Computed tomography

Assessing retrospective **spectral analysis workflow** considerations and dose management

Philips IQon Spectral CT

Z. Romman, I. Uman, Y. Yagil, D. Finzi, N. Wainer, D. Milstein; Philips Healthcare

CT has become an essential diagnostic tool worldwide, with many millions of CT scans performed annually. While advances in multi-energy CT promise sophisticated analysis techniques to allow clinicians to quickly reach a confident diagnosis, certain trade-offs have remained with regard to special modes, image quality, and dose penalties,* resulting in upfront decision-making. Until now, these compromises have inhibited the clinical potential of spectral imaging. The introduction of Philips IQon Spectral CT features iconic color quantification, heralding a new era in CT technology. Not merely a modification of an existing CT system, IQon Spectral CT is the first and only spectral detector CT system built from the ground up for spectral imaging and as such offers advantages in color quantification, workflow, and dose management.

* Dose penalties are defined as taking on additional radiation dose relative to a best case baseline.

How does **spectral CT** work?

Traditional grayscale Hounsfield CT images are limited by their inability to discern contrast agents and to discriminate between body materials. Color quantification adds spectral resolution to image quality, delivering not just anatomical information but also the ability to identify and characterize structures based on material content.

Just as white light consists of an entire spectrum of colors, so also the X-ray photon beam produced by CT scanners consists of a spectrum of photons with a range of X-ray energies from low to high. The Philips IQon spectral detector has the ability to simultaneously distinguish between X-ray photons of high and low energies. This spectral analysis allows the discrimination of materials consisting of specific atomic numbers, such as iodine or calcium. Various elements are assigned individual colors, allowing them to be visually distinguished on CT scans.

Workflow considerations

No need to pre-select a spectral protocol: **spectral on demand**

With IQon, prospective and retrospective spectral results are acquired within a single scan without the need for special modes. Because the acquisition of spectral data is dependent on the detector rather than the X-ray tube, there is no need to decide in advance of the scan whether or not to use a spectral protocol. This means the user can adhere to tried-and-trusted established workflows.

The patient is scanned as usual and a conventional anatomical image can be generated and interpreted.

Should the clinician decide that spectral information would be of additional value in a particular region of interest, the spectral information acquired during the single spectral scan can be easily accessed for retrospective, on-demand spectral data analysis.

Results are ready to be read on the PACS.

Routine clinical protocols and workflow are maintained.

Retrospective spectral reconstruction

Using the Philips IQon Spectral CT, the personalized quantitation of spectral CT data can be seamlessly integrated into established scanning and reading workflows. Because there is no pre-scan determination of use, when incidental abnormalities are encountered there is no need to call the patient back for additional imaging. On-demand spectral analysis of a Region of Interest allows the physician to further interrogate incidental findings.

The value of retrospective interrogation of incidental findings

A recent study has evaluated the clinical impact of retrospective spectral analysis in achieving a diagnosis.[1] Forty-three patients were included in the study and were scanned using a Philips spectral CT prototype. In 11 patients, retrospective reconstruction was used to improve visualization of unexpected incidental findings. Additionally, spectral CT data helped to achieve a diagnosis for 19 patients (44%). In eight of the patients, clinical history suggested that spectral data would be useful prior to scanning. The authors of the study concluded that the option to use retrospective spectral reconstruction may offer a clinical advantage in patients for whom spectral imaging is not indicated based upon clinical history.

Enhanced spectral visualization

After reviewing a conventional grayscale CT image, what happens if the clinician decides that spectral information would be of additional value in a particular Region of Interest? Spectral data acquired during a single scan can easily be accessed from the PACS for retrospective, on-demand, spectral data analysis.

Spectral Magic Glass

The Spectral Magic Glass tool is superimposed on the conventional CT image to provide a color view of an area of special interest. Materials such as iodine, calcium, water, or fat can then be visually distinguished.

