Comparison of Dual-energy CT and Subtraction CT for Renal Lesion Detection and Characterization

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Introduction

The incidence of renal lesions has been rising steadily, which partly can be attributed to the expanding application of imaging in routine practice. In most centers, multi-phase renal mass protocol with single energy CT (R-CT) is the preferred approach to characterization of renal lesions. Despite concerns for additional cost, radiation dose and contrast media use, R-CT fails to characterize up to 16% of these lesions, leading to additional interventions, investigations and increase in economic burden. Some centers have applied subtraction software on R-CT images (CT-S) to facilitate recognition of enhancing and non-enhancing lesions and improve readers’ diagnostic confidence. Dual energy CT (DECT) acquisition also have been reported to display high quality which facilitates detection of enhancement and allow quantification of iodine concentration.

Materials and Methods

The study cohort and patient selection illustrated in Figure 1. A total of 108 subjects (55 male, 43 female) comprised our final study cohort with a total of 266 lesions.

Database search for patients who underwent multiphase rapid KV switching DECT scan with renal protocol from JAN 2015 to FEB 2018 who were suspected of renal lesions N=220 patients

N=108 patients

No subtraction CT images (n=14)

No lesions (n=11)

Post op. ablation (n=2)

Liver metastasis (n=9)

Lesion Assessment

• Subjective assessment of IQ

• Quantitative analysis

Scan parameters

Table 1 scan parameters

CT Technique and Image Reconstruction

All CT scans were performed on a single-source 64-channel scanner with nDECT technology (Discovery CT750 HD scanner GE healthcare, Milwaukie, WI, USA). The bi-phase scan consisted of true unenhanced phase (TUE), acquired in single-energy, followed by nephrographic phase at a delay of 100 seconds, acquired in dual-energy mode. The scan covered the abdomen only (top of kidneys to iliac crest), which was acquired at end expiration. The acquisition parameters are listed in Table 1.

Image interpretation

Image analysis was performed independently by three board-certified radiologists specialized in abdominal imaging (R1=11 years, R2=9 years, R3=3 years) on a PACS workstation in a blinded fashion. To minimize recall bias, interpretation was carried out in two separate sessions a minimum of 2 weeks apart.

Area under curve (AUC) for overall accuracy of the three groups are as follows: Group A (AUC=0.8854, 95% CI: 0.8656-0.9014), Group B (0.7515, 95% CI:0.7117-0.7912), Group C (AUC=0.8748, 95% CI: 0.8460-0.9036). Diagnostic performance of group A was significantly better than group B (p < 0.05), but not significantly different from group C (figure 5).

Conclusion

DECT enables confident and efficient characterization of renal lesions in a single acquisition. DECT is accurate irrespective of reader experience, especially in smaller lesions in comparison to conventional approaches and subtraction CT.

DECT have the potential to reduce dose by obviating the need for additional TUE images.

DECT have the potential to save time by using fewer image sets that have a high IQ.

DECT have the potential to decrease cost by reducing the number of diagnostic procedures.

Quantitative IC and NIC were comparable to ∆HU for discerning lesions enhancement.

References:


We assessed the applicability of an in-house deep learning model directed by radiologist hyperlinks in interactive radiology reports to their annotations on chest CT lung findings in patients with autoimmune polyendocrinopathy candidiasis ectodermal dysplasia (APECED), a monogenic disease. Correlating autoimmune regulator (AIRE) single gene mutation with pathology-verified APECED pneumonitis and labeled CT lung findings should greatly augment deep learning radiomic models.

Radiologists typically follow disease progression by comparing the current exam with the most recent priors.

At NIH Clinical Center, it is common to provide surveillance of genetically defined conditions over an individual’s lifetime. As such, deep learning models have important clinical applications to these conditions, especially those that are monogenic in etiology.

**Purpose:**

- APECED pneumonitis and routinely labeled CT lung findings with interactive reports can serve as a model for accelerating deep learning radiomics.

