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Intra-operative positron probe to address surgical challenges in brain surgery

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The survival outcome of a patient suffering from a glioma is directly linked to the complete surgical resection of the tumor. To help surgeons delineate precisely the boundaries of a tumor, we developed an intra-operative positron probe with gamma background rejection capability. The probe was designed to be directly coupled to the excision tool such that detection and removal of the radiolabeled tumors could be simultaneous. The device consists of two interchangeable detection heads composed of clear plastic scintillating fibers. Each head is coupled to an optical fiber bundle that transmits the scintillation light to a photodetector and processing electronic module placed outside the surgical bed. The background rejection method is based on a real-time subtraction technique. In performed phantom tests, the measured probe sensitivity for 18F was 41cps/kBq for the small detection head and 121cps/kBq for the large head. The obtained mean spatial resolution was 1.6 mm FWHM on the detector surface. The γ-ray rejection efficiency measured by realistic brain phantom modeling of the surgical cavity was 99.6%. These phantom studies also demonstrated the ability of the probe to detect disc tumor lesions as small as 5 mm in diameter (20 mg) for tumor-to-background ratios higher than 3:1 and with an acquisition time around 4s at each scanning step. These results indicate that our detector could be a useful addition to existing techniques for the accurate excision of brain tumor tissue and more generally to improve the efficiency of radio-guided cancer surgery.

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