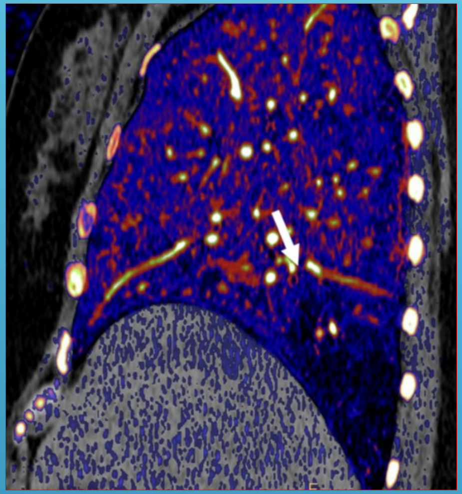

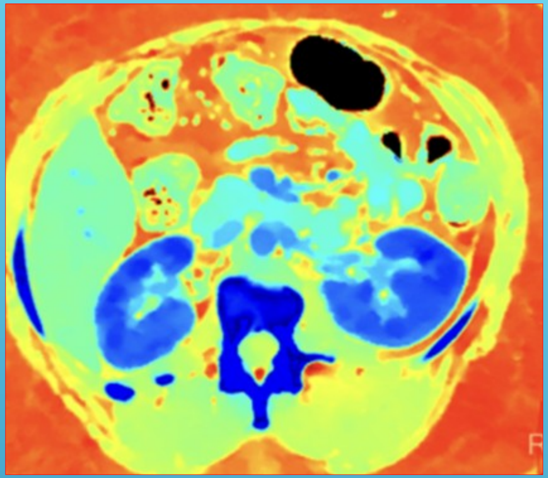
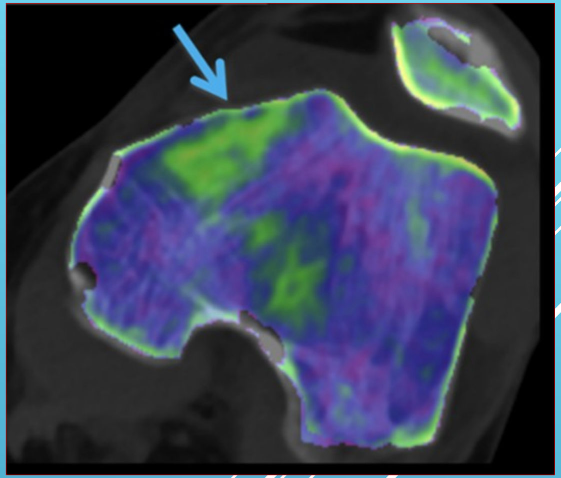

DUAL-LAYER SPECTRAL-CT: REAL CLINICAL ADVANTAGES

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UNIVERSITAS STUDIORUM INSUBRIAE

Sistema Socio Sanitario
Regione Lombardia
ASST Sette Laghi

SPECTRAL TECHNOLOGY

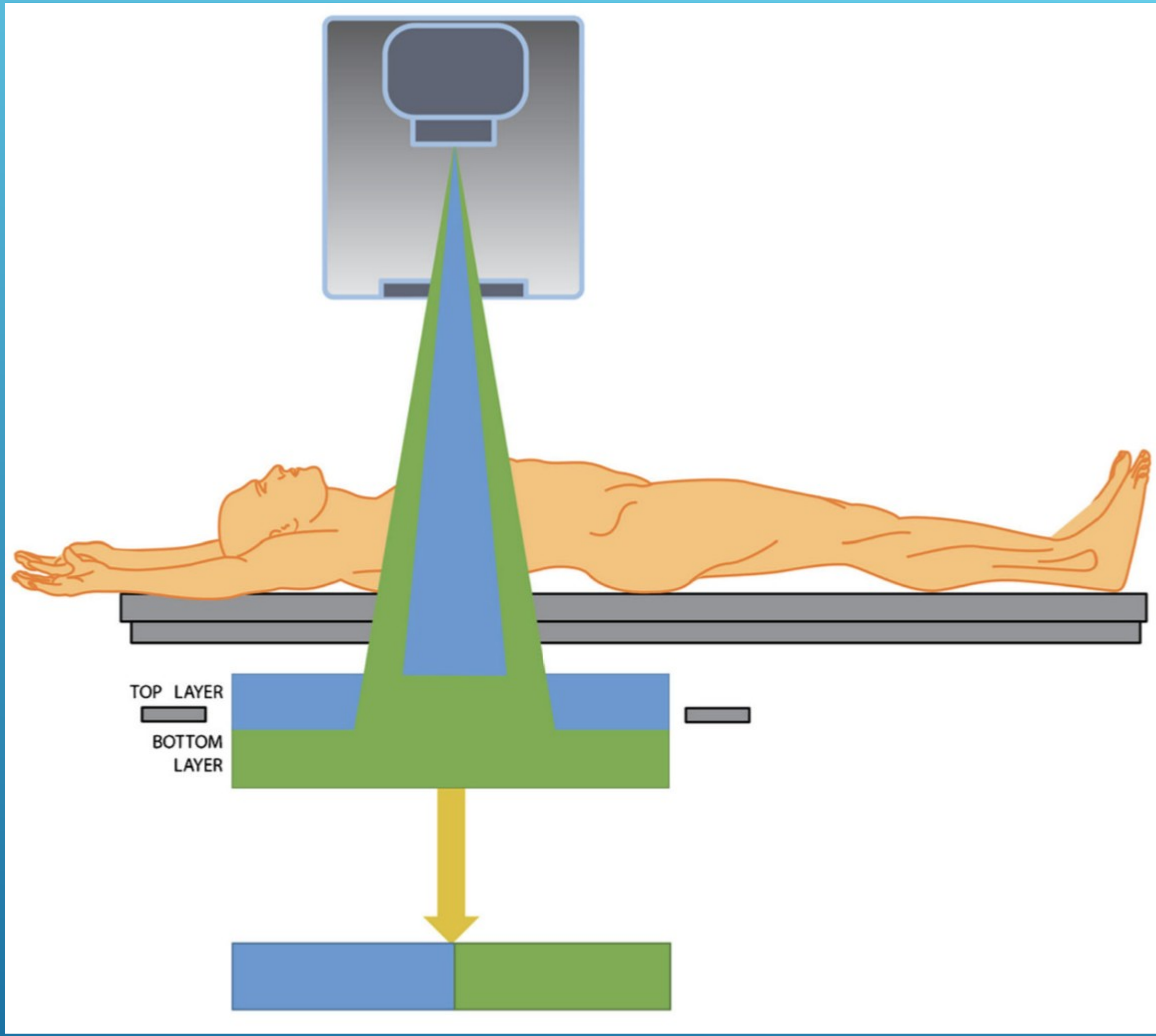
Two layers of detectors

- Top layer: yttrium-based garnet scintillator; selectively absorbs low-energy photons;

- Bottom layer: gadolinium oxysulphide; selectively absorbs high energy photons;

Attached to each layer, a photodiode converts light into an analogue electrical signal and an application-specific integrated circuit converts it into digital signal.

