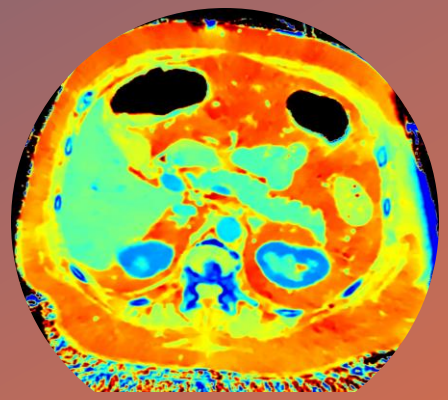
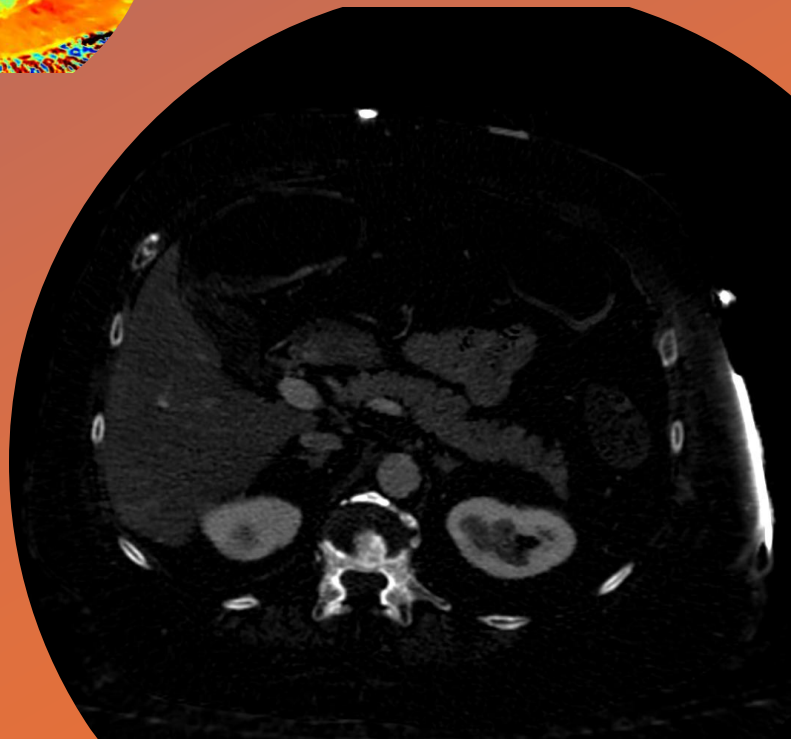
Spectral CT in Abdominal Radiology





Dr R. Healicon, Dr A. Spencer, Dr G. Nandra, Dr S. Eleti

Barts Health NHS Trust

Objectives

To provide an introduction to the use of spectral imaging within abdominal radiology, empowering the Radiologist to apply spectral CT in their day-to-day practice

To provide a pictorial case-based review to educate on when and how to use these imaging techniques to provide better care for patients and more information to the multidisciplinary team

Background

Dual energy spectral CT (DECT) is a widely available but under-utilised resource across the UK

Dual energy CT uses two photon energy levels to extract additional information from CT imaging, enabling the Radiologist to gain additional diagnostic data while reducing radiation dose to the patient

What is spectral CT?

- Unlike conventional CT, which utilises a continuous spectrum of emitted x-ray energies, usually centred around 120 keV, spectral CT utilises pulses of narrow bands of high- and low-energy photons.
- Photons are emitted either continuously from two different sources and detectors mounted separately on the gantry (Fig. 1a), or alternate emission of high and low energy photons with a single detector (Fig. 1b).
- Known information about the x-ray absorption properties of different tissues and compounds, including iodinated contrast, can then be used to extract information about the amount of substances such as water, iodine and urate within each voxel.

