World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:18, No:07, 2024

A Wearable Fluorescence Imaging Device for Intraoperative Identification of Human Brain Tumors

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Abstract : Malignant glioma (MG) is the most common type of primary malignant brain tumor. Surgical resection of MG remains the cornerstone of therapy, and the extent of resection correlates with patient survival. A limiting factor for resection, however, is the difficulty in differentiating the tumor from normal tissue during surgery. Fluorescence imaging is an emerging technique for real-time intraoperative visualization of MGs and their boundaries. However, most clinical-grade neurosurgical operative microscopes with fluorescence imaging ability are hampered by low adoption rates due to high cost, limited portability, limited operation flexibility, and lack of skilled professionals with technical knowledge. To overcome the limitations, we innovatively integrated miniaturized light sources, flippable filters, and a recording camera to the surgical eye loupes to generate a wearable fluorescence eye loupe (FLoupe) device for intraoperative imaging of fluorescent MGs. Two FLoupe prototypes were constructed for imaging of Fluorescein and 5-aminolevulinic acid (5-ALA), respectively. The wearable FLoupe devices were tested on tumor-simulating phantoms and patients with MGs. Comparable results were observed against the standard neurosurgical operative microscope (PENTERO® 900) with fluorescence kits. The affordable and wearable FLoupe devices enable visualization of both color and fluorescence images with the same quality as the large and expensive stationary operative microscopes. The wearable FLoupe device allows for a greater range of movement, less obstruction, and faster/easier operation. Thus, it reduces surgery time and is more easily adapted to the surgical environment than unwieldy neurosurgical operative microscopes.

Keywords : fluorescence guided surgery, malignant glioma, neurosurgical operative microscope, wearable fluorescence imaging device
Conference Title : ICOP 2024 : International Conference on Optics and Photonics
Conference Location : Tokyo, Japan
Conference Dates : July 22-23, 2024