The fasted gantry rotation time is 270 milliseconds

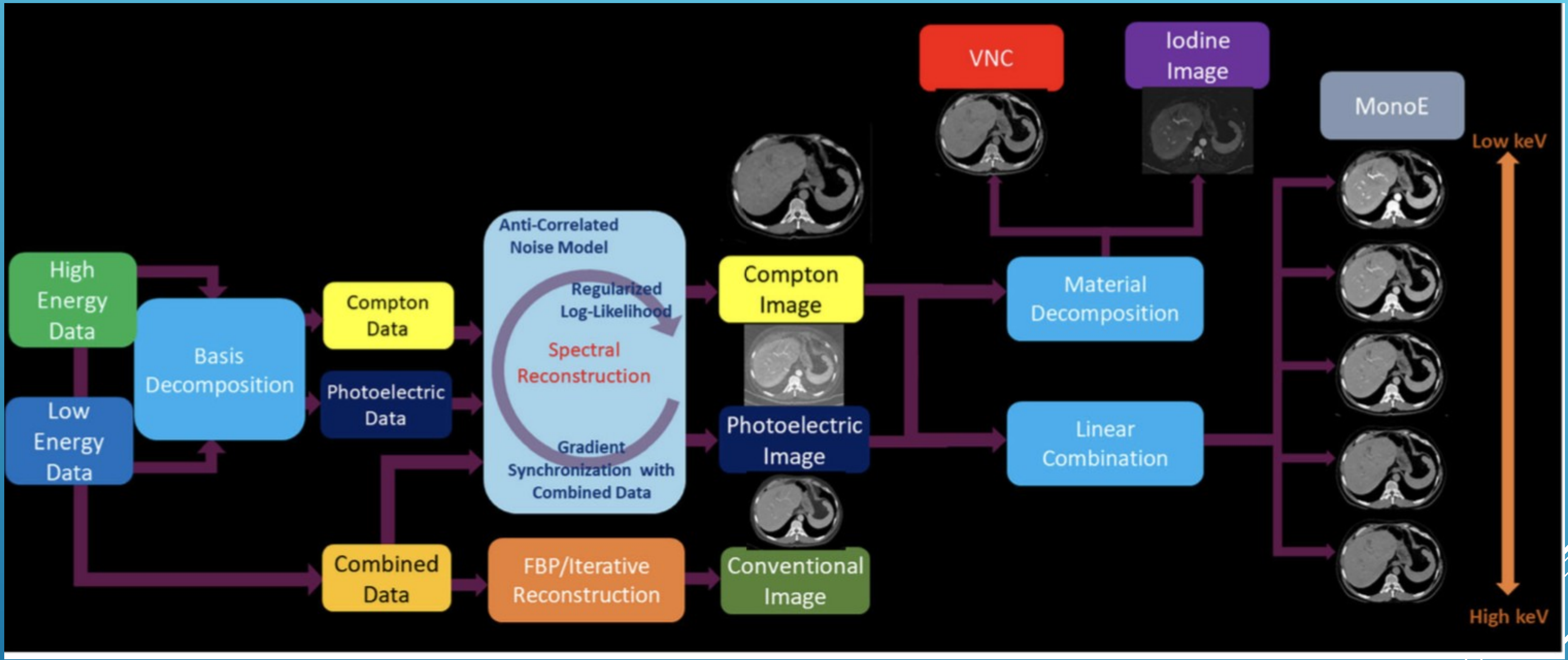


Detector-based spectral CT with a novel dual-layer technology: principles and applications

Negin Rassouli[1] · Maryam Etesami[1,2] · Amar Dhanantwari[3] · Prabhakar Rajiah[1,4]

Insights Imaging (2017) 8:589–598
DOI 10.1007/s13244-017-0571-4

SPECTRAL TECHNOLOGY



Technique of image generation: data from the two layers is utilised to generate photoelectric and Compton scatter basis pairs. Linear combination gives virtual monoenergetic images, material decomposition gives iodine-density, virtual non-contrast and effective atomic number-based images.

IMAGE GENERATION

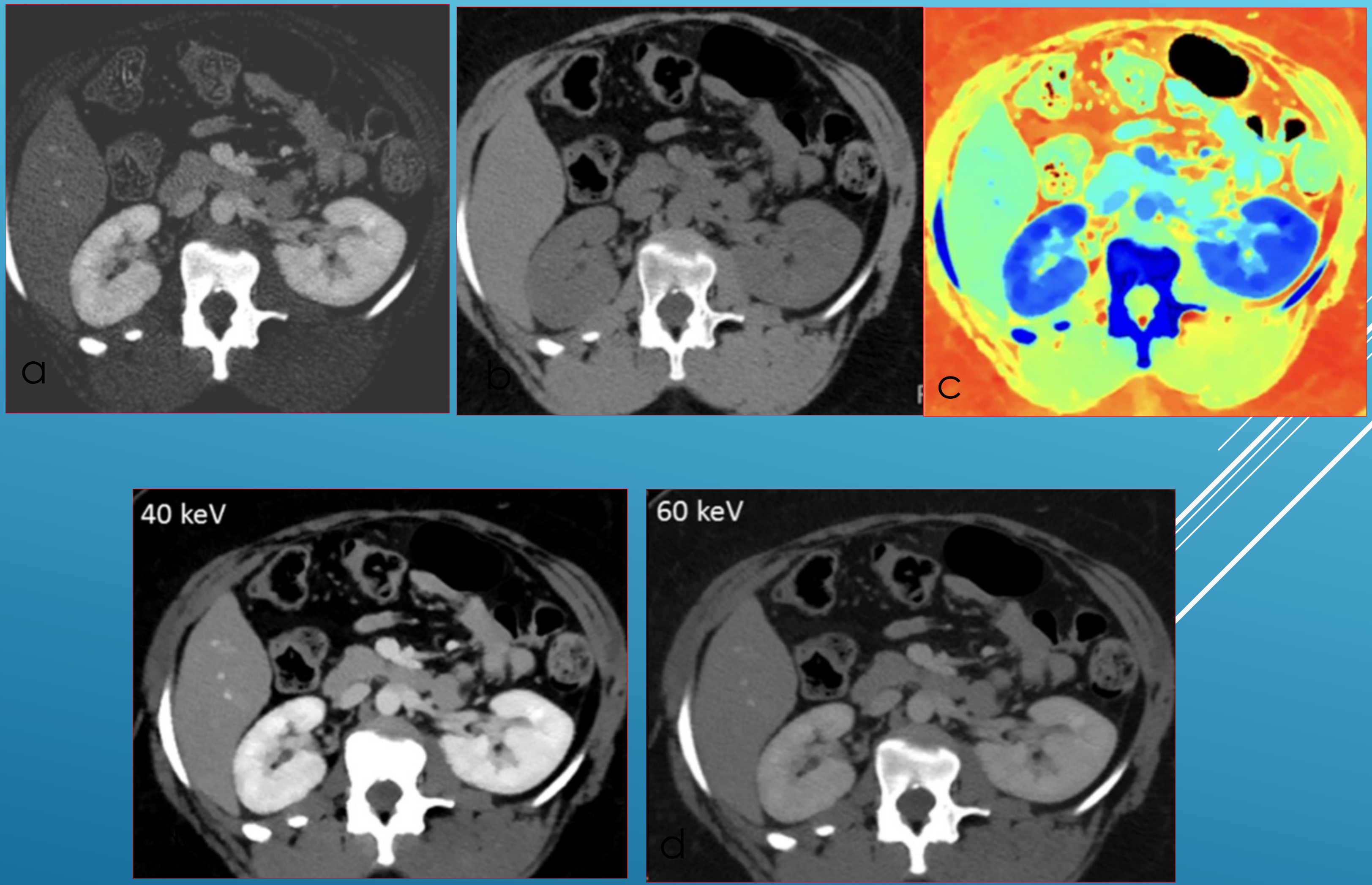
Image type	Mechanism of generation	Clinical uses
Conventional (Polyenergetic/routine diagnostic)	Data from both layers considered as a single detector	Routine diagnostic use for all cases
Iodine density (iodine map)	Material decomposition with pixels representing iodine	Visualisation and quantification of iodine in vessels and organs of interest
Virtual non-contrast	Material decomposition and removal of iodine containing pixels	-Characterisation of lesions such as renal cysts/masses, adrenal nodules, lung nodules, etc. -Radiation dose saving by eliminating need for true non contrast
Uric acid pair	Material decomposition; depiction of pixels containing uric acid	Urinary calculus characterisation
Effective atomic number	Material decomposition; colour coding depending on atomic number	Tissue characterisation
Virtual monoenergetic	Linear combination of basis pair images (40–200 keV)	-Low monoenergetic: enhanced vascular contrast -High monoenergetic: decreased artefacts
Equivalent monoenergetic	Linear combination of basis pair, with attenuation values equivalent to conventional images	Higher image quality, with lower noise

IMAGE GENERATION

Image type

Spectral images

- Iodine density images (a)
- Virtual non-contrast images (b)
- Effective atomic number (c)
- Virtual monoenergetic (d)
- Uric acid pair images



CLINICAL UTILITY

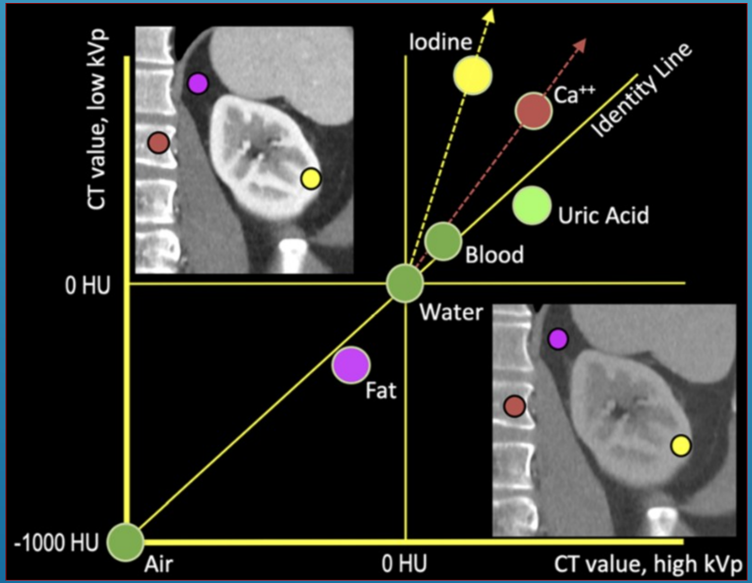
- Enhanced visualisation of vascular contrast;
- Artefact reduction;
- Material decomposition;
- Radiation dose reduction;

CLINICAL UTILITY

Enhanced visualisation of vascular contrast

VMI (Virtual Monoenergetic Images) reconstructions at lower energies (40-70 keV): to enhance the visualisation of intravascular contrast:

- suboptimal enhanced vascular studies;
- vascular studies with low contrast dose;
- improve the visualisation of several lesions.



