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Validating Retrospective SPECT Frame Duration Shortening Using Phantom Measurements

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Keywords

Radiopharmaceutical dosimetry; Quantitative SPECT; ^{177}Lu dosimetry

Abstract

Introduction

The current OHSU Single Photon Emission Computed Tomography (SPECT) protocol for ^{177}Lu radiopharmaceutical dosimetry takes roughly 1 hour, which is difficult for both patients and scheduling. Reducing frame duration would reduce scan time, however the effect on dosimetry results is unknown. In this research, we investigated the validity of a retrospective frame shortening reconstruction technique using phantom scans, with the eventual goal of shortening patient scans.

Methods

A NEMA IEC PET Body phantom was injected with $14.6\mu\text{Ci/ml}$ $^{99\text{m}}\text{Tc}$ in hot spheres, and $1.97\mu\text{Ci/ml}$ in background. SPECT/CT scans were taken with frame durations of 15s, 7s, and 3s. The 15s scan was then reconstructed using vendor software to mimic 7s and 3s frame durations. ROIs were created for hot spheres and background. Voxel counts were extracted and counts/second per μCi (cps/ μCi i.e. sensitivity) was calculated. A student's t-test was performed to test for differences between real vs. reconstructed scans.

Results

Sensitivity calculations of hot spheres and background yielded 2.17 ± 0.20 cps/ μCi for 15s/frame, 2.25 ± 0.18 for 7s/frame, 1.99 ± 0.23 for 3s/frame, 2.18 ± 0.23 for 7s/frame reconstructed, and 2.12 ± 0.29 for 3s/frame reconstructed. These sensitivity values show no statistically significant difference between real shortened frame scans and reconstructed frame shortened scans, and sensitivity values of all shortened scans agreed with the current clinical 15s/frame duration scan. Additionally, t-test comparison of voxel count values in ROIs show no statistically significant difference between the 7 second real vs reconstructed frame duration images ($p < 0.001$), nor for the 3 second real vs reconstructed frame duration images ($p < 0.0001$).

Conclusion

This study provides strong evidence that retrospective scan reconstruction with frame duration shortening is an accurate way to mimic frame shortened scans. Using this tool, patient scans can be reconstructed with shortened frames, and dosimetry results compared to assess the feasibility of shortening SPECT scans clinically.