

Development Towards Non-invasive Breast Cancer Imaging Using Novel Estrogen Conjugates Fluorescent Dye

Francis .K. J.¹, I. Jose¹

¹Christ University, Bangalore, Karnataka, India

Abstract

Determination of Estrogen Receptor [ER] status is a key in detecting cancer pathogenesis at early stage. In our work we discuss Near Infrared Fluorescence [NIRf] Molecule Optical Imaging Diagnostic modality for early detection of breast cancer. A novel target-specific NIRf dye conjugate aimed at measuring Estrogen Receptor[ER] status was synthesized by ester formation between 17- β estradiol and a hydrophilic derivative of Indocyanine Green (ICG) cyanine dye, bis-1,1-(4-sulfobutyl) indotricarbocyanine-5-carboxylic acid, sodium salt. In-vitro studies regarding specific binding and endocytosis of the dye performed on ER+ve [MCF-7] and control [MDA-MB-231] adenocarcinoma breast cancer cell lines clearly indicated nuclear localization of the dye for MCF-7 as compared to plasma level staining for MDA-MB-231. Furthermore, MCF-7 cells showed ~4.5-fold increase in fluorescence signal intensity compared to MDA-MB-231.

Phantom model is created in COMSOL Multiphysics to study the in-vivo efficiency of the dye. It is excited with point source modeling laser diode and fluency at the boundary is calculated with Standard Diffusion Approximation. Model with inclusions imitating property of cancerous cell is excited with laser (Figure 1) and the emission (Figure 2) is used as measurement set, and another model of homogenous optical property is taken as the initial set for inverse solving. Both the excitation (754nm) and emission (787nm) equations are inverted using iterative Levenberg-Marquardt method with Tikhonov minimization of measurement and calculated matrix. The result of reconstructed absorption and scattering properties were recorded for different concentrations of dye. Comparison in terms of error function, Normalized Root Mean Square (NRMS) error and computing time are also produced in the result. We conclude by stating that this lipophilic dye can be potentially used as a target specific exogenous contrast agent in molecular optical imaging for early detection of breast cancer.

Reference

- 1) Shubhadeep Bhattacharjee & Iven Jose, "Early detection of Breast Cancer: A Molecular Optical Imaging approach using novel estrogen conjugate fluorescent dye", Proc. of SPIE Vol. 7896 78961F-1-15(2011)
- 2) Iven Jose & Kodand Dinakar Deodhar et al, "Early Detection of Breast Cancer: Synthesis and Characterization of Novel Target Specific NIR-Fluorescent Estrogen Conjugate for Molecular Optical Imaging, Springer, J Fluoresc, 1171-1177 (2010)
- 3) Hamid Dehghani and Matthew E. Eames et al, "Near infrared optical tomography using NIRFAST: Algorithm for numerical model and image reconstruction", John Wiley & Sons, communications in numerical methods in engineering, (2008)

Figures used in the abstract

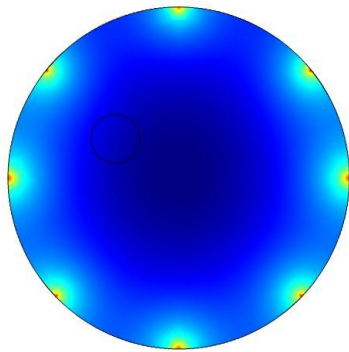


Figure 1: Laser excited(754nm) phantom model.

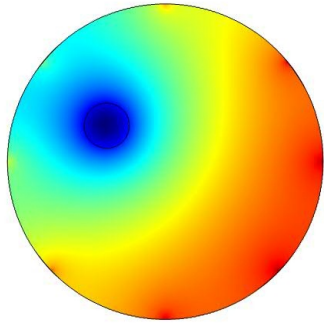


Figure 2: Fluorescent emission(787nm) from phantom.