DICOM 3.0 compliance

Data generated during scanning with the IQon Spectral CT is fully DICOM 3.0-compliant and images can be sent to the PACS for archival for retrospective spectral reconstruction and evaluation. DICOM 3.0 compliance provides lossless image compression/decompression during storage and retrieval, as well as compatibility with other DICOM 3.0-compliant equipment such as workstations and printers. The XPI-format images impose a minimal burden on image storage capacity.

Dose considerations, image quality, and **patient-centered** CT

Effect of IMR on dose and image quality

For conventional scans, Iterative Model Reconstruction (IMR) can generate images that are virtually noise-free. Besides improving on the quality of conventional imaging, studies using phantoms (data on file) suggest that IMR may reduce patient dose by 60–80% depending on the clinical task, patient size, anatomical location, and clinical practice.*

Phantom studies suggest that Philips iDose[4] improves spatial resolution and/or noise reduction at low dose.

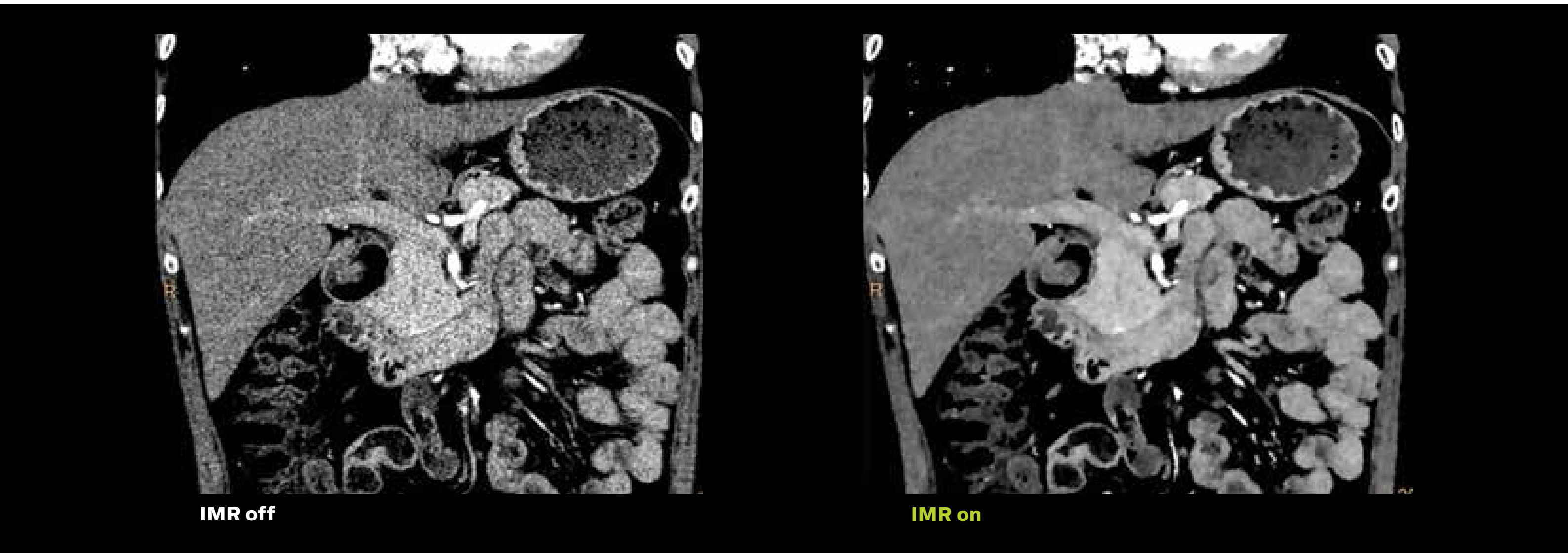
DoseWise strategies offer tools

Philips IQon Spectral CT adheres to the Philips DoseWise approach to dose management, which is an array of techniques and programs based on the ALARA (As Low As Reasonably Achievable) principle.

During scanning, tube current modulation is used to change the X-ray dose from location to location, attenuating the dose by body region.

