The Role of Dual-Energy Computed Tomography in Assessment of Abdominal Oncology and Beyond

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KEYWORDS

• Dual energy CT • Oncologic imaging • Low keV images • Iodine concentration • Cancer

KEY POINTS

- Dual energy computed tomography 50 keV simulated monoenergetic images and iodine material density images should be routinely viewed to improve detection and characterization of focal pancreatic lesions.
- Dual energy computed tomography 50 keV simulated monoenergetic images and iodine material density images are used to improve detection of focal hepatic lesions.
- Identification of iodine in renal lesions is equally sensitive and more specific than standard Hounsfield unit enhancement to identify renal neoplasms.
- For incidentally discovered adrenal masses, benign lesions can be confirmed on a single postcontrast dual energy computed tomography image and obviate the need for further imaging.

INTRODUCTION

Dual energy computed tomography (DECT) applications have been investigated in various tumors from head to toe. Many of the earliest clinical experiences with DECT involved the study of patients with cancer, and now with more than 10 years of experience, this modality is well-established, particularly for soft tissue tumors in the abdomen. It is important at the outset of this article to note that, just as for all patients but particularly pertinent for the cancer population, which undergoes repeated imaging surveillances, exposure to ionizing radiation should be minimized and this is achievable in the practice of DECT.[1] It has been shown that abdominal DECT is feasible without increasing radiation dose or sacrificing image quality,[2] and many have reported this technology to produce dose neutral or dose negative exposure profiles compared with conventional single energy CT.[3,4]

DECT allows for qualitative and quantitative analysis of tissue composition beyond the standard anatomic evaluation available with conventional single energy CT. Especially advantageous in patients with neoplasms is the ability of the radiologist to interrogate iodine concentration captured in DECT image data, or to increase the contribution of iodine signal to the image by viewing of lower energy simulated monoenergetic reconstructed images, which increase lesion conspicuity.[1,5] In addition to improving detection and characterization of suspected tumors, DECT may provide early evaluation of therapeutic response that is more accurate than standard anatomic size-based treatment monitoring.[6] One way this may be achieved is by using a quantitative iodine concentration rather than standard perfusion CT biomarkers,[7–9] a strategy that also results in a large reduction in radiation exposure to patients.

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Another benefit of DECT involves the potential reduction in the amount of intravenous iodinated contrast administered to patients.[1] This practice is coupled with the use of viewing lower energy simulated monoenergetic reconstructed images to preserve image contrast, contrast-to-noise ratios (CNR) and signal-to-noise ratios. In 1 study, a 50% decrease in intravenous iodine concentration administered during DECT did not adversely affect the CNR in an animal model of hypervascular liver lesions when monoenergetic images ranging from 40 to 140 KV were used.[10] Phantom studies have shown that viewing of low-energy simulated monoenergetic images is helpful and can be performed with preservation of image quality, even in large patients[11] (**Fig. 1**), although many centers do limit the size of patients undergoing DECT.

Finally, the use of spectral imaging information combined with color-coded maps or filters is beneficial for the detection and characterization of neoplastic lesions,[12] and the practitioner using DECT will have to learn to optimize these new postprocessing methods in addition to becoming familiar with the nomenclature of a new CT practice environment.[13] This article summarizes the advantageous aspects of DECT as well as challenges to successful implementation in clinical practice, using an organ-based approach to various neoplasms and focusing on the abdomen while applicable throughout the body.

ABDOMINAL NEOPLASMS

Pancreas

One of the earliest applications of DECT in oncology was for evaluation of pancreatic ductal adenocarcinoma. Macari and colleagues[14] first showed that viewing 80 kVp images obtained with a first-generation dual source DECT produced better conspicuity of tumors compared with blended 120 kVp images when patients with pancreatic cancer were scanned in portal venous phase. Patel and colleagues[15] first reported the benefits of doubling tumor to nontumoral Hounsfield units differences when viewing simulated monoenergetic images at 52 keV compared with the “pictorial archive and communication system (PACS) equivalent” 70 keV images using a rapid kV switching DECT scanner when patients with pancreatic cancer were scanned in the pancreatic parenchymal phase. This same group later showed with a multireader study that agreement for objective image quality measurements was highest at 52 keV, subjective reader confidence and lesion conspicuity were best using iodine

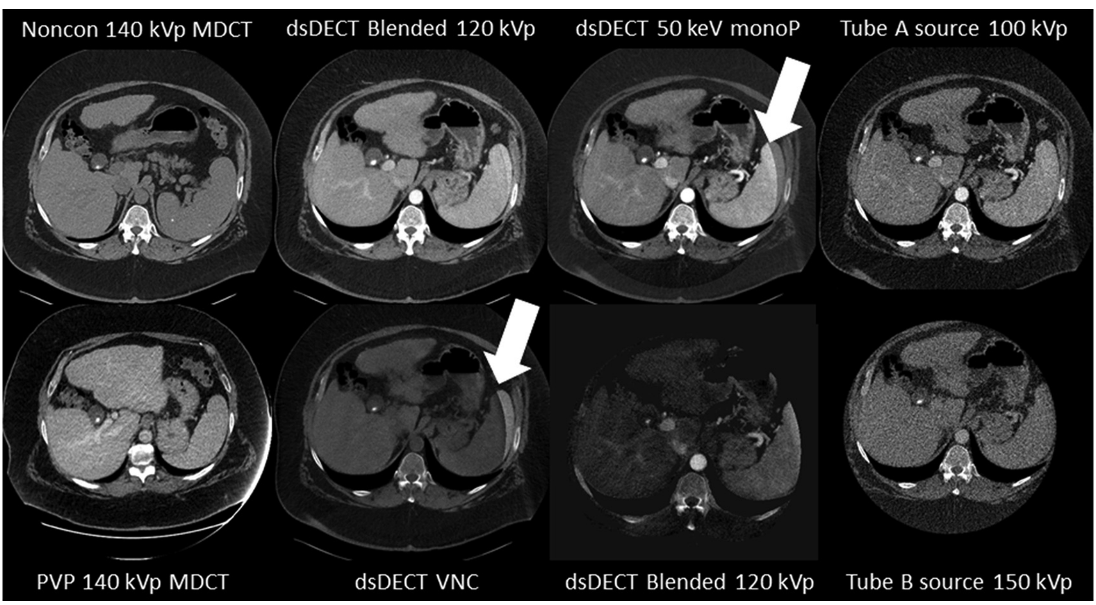

Fig. 1. A 409-pound 56-year-old man undergoing multiphasic abdominal dual energy computed tomography (DECT) for hepatocellular carcinoma surveillance. Dual source DECT image set obtained in late hepatic arterial phase demonstrates reasonable image quality on blended, low keV, and virtual noncontrast images, including visualization of the small gallstone on all images. No suspicious hepatic mass was seen. Note that the smaller of the 2 tubes (tube B, *lower right*) does not cover the full anatomic area of this large patient, resulting in the demarcation of dual from single energy image signal (*arrow*); however, the critical structures are included in the 35-cm field of view.