DECT of the Liver
Multi Energy CT Workshop

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Our Multi Energy CT Experience:
GE HD750 Rapid-Switch Dual Energy

GE HD 750
Rapid-Switch
80/140 kVp
Physical Basis

![Graph showing mass attenuation coefficients for different elements across varying energies.](image-url)
Liver Applications

- Enhance the subtle hepatic lesion
- Iodine content to characterize lesions
- Focal fat, iron, fibrosis
- Response to Y-90 and ablation
- Virtual unenhanced images
- Artifact reduction
Enhancing Subtle Hepatic Lesions

• In patients with cirrhosis, CT imaging is frequently used to screen for early detection of hepatocellular carcinoma (HCC)
• HCC often presents as a focal hyperenhancing liver lesion in arterial phase with delayed washout
• Dual Energy CT may make the arterial phase iodine blush of HCC appear brighter
Enhancing Subtle Hepatic Lesions

- Low keV images make iodine very bright but also have increased image noise compared to higher keV images.
- DECT can also be postprocessed to map the concentration of iodine in tissue as a basis pair with water (material decomposition).
- Together, these effects may improve hypervascular lesion conspicuity during iodine enhanced DECT of the liver.
Dual Energy Monochromatic Imaging: HCC

40 kev

80 kev
Dual Energy CT

Multi energy CT in patients with end stage liver disease may improve hypervascular lesion

- Conspicuity of individual lesions
- Number of lesions detected
- Accuracy of measurements
- Characterization of lesions
CNR
Vs.
KeV
The Very Subtle Early Blush

50 keV

Iodine Only
Tumor versus Cyst

Evaluate the ability of liver DECT monochromatic and material decomposition data *from only the arterial phase* to differentiate perfused solid lesions from cysts.
Monochromatic Imaging: HCC

70 keV
On Postprocessing Workstation: From arterial phase DECT data only, plot keV vs HU from lesion and liver:

- **Iodine Present**: curve shape similar to liver, greater than 20 HU change between 40 - 60 keV
- **Iodine Absent**: flat curve compared to liver, less than 20 HU change between 40 - 60 keV
Iodine Present
Greater than 20 HU change in the 40-60 keV range, shape similar to liver
Iodine absent
Less than 20 HU change in the 40-60 keV range, flat shape
Iodine material density image shows iodine within the lesion (arrow), indicative of an enhancing solid mass.
Hemangioma versus HCC

| Thresholds, Sensitivities, and Specificities for Distinguishing HH from HCC with Cirrhosis |
|---------------------------------|-----------------|----------------|
| Parameter                      | Threshold Value* | Sensitivity†   | Specificity‡   |
| NIC during AP                  | 0.3             | 77 (23)        | 89 (8)         |
| LNR during AP                  | 4.6             | 70 (21)        | 100 (9)        |
| NIC during PVP                 | 0.6             | 97 (29)        | 100 (9)        |
| LNR during PVP                 | 1.2             | 87 (26)        | 100 (9)        |
| ICD                            | 0.8             | 70 (21)        | 100 (9)        |

NIC = normalized iodine concentration

Bland vs. Tumor Thrombosis in PV

Ascenti et al. Clinical Radiology, 2016, 2016 Sep;71(9):938.e1-9. doi
Liver Fat, Iron, Fibrosis
Liver Fat Quantification with DECT

Liver Iron Overload

R2* Map

Published in: "Dual-Energy CT for Patients Suspected of Having Liver Iron Overload: Can Virtual Iron Content Imaging Accurately Quantify Liver Iron Content?"
Luo et al.
Radiology Vol. 277, No. 1: 95-103
©RSNA, 2015
Liver Fibrosis Quantification with DECT

Published in: "Material Separation Using Dual-Energy CT: Current and Emerging Applications "
©RSNA, 2016
Response to Focal Therapy
Post TACE Assessment

TACE 70keV

TACE VNC
Post- RF Ablation Assessment

Published in: "Dual-energy CT after radiofrequency ablation of liver, kidney and lung lesions: a review of features"
Vandenbroucke et al.
Insights in Imaging Vol. 6, 363-379, 2015
Virtual Non-Contrast
Dual Energy Monochromatic Imaging: HCC

VNC

Iodine Only
Virtual Unenhanced

Water Only

MSI

Arterial Phase (50 keV)
Metal Artifact Reduction

Metal artifact reduction software programs improve accuracy of metal artifact reduction

Looking at high monochromatic energy levels
Dual Energy Metal Artifact Suppression

Metal 77 keV

Metal 140 keV
Dual Energy Metal Artifact Suppression

77 keV

140 keV
Dual Energy Metal Artifact Suppression

140 keV windowed
Dual Energy Workflow
What goes to PACS?

- Best CNR and lesion conspicuity at 50 keV
- Best image quality (lowest noise) at 70 or 77 keV.
  - Will look like 100 or 120 kVp imaging
- May see a few more very subtle hyperenhancing lesions than with single energy viewed at very narrow windows or with iodine color overlay
- VNC when appropriate
DE Workflow for Liver CT

- Inject usual amount of iodinated contrast, rate
- Scan late arterial and delayed phases with DECT
  - Select rotation time and preset protocol to match patient radiation dose of a simulated single energy CT in same patient (or a bit higher ? – patient specific)
- Post process DECT data into single keV image sets at 50 and 70 or 77 keV plus iodine overlay – send these to PACS
- View in PACS at routine and narrow windows
Postprocessing Hints and Tips:

- If it can be done at the scanner, it should be
  - Can add ASIR there, most direct, single step
- Have your routine reconstructions for the keV levels and image planes automated in scanner
  - Standardized naming of series
- Send data file to AW (server or stand alone)
  - Backup on PACS
  - Measurements