Dual energy CT in clinical routine: how it works and how it adds value

Emergency Radiology (2021) 28:103–117
https://doi.org/10.1007/s10140-020-01785-2

REVIEW ARTICLE

Aaron D. Sodickson[1,2] · Abhishek Keraliya[1,2] · Bryan Czakowski[1] · Andrew Primak[3] · Jeremy Wortman[4,5] · Jennifer W. Uyeda[1,2]

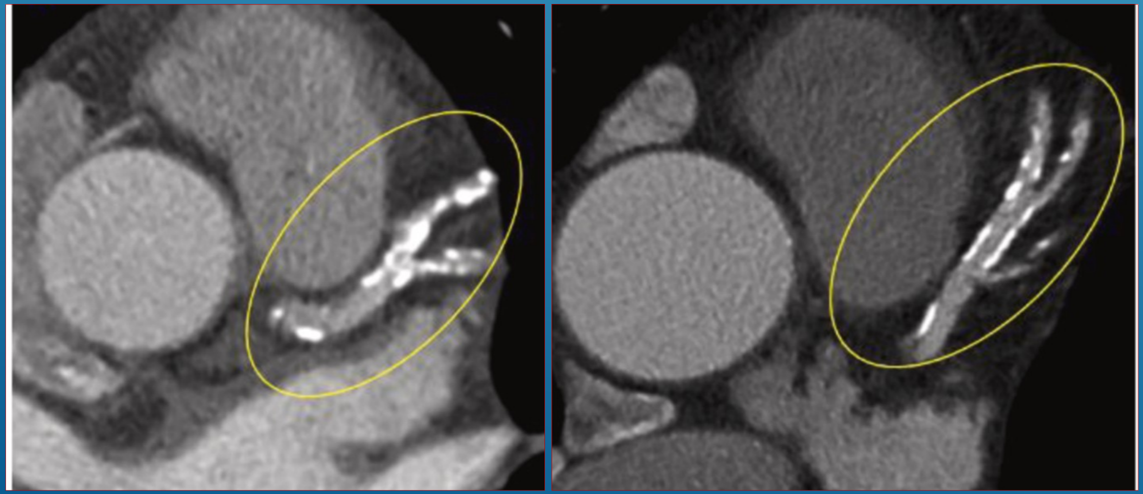
CLINICAL UTILITY

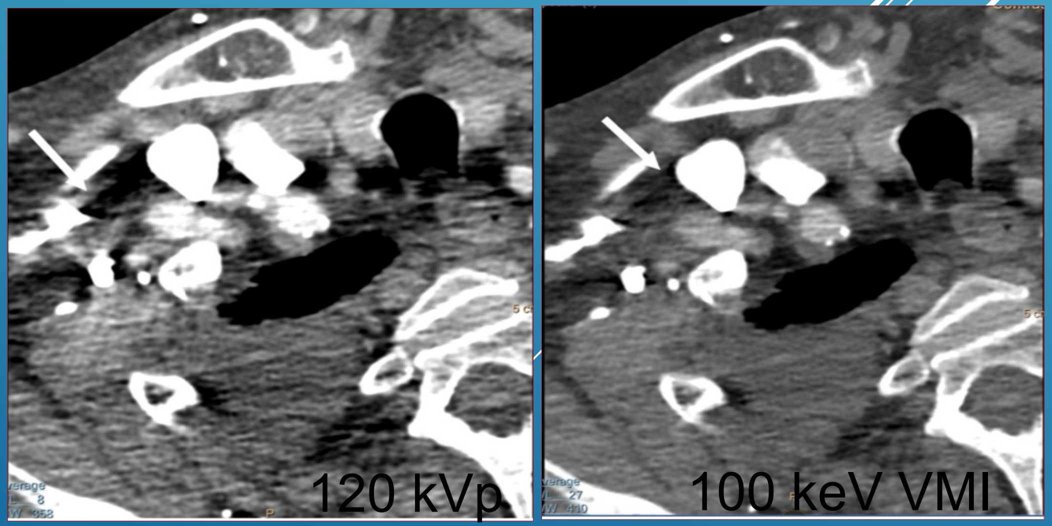
Artefact reduction

- Retrospectively generated high-energy VMI can be used to reduce/eliminate incidentally encountered *metallic artefacts* (metals with low atomic number – stainless steel, aluminium);

- *Beam hardening artefacts* caused by the polyenergetic nature of the X-ray energy can be minimised/eliminated by using the high-energy VMI

- *Calcium blooming* is an important artefact in vascular imaging with overestimation of stenosis and inappropriate classification of the lesion





CLINICAL UTILITY

Material decomposition

- Z-effective images

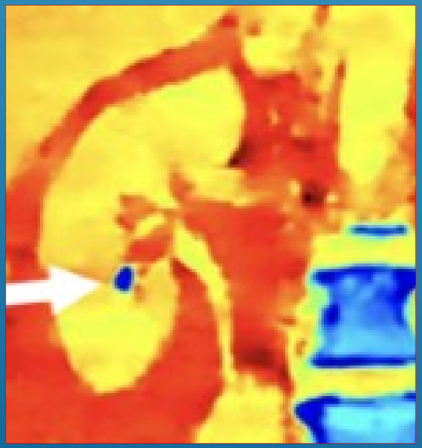
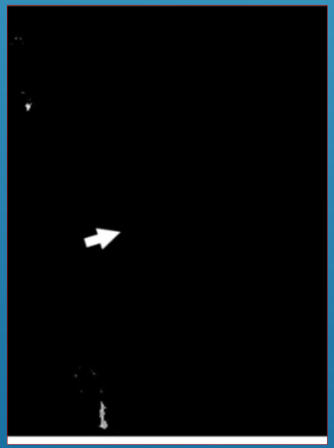
  Colour-coded based on the effective atomic number of tissues

- Iodine maps

  Iodine-containing pixels are assigned values equal to the concentration of the iodine in each pixel; pixel containing no iodine appear dark

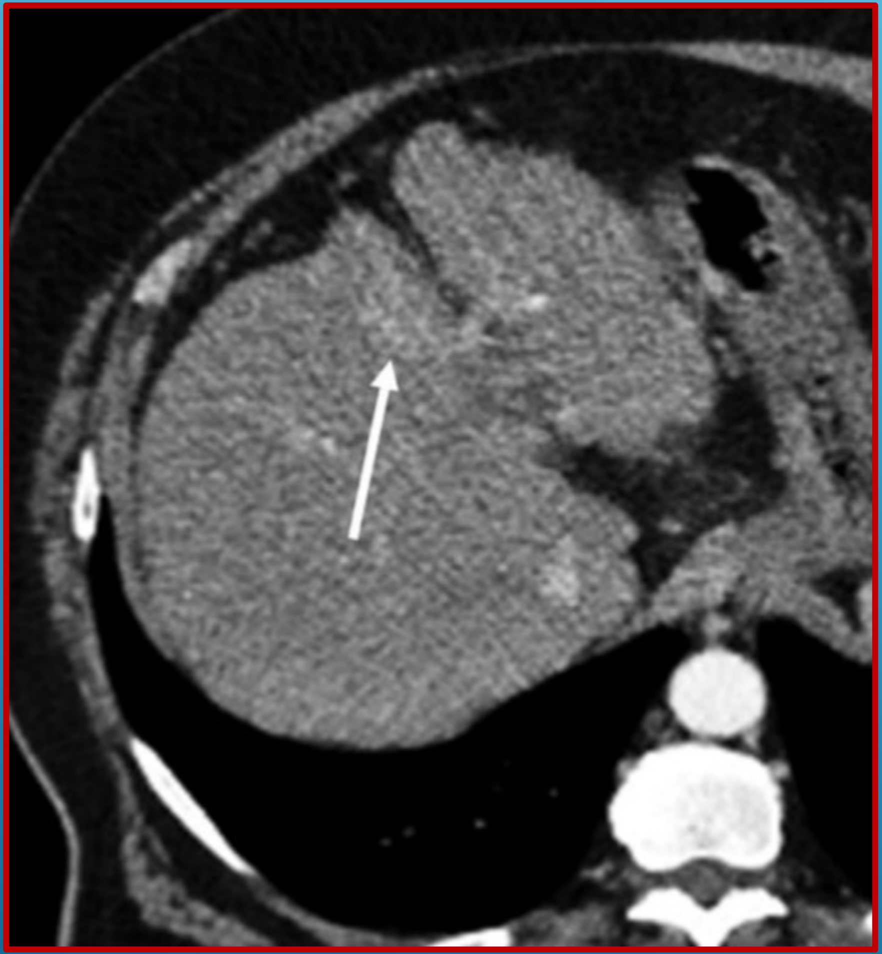
- Calcium-uric acid images

  a uric acid image displays only uric acid pixels with original HU values while all others apperas dark