**Methods:**

- Currently, there are approximately 100 patients diagnosed with APECED undergoing surveillance at NIH CC with CT imaging.
- We assessed 70 chest CTs from 50 patients (to date) with APECED over time using an established disease severity scoring system to compare to deep learning assessment.
- We exported DICOM data from 30 chest CTs and radiologist reports with annotation-matched hyperlinked text in our PACS (Carestream Health, Rochester, NY).
- Three features were selected as “labels” for the testing dataset (ground glass opacity (GGO), consolidation (CO) and cavity (CA)) in comparison with normal lung parenchyma to evaluate our in-house deep learning algorithm, assisted by annotation-directed bounding boxes.

**Introduction and Purpose:**

- We evaluated 57 regions in 30 patients that were normal, GGO, CO or CA using an in-house pre-trained deep learning algorithm.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Dice Coefficient</th>
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<tbody>
<tr>
<td>Normal</td>
<td>48%</td>
</tr>
<tr>
<td>GGO</td>
<td>56%</td>
</tr>
<tr>
<td>CO</td>
<td>58%</td>
</tr>
<tr>
<td>CA</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Results:**

- The relatively low scores are likely due to coarse (for purposes of deep learning training/evaluation) radiologist annotations of poorly defined lung pathology. Preliminary results have helped guide radiologists to improve routine annotations.

**Discussion/Summary:**

- Radiologists at NIH routinely annotate cross-sectional imaging exams and directly connect them to hyperlinked textual descriptions in interactive radiology reports. This acts as a form of labeling, fulfilling a major “missing link” in supervised deep learning.
- We demonstrate feasibility to correlate hyperlinked text in radiology reports to their annotations, directing deep learning algorithm training/evaluation and eventual automatic detection/classification.
- The previously overly large radiologist annotations resulting in slightly lower dice coefficients are now being refined based on preliminary results to improve deep learning results.
- Making more precise annotations has been recently implemented into radiology workflows at NIH.

**Clinical Significance:**

- Our model addresses the major missing “link” needed for supervised deep learning: expert labeling of abnormal lung findings (often with path correlation in a monogenic defined disease) on CT by radiologists understanding the implied contextual information, providing the “supervision” of deep learning on a routine basis.
- We believe our deep learning approach to automated temporal scoring on serial imaging in genetically defined diseases will greatly augment radiologists by improving radiologist report value as opposed to limiting comparison to a few recent prior exams.

**References:**


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Introduction

Acute appendicitis is commonplace, and easily diagnosed with CT, however the abdominal radiologist should be familiar with atypical appearances of acute appendicitis and other uncommon inflammatory conditions of the appendix. We provide a review and discussion of atypical imaging appearances of acute appendicitis and rare inflammatory conditions of the appendix which can clinically mimic acute appendicitis. It may be classified into three categories: 1) Rare causes of secondary appendicitis; 2) Atypical locations of appendicitis; 3) Rare causes of appendicular inflammation that may be confused with appendicitis.

Rare causes of appendicitis

De Garengneot hernia

De Garengneot hernia is defined by the appendix herniating into the femoral canal. The incidence of these hernias is very low (0.5-3%). Femoral hernias are much more common in women. The incidence of acute appendicitis within a De Garengneot hernia is less than 1% (3). Less than 80 cases have been reported in the medical literature. These hernias are generally drained and treated with oral analgesics. Rarely does this cause a swelling on the right side. Left sided Amyand hernia’s, named after a British surgeon who performed the first recorded appendectomy, is defined by a hernia of the appendix into the femoral canal (4). It occurs in the cecum where they rarely cause appendiceal obstruction leading to acute appendicitis. In a large review of appendectomy specimens, 0.8% of acute appendicitis cases were secondary to an obstructing colonic tumor. There were multiple case reports in the literature of acute appendicitis being the first presentation of colon cancer in the elderly. Primary tumors of the appendix are rare and mostly found incidentally in 1-2% of appendectomies. Carcinoïd tumors make up to 75% of primary appendiceal tumors. Unlike adenocarcinomas, carcinoïd tumors is most often found in women aged 50 to 60 years. Carcinoïd tumors are typically found in the appendix with a median diameter of 2 cm. Carcinoïd tumors are usually less than 1 cm and carcinoid measuring less than 1 cm can be treated by appendectomy alone. For carcinoid tumors greater than 2 cm, a right-hemicolectomy is the standard of care. Management for lesions between 1-2 cm is controversial.

