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Breast tumor imaging using coded aperture: Monte-Carlo simulation study

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Background: Scintimammography (SM) is a promising functional radionuclide imaging technique that is generally undertaken using high resolution parallel-hole collimators with Gamma Cameras. The main clinical limitation of this technique is inaccuracy in detecting small lesions less than 1 cm diameter. This limitation is due to resolution-efficiency trade-off that is inherent in the use of collimation. As an alternative approach this study proposes using a simple Coded Aperture (CA) mask, instead of a collimator, coupled to a standard clinical gamma camera for breast tumor imaging. This imaging technique successfully predicts the overall form of artefacts arising from the near-field imaging geometries.

Aim & Methods: To investigate the applications of CA technique a Monte Carlo Simulation (MCS) is used using MCNPX package. To emulate SM, 3D pseudo-anthropomorphic phantoms have been developed and verified and used along with a realistic model of a clinical gamma camera. This study examines a moderately compressed breast phantom in a cranio-caudal-projection. The performance of such an imaging system is modeled by the MCS method and images are reconstructed by correlation analysis. This imaging system was quantitatively evaluated using variable parameters: The detected photon from tumor, spatial resolution, photon statistics and lesion visibility of the system at several tumor-background activity ratios. The effectiveness and the performance of the CA-SM system was assessed and compared with low energy high resolution parallel-hole collimator and ultra-high resolution parallel-hole collimator image formation systems.

Results: The predicted background can be used to correct the near-field effect of 3D sources, as might be found in SM using CA. The simulated planar images from these collimator-based image formation systems suggest tumors of 1 cm diameter may be observable with a tumor-background-ratio of 5:1. However, when the tumor diameter is ≤0.8 cm these become less reliable detecting small (less than 1 cm in diameter) lesion unless a tumor-background-ratio of more than 10:1 is used.

Conclusion: The results of the simulations demonstrate that with near-field artefacts corrections the CA-SM approach shows good performance in lesion detection for all lesions (located 3 cm deep in a 6 cm thick breast phantom) and for a tumor-background ratio as low as 3:1. This level of performance is highly competitive, in some cases, superior to conventional collimator based image formation methods.

Biography

M A Alnafea is presently working as an Assistant professor in ***King Saud University, Saudi Arabia.*** He attended several International and National conferences. He published several article in different journals as well.

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