Low Dose Molecular Breast Imaging.

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Abstract

Background: Several new nuclear medicine-based breast imaging techniques have emerged over the last few years. These include Positron Emission Mammography (PEM), Breast Specific Gamma Imaging (BSGI) and Molecular Breast Imaging (MBI). These techniques usually employ doses of ~ 10 mCi F-18 FDG in the case of PEM, or 20-30 mCi Tc-99m sestamibi in the cases of BSGI or MBI. In addition to their potential value as adjunct diagnostic tools, these techniques hold promise as potential adjuncts to screening mammography particularly for women with dense breast tissue where the sensitivity of mammography is known to be reduced. A previous study has shown MBI to have 2-3 times the sensitivity and equivalent specificity to screening mammography in women with dense breasts. However, the current administered doses employed in these techniques deliver effective radiation doses that are ~10 times higher than mammography.

From the BEIR VII tables, the lifetime associated risks from PEM, BSGI and MBI can be calculated and compared to that of screening mammography. These estimates indicate that in order to achieve a comparable radiation burden to mammography, the administered doses of F-18 FDG and Tc-99m sestamibi need to be reduced to less than 2 mCi F-18 FDG and 4 mCi Tc-99m sestamibi.

This presentation will briefly review the clinical literature demonstrating the value of these new techniques in both diagnostic and screening applications, and will review the dosimetry and estimated lifetime associated risks from these technologies. It will then focus on one of these technologies – MBI, and will illustrate how we can optimize the physics of the collimation and detector to achieve a 5-fold reduction in the required dose of Tc-99m sestamibi for clinical studies. We will also review possible post-acquisition processing techniques that may enable further reduction in dose, along with alternative radiopharmaceuticals that deliver low doses due to their biodistribution.

A total of 4 dose reduction schemes will be discussed – a) development of optimized collimation for single-photon imaging, b) improved utilization of the energy spectral characteristics of the gamma cameras, c) implementation of noise reduction and resolution recovery algorithms, and d) use of adaptive geometric mean algorithms for combination of images from opposing detectors. In addition we will consider alternative radiopharmaceuticals, such as Tc-99m MDP that deliver a lower radiation burden than Tc-99m sestamibi.

We will demonstrate that image quality obtained with low-dose MBI performed with 4 mCi Tc-99m sestamibi matches that of standard MBI performed with 20 mCi dose. Low-
dose MBI presents radiation risks to the patient comparable to that of digital screening mammography, allowing its safe implementation as a screening technique.