Foreign bodies

Foreign bodies have a rare known cause of acute appendicitis. Case reports describe fish bones, razor blades, tooth picks, staples, and even common fragments of producing acute appendicitis. In some cases the onset of acute appendicitis is within days to weeks, in others, it may be months before appendicitis presents. Foreign body reactions to fish bones, razor blades, tooth picks, staples, and even dental implants have been reported in the literature as creating an inflammatory reaction producing appendicitis.

Rarer causes of appendiceal inflammation & mimics

1) Atypical locations of appendicitis. 2) Rare causes of acute appendiceal inflammation that may be confused with acute appendicitis. Only two cases in the literature discuss acute epiploic appendagitis of the appendix. Appendiceal diverticulitis and diverticular disease is a distinctive entity preoperative diagnosis by computed tomography. Imaging findings are analogous to other forms of intussusception. Appendiceal enterocele is a rare entity resulting from obstruction and herniation of the uterine cavity and myometrium. As these endometrial cells are shed into the uterine cavity, they are retained within the cecum and appendix. Acute appendagitis include a less than 5 cm oval fat density mass adjacent to the cecum, blind loop syndrome, and subcutaneous location of the appendix. Rare endosalpingiosis include a less than 5 cm oval fat density mass adjacent to the cecum, nonsecreting adenomatous endosalpingiosis, and inflammatory changes at the base of the appendix (dashed red arrows).

Gastro-intestinal lymphoma

Gastro-intestinal lymphoma is a rare neoplasm often thought to be acquired through either an obstructive or inflammatory mechanism. In some cases, the diverticula diverticulitis tend to occur in an older age group when compared to appendicitis with mean age being 35. Although both appendiceal diverticulitis and appendiceal appendicitis are both treated by appendectomy, appendiceal diverticulitis carries a six fold increased risk for perforation. When found incidentally, prophylactic appendectomy is recommended due to an increased risk for future diverticulitis, and risk for perforation.

Appendiceal diverticulitis

Appendiceal diverticulitis are found in up to 2% of appendectomy specimens thought to be acquired through either an obstructive or inflammatory mechanism. In some cases, the diverticulitis diverticulitis tend to occur in an older age group when compared to appendicitis with mean age being 35. Although both appendiceal diverticulitis and appendiceal appendicitis are both treated by appendectomy, appendiceal diverticulitis carries a six fold increased risk for perforation. When found incidentally, prophylactic appendectomy is recommended due to an increased risk for future diverticulitis, and risk for perforation.

Intussusception of the appendix

Intussusception of the appendix is an extremely rare entity with an incidence of 0.1% of surgical specimens. The presentation is variably sudden onset, mimicking acute appendicitis, to chronic with intermittent symptoms. Preoperative diagnosis is often difficult and the use of CECT scanners, but has improved from 20% to 58%. In the adult, like ileocecal intussusception, the presentation is acute with intermittent symptoms. Preoperative diagnosis was poor before the wide use of CT scanners, but has improved from 20% to 58%. In the adult, like ileocecal intussusception, the presentation is acute with intermittent symptoms. Preoperative diagnosis was poor before the wide use of CT scanners, but has improved from 20% to 58%

References

Introduction

Diagnostic Reference Levels (DRLs) are important radiation dose optimization tools and have established DRL for dose standardization in many countries (1). However, previous literatures have suggested that the number of data acquisition channels might affect DLP values and there is a close relationship between the type of CT scanner and the CT dose index (CTDIvol) (2). Therefore, the purpose of this study is to compare radiation doses of different CT scanners in Asian countries and suggest diagnostic reference level (DRLs) for the specific scanner.

