Low-dose CT with SPECT for Assessment of Neuroendocrine Tumors

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Introduction

In nuclear medicine, dose, image quality, and time are tightly linked. If one factor changes, then the others must also adjust. As clinicians and patients become increasingly concerned about exposure to both ionizing and injected radiation dose across varying medical imaging examinations, there is a desire to reduce dose. This is particularly important when scanning pediatric patients. However, reducing dose can negatively impact image quality or increase the length of the exam.

Reconstruction algorithms including Evolution Toolkit and Q.AC for attenuation correction, which are available on Xeleris™ and Discovery™ NM/CT 670 Pro, enable clinicians to reduce time or dose in nuclear medicine scanning procedures while maintaining excellent image quality.*

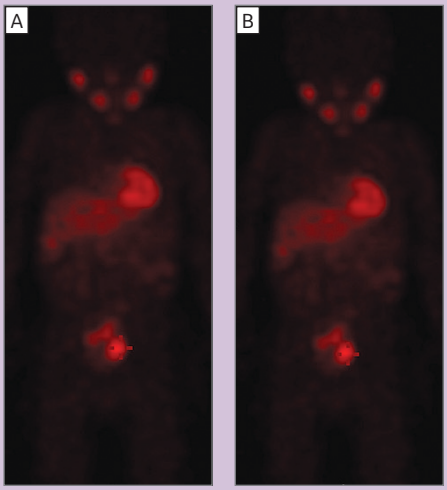

Figure 1. Comparison of SPECT images (A) without Q.AC at 20 mAs and (B) with Q.AC at 7.5 mAs.‡

Parameters:
(A) CT: 80 kV, 40 mA, 0.5 sec/rot; DLP: 26.77 mGy-cm; CTDIvol: 0.37 mGy.
(B) CT: 80 kV, 15 mA, 0.5 sec/rot; DLP: 10.07 mGy-cm; CTDIvol: 0.14 mGy.

Patient history

Two-year-old pediatric patient with initial diagnosis of stage III neuroblastoma.

Status post whole-body MR: several tumor masses in the pelvis as well as in the neuroforamina. mIBG SPECT/CT was planned as a theranostic approach for potential treatment of mIBG-positive lesions.

Acquisition

Injection: 63 MBq 123 I-mIBG 4 and 24 hr post injection.

LEHR collimator: 360 tomo 60 steps of 30 sec, 64 x 64 zoom 1.0.

The CT examinations with Q.AC for attenuation correction were performed separately for both exams. Additional contrast-enhanced, low-dose CT with 20 mAs was acquired on day two.

* In clinical practice, Evolution options[1a] (Evolution for Bone, Evolution for Cardiac, Evolution for Bone Planar) and Evolution Toolkit[1b] are recommended for use following consultation of a NM physician, physicist, and/or application specialist to determine the appropriate dose or scan time reduction to obtain diagnostic image quality for a particular clinical task, depending on the protocol adopted by the clinical site.

[1a] Evolution Options – Evolution claims are supported by simulation of count statistics using default factory protocols and imaging of 99mTc based radiotracers with LEHR collimator on anthropomorphic phantom or realistic NCAT – SIMSET phantom followed by quantitative and qualitative images comparison.

[1b] Evolution Toolkit – Evolution Toolkit claims are supported by simulation of full count statistics using lesion simulation phantom images based on various radiotracers and collimators and by showing that SPECT image quality reconstructed with Evolution Toolkit provide equivalent clinical information but have better signal-to-noise, contrast, and lesion resolution compared to the images reconstructed with FBP/OSEM.

‡ Quantitative accuracy defined as equivalence‡‡ to well-countered-measured injected activity in the test phantom.

‡‡ Equivalence means <11% difference when comparing measured counts in SPECT studies corrected by Q.AC – reconstructed CTAC to measured counts in studies corrected by benchmark-reconstructed CTAC. Measured counts are defined as average within identical ROIs positioned on SPECT-reconstructed slices of homogeneous 99mTc solution phantom study.

Findings

Whole-body SPECT/CT shows a focal mIBG-positive tumor mass in the pelvis minor, but no significant uptake in the already known neuroblastoma lesions in the pelvis, in the retroperitoneum as well as in the neuroforamina.

No additional lesion was found by means of additional contrast-enhanced CT, including in the lung.

Conclusion

Q.AC ultra low-dose CT can be used to perform an accurate attenuation correction and significantly reduce a patient's radiation exposure. This is particularly important in pediatric patients and if sequential imaging procedures (e.g., mIBG-SPECT/CT) are planned.

