The ^{123}I -*m*IBG heart/mediastinum ratio: Moving from 2D to 3D imaging

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The first observation on the possibility of investigating the cardiac adrenergic system using ^{123}I -*meta*iodobenzylguanidine (^{123}I -*m*IBG) scan date back to the early 1980s¹. Since then, the clinical role of cardiac imaging with ^{123}I -*m*IBG has become a widely accepted method to assess the integrity and activity of cardiac sympathetic innervation. Currently, it represents a fundamental approach in the diagnosis of Parkinson's disease and the study of Heart Failure^{2,3}. ^{123}I -*m*IBG scintigraphy relies on the evidence that norepinephrine and *m*IBG have the same mechanisms for uptake, storage, and release. ^{123}I -*m*IBG uptake is semi-quantitatively assessed by calculating the heart (H) to mediastinum (M) ratio (H/M ratio), by drawing regions of interest (ROI) over the heart and the upper mediastinum in the planar anterior view, generally obtained 15 minutes and 4 hours after injection (early and late imaging). A major issue affecting H/M ratio reproducibility is due to physical characteristics of ^{123}I , where high-energy photons cause collimator septal penetration and scatter detected in the energy window of the 159-keV photopeak. Consequently, both low energy and medium energy collimators equipping Anger cameras are used in clinical practice, leading to different acquisition set-up characteristics applied, therefore, results in different normal and pathologic H/M ratio values among

different centers^{4,5}. Many authors have addressed this issue by proposing systems of data harmonization between different collimation and acquisition methods^{6,7}. Moreover, the continuous technological advances have led to the use of newly developed detectors (i.e., CZT detectors) in clinical practice, and based on the most recent literature data, further innovations in terms of introduction of new concept collimation systems for Anger camera, introduction of new scintillation crystals, as well as new concept of radionuclide imaging systems are expected soon^{8–10}. By focusing only on the collimation field, in the last years, a number of different methods have been studied. Some of these are based on fixed angle collimation systems: the acquisition is obtained during an orbital rotation of the detector that acquires different projections of the object, and sectional images are then obtained by summing filtered projections. Another proposed rotational system is the Rotating Multi-Segment Slant-Hole (RMSSH) single-photon emission computed tomography (SPECT), where the RMSSH system combines a conventional SPECT system with an RMSSH collimator^{11,12}. It appears evident how most of the technological improvements lead to a tomographic rather than a planar acquisition approach. Therefore, the need to introduce and clinically validate cross-calibration methodologies is evident not only between different detectors, but also between different acquisition methods. When approaching with functional images, the visibility of organs or lesions, represented by a radioactive source, becomes a fundamental aspect. In this field, a primary parameter is represented by the contrast-to-noise ratio, in which effective organ contrast is defined as (organ signal—background signal) divided by background signal, and the noise level (i.e., percentage noise) is given by the inverse square root of the background count density multiplied by the area of the source to be detected. For low energy emitting nuclides (such as $^{99\text{m}}\text{Tc}$ and ^{123}I), the Anger camera detection sensitivity of the gamma

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rays is very high, and the collimator is the limiting factor with respect to sensitivity. For parallel-hole collimators used in gamma cameras, sensitivity ranges from a low of $100 \text{ cpm}\cdot\text{pCi}^{-1}$ (for a very high spatial resolution collimator) to a high of $1,350 \text{ cpm}\cdot\text{pCi}^{-1}$ (for a high sensitivity collimator). We can affirm that the visibility and the estimation of the uptake ratio between organ and background, (in our case H/M ratio), is greatly influenced by the type of collimator, acquisition matrix, and acquisition times used in the various centers. This represents a very well-known issue to operators, for example, evidenced by the significant change in the normal and pathological values of the H/M ratio if measured with low or medium energy collimators. If we then try to imagine how conceptually distant is to measure an uptake ratio on “raw” data, coming from planar images, compared to that obtainable from image subjected to filtered reconstruction processes, which in turn can vary between the various centers (FBP or OSEM, just to provide an easy-to-understand example), we can realize what impact a procedure can have to make the obtained data comparable. It is our opinion that, based on what has been described so far, the work of Shibutani et al published in this issue of the Journal of Nuclear Cardiology® is of primary importance¹³. We believe that this work clearly demonstrates the possibility of converting tomographic images into a “planar surrogate” in the specific case of an IQ-SPECT, whereby using a dedicated multifocal collimator system on a general-purpose gamma camera, an increased count sensitivity is obtained. Moreover, it provides a conceptual approach, which consists in obtaining what the authors call “planar-equivalent images”, a sum of coronal images obtained from a transversal image by applying multi-planar reconstruction and ray-summation processing. Even though tomographic images inevitably increase the contrast values compared to the planar ones, the validated approach of cross-calibration procedures based on phantoms, provides a repeatable method of data reproducibility. The introduction of new detectors dedicated to nuclear cardiology studies that are able to generate tomographic images only, together with the possibility of reducing patient dose as well as scan times, entail the impossibility of obtaining planar images, leading to the potential risk of having to renounce to validated parameters, which as in the case of H/M ratio in ^{123}I -mIBG cardiac scan, have proven to be of great value and are universally accepted by clinicians. It appears completely evident, as indeed happens in many aspects of life, how technological progress must not lead to the loss of reliable diagnostic elements, such as the planar H/M ratio, which are the basis of the diagnostic usefulness and effectiveness of this imaging method. Cardiac scintigraphy with ^{123}I -mIBG has proven its

efficacy in many areas of neurological and cardiological pathology, where today it plays a leading role. The work of Shibutani et al meets the need to improve the diagnostic performance and the usefulness of any nuclear medicine imaging method without renouncing the potential of the information provided. This avoids that the maximum exploitable potential of a given diagnostic method could depend on the available technologies, but rather increasing their usability widely in the world, also for investigations with a 40-year history behind it. This study, of course, is not without limitations. The patients’ sample size is limited, therefore, the results presented must be confirmed by a prospective large-scale study involving other types of detectors, as stated by the authors themselves. However, by concluding, it is our opinion that the authors should be congratulated for their work, as they introduce a repeatable and effective approach that allows increasing the usability and reproducibility of a method, such as the ^{123}I -mIBG cardiac scan, which is a cornerstone of nuclear cardiology studies.

Disclosure

All authors have no conflicts of interest to disclose.

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