CLINICAL UTILITY – BODY

Liver



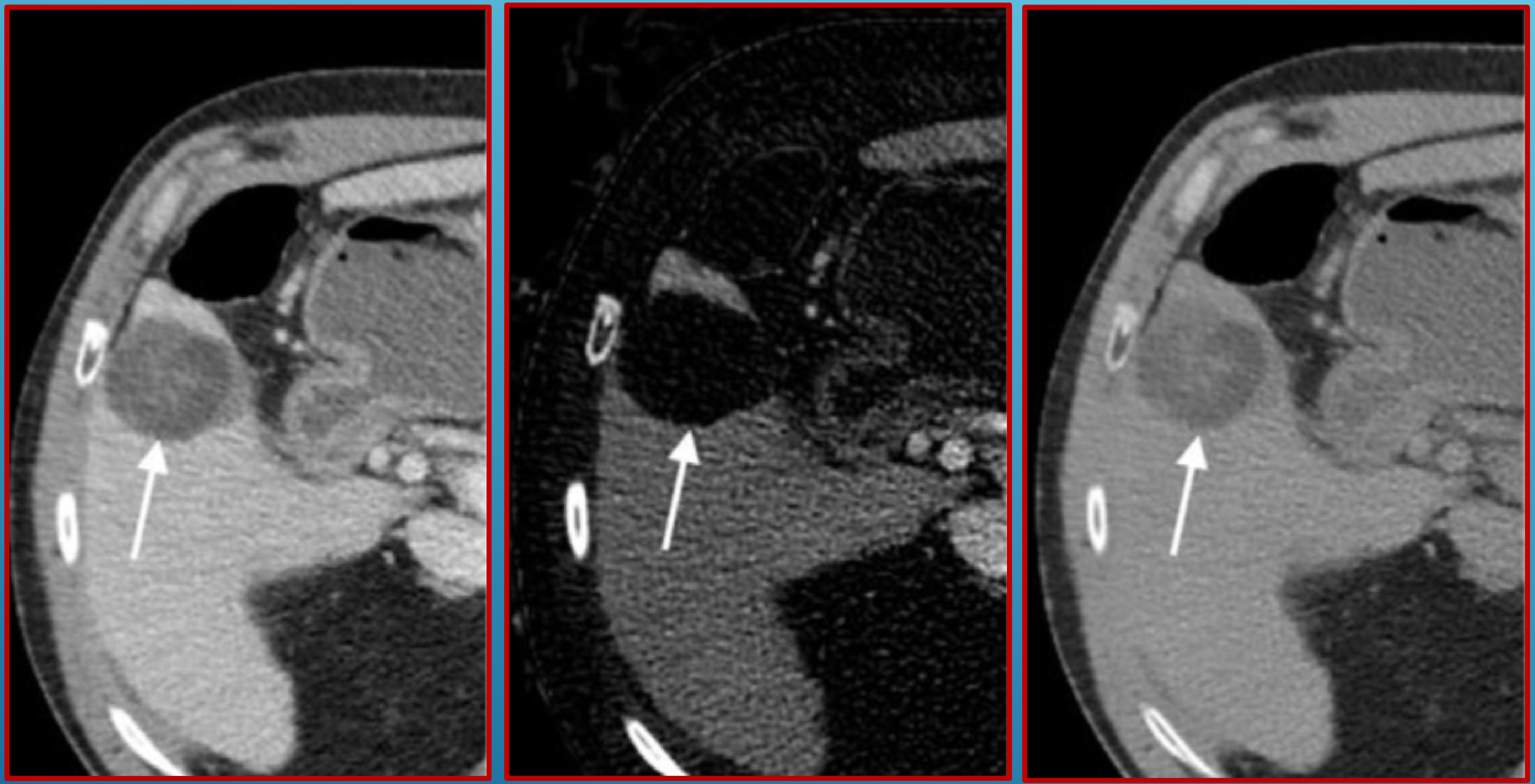
Low KeV VMI

Improve detection of liver lesions

Spectral detector CT applications in advanced liver imaging *Br J Radiol* 2021; **94**:

CLINICAL UTILITY – BODY

Liver

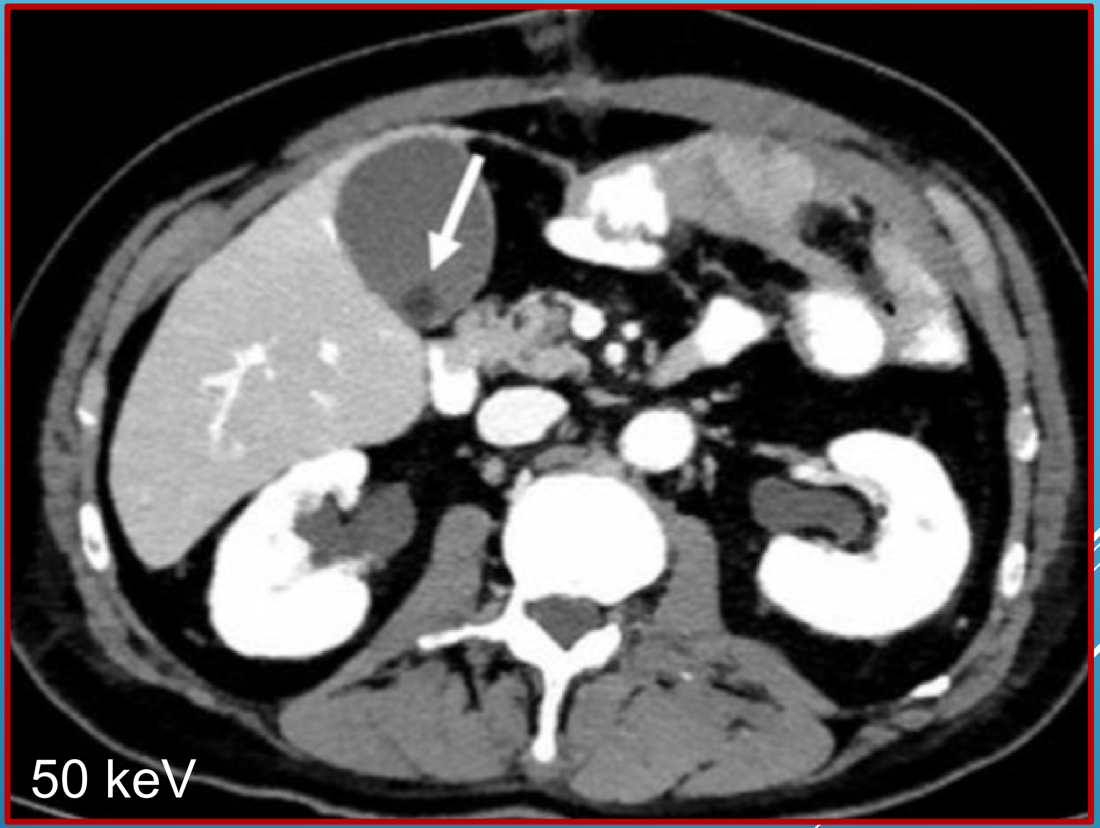


Conventional image | Iodine density image | VNC image

Iodine selective images - Post treatment evaluation for HCC following radiofrequency ablation, microwave ablation, TACE, radioembolization and antiangiogenic therapy

