

Estimation of Normalized Glandular Doses Using a Three-Layer Mammographic Phantom

Authors : Kuan-Jen Lai, Fang-Yi Lin, Shang-Rong Huang, Yun-Zheng Zeng, Po-Chieh Hsu, Jay Wu

Abstract : The normalized glandular dose (DgN) estimates the energy deposition of mammography in clinical practice. The Monte Carlo simulations frequently use uniformly mixed phantom for calculating the conversion factor. However, breast tissues are not uniformly distributed, leading to errors of conversion factor estimation. This study constructed a three-layer phantom to estimate more accurately of normalized glandular dose. In this study, MCNP code (Monte Carlo N-Particles code) was used to create the geometric structure. We simulated three types of target/filter combinations (Mo/Mo, Mo/Rh, Rh/Rh), six voltages (25 ~ 35 kVp), six HVL parameters and nine breast phantom thicknesses (2 ~ 10 cm) for the three-layer mammographic phantom. The conversion factor for 25%, 50% and 75% glandularity was calculated. The error of conversion factors compared with the results of the American College of Radiology (ACR) was within 6%. For Rh/Rh, the difference was within 9%. The difference between the 50% average glandularity and the uniform phantom was 7.1% ~ -6.7% for the Mo/Mo combination, voltage of 27 kVp, half value layer of 0.34 mmAl, and breast thickness of 4 cm. According to the simulation results, the regression analysis found that the three-layer mammographic phantom at 0% ~ 100% glandularity can be used to accurately calculate the conversion factors. The difference in glandular tissue distribution leads to errors of conversion factor calculation. The three-layer mammographic phantom can provide accurate estimates of glandular dose in clinical practice.

Keywords : Monte Carlo simulation, mammography, normalized glandular dose, glandularity

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