Methods and Materials

Between 2015 and 2017, the radiation dose of the five most common CT protocols (head, abdomen, genitourinary, cardiovascular, and chest examinations) were obtained in the multiple centers of the Asian countries.

The study included 294,577 scans of 12 different CT scanners.

Results

The Brilliance 64 (Brilliance CT, Philips Healthcare, Cleveland, OH, USA) was the most common used CT scanners, followed by Aquilion one (Aquilion ONE Vision Edition, Toshiba, Tochigi, Japan).

The CTDIvol of our study showed similar to those reported from other studies, and all of the median CTDIvol were lower than the European or national DRLs (2-4). However, median CTDIvol between CT scanners was significantly different. In the comparison of radiation dose between different CT scanners, median and IQRs of CTDIvol for iCT256 (Brilliance iCT 256 Philips, Philips Healthcare, Eindhoven, The Netherland) were substantially lower than those of other CT scanners, including Aquilion one, which has the highest median and IQRs of CTDIvol. Median CTDIvol were 2.11 mGy (IQR, 1.35-3.51) with the iCT 256 and 8.63 mGy (IQR, 5.80-37.94) with the Aquilion one.

In a comparative study by the number of detector channel, more than 64 channels multi-detector CT scanners display lower radiation doses than CT scanners with 64 or fewer channels (median CTDIvol 5.55 mGy versus 4.90 mGy).

Table 1. number of scans for each CT scanner.

<table>
<thead>
<tr>
<th>Device</th>
<th>No. of examinations</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquilion ONE</td>
<td>43662</td>
<td>14.82</td>
</tr>
<tr>
<td>Brilliance 64</td>
<td>48112</td>
<td>16.33</td>
</tr>
<tr>
<td>Discovery CT750 HD</td>
<td>25746</td>
<td>8.74</td>
</tr>
<tr>
<td>iCT 256</td>
<td>34743</td>
<td>11.79</td>
</tr>
<tr>
<td>Ingenuity CT</td>
<td>24477</td>
<td>8.31</td>
</tr>
<tr>
<td>LightSpeed Ultra</td>
<td>6976</td>
<td>2.37</td>
</tr>
<tr>
<td>Sensation 16</td>
<td>30847</td>
<td>10.47</td>
</tr>
<tr>
<td>SOMATOM Definition</td>
<td>40538</td>
<td>13.76</td>
</tr>
<tr>
<td>SOMATOM Definition Flash</td>
<td>10270</td>
<td>3.49</td>
</tr>
<tr>
<td>iQon - Spectral CT</td>
<td>14488</td>
<td>4.92</td>
</tr>
<tr>
<td>SOMATOM Force</td>
<td>14718</td>
<td>5.00</td>
</tr>
<tr>
<td>Sensation 16 with Akron Q tube</td>
<td>143</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>294577</td>
<td></td>
</tr>
</tbody>
</table>

Chart 1 Comparison of median CTDIvol (mGy) of each CT scanner

Chart 2 Comparison of median CTDIvol between more than 64 channels multi-detector CT scanners and 64 or fewer channels CT scanners

Conclusion

On the basis of our findings, radiation doses of the modern CT scanners are far below the suggested DRL values and the difference of radiation dose between CT scanners are significantly high.

Therefore, we suggest that CT scanner specific DRLs are needed to guide healthcare providers for the radiation dose monitoring and quality assurance to minimize unnecessary radiation exposure to the patients.

References

Renal lesions are a common incidental finding on abdominal CT performed for another indication. In the absence of non-contrast phase, these lesions are incompletely characterized and often require additional imaging. Dual-energy CT (DECT) can theoretically provide the information necessary to characterize renal lesions. In this study, we used an anthropomorphic phantom environment with simulated, custom-fabricated renal lesions to evaluate whether a post-contrast dual-source DECT scan can discriminate enhancing and non-enhancing renal lesions using calculated iodine concentration (IC) and effective atomic number (EAN).