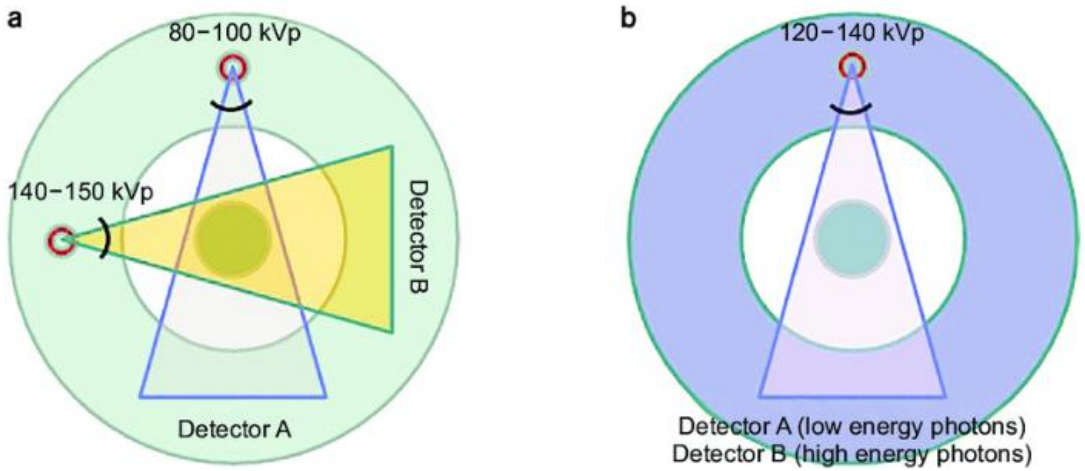
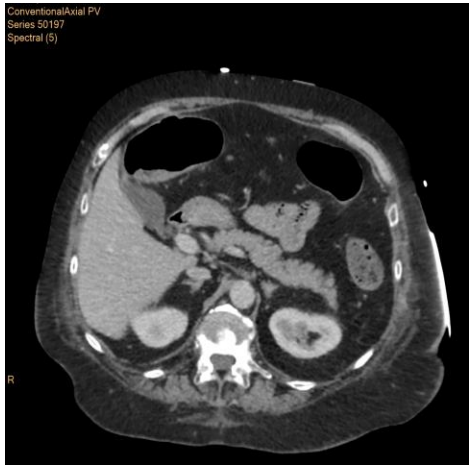
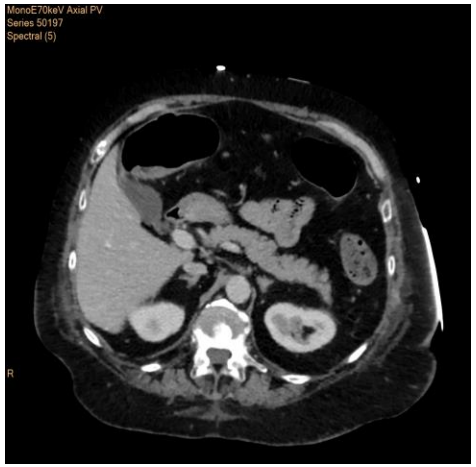


Fig. 1 reproduced from Jung, Haijo. (2021). Basic Physical Principles and Clinical Applications of Computed Tomography. Progress in Medical Physics. 32. 1-17.10.14316/pmp.2021.32.1.1.

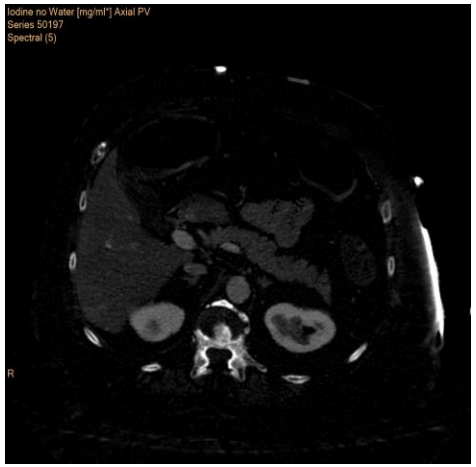
Multiple image types can be reconstructed from spectral data