CLINICAL UTILITY – BODY

Gallostones



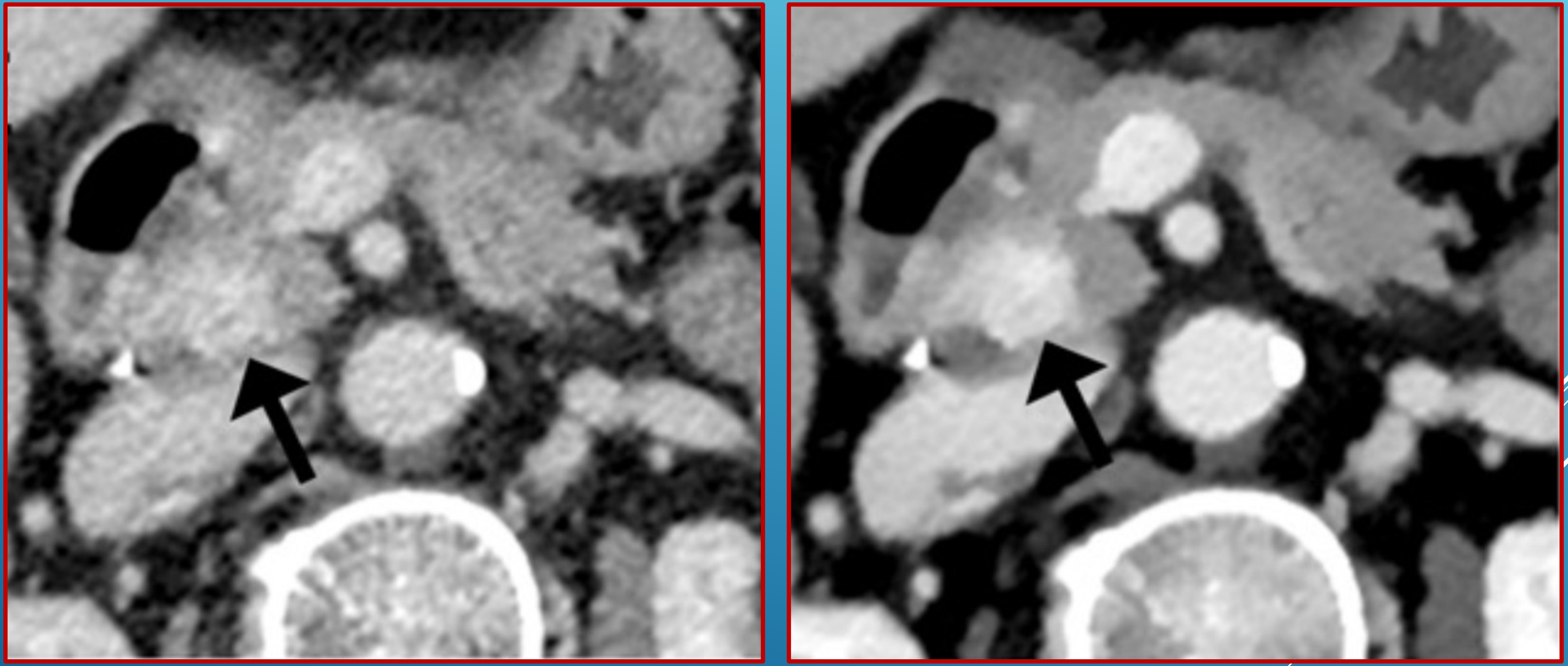
Low KeV VMI - Detection of noncalcified gallstones

