Image-based SPECT calibration based on the Fraction of Activity in Field of view (FAF)

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Résumé

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Introduction: SPECT quantification is particularly important for dosimetry in Targeted Radionuclide Therapy (TRT) and the calibration of SPECT images is a crucial stage for image quantification. The current standardized calibration protocol (MIRD 23 [1]) makes use of phantom acquisitions in specific conditions and require an additional phantom calibration for every clinical acquisition protocol. We proposed an alternative and complementary image-based calibration method that allows obtaining a single calibration factor adapted to each patient, radionuclide and acquisition protocol, without specific phantom acquisition.

Methods: This method consists in SPECT images quantification from WB planar images. First, the conjugate view of WB planar images is computed after scatter and attenuation corrections. 3D SPECT images are acquired in the same patient position, reconstructed with scatter, attenuation and Collimator Detector Response (CDR) corrections, and finally corrected from apparent dead-time. The Field of View (FOV) of the SPECT images is then projected on the corrected WB planar image. The fraction of activity located in the area corresponding to the SPECT FOV is calculated based on the counts on the corrected WB planar image. The Fraction of Activity in Field of View (FAF) is then proposed to compute the calibration factor as the total number of counts in the SPECT image divided by this

*Intervenant

activity. Quantification accuracy was compared with the standard calibration method both with phantom experiments and on patient data.

Results: Both standard and our image-based calibrations give good accuracy (ranges of respectively [-0.97; 2.86]% and [0;3.16]%) on large region of interest on phantom experiments. Apparent dead-time correction allows reducing the uncertainty associated with standard calibration with a coefficient of variation of the calibration factor of 0.17% instead of 2.39%. The differences on accuracy found between both methods on phantom study were lower (1.01% in average) than the uncertainty range with the standard calibration (2.90% in average). On patient study, although the ground truth is unknown, the standard calibration factor is also close (3.96% in average) to the image based patient specific one.

Conclusions: Calibration was performed directly on the image acquisition of interest. This method allows overriding the errors caused by imperfect attenuation and scattering corrections due to different conditions. This protocol is as accurate as standardized calibration protocol but only requires an additional WB planar acquisition. The main limitation relies on the need of performing the acquisition before patient biological elimination.

References:

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Mots-Clés: Targeted Radionuclid Therapy, SPECT Quantification, Calibration Factor