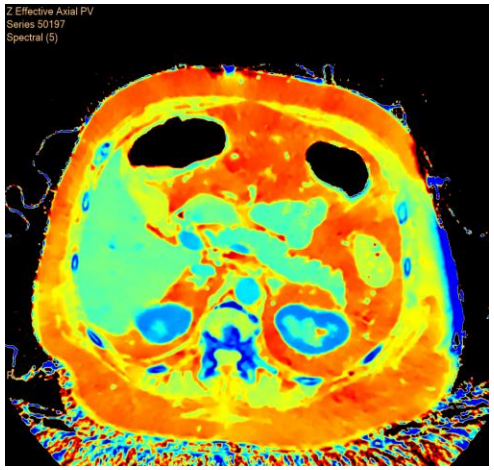
Conventional CT



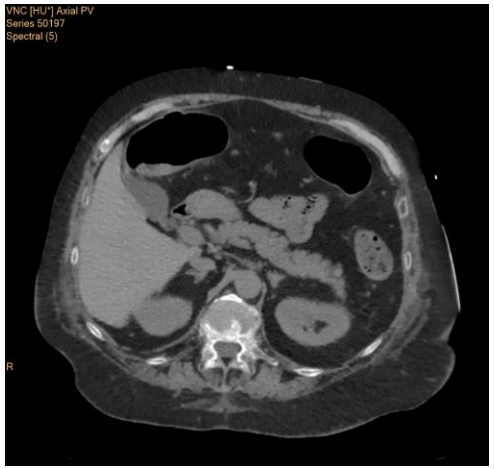
Mono-keV



Iodine Map



Z-effective Map



Virtual non-contrast (VNC)

Benefits of spectral imaging

- Improved image quality
- Reduced radiation dose
- Reduced contrast dose
- Increased diagnostic information including:
  - Improved lesion conspicuity
  - Decreased metalwork artefact
  - Reducing pseudoenhancement
  - Enhanced vascular contrast

