A Versatile Imaging System for In Vivo Small Animal Research

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Abstract

The goal of this dissertation is to develop a high-performance imaging system that can readily meet a wide range of requirements for a variety of *in vivo* small animal imaging applications. Several achievements have been made in order to fulfill this goal.

To supplement our system for parallel-hole single photon emission computed tomography (SPECT) based upon a 110 mm diameter circular detector, we have developed novel compact gamma cameras suitable for imaging an entire mouse. Both phantom and animal studies have demonstrated that these gamma cameras perform well for planar scintigraphy and parallel-hole SPECT of mice.

To further address the resolution limitations in parallel-hole SPECT and the sensitivity and limited field of view of single-pinhole SPECT, we have developed novel multipinhole helical SPECT based upon a 110 mm diameter circular detector equipped with a pixellated NaI(Tl) scintillator array. Results obtained in SPECT studies of various phantoms show an enlarged field of view, very good resolution and improved sensitivity using this new imaging technique.

These studies in small-animal imaging have been applied to in vivo biological studies related to human health issues including studies of the thyroid and breast cancer. A re-evaluation study of potassium iodide blocking efficiency in radioiodine uptake in mice suggests that the FDA-recommended human dose of stable potassium iodide may not be sufficient to effectively protect the thyroid from radioiodine contamination. Another recent study has demonstrated that multipinhole helical SPECT can resolve the fine structure of the mouse thyroid using a relatively low dose (200 μCi). Another preclinical study has focused on breast tumor imaging using a compact gamma camera and an endogenous reporter gene. In that ongoing study, mammary tumors are imaged at different stages. Preliminary results indicate different functional patterns in the uptake of radiotracers and their potential relationship with other tumor parameters such as tumor size.

In summary, we have developed a versatile imaging system suitable for *in vivo* small animal research as evidenced by a variety of applications. The modular construction of this system will allow expansion and further development as new needs and new opportunities arise.