Dual-energy CT of the Pediatric Patient 2016: How I Do It

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Objectives

- Discuss dual energy CT (DECT) clinical experience in a pediatric population
- Review radiation exposure and image quality associated with pediatric DECT
Dual Energy CT (DECT)

- 2\textsuperscript{nd} generation dual source system (Siemens SOMATOM Definition Flash Software)
- Collimation: 128 X 0.6
- Pitch 1.2
- Automatic exposure control
- kVp: 80/140
- Iterative reconstruction
Images for Review
Sent from the console

- 80 kVp (moving to 50 keV)
- Blended (linear)
- MPRs (blended)
- PRN: VNC, iodine map, monoenergetic images
Radiation Exposure

- 79 children (12 days to 18 yrs)
- Chest and/or abdomen DECT
- DECT CTDI$_{vol}$ compared with estimated prescan CTDI from SECT protocol
- Median CTDI$_{vol}$ 3.7 mGy DECT vs 4.4 mGy SECT - 12.5% reduction ($P < .01$)

Siegel M, et al AJR 2016; 207:1–10
Examples: DECT Chest and Abdomen

- Diagnostic image quality in all patients

Chest CT

1 yo: 1.06 mGy
5 yo: 1.39 mGy
10 yo: 3.6 mGy

Abdomen CT

1 yo: 1.09 mGy
5 yo: 1.39 mGy
10 yo: 3.6 mGy
• Common DECT applications in children
  – Bone removal, CTA angiography
  – Assessment of lung blood volume
  – Monoenergetic imaging for metal artifact reduction and improvement of CNR
Neck CTA: Complex Anatomy
14-year-old girl, C2 fracture, syncope

Patent vertebral artery

Neck CT CTDIvol 6.10 mGy
Bone Removal Tool
trauma, skull fracture? - vascular injuries

CTDIvol 5.19 mGy
Abdominal CTA Bone Removal
6 month old girl hypertension
Rule out aortic coarctation

- Normal vessels

CTDIvol 2.32 mGy
CTA: Iodine Map
Normal kidneys
Pulmonary Blood Volume (PBV)

- Congenital heart disease (CHD)
- Arteriovenous malformations
- Pulmonary embolism

Clinical question: Are the lungs perfused?
11-month-old girl with absent pulmonary artery and multiple aortopulmonary collaterals

80 kVp

3D recon

Few small defects

Chest CTA CTDIvol 1.03 mGy
4 year old boy with pulmonary hypertension

Beaded, tapered arteries

CTDIvol 0.93 mGy
14-year-old girl, hereditary telangiectasia

Chest CTA CTDIvol 3.17 mGy

PBV Lung analysis -600 HU
Monoenergetic Imaging

Examples
Monoenergetic Plus

- Use low keV to visualize iodine
  - 40, 50, 60 keV
  - Application: improvement in CNR
- Use high keV to reduce image noise
  - Above 100 keV
  - Application: reduction of metal artifacts
Monoenergetic (Mono +) Images
Abdomen-Pelvis 9-year-old boy, CTDIvol 2.14 mGy

Contrast 1140 HU
CNR = 18

Contrast 740 HU
CNR = 16

Contrast 580 HU CNR = 14

40 keV  50 keV  60 keV

-Low keV offers MORE contrast but higher noise
Monoenergetic Images
Metal Artifact Reduction

15-year-old boy; DECT 100/140Sn kVp

140 kVp

120 keV

CTDIvol 18.1 mGy
Monoenergetic Images
Barium Artifact

6-year-old boy CTDIvol: DECT 80/140Sn kVp

50 keV  70 keV  100 keV

CTDIvol 3.66 mGy
DECT in Pediatric CT 2016
Applications

• Occasional applications
  – Lesion characterization
  – Renal Stones
  – Assess bowel disease
13-year-old boy, mediastinal mass
Characterization Renal Stones

Blended Image non contrast CT

Coded blue = Calcium oxalate stone
Intussusception: Ischemic Bowel

- 9-year-old girl with severe abdominal pain
- No flow on the iodine map

CTDIvol 2.14 mGy
Conclusion

- *Dual source dual-energy CT does NOT require additional radiation dose compared with conventional single-energy*
- Image quality is maintained
- Win-Win scenario