Specific use cases in abdominal imaging

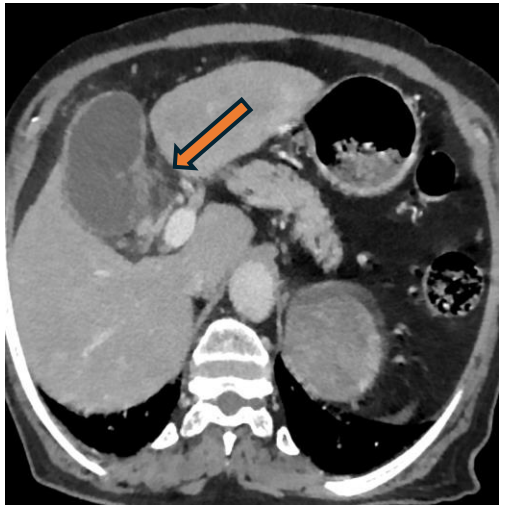
Trauma

Acute abdominal pathology

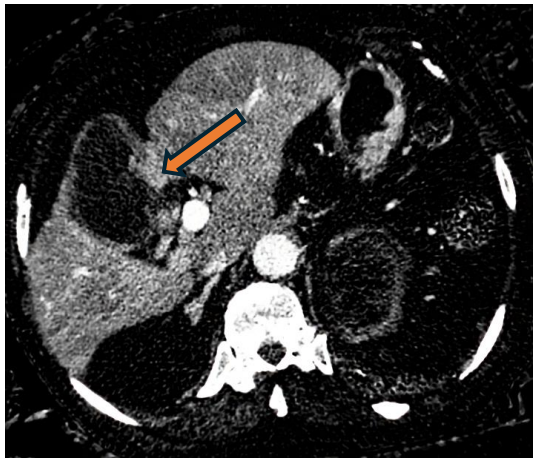
Oncology

Acute abdominal pathology

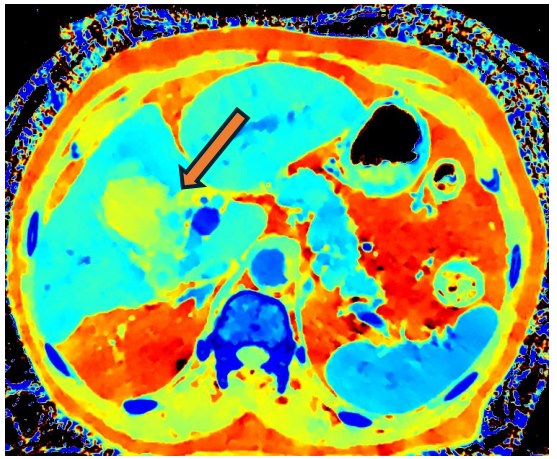
- 89-year-old male presented with right upper quadrant pain, raised inflammatory markers, obstructive jaundice and hypotension.
- Conventional portal venous phase CT demonstrates an irregular gallbladder wall without a clearly defined perforation.
- On iodine map, a large mucosal defect is clearly visible communicating with the gallbladder fossa. Findings are confirmed by demonstration of the same defect on the z-effective map.



Conventional Portal Venous



Iodine map

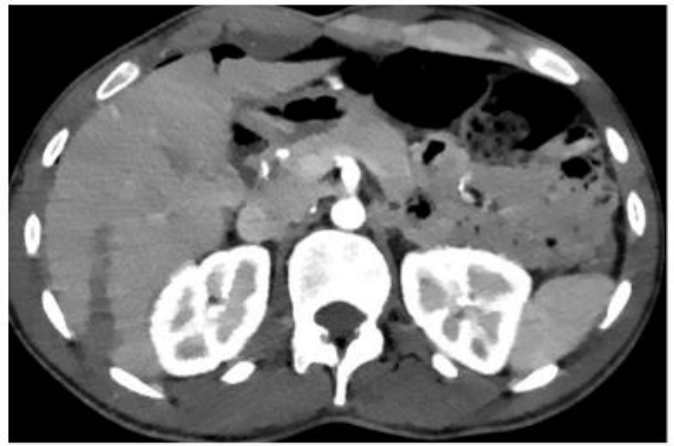


Z-effective map

DECT in Abdominal Trauma

- 21-year-old male patient presented with multiple bilateral abdominal stab wounds
- On conventional split bolus imaging of the liver, the large segment 6 laceration is visible, but there is sub-optimal contrast relative to the normal hepatic parenchyma.
- On mono-keV images, the hepatic laceration becomes significantly more conspicuous, and the full extent is better delineated. This allows for accurate radiological grading of the injury.
- More broadly, DECT can improve conspicuity of solid viscus injury generally

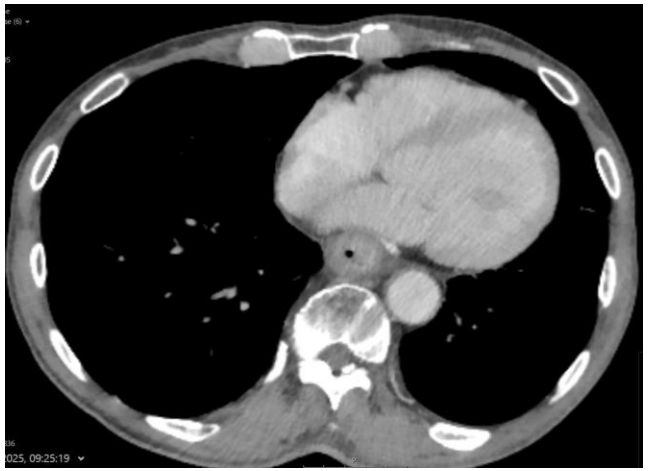
Conventional portal venous phase



Mono-keV (40keV)

