

Purpose: Single photon emission computed tomography (SPECT) is being investigated for imaging inside radiation therapy (RT) treatment rooms to target tumor biology. Because of the space occupied by RT devices and the size and weight of typical gamma cameras, it may be more practical to image with a compact detector. However, data truncation due to smaller detector size can potentially degrade target localization. Here target localization is evaluated for full-size and compact parallel-hole-collimated SPECT detectors.

Methods: Twelve 1.5-cm-diameter tumors, with 6:1 activity ratios, were simulated in a XCAT phantom. Modeled scan time was 5 minutes. Ensembles of 100 scans were simulated for 3 cases: (a) 45-cm-wide detector, no image truncation; (b) 20-cm-wide detector with surface-connected, completely-sampled common volume (CV); and (c) 20-cm-wide detector with interior, incompletely-sampled CV. On average, the 20-cm-wide detector could achieve closer proximity to the phantom, thus improving spatial resolution. Images were reconstructed using OSEM. Localization error was evaluated as the distance between the true tumor location and the location estimated by a numerical observer. Differences in localization were assessed for significance using the Wilcoxon rank-sum test.

Results: Localization errors from the 45-cm-wide detector were used as a baseline for evaluating the performance of the 20-cm-wide detector. Finding 1: For tumors inside the CV of the 20-cm-wide detector, localization performance was generally comparable to the 45-cm-wide detector. However, localization was significantly better ($p=0.012$) using the 20-cm-wide detector in one case. Finding 2: Localization was degraded for tumors on the CV boundary. Finding 3: Localization performance of the 20-cm-wide detector was typically worse, and substantially so, for tumors outside its CV.

Conclusions: These preliminary results show that, with 180-degree parallel-hole-collimated detector trajectories, localization performance of a compact detector was comparable to that of a full-size detector within the CV of the smaller detector, even an interior CV.

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None.