### Materials and Methods

Three cylinders (simulating renal non-contrast, excretory, and nephrographic phases) and six rods (simulating simple cysts, hyperdense cysts, and pre- and post-contrast states of minimally-, moderately-, and highly-enhancing solid renal masses) were serially placed in an anthropomorphic phantom (ATOM 701, CIRS Inc.) and scanned at 120kV and 90/150kV modes using a dual-source DECT (SOMATOM Force, Siemens). Pre- and post-contrast attenuation was measured on 120kV and 0.6-mixed images. IC and EAN values were measured on iodine maps and effective atomic number maps.

### Results

When comparing attenuation from pre-contrast 120kV and post-contrast 0.6-mixed images, non-enhancing cysts showed a <15HU attenuation change, whereas enhancing masses yielded a >15HU attenuation change (P<.05). 15HU corresponded to IC and EAN values of 0.5mg/ml and 7.7, respectively.

**Figure (left):** Moderately and highly enhancing masses showed significantly higher IC and EAN values compared to non-enhancing cysts on nephrographic and excretory phases (P<.01). The minimally-enhancing mass showed significantly higher IC than the hyperdense cyst on nephrographic phase (P=.04). A non-significant increase in IC was noted between the minimally-enhancing mass and hyperdense cyst on excretory phase (P=0.06) and EAN on nephrographic and excretory phases (P=0.10, 0.29).

### Conclusion and References

IC and EAN derived from a DECT acquisition can be used to differentiate enhancing solid renal lesions from non-enhancing cysts. Of note, IC values can be used to discriminate minimally enhancing solid masses from non-enhancing hyperdense cysts when a renal lesion is incidentally found on post-contrast imaging.

Israel GM, Bosniak MA. Pitfalls in renal mass evaluation and how to avoid them. Radiographics 2008; 28(5):1325-1338.


Chronic Pulmonary Embolism: Role of CT in Diagnosis and Management

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Background Information

Chronic pulmonary thromboembolism (PE) is a complication of acute pulmonary embolism that can result in pulmonary arterial hypertension and right-sided cardiac failure. It is important to recognize chronic pulmonary embolism and differentiate this entity from acute pulmonary embolism on CT pulmonary angiography since the treatment differs significantly. Patients with chronic pulmonary embolism require lifelong anticoagulant therapy and early referral for evaluation for pulmonary thromboendarterectomy, which is the only potential curative therapy.

Educational Goals

The objectives of this presentation are to illustrate and discuss selection of patients for thromboendarterectomy.

Key Imaging Findings

Signs of chronic pulmonary embolism can be divided into two categories: vascular signs (the most specific of which are due to evolution and incomplete resolution of thrombus), and parenchymal signs resulting from decreased perfusion. Vascular signs include eccentric thrombi, calcified thrombi, bands or webs in the pulmonary arteries, and signs related to pulmonary hypertension such as pulmonary artery enlargement, right ventricular hypertrophy and enlargement of bronchial arteries. Parenchymal signs include scarring from prior pulmonary infarcts, mosaic perfusion, and bronchial dilatation.

Vascular signs | Parenchymal signs
--- | ---
Eccentric thrombi | Scarring
Calcified thrombi | Mosaic perfusion
Band or web in pulmonary artery | Bronchial dilatation
Signs of pulmonary hypertension |  

Eccentric Thrombi

71-year-old woman with lung cancer presented with shortness of breath for 2 months. Coronal reformatted image from CT pulmonary angiogram demonstrates an eccentric filling defect (arrow) in the right interlobar pulmonary artery representing chronic thrombus.

Calcified Thrombi

47-year-old woman who presented with chest pain and dyspnea. Sagittal reformatted image from CT pulmonary angiogram demonstrates an eccentric filling defect (arrow) containing foci of calcification in the left pulmonary artery representing chronic organizing thrombus.

Bands or Webs

68-year-old man with history of prior pulmonary embolism presented with dyspnea and hypoxia. CT pulmonary angiography was performed due to concern for acute pulmonary embolism. Axial image shows linear filling defect (arrow) with calcification traversing the right pulmonary artery representing a web from chronic pulmonary embolism.

