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Neurosurgical Techniques in Brain Tumor Resection: Innovations and Challenges

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INTRODUCTION

Brain tumor resection, the surgical removal of brain tumors, is a critical component in the management of brain cancer. The primary goal of this procedure is to remove as much of the tumor as possible while preserving neurological function. Over the years, advancements in neurosurgical techniques have significantly improved the outcomes for patients with brain tumors, offering new hope for survival and quality of life. Historically, brain tumor resection has been performed using craniotomy, where a portion of the skull is removed to access the brain. Surgeons would rely on their experience and visual inspection to differentiate between healthy brain tissue and tumor cells. However, this method posed significant challenges, particularly in distinguishing the tumor margins and minimizing damage to critical brain structures. These technologies allow surgeons to visualize the brain and tumor in real-time during surgery, improving precision and reducing the risk of leaving behind residual tumor tissue.

DESCRIPTION

Intraoperative MRI provides high-resolution images of the brain during surgery, enabling surgeons to assess the extent of tumor resection and make adjustments if necessary. This technology has been particularly useful in cases where tumors are located in eloquent areas of the brain, such as those responsible for speech, movement, or sensory functions. Intraoperative ultrasound is another imaging technique used to guide brain tumor resection. It offers real-time imaging and can help identify the tumor's boundaries, making it easier for surgeons to differentiate between tumor tissue and normal brain tissue. This technique is especially valuable for tumors that are difficult to visualize with traditional methods. Fluorescence-guided surgery involves the use of fluorescent dyes that are absorbed by tumor cells, causing them to glow under specific lighting conditions. The most commonly used dye, 5-aminolevulinic acid has been shown to improve the extent of tumor resection and patient outcomes. Neuronavigation reduces the risk of damaging critical brain structures and enhances the surgeon's ability to achieve maximal tumor resection. In cases where the tumor is located near critical brain areas, an awake craniotomy may be performed. During this procedure, the patient is awake and responsive while the surgeon removes the tumor. Laser Interstitial Thermal Therapy is a minimally invasive technique that uses laser energy to ablate tumor tissue.

CONCLUSION

Neurosurgical techniques in brain tumor resection have evolved significantly over the past few decades, leading to better outcomes for patients with brain tumors. Intraoperative imaging, advanced surgical tools, and innovative techniques like awake craniotomy and LITT have enhanced the surgeon's ability to remove tumors while preserving neurological function. However, challenges remain, particularly in achieving complete resection and minimizing damage to critical brain areas. Continued research and technological advancements will be essential in overcoming these challenges and further improving the care of patients with brain tumors. Ongoing research and development in neurosurgical techniques aim to address these challenges. For instance, the integration of artificial intelligence in neurosurgery holds promise for enhancing the accuracy of tumor resection.

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CONFLICT OF INTEREST

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