The anatomical information of Q.AC ultra low-dose CT can also be easily used to perform image fusion/co-registration with other examinations such as MR, thus enabling enhanced multi-modality imaging. ■

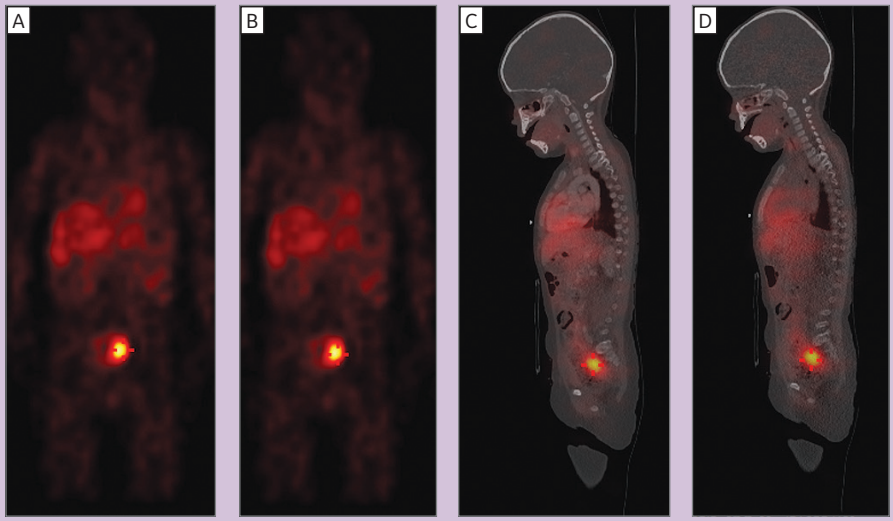

Figure 2. (A, C) Attenuation correction without Q.AC at 20 mAs compared to (B, D) attenuation correction with Q.AC at 7.5 mAs. Lowering dose will impact CT image quality but Q.AC will improve CT value accuracy for attenuation correction.

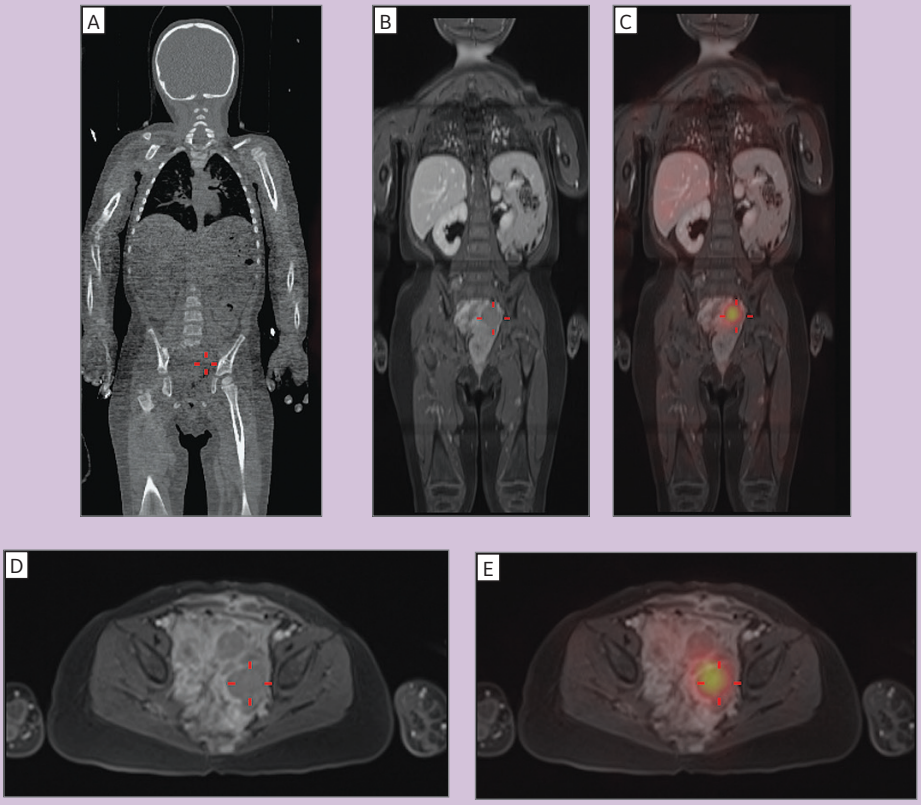

Figure 3. (A) Q.AC ultra low-dose CT was used as a bridge to register (B) MR image data with (C) SPECT. (D, E) The axial MR was fused with axial SPECT to help visualize the lesion.