CLINICAL UTILITY – BODY

Gallostones

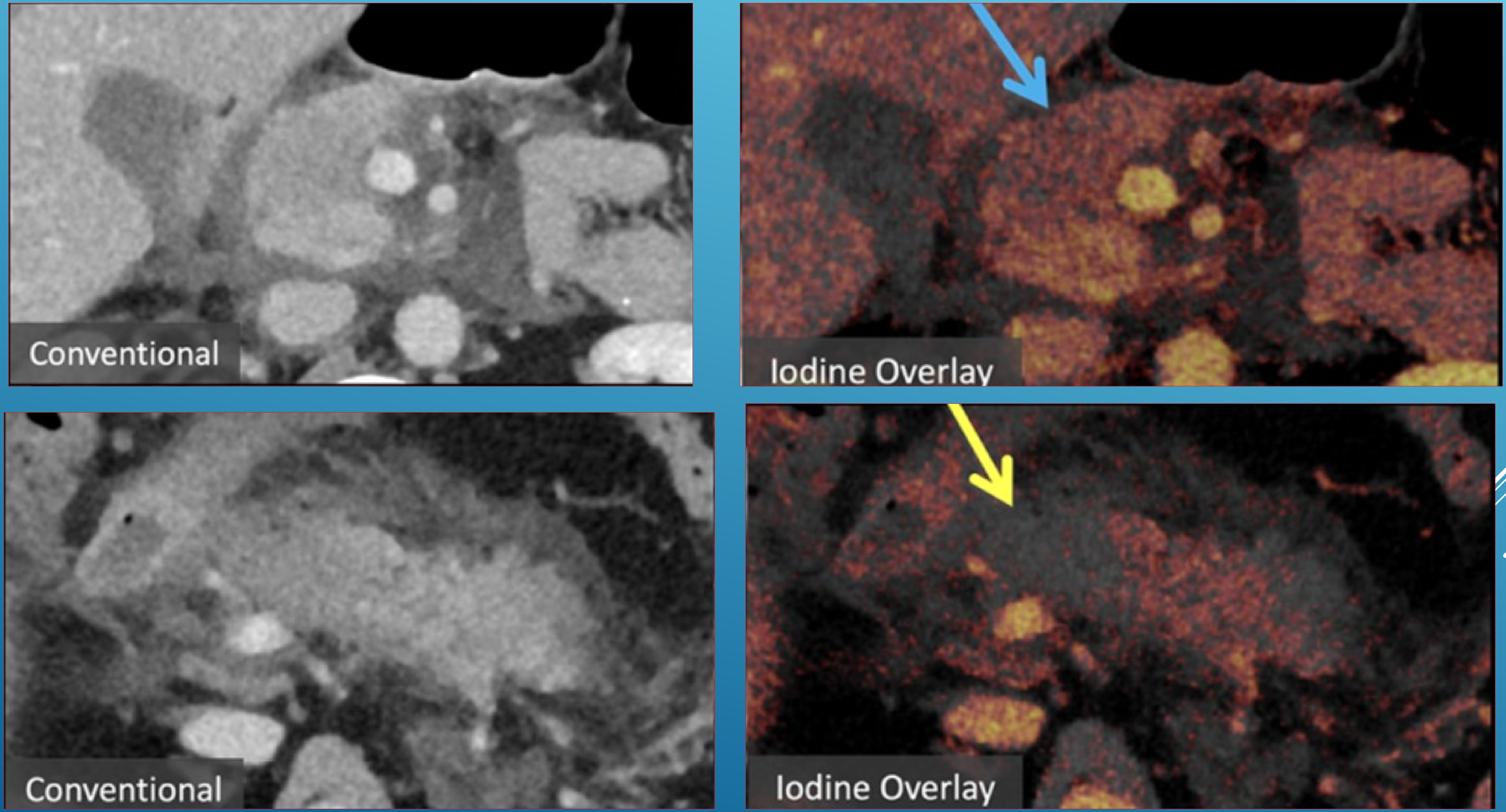
CLINICAL UTILITY – BODY

Pancreas



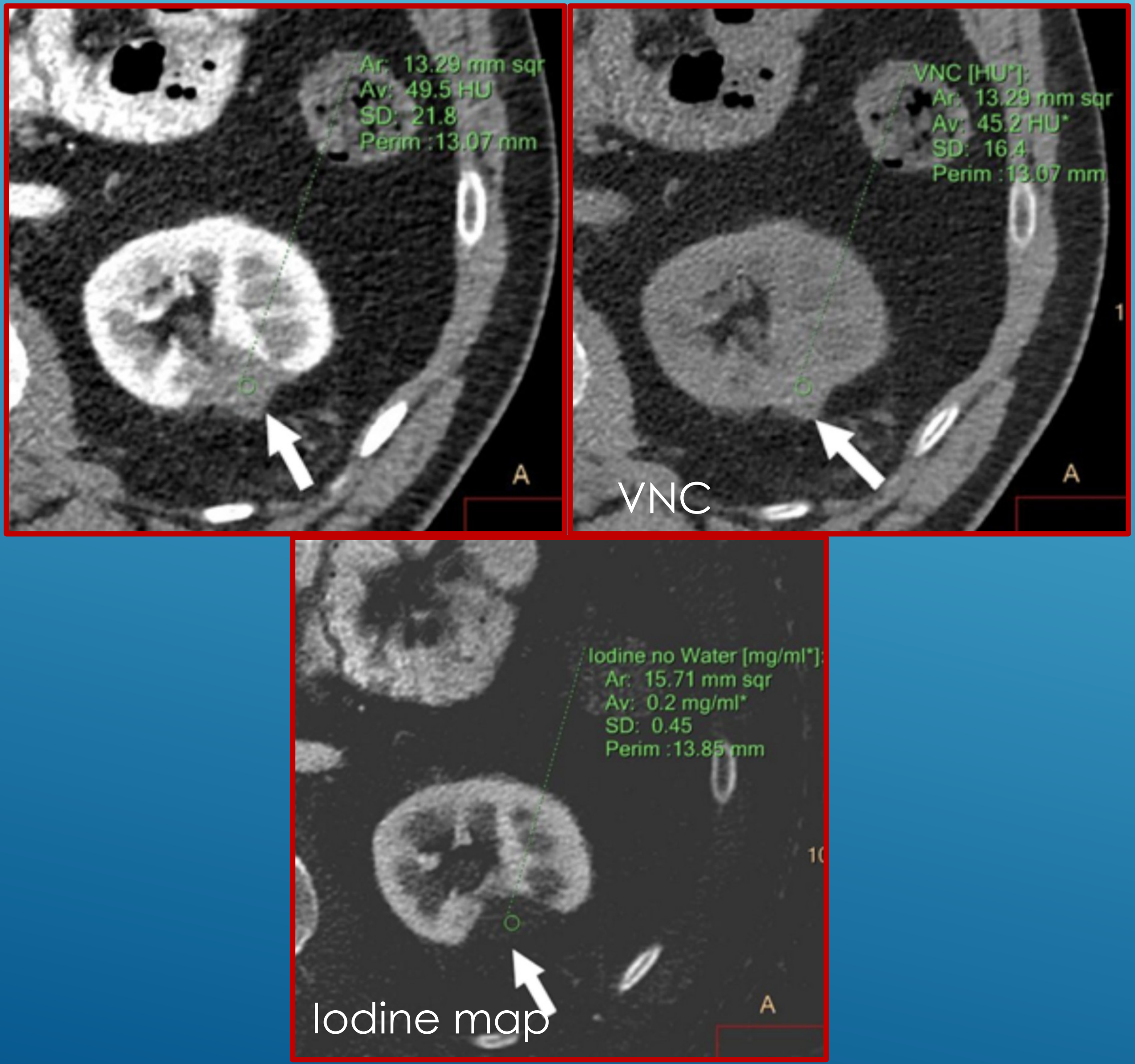
Monoenergetic images at 40 keV

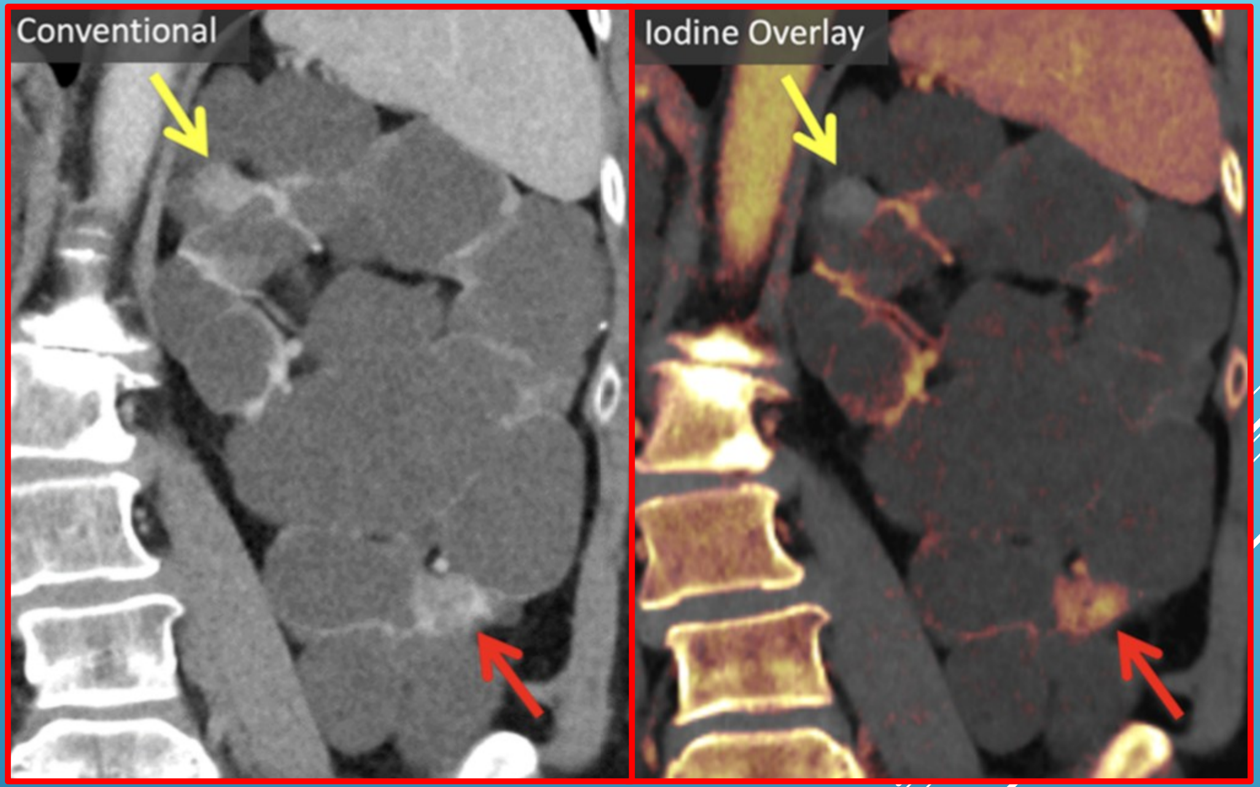
Pancreas


Conventional
Iodine Overlay
Conventional
Iodine Overlay

CLINICAL UTILITY – BODY

Kidney



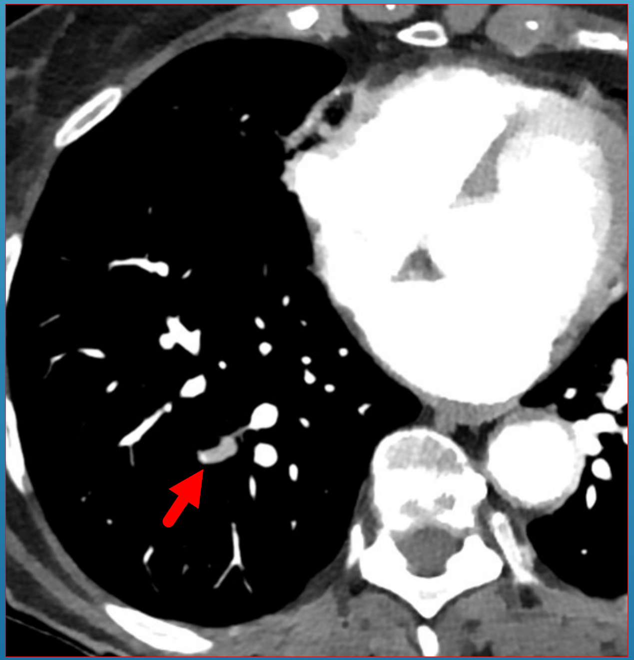


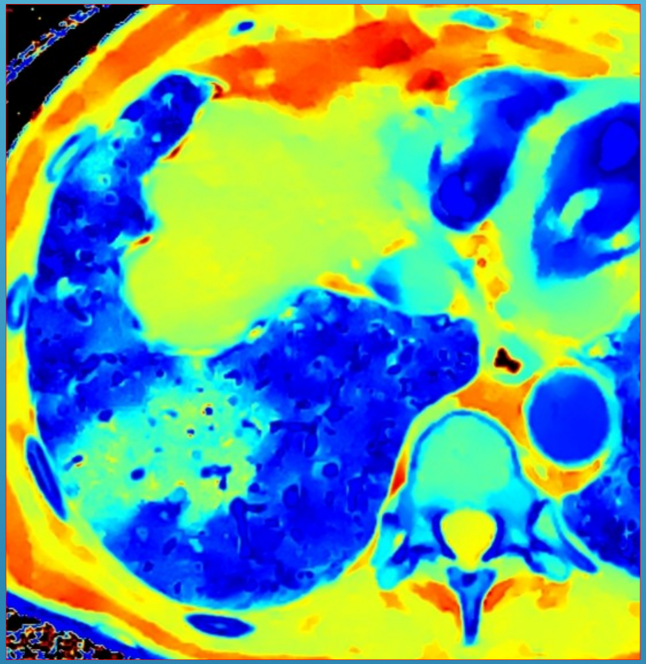
Dual energy CT in clinical routine: how it works and how it adds value

