Purpose: To characterize the suitability of the use of a homogeneous mixture of adipose and glandular tissue approximation for breast imaging dosimetry.

Methods: Fifteen patient breast computed tomography images (BCT) were classified into skin, adipose, and glandular tissue. The segmented breasts underwent simulated mechanical compression to mimic breast compression during mammographic acquisition. Using Monte Carlo simulations representing BCT and mammographic acquisitions, the radiation dose to the voxels representing glandular tissue for both the uncompressed and compressed breasts was estimated. The BCT simulations used both a 49 kVp and 80 kVp tungsten target spectrum, while the mammography simulations used the spectra corresponding to the patient’s screening cranio-caudal view mammogram. The simulations were repeated by replacing the adipose and glandular voxels with voxels representing a homogeneous mixture of the two tissues in their corresponding proportions. The normalized glandular dose (DgN) of the true heterogeneous breast tissue distribution and the homogeneous approximation was compared using a paired t-test.

Results: For mammography, the approximated homogeneous DgN was on average 61% higher than the heterogeneous DgN (p<10^-6). For BCT, the homogeneous DgN overestimated dose by an average of 27% (p<10^-5) and 12% (p<10^-4) for the 49 kVp and 80 kVp spectra, respectively. For all conditions and all breasts the homogenous DgN was higher than the heterogeneous DgN except for one breast, in which they were equal for the BCT simulations.

Conclusions: The homogeneous mixture approximation commonly used for breast imaging dosimetry significantly overestimates the actual dose to the glandular tissue. Although this may be adequate for technique, modality and/or system comparisons, it is inevitable that these dose estimates are used inappropriately (e.g. for risk estimates), making this overestimation undesirable. Further study with a larger number of patients is required to obtain appropriate correction factors to better estimate breast glandular dose in the future.