Monte Carlo design of optimal wire mesh collimator for breast tumor imaging process.

ABSTRACT

This paper presents the modeling of breast tumor imaging process using wire mesh collimator gamma camera. Previous studies showed that the wire mesh collimator has a potential to improve the sensitivity of the tumor detection. In this paper, we extend our research significantly, to find an optimal configuration of the wire mesh collimator specifically for semi-compressed breast tumor detection, by looking into four major factors: weight, sensitivity, spatial resolution and tumor contrast. The numbers of layers in the wire mesh collimator is varied to optimize the collimator design. The statistical variations of the results are studied by simulating multiple realizations for each experiment using different starting random numbers. All the simulation environments are modeled using Monte Carlo N-Particle Code (MCNP). The quality of the detection is measured directly by comparing the sensitivity, spatial resolution and tumor contrast of the images produced by the wire mesh collimator and benchmarked that with a standard multihole collimator. The proposed optimal configuration of the wire mesh collimator is optimized by selecting the number of layers in wire mesh collimator, where the tumor contrast shows a relatively comparable value to the multihole collimator, when it is tested with uniformly semi-compressed breast phantom. The wire mesh collimator showed higher number of sensitivity because of its loose arrangement while the spatial resolution of wire mesh collimator does not shows much different compared to the multihole collimator. With a relatively good tumor contrast and spatial resolution, and increased in sensitivity, a new proposed wire mesh collimator gives a significant improvement in the wire mesh collimator design for breast cancer imaging process. The proposed collimator configuration is reduced to 44.09% from the total multihole collimator weight.