Mosaic Perfusion

50-year-old man with history of prior pulmonary embolism presented with chest pain and syncope. Axial images from CT pulmonary angiography show signs of pulmonary arterial hypertension including dilated right atrium (*), dilated main pulmonary artery (green arrow) and reflux of intravenous contrast material to the inferior vena cava and hepatic veins (yellow arrow). Sagittal oblique reformat shows eccentric filling defect in the left interlobar pulmonary artery compatible with chronic thrombus (orange arrow).

Pulmonary Arterial Hypertension

66-year-old woman presented with dyspnea, initially diagnosed with acute PE which later progressed to chronic PE. Axial image from CT pulmonary angiogram demonstrates peripheral opacity representing parenchymal scarring from chronic PE (green arrow). Coronal reformatted shows filling defect in the right lower lobe segmental pulmonary artery (yellow arrow) unchanged from prior study (not shown) representing chronic PE.

Bronchial Artery Dilatation

48-year-old man with chronic pulmonary embolism (not shown). Volume rendered images from CT pulmonary angiogram demonstrate multiple dilated and tortuous bronchial arteries (arrows). The dilated bronchial arteries serve as collateral supply to the pulmonary parenchyma when the pulmonary arteries are obstructed.

Bands or Webs

36-year-old man with history of chronic PE (not shown) who presented with chest pain. Coronal reformatted image from CT pulmonary angiogram demonstrates bilateral perihilar ground glass opacities (arrows). Vessels in the relative radiolucent areas are smaller in caliber due to decreased perfusion.

Treatment

Patients with chronic PE can progress to chronic thromboembolic pulmonary hypertension. Surgical pulmonary thromboendarterectomy (PTE) is the preferred and only curative therapy. CT pulmonary angiography allows for non-invasive preoperative testing to identify operable patients, evaluate the extent of disease, and predict prognosis. PTE is a challenging procedure that entails median sternotomy and cardiopulmonary bypass with deep hypothermia and total circulatory arrest. Perioperative mortality ranged from 20% in the 1970s to <2% recently in experienced centers.

The location of the fibrotic thromboembolic material is classified into 4 levels based on the most proximal extent of the clot:

- **Level 1**: Main pulmonary arteries (between orange lines)
- **Level 2**: Lobar branches (between orange and green lines)
- **Level 3**: Segmental branches (peripheral to the green lines)
- **Level 4**: Subsegmental branches

Resection of level 3 and 4 disease is more technically challenging with higher complication rates, and until recently was considered nonoperable. Recent experience suggest that hemodynamic improvement can be obtained after the procedure.

Checklist for preoperative evaluation:

- Level of involvement of the thromboembolic material
- Coexisting parenchymal and mediastinal disease
- Cardiac findings including: cardiac chamber size, heart position, deviation of interventricular septum, presence of congenital cardiac abnormalities, anomalous pulmonary venous drainage, and size and distribution of collateral vessels arising from systemic arterial circulation

Summary

CT pulmonary angiography is the optimal non-invasive test for diagnosis of chronic pulmonary embolism. Preoperative CT is helpful for surgical planning, risk stratification and determination of prognosis for patients with chronic thromboembolic pulmonary hypertension.

References


Virtual non-contrast CT: Effect on size and conspicuity of liver metastases from breast carcinoma

Brian Fleming, Philip Burchett, Mark Kovacs, Douglas Sheafar, Andrew Hardie
Medical University of South Carolina, Department of Radiology and Radiological Science

Background and Purpose

It has become common to use portal venous phase-only (PVP) to assess for hepatic metastases, driven by cost and radiation dose reduction. Several studies have shown that PVP is the single most useful phase for identification of hepatic metastases, particularly in the setting of hypovascular tumors (1).

