Feasibility of Brain Tumor Surgery Guided by High Resolution Intraoperative Positron Emission Tomography (PET) Imaging, Phantom Study

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Disclosure

Herewith we confirm that we do not have any relevant financial relationships with commercial interests

We have no actual or potential conflict of interest in relation to this presentation.
Introduction

PET imaging with $^{18}\text{F}$-fluorodihydroxyphenylalanine ($^{18}\text{F}$-DOPA) have been successfully used for preoperative visualization of brain tumors, but intraoperative PET imaging was not previously feasible due to limitations in conventional scanner design and low spatial resolution. New generation of portable, high-resolution, dedicated brain PET devices enables intraoperative PET imaging to control tumor removal.
Methods

In the first series of experiments, 1200cc gelatin “brain” phantom was mixed with $^{18}$F-DOPA to background activity concentration of 0.23 uCi/cc. Gelatin lesions (“tumors”) with volumes of 2ml, 1ml, 0.5 and 0.2 ml were mixed with $^{18}$F-DOPA to activity concentration of 0.61 uCi/cc and 1.22 uCi/cc to achieve the lesion/background ratio of 2.5:1 and 5:1 respectively. The “tumors” were implanted into the “brain” phantom before scanning. PET was performed with a portable, high-resolution, dedicated brain PET scanner. Whole-brain PET datasets were acquired for 10 minutes and reconstructed using Maximum Likelihood Estimation Method (MLEM).

In the second series the phantom colored gelatin lesions with volumes of 2ml, 1ml, 0.5 and 0.2 ml were inserted into the gelatin brain phantom to achieve lesion/background ratio of 5:1. The phantom was installed in the field of view of PET scanner and lesions were removed gradually under PET guidance to imitate partial and gross total tumor removal.
**iCerePET spatial resolution experiment**

**Brain Phantom:** 250 grams of food yellow gelatin was dissolved in hot water to receive 1 liter of solution. After that of 18F-FDOPA was administered and the solution was cooled in ice to a tight-elastic consistency. Therefore background was 0.23 uCi/cc.

**Lesion Phantom:** The same stuff and technology was used to get the samples of cherry and orange color. In a 500 ml flask the cherry solution of gelatin was mixed with 18F-FDOPA to get activity 0.61 uCi/cc. Therefore the ratio lesion: background was 2.5:1.

200 ml orange solution was mixed with 18F-FDOPA and obtained activity 1.22 uCi/cc. The ratio was 5:1.

**Model I:** Lesion phantom samples were implanted into the brain phantom.
Model I iCerePET scanning

5:1 and 2.5:1 lesions can be clearly visualized on PET scans, however at 2.5:1 lesion/background ratio 0.2 mL lesions are likely close to the limit of detection.
iCerePET “brain tumor” removal experiment

Colored gelatin lesions with volumes of 2ml, 1ml, 0.5 ml and 0.2 ml were inserted into the gelatin brain phantom to achieve lesion/background ratio of 5:1

Model II iCerePET scanning
iCerePET “brain tumor” removal experiment

Gelatin lesions were removed gradually under PET guidance to imitate partial and gross total tumor removal
Results

In the first experiment series all 5:1 and 2.5:1 lesions can be clearly visualized on PET scans, however at 2.5:1 lesion/background ratio 0.2 mL lesions are likely close to the limit of detection. In the second experiment, gradual extraction of gelatin “tumors” under PET guidance was successful and no colored “tumor” residues were found on subsequent visual inspection of the phantom by an independent observer.
Conclusion

High-resolution brain PET imaging is feasible in the intraoperative environment. The $^{18}$F-FDOPA PET guidance can be successfully used for monitoring the extent of tumor removal.