The Clinical Utility of Spectral CT in Interventional Oncology: Innovations in Diagnosis and Intraoperative Guidance

Milin Patel BHSc[1], Moaz M. Choudhary MD[2], Patrick D. Sutphin MD PhD[3], Sanjeeva P. Kalva, MD[2]
1. Faculty of Medicine, University of Ottawa, Canada
2. University of Texas Southwestern Medical Center, Dallas, TX 75390, USA
3. Massachusetts General Hospital, Harvard Medical School, Boston, MA 02114, USA

CIO SYMPOSIUM ON CLINICAL INTERVENTIONAL ONCOLOGY

Introduction

- Spectral Computed Tomography (Spectral CT) is a form of CT imaging encompassing different techniques, including dual-energy CT, dual-detector-based CT, and photon-counting CT, that allows image reconstruction at **various X-ray energy levels** (1).
- This imaging modality offers **advanced tissue characterization** and differentiation
- Despite its use in diagnostic imaging, spectral CT remains **underutilized in interventional oncology** (IO).
- This learning exhibit aims to highlight the clinical applications and emerging role of this imaging modality across the IO workflow.

Pre-Procedural Planning

- Spectral CT allows for **greater differentiation** between various **tissue types**, such as tumors, blood vessels, and surrounding healthy tissues.
- Spectral CT improves imaging contrast and can distinguish benign and malignant renal lesions, guiding biopsy and surgical planning (2,3).
- In liver lesions, Spectral CT allows for detailed visualization and aids in **differentiating tumor types** and assessing **vascular invasion vs bland thrombus.**

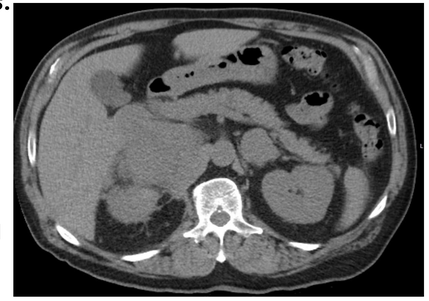

Figure 1. Non-contrast axial CT of the abdomen in a 68-year-old male presenting with back pain. Imaging demonstrates **heterogeneous bilateral adrenal masses**, noted incidentally during evaluation.

Intraoperative Guidance

- Spectral CT enhances the accuracy of needle and ablation **probe positioning** during interventional procedures.
- The use of virtual monochromatic and virtual non-contrast images obtained on spectral CT has been shown to improve lesion detection and reduce artifact reduction, allowing **accurate positioning of needles** during CT guided needle biopsies and ablations (4).
- Spectral CT technology enables **temperature mapping** during procedures to ensure complete tumor ablation
- Provides real-time, in-vivo **temperature monitoring** of tissues.
- Allows adjustments to ablation parameters to ensure adequate treatment

Figure 2. Axial contrast-enhanced CT obtained during biopsy. Image demonstrates the use of a metal artifact reduction protocol, allowing for visualization of the biopsy needle trajectory and accurate assessment of needle positioning.

Post-Procedural Assessment

- Spectral CT enables accurate post-procedural assessment.
  - Useful for evaluating **ablation zones** and **residual** disease.
- For evaluating the therapeutic response of transcatheter arterial chemoembolization (TACE) for hepatocellular carcinoma (HCC), spectral CT was shown to be comparable to the conventional liver CT protocol, with a **reduction in radiation dose** (5)
- Complication Monitoring
  - Detects **endoleaks** and other **post-treatment issues** (6).

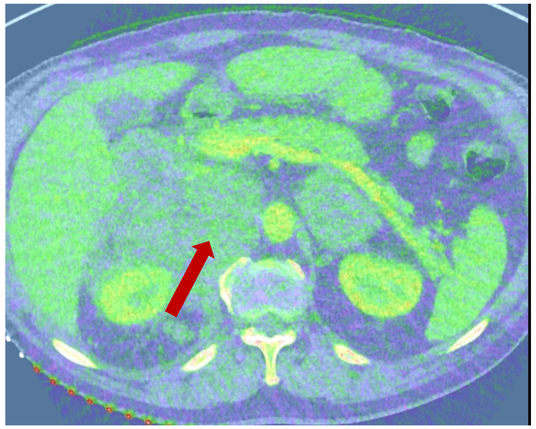

Figure 2. Axial post-contrast CT performed on the day of biopsy with iodine map reconstruction from spectral CT. The lesion demonstrates **heterogeneous enhancement**, and the **hypervascular component** (arrow).

Conclusion

- Spectral CT is a transformative imaging modality in interventional oncology
- Provides quantitative functional and anatomical data allowing for enhanced precision in diagnosis, intervention, and follow-up.
- Continued research is essential to address limitations and fully realize the potential in interventional practice.
- Future innovations include the application of spectral CT for functional guidance and analyzing biomarkers of tumor biopsies

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