However, multiple studies of hypervascular tumors have shown that the use of non-contrast (NCP), images can increase the number of lesions identified (2,3) and breast cancer has historically been included in the differential for hypervascular liver lesions. In the setting of breast cancer, prior studies have show that while there are lesions seen on NCP images that are not seen during the PVP, per patient sensitivity and specificity are not affected (4). An example of this phenomenon is seen in figure 3.

Given establishment of Response Evaluation Criteria in Solid Tumors (RECIST), the size and number of individual lesions have become more important for the treatment of individual patients (5). Also, underestimation of true lesion size can lead to false positive findings of progression after treatment (6).

Unpublished data from a subset of breast cancer patients at our institution has shown that 58% of hepatic metastases measured larger using NCP in comparison to PVP. In this subset, the mean sum of largest diameters (SLD) was 6 mm and 19% larger on NCP. This is very close to the 20% threshold required for progression in RECIST.

Given these findings and the increased clinical usage of dual energy CT (DECT), our group considered that DECT with creation of virtual non-contrast (VNC) images, could confer similar advantages to NCP images without additional cost or radiation exposure to the patient. Therefore, the purpose of this study was to assess differences in lesion size and conspicuity using DECT at NCP, PVP, and VNC in patients with liver metastases from breast cancer.

Methods

14 consecutive CT scans in 12 patients with clinically or pathologically proven metastatic breast cancer were selected. DECT imaging was performed using a third generation dual-source CT scanner with weight-based contrast dosing, fixed 65 second PVP delay, and 3 mm slice thickness. VNC reconstruction were performed using the PVP data set.

True NCP, PVP and reconstructed VNC image-sets were reviewed by lesion size: 2 fellowship-trained body imagers during 3 separate reading sessions separated by 2 weeks. One reader measured liver-to-lesion contrast-to-noise ratio (CNR) for each metastasis. By consensus, readers also ranked the image sets for lesion conspicuity for each metastasis.

Results

<table>
<thead>
<tr>
<th>Lesion Size</th>
</tr>
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<tbody>
<tr>
<td>50 hepatic metastases visualized</td>
</tr>
<tr>
<td>38 measured larger on NCP than PVP (76%)</td>
</tr>
<tr>
<td>Mean lesion size: 1.63 cm on PVP 1.87 cm on VNC (16% larger) 2.09 cm on NCP (28% larger)</td>
</tr>
<tr>
<td>Size differences are all statistically significant (P &lt; .001)</td>
</tr>
</tbody>
</table>

Liver-to-lesion contrast-to-noise ratio

- 2.7 on PVP
- 2.8 on VNC
- 1.2 on NCP

Contrast to noise ratios of PVP and NCP were statistically significant as those were between VNC and NCP (P < .001)

Lesion Conspicuity

- PVP: Ranked 1st or 2nd in 34/50 lesions (68%)
- VNC: Ranked 1st or 2nd in 39/50 lesions (78%)
- NCP: Ranked last in 22/50 lesions (44%)

Conclusions

- Hepatic metastases from breast cancer measure larger on non-contrast images.
- Accurate assessment of lesion size has the potential to avoid misclassifying disease response as progression.
- DECT affords the opportunity to produce VNC images at little to no radiation increase to patients.
- There are unique characteristics of VNC images as demonstrated by increased conspicuity of many lesions in comparison to the true NCP images, likely due to some residual contribution of iodine to the image.
- VNC reconstructions in patients with breast cancer hepatic metastases have the potential to outperform PVP-only imaging for lesion conspicuity and size evaluation.

References


Figure 1: Number of lesions for which each phase was rated best for conspicuity.

- PVP: Ranked 1st or 2nd in 34/50 lesions (68%)
- VNC: Ranked 1st or 2nd in 39/50 lesions (78%)
- NCP: Ranked last in 22/50 lesions (44%)

Figure 2: Patient with known metastatic breast cancer scanned with dual-phase DECT. Known right hepatic metastases is visualized on all phases, but measures larger on the NCP image, as the peripheral isodense tumour is difficult to differentiate from background parenchyma during the PVP. However, this isosattenuating tumour is well-visualised on the VNC image.

