Near-Infrared Fluorescence-Guided Stereotactic Biopsy of High Grade Glioma

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Introduction

Stereotactic needle biopsies provide a minimally invasive option for the diagnosis of intracranial lesions but are limited by inconclusive diagnoses on frozen pathology. Additional samples and prolonged procedure times increase risk of complications (1). 5-Aminovelunic acid (5-ALA) and sodium fluorescein have previously demonstrated potential as diagnostic adjuvants for rapid intraoperative pathology (2,3). Stereotactic biopsy with near-infrared (NIR) fluorescence has not been reported. We identified five representative cases utilizing the NIR-fluorescent dye Indocyanine-Green (ICG), administered in a high dose, delayed manner.

Proposed Mechanism of Second Window ICG (SWIG)

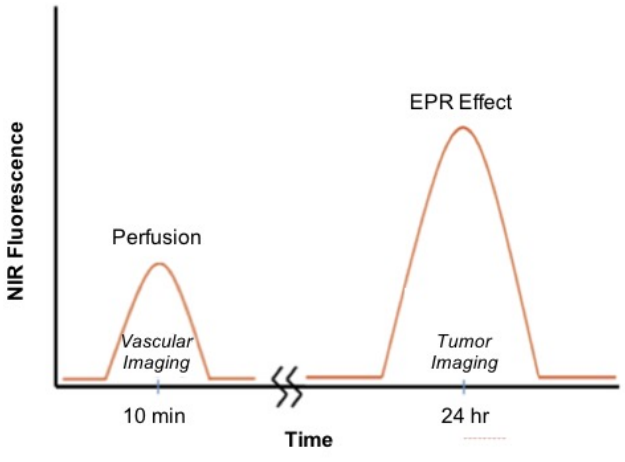
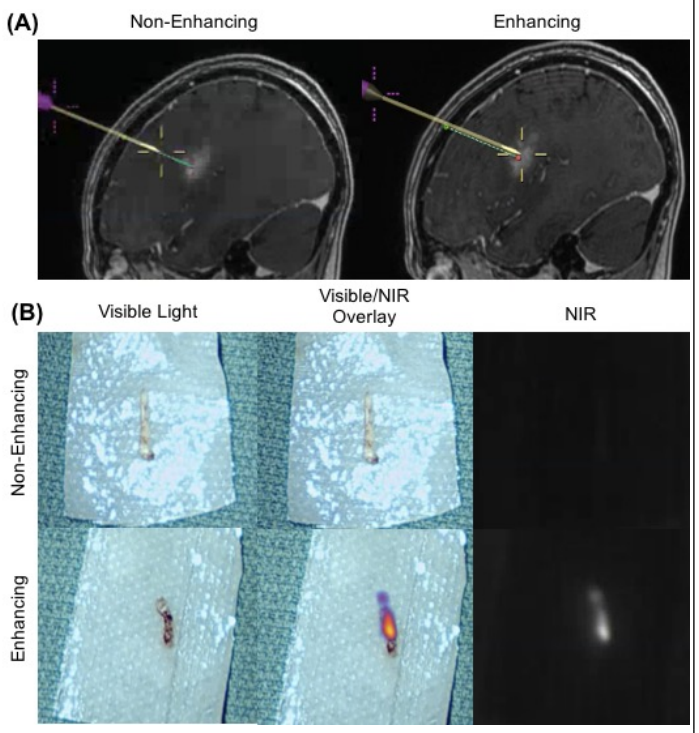


Illustration of extended time window of ICG perfusion required for tumor visualization underlying SWIG

Methods

We identified five patients enrolled in an ongoing IRB-approved protocol who underwent Second Window ICG (SWIG)-guided stereotactic biopsy for diagnosis of suspected glioma or tumor recurrence. Up to 5 mg/kg ICG was administered approximately 24 hours prior to surgery. Stereotactic core needle biopsies were conducted in the standard fashion, targeting regions of suspected tumor using intraoperative frameless navigation. Core samples were examined under standard visible light and for fluorescence using conventional NIR imaging platforms intraoperatively. Findings were correlated with frozen and final tumor pathology for all cases.

Correlation of Biopsy Tissue Enhancement with Near-infrared Fluorescence



(A) Intraoperative views of navigational MRI showing biopsied locations outside (L) and with n (R) contrast-enhacing target tissue. (B) Respective biopsy specimen appearance under visible, visible/NIR overlay, and NIR black and white.

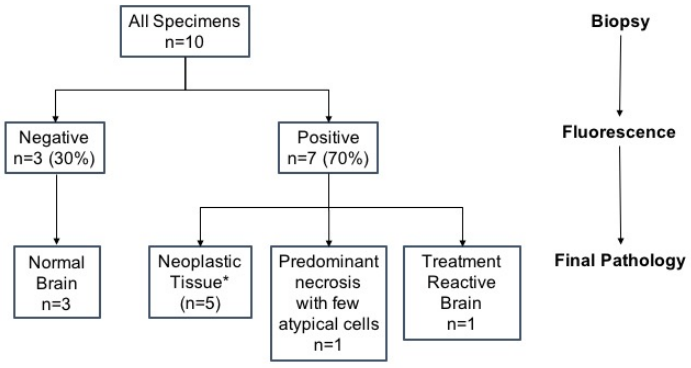
Results

Ten specimens were obtained in five patients. Three (30%) did not fluoresce and did not demonstrate tumor on preliminary or final pathology, including a non-gadolinium-enhancing sample taken proximal to the final target. The remaining 7 (70%) samples fluoresced, of which 5 (71%) contained positively identifiable tumor. One sample (14%) contained necrosis; however, a separate fluorescent biopsy from this patient demonstrated glioblastoma. Fluorescence was also noted in a patient with radiation treatment effect. Overall fluorescence characteristics were highly concordant with both preliminary and final diagnoses.

Conclusions

SWIG provides rapid intraoperative confirmation of gadolinium-enhancing, pathologic brain tissue during stereotactic biopsy. Because the mechanism of ICG accumulation is similar to that of gadolinium in permeating neoplastic or inflammatory brain tissue, we believe SWIG-guided stereotactic biopsy can improve surgical efficiency by improving confidence in acquisition of target tissue.

Biopsy Fluorescence Correlation with Final Pathology



* Final pathologies:
Glioblastoma, IDH-wildtype, WHO grade IV (n=2)
High grade astrocytoma, IDH-wildtype, at least WHO grade III (n=2)
Anaplastic astrocytoma, IDH-wildtype, WHO grade III (n=1)

Histologic determination of all biopsy specimens classified by positive/negative intraoperative near-infrared fluorescence.

Acknowledgements

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References

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