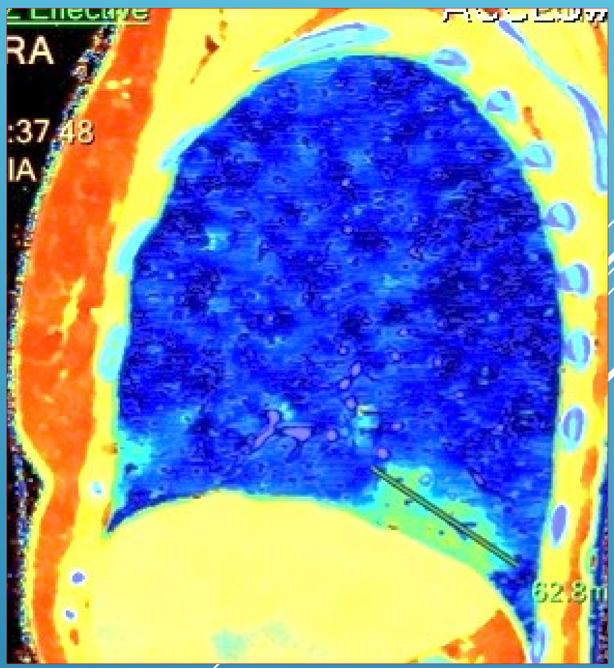
Emergency Radiology (2021) 28:103–117
https://doi.org/10.1007/s10140-020-01785-2

CLINICAL UTILITY – BODY

Pulmonary embolism







CLINICAL UTILITY – BODY

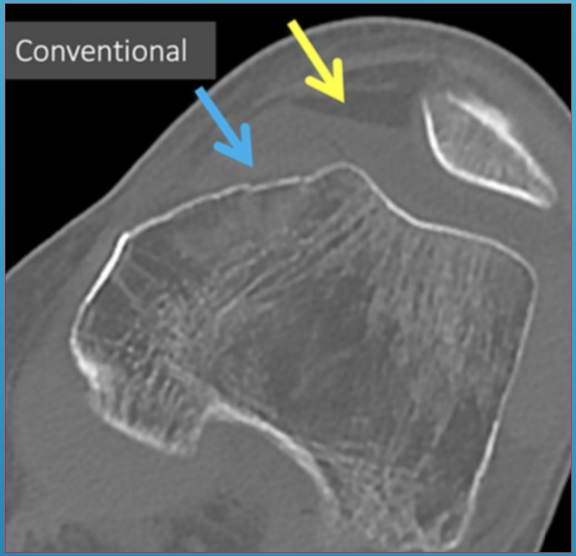
Node

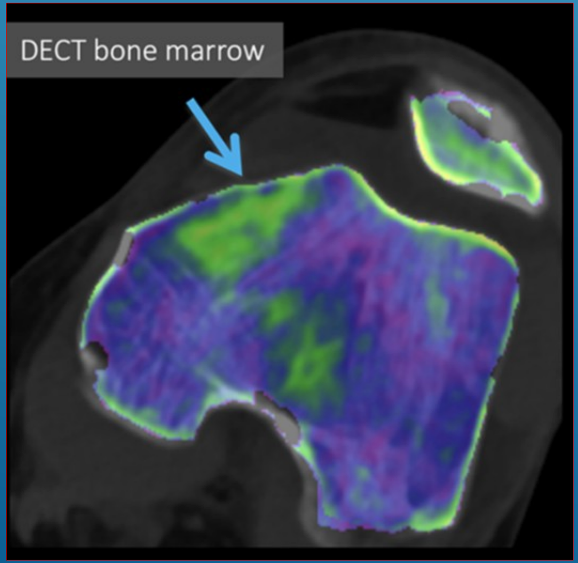
Use quantitative parameters in spectral computed tomography for the differential diagnosis of metastatic mediastinal lymph nodes in lung cancer patients

