ABSTRACT

The utilization of Single Photon Emission Computed Tomography - Computed Tomography (SPECT-CT) modalities in nuclear medicine heavily relies on the mechanical stability of the gantry and the accuracy of software quantification. This study aims to evaluate the mechanical quality assurance through Center of Rotation (COR) testing and analyze the volumetric accuracy of Iodine-131 (I-131) radiopharmaceuticals inside a syringe using the GE NM/CT 670 SPECT-CT system and Xeleris 4 software. The COR test was performed using a 0.05 cc I-131 point source with a High Energy General Purpose (HEGP) collimator. Meanwhile, the volumetric accuracy evaluation was conducted by scanning a syringe with volume variations of 1 mL, 3 mL, and 5 mL at a constant activity of 1 mCi using a step-and-shoot tomographic protocol. Region of Interest (ROI) delineation was executed on CT images using visual thresholding based on color bar contrast, which was then copied to SPECT images for total volume calculation. The COR test results revealed that the spatial shift deviation on the X and Y axes for both detectors ranged from -0.10285 mm to 0.00000 mm. This completely satisfies the acceptance criteria of NEMA and IAEA standards ($-0.55 < x < 0.55$ mm), confirming that the gantry is in excellent condition and operational without the risk of ring artifacts. Regarding object quantification, the volumetric accuracy varied. CT images demonstrated a highly stable and linear volume detection performance, across the 1 mL to 5 mL volume range due to the high spatial resolution of X-rays. Conversely, SPECT images suffered from significant overestimation with high error percentages at micro volumes (1 mL and 3 mL) due to the dominance of the Partial Volume Effect (PVE) and the spill-out phenomenon of high-energy photons from I-131 on the HEGP collimator. However, SPECT accuracy increased drastically and reached an optimal point with the lowest error of 8.18% when the object volume dimension (5 mL) exceeded the gamma camera system's Full Width at Half Maximum (FWHM) resolution limit. This study concludes that despite highly precise mechanical gantry alignment, functional volume quantification of small objects still requires the implementation of a Recovery Coefficient to minimize systemic bias in internal dosimetry calculations.

Keywords*: SPECT-CT, Center of Rotation, I-131, volume, nuclear medicine.*