more accessible and effective.

Conclusion

Awake brain mapping represents a paradigm shift in glioma surgery, merging the art and science of neurosurgery to optimize patient outcomes. By enabling real-time functional mapping, it reduces neurological deficits and enhances the extent of tumor resection, ultimately improving both survival and quality of life for glioma patients. As advancements in imaging, anesthesia, and navigation systems continue, awake brain mapping will remain a cornerstone of functional neurosurgery, offering hope for patients with these complex tumors.

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