Figure 3. Patient with history of breast cancer and dual phase CT scan performed. Single metastasis was seen during the PVP (arrow), but many more lesions were visualized on the NCP image, consistent with multiple metastases.
Single phase assessment of the abdominal aorta and its major branches using Spectral Detector CT

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Introduction
The common CT protocol for the assessment of the abdominal aorta includes at least two phases: non-contrast and arterial phase. In some cases it is also acceptable to perform a triple-phase CT angiography (CTA) which includes a delayed phase, especially for patients after endovascular aortic repair. The unenhanced images are used in order to differentiate calcifications from an intramural hematoma or an endoleak that may appear on the arterial or the delayed phase (1).

Several studies have shown that virtual non-contrast (VNC) images can be comparable to true non-contrast (TNC) images in different scenarios, using different types of dual-energy CT (DECT) (2-4). These studies raise the question whether single phase DECT (or spectral CT) can replace multi-phase CTA as the protocol of choice for the assessment of aortic pathologies. The purpose of this study was to evaluate the diagnostic performance of single phase Spectral Detector CT (SDCT) in comparison with a conventional biphasic CTA of the abdominal aorta.

Materials and Methods
The files of 44 patients that underwent multiphase abdominal CTA on a dual-layer SDCT were reviewed. All the patients had a non-contrast phase and an arterial phase scans of the abdomen. Virtual non-contrast (VNC) images were generated from the dual-energy acquisition. Two blinded radiologists evaluated only the arterial phase and the VNC images. Their interpretations were compared to the clinical follow-up of the patients and to the original interpretations of other radiologists, that used both the true non-contrast and the arterial phase images. The diagnostic performance of the two radiologists in the detection of pathologies of the aorta and its main branches was evaluated. The potential dose reduction of a single-phase over a multiphase protocol was calculated.

Figures
Examples of the high similarity between true and virtual non-contrast images, that provide the same information for the assessment of the abdominal aorta and its branches.

<table>
<thead>
<tr>
<th>Pathology</th>
<th>N (%)</th>
<th>Sensitivity of single phase SDCT</th>
<th>Specificity of single phase SDCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic aneurysm</td>
<td>20 (45.5%)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Aortic dissection / IMH / PAU</td>
<td>9 (20.5%)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Celiac artery pathology</td>
<td>6 (13.6%)</td>
<td>83.3%</td>
<td>97.4%</td>
</tr>
<tr>
<td>SMA pathology</td>
<td>5 (11.4%)</td>
<td>100%</td>
<td>95.1%</td>
</tr>
<tr>
<td>Renal arteries pathology</td>
<td>6 (13.6%)</td>
<td>100%</td>
<td>97.4%</td>
</tr>
<tr>
<td>IMA pathology</td>
<td>3 (6.8%)</td>
<td>100%</td>
<td>97.6%</td>
</tr>
<tr>
<td>Iliac arteries pathology</td>
<td>13 (29.5%)</td>
<td>92.9%</td>
<td>93.9%</td>
</tr>
<tr>
<td>No pathology</td>
<td>17 (38.6%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. The distribution of pathologies of the aorta and its branches among the study patients and the diagnostic performance parameters of single phase spectral-detector CT. SDCT = Spectral Detector CT, IMH = intramural hematoma, PAU = penetrating atherosclerotic ulcer, SMA = superior mesenteric artery, IMA = inferior mesenteric artery.

Results
The sensitivity and specificity of single-phase abdominal CTA in conjunction with VNC images in the detection of aortic pathologies (aneurysm, dissection, intramural hematoma and penetrating ulcer) and pathologies of the main branches (severe stenosis, thrombosis, aneurysm and dissection) are summarized in table 1.

The potential mean dose reduction that can be achieved by omitting the non-contrast acquisition in our patients was 52%.

Conclusions
Our study suggests that single phase CTA including spectral features as virtual unenhanced images is sufficient for the detection of pathologies of the aorta and its major branches. This protocol allows a substantial reduction in dose exposure to patients.

References