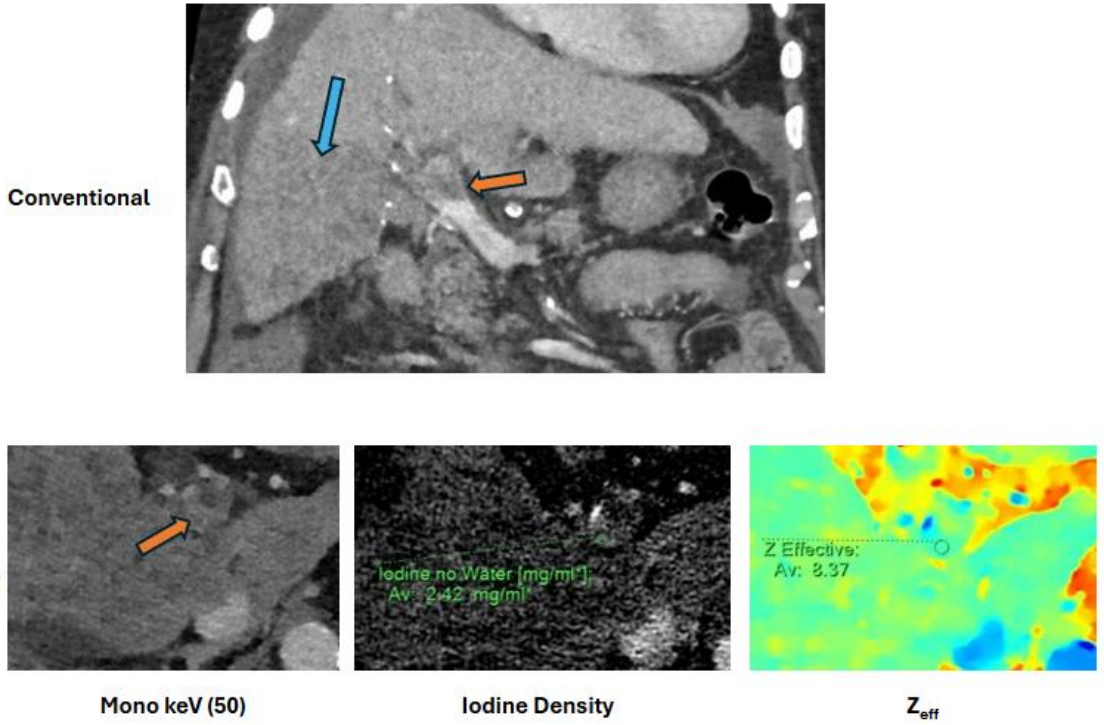
Oeseophageal malignancy

- 72 M with previous, radically treated, squamous cell carcinoma of the distal oesophagus on routine surveillance.
- Conventional portal venous phase CT demonstrates non-specific oesophageal thickening and mild altered enhancement which may be explained as post-treatment changes/inflammation.
- On spectral Mono keV images, there is significantly greater conspicuity of the altered enhancement concerning for recurrence – confirmed on OGD.



DECT can help distinguish between tumour thrombus and bland thrombus

- 83 M with a large infiltrative right lobe hepatocellular carcinoma (blue arrow) presented with features of hepatic decompensation.
- Conventional portal venous phase CT demonstrates a portal vein filling defect (orange arrow) suspicious for a tumour thrombus.
- Spectral reconstructions demonstrate increased attenuation of the thrombus on Mono keV image, iodine content (2.42 mg/ml) and effective atomic number (8.37) consistent with malignant aetiology of the thrombus).



Conclusion

- Spectral CT (DECT) is a widely available and under-utilised diagnostic resource in abdominal imaging.
- 4 examples are given here – 2 acute and 2 oncology cases – demonstrating the diverse applications of DECT in abdominal imaging
- With greater familiarity and education, DECT is a valuable resource that can be implemented effectively in a Radiologist's practice to extract crucial additional information from CT studies

References

- Wortman JR, Uyeda JW, Fulwadhva UP, Sodickson AD. Dual-Energy CT for Abdominal and Pelvic Trauma. Radiographics. 2018 Mar-Apr;38(2):586-602. doi: 10.1148/rg.2018170058. PMID: 29528816.
- Jung, Haijo. (2021). Basic Physical Principles and Clinical Applications of Computed Tomography. Progress in Medical Physics. 32. 1-17. 10.14316/pmp.2021.32.1.1.