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Awake Brain Surgery: Advancements and Insights into a Revolutionary Procedure

Ingo Willuhn*

Department of Neurology, Erasmus University Rotterdam, Rotterdam, The Netherlands

Introduction

Awake brain surgery, also known as awake craniotomy or awake brain mapping, is a ground-breaking procedure that involves performing brain surgery while the patient is awake and conscious. This innovative technique allows neurosurgeons to accurately map and navigate delicate areas of the brain while minimizing the risk of damage to critical functions such as speech, movement, and sensory perception. Awake brain surgery has revolutionized the field of neurosurgery, enabling more precise and effective treatments for various neurological conditions. In this article, we will explore the advancements and insights surrounding awake brain surgery, shedding light on its techniques, applications, benefits, and future prospects. Awake brain surgery involves a delicate balance between anesthesia and wakefulness. Patients are typically given a combination of sedatives and local anesthesia to numb the scalp and skull. During the surgery, the anesthesiologist continuously monitors the patient's vital signs and ensures their comfort and safety. The use of short-acting anesthetics allows the patient to wake up quickly for interactive cortical mapping [1].

Awake brain surgery is primarily performed to treat brain tumors and epileptic seizures. The main goal is to remove as much of the tumor or abnormal tissue as possible while preserving vital brain functions. By keeping the patient awake during the surgery, neurosurgeons can actively engage them in tasks such as counting, reading, or naming objects, allowing real-time monitoring of brain function. This helps to identify and protect critical brain areas, reducing the risk of post-operative complications. A crucial aspect of awake brain surgery is meticulous pre-operative planning. Neurosurgeons work closely with neurologists, neuropsychologists, and radiologists to identify the precise location of critical brain regions, such as the areas responsible for language, movement, and sensory perception. Advanced imaging techniques like Functional Magnetic Resonance Imaging (fMRI), Diffusion Tensor Imaging (DTI), and Magnetoencephalography (MEG) play a pivotal role in mapping brain function and defining safe surgical corridors [2].

One of the key components of awake brain surgery is intraoperative brain mapping, which enables surgeons to precisely identify and preserve functional areas. Direct Cortical Stimulation (DCS) is commonly employed, involving the application of a mild electrical current to specific brain regions while the patient performs tasks. This technique allows the surgeon to identify eloquent areas and avoid causing damage that could result in neurological deficits. Preserving language function is of paramount importance during brain surgery. Language mapping techniques involve stimulating different cortical regions while the patient names objects, reads, or speaks. Mapping the language areas aids in avoiding deficits such as aphasia. Surgeons often create detailed maps of language-related regions to guide their surgical approach and decision-making during tumor resection. Motor mapping is another critical aspect of awake brain surgery, particularly for tumors located near the motor cortex. By stimulating different areas of the motor cortex, surgeons can identify the precise location of motor function and develop strategies to avoid impairing motor abilities [3].

Description

Motor mapping assists in preserving motor function and reducing the risk of post-operative paralysis or weakness. Mapping sensory areas is essential when operating near sensory cortex regions. Neurosurgeons stimulate specific areas while monitoring the patient's responses to ensure preservation of sensory perception, such as touch, temperature, and proprioception. By accurately identifying and sparing sensory regions, surgeons enhance patient outcomes and quality of life post-surgery. Awake brain surgery has witnessed significant advancements in recent years, driven by advancements in neuroimaging, neurophysiology, and surgical techniques. The integration of intraoperative MRI (iMRI) allows real-time imaging during surgery, enabling better visualization and guidance for the surgeon. Moreover, advanced neurophysiological monitoring techniques, such as Electrocorticography (ECoG) and High-Frequency Oscillations (HFOs), provide valuable insights into brain function and enable more precise mapping. Furthermore, emerging techniques such as optogenetics, which uses light to manipulate brain cells, hold potential for more precise brain mapping and treatment [4].

Apart from tumor resection and epilepsy treatment, awake brain surgery has found applications in various other neurological conditions. It can be utilized for the resection of Arteriovenous Malformations (AVMs), cavernous malformations, and brain lesions near critical functional areas. Additionally, awake brain surgery has shown promise in the treatment of movement disorders like Parkinson's disease, where Deep Brain Stimulation (DBS) electrodes can be accurately placed while the patient is awake. While awake brain surgery offers numerous advantages, it also poses challenges and limitations. The procedure requires highly skilled multidisciplinary teams and specialized facilities. Some patients may experience anxiety or discomfort during the surgery. Additionally, awake brain surgery may not be feasible for all cases, particularly those with significant medical comorbidities or limited patient cooperation. The future of awake brain surgery looks promising. Ongoing research focuses on improving brain mapping techniques, refining surgical approaches, and developing new technologies. Advancements in virtual reality and augmented reality may enhance pre-operative planning and intraoperative guidance. Awake brain surgery has demonstrated favourable outcomes in terms of tumor resection rates and preservation of neurological function. Studies have shown that awake surgery for brain tumors can achieve comparable or even superior tumor removal rates compared to traditional surgery under general anesthesia. Moreover, by preserving critical brain functions, awake brain surgery minimizes the risk of post-operative deficits, leading to improved quality of life for patients.

Awake brain surgery necessitates a collaborative approach involving a multidisciplinary team of healthcare professionals. Neurosurgeons, neurologists, anesthesiologists, neuropsychologists, radiologists, and speech-language pathologists work together to plan, execute, and optimize the surgical procedure. Each team member brings their expertise to the table, contributing to the overall success of the surgery and the patient's well-being. Performing

***Address for Correspondence:** Ingo Willuhn, Department of Neurology, Erasmus University Rotterdam, Rotterdam, The Netherlands, E-mail: ji.willuhn@knaw.nin.nl*

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awake brain surgery raises ethical considerations, particularly regarding patient autonomy, informed consent, and the balance between the potential benefits and risks. It is essential for healthcare providers to thoroughly explain the procedure, potential outcomes, and any associated risks to the patient, allowing them to make an informed decision. Clear and comprehensive informed consent is crucial in ensuring patient autonomy and ethical practice [5].

Conclusion

Awake brain surgery has transformed the field of neurosurgery, enabling surgeons to navigate the intricate landscape of the brain with unprecedented accuracy and safety. By involving patients in real-time brain mapping tasks, neurosurgeons can maximize tumor resection while minimizing the risk of functional deficits. Continued advancements and research in this field offer hope for further refinements and expanded applications, promising better outcomes and improved quality of life for patients with neurological disorders. Awake brain surgery exemplifies the remarkable synergy between medical expertise, technological innovation, and patient-centered care.

Acknowledgement

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Conflict of Interest

None.

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