Image quality for each diagnostic task is specified by the DoseRight Index (DRI) for various scanning regions, to allow for the appropriate dose and image quality within a single acquisition.

- **Personalized doses** for individual patients are suggested by the DoseRight automatic current selection.
- **Longitudinal dose modulation** is achieved using the DoseRight Z-DOM, which adjusts the tube current-time product (mAs) in the z-axis according to a patient's size and shape.
- **DoseRight 3D-DOM** (three dimensional dose modulation) combines angular and longitudinal patient information to modulate dose in three dimensions (x-y-z-axis). It incorporates modulation of tube current-time product (mAs) according to changes in individual patient's size and shape in the transverse (x-y-axis; angular) direction during helical scans, in addition to changes in the craniocaudal or caudocranial (z-axis; longitudinal) direction, as the tube rotates.
- **Dedicated pediatric protocols** offer high-quality conventional images at low doses taking into account the pediatric patient's size and clinical indication.



Comparison of conventional CT images with IMR off and IMR on.

* In clinical practice, the use of IMR may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. Lower image noise, improved spatial resolution, improved ow-contrast detectability, and/or dose reduction were tested using reference body protocols. All metrics were tested on phantoms. Dose reduction assessments were performed using 0.8 mm slices, and tested on the MITA CT IQ Phantom (CCT183, The Phantom Laboratory), using human observers. Data on file.

“ You don’t have to prescribe a multi-energy acquisition mode in advance, which has a great effect on the workflow.”

Zimam Romman, Clinical Scientist, Philips

Through the detector-based approach of the IQon Spectral CT, the user has full access to all the dose management tools in spectral scanning normally available in conventional scanning mode. This means that valuable tools such as dose modulation are not discarded in order to perform spectral exams.

Patient-centered CT imaging

- **iPatient** is an advanced platform that facilitates the patient-centered approach to CT imaging and has the flexibility to support future innovations. It includes methods to adapt scan protocols and techniques such as dose modulation and iterative reconstruction for individual patients and diagnostic tasks. Using patient-specific methods, iPatient facilitates optimal* management of image quality and radiation dose.

- **ExamCards** for the Philips IQon Spectral CT are individualized protocols, fully equipped with spectral capabilities, that allow planning to be based on the desired result, rather than just the scan. For each ExamCard, besides results such as axials, coronals, sagittals, MRPs, and MIPs, spectral results for the specific clinical question can be added. ExamCards can be designed for each clinical question. Results are automatically reconstructed and can be sent for viewing without any additional work from the operator. Protocols can be shared, allowing scan-to-scan consistency.

- **Scan Ruler** provides the operator with a clear interactive timeline of events during the study, such as acquisition, bolus tracking, and injection.

- **DoseRight Index** (DRI) is an image-quality reference parameter, designed to simplify adjustments to specify the required image quality for a particular diagnostic task. Increasing DRI decreases image noise and increases volume CTDI while decreasing DRI increases image noise and decreases volume CTDI. So, for example, DRI allows a controlled increase in suggested noise levels for larger or obese patients and a decrease in noise for smaller adults. Decreasing DRI (increasing) by -1 (+1) decreases (increases) the average tube current by 12% while increasing (decreasing) the image noise by 6%, if other settings remain unchanged. DRI is a convenient tool to manage low-dose (ALARA) scans. After the appropriate number of cycles and due consideration of the results, adjustments to the DRI and iterative reconstruction technique settings can be incorporated into the Exam Card to manage individual patient examinations.

All of these tools are standard on the IQon Spectral CT. There is no need to alter workflow habits to obtain more clinical information.

* “Optimal” refers to the use of strategies and techniques that facilitate the management and control of both image quality and dose.

Reference

1. Gabbai, M, et al. The Clinical Impact of Retrospective Analysis in Spectral Detector Dual Energy Body CT. Radiological Society of North America 2013 Scientific Assembly and Annual Meeting, December 1 - December 6, 2013 ,Chicago IL. http://archive.rsna.org/2013/13018312.html Accessed June 24, 2014

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