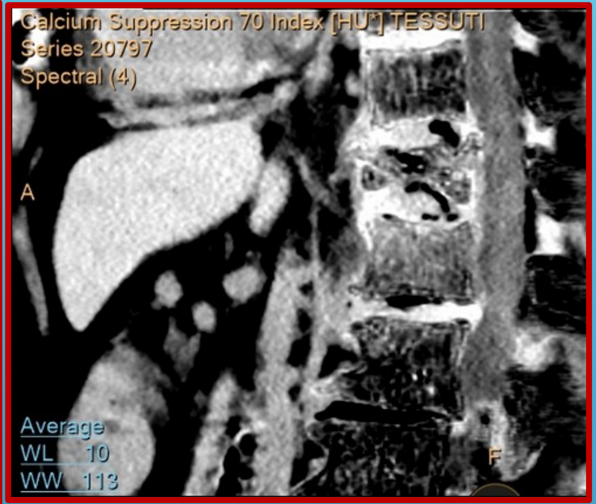
J Thorac Dis 2021;13(8):4703-4713

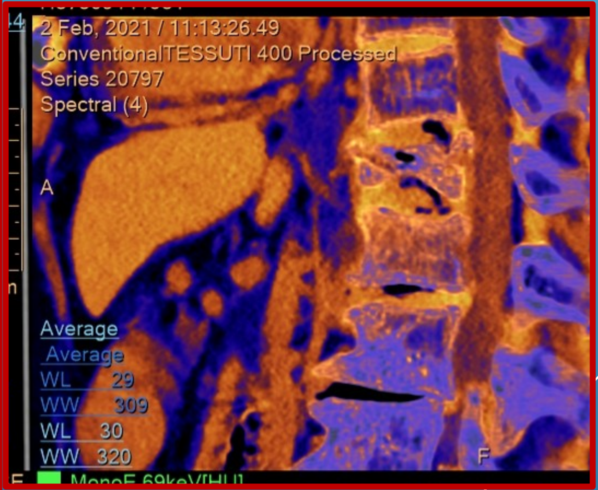
CLINICAL UTILITY – BODY

Bone









CLINICAL UTILITY

Radiation dose reduction

Axial 120 KVp routine diagnostic image

Virtual non contrast images

True non-contrast image

SPECTRAL-CT IQON

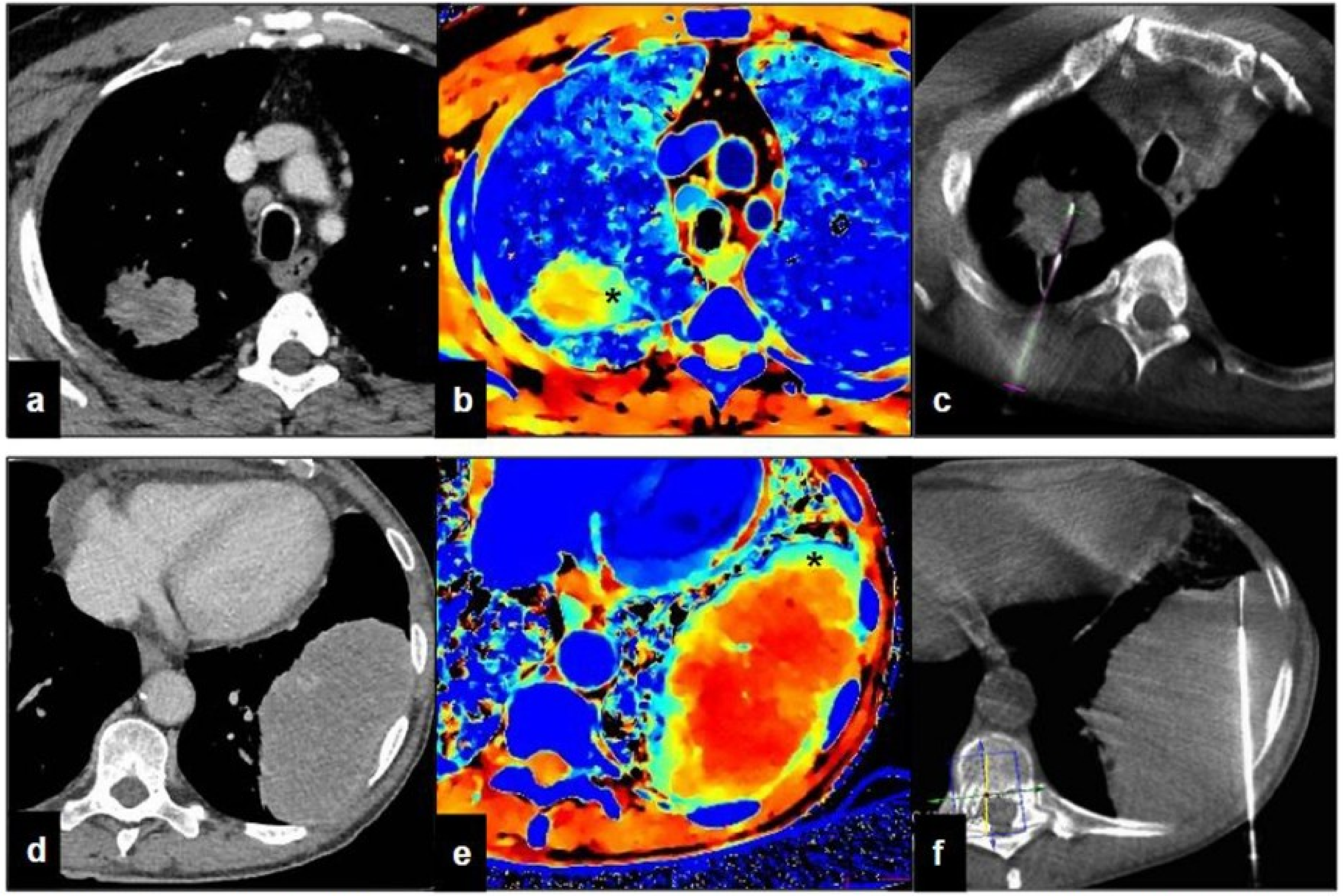


Fig. 1 Percutaneous lung biopsy. **a** Axial routine diagnostic image in a patient with solid lung lesion at the upper right lobe. **b** Effective atomic number-based reconstruction at the same level: the lesion is characterised by inhomogeneous intralesional atomic number with a central area showing a reduced atomic number (yellow–red) and a medial eccentric area showing a higher atomic number (light blue, asterisk). **c** Intraprocedural cone beam computed tomography (CBCT) shows that the needle has been located in the area with the highest atomic number. **d** Axial routine diagnostic image in a patient with solid lung lesion at the lower left lobe. **e** Effective atomic number-based reconstruction at the same level: the lesion is characterised by inhomogeneous intralesional atomic number with a central area showing a reduced atomic number (yellow–red) and an external circular area showing a higher atomic number (light blue, asterisk). **f** Intraprocedural CBCT shows that the needle has been located in the area with the highest atomic number

Curti *et al. European Radiology Experimental* (2022) 6:34
https://doi.org/10.1186/s41747-022-00290-0
European Radiology Experimental

HYPOTHESIS — Open Access

Dual-layer spectral CT fusion imaging for lung biopsies: more accurate targets, diagnostic samplings, and biomarker information?

Marco Curti[1], Federico Fontana[1], Filippo Piacentino[1], Christian Ossola[1], Andrea Coppola[1], Giulio Carcano[2] and Massimo Venturini[1*]

SPECTRAL-CT IQON

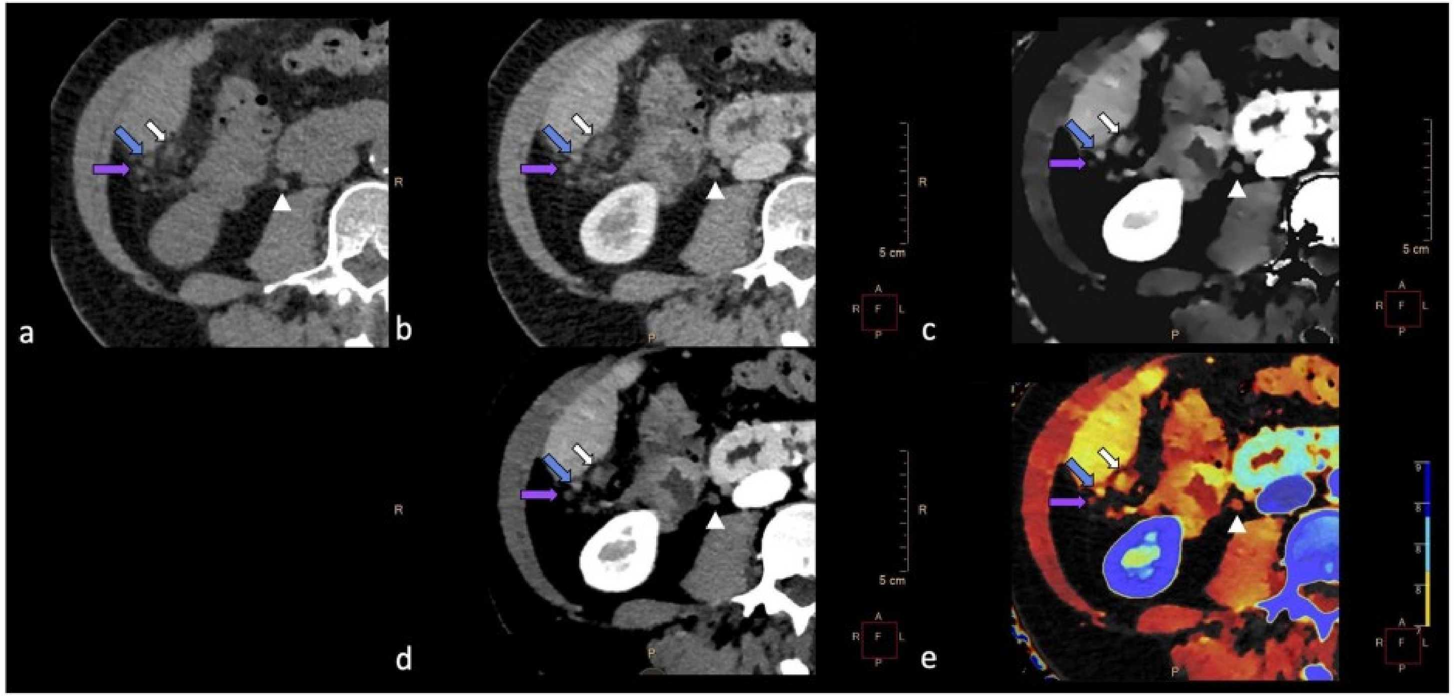


Fig. 1 a–e Spectral computed tomography of a 64-year-old woman with peritoneal carcinomatosis from ovarian cancer. In the native CT scan, obtained before the intravenous administration of contrast agent (**a**) and in the portal-venous phase (**b**), two small and almost apparently identical subhepatic nodules (purple and blue arrows) and a large peritoneal carcinomatosis lesion (white arrow) can be seen. Please also note a small paracaval lymph node (arrowhead), benign in appearance. Iodine density map (**c**), 40 keV monoenergetic image (**d**), and Z-effective image (**e**), obtained at the same level of image **b**; the two small subhepatic nodules present different appearances. While the blue arrow nodule is similar to the large peritoneal carcinomatosis lesion (white arrow), the purple arrow nodule is similar to the small benign para-caval lymph node (arrowhead). This could suggest a different nature of these nodes: the blue arrow one is more likely to be a peritoneal carcinomatosis node, and the purple arrow node is instead more likely to be a small peritoneal lymph node or a fibrotic nodule

Zorzetto *et al.*
European Radiology Experimental (2022) 6:45
https://doi.org/10.1186/s41747-022-00302-z

European Radiology Experimental

HYPOTHESIS **Open Access**

Spectral CT in peritoneal carcinomatosis from ovarian cancer: a tool for differential diagnosis of small nodules?

Giada Zorzetto[1], Andrea Coppola[1], Valeria Molinelli[1], Maria Gloria Angeretti[1], Jvan Casarin[2], Federico Fontana[1], Filippo Piacentino[1], Giulio Carcano[3], Fabio Ghezzi[2] and Massimo Venturini[1*]

SPECTRAL-CT IQON

REAL CLINICAL ADVANTAGES AND CHANGES IN RADIOLOGICAL ACTIVITY

- Elimination of the requirement to prospectively select patients who need dual energy CT.
- Spectral data are available for all patients imaged with spectral-CT without a change in clinical workflow.
- Acquisition phase similar to conventional CT, reconstruction phase different: more prolonged time but significant improvement of information for radiologists.
- Possibilty to reduce radiation dose: no pre-contrast acquisition.
- Possibility to reduce contrast medium amount in diabetiic, nephrophatic patients.
- Possibilty to avoid diagnostic insights with PET-CT or MRI: more information, less examinations.
- Using Z-effective images traditional greyscale-based diagnostic tool may become a colorscale-based technique similar to color-Doppler.

CONCLUSIONS

- Spectral CT provides a wide range of body applications: enhance the information content available in CT imaging
- These technique can be applied in multiple ways to add clinical value in the diagnosis and management of our patients
- Spectral CT can reduce a traditional gap with MRI and PET-CT.