# Single- and Dual-Energy CT: A Comparison

MISERICORDIA UNIVERSITY

**Student Researcher: Emilee Bixler**

**Faculty Advisor: Dr. Elaine Halesey, Ed.D, R.T.(R)(QM)**

## INTRODUCTION

- Computed tomography (CT) is an advanced imaging modality that creates cross sectional images of a patient by utilizing x-rays.
- The purpose of this research is to evaluate single-energy computed tomography (SECT) and dual-energy computed tomography (DECT) and determine the benefits of each configuration.
- SECT utilizes a polyenergetic beam that is emitted by a single source and collected by a single detector.
- DECT utilizes two x-ray sources inside the gantry, one source producing a high kV and the other producing a low kV (or one tube simultaneously producing two energy levels).

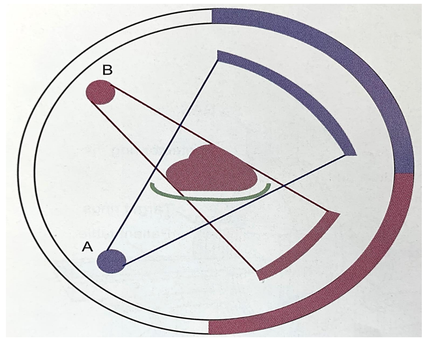


*Image 1: A dual-source DECT array with two tubes (A and B) - each emitting a different energy level - and two receiving detectors* (Long, Rollins, & Smith, 2019).

- Conventional SECT has been standard until the advancement of DECT, which is sought after for its potential in superior delineation and differentiation of structures without an increase in dose (Almeida, Parodi, Landry, & Verhaegen, 2017).
- CT has been a major contributor in issues regarding patient dose in radiology, thus the technological advancement in the field such as DECT maintaining image quality and diagnostic efficacy without an increase in dose to patients is greatly pursued.
- DECT can be particularly useful in procedures with contrast agents in the thorax and abdomen, as it allows for improved visualization of soft tissues such as the liver, lungs, tendons, and ligaments.

## PROS AND CONS OF SECT

- **Pros**
  1. SECT is conventional, well researched, commonly known and been in use longer.
  2. Provides imaging specifications that lead to quality images with good diagnostic efficacy, such as contrast-to-noise ratio (CNR) and spectral separation (Almeida et al., 2017).
  3. Quicker protocol setup time than DECT
- **Cons**
  1. Higher radiation dose to patient than DECT (Wichmann et al., 2017).
  2. Less differentiation and delineation of region of interest (ROI) measured structures in the brain than DECT (Taasti et al., 2018).
  3. Less efficient discrimination of iodine quantification than DECT, so more iodine is needed in SECT (Shuman et al., 2017).
  4. No metal, iodine, or bone reduction abilities as in DECT.

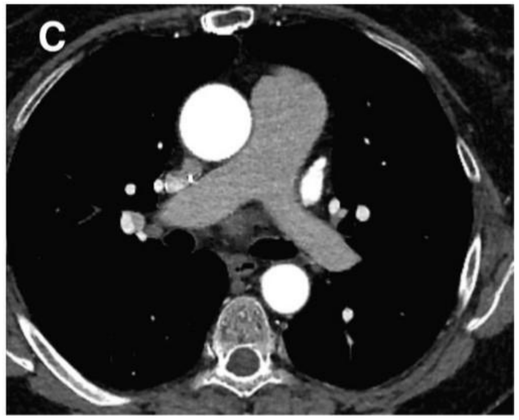


*Image 2: A prior SECT scan in a patient with history of ascending aortic aneurysm, scanned with SECT at 120 kVp and 44 g of iodine* (Schuman et al., 2017).

## PROS AND CONS OF DECT

- **Pros**
  1. By scanning at two energy levels, DECT allows for two separate image sets. These can be kept apart for structure analysis or joined to create a virtual monoenergetic image (VMI), which provides better diagnostic information.
  2. Larger variety of scanner types – rapid kVp-switching (KVSCT), dual layer CT (DLCT), or dual source CT (DSCT) (Sellerer et al., 2018).
  3. More accurate iodine quantification, regardless of type of DECT.
  4. Dose reduction while maintaining the same standard of image analysis as SECT (Schuman et al., 2017).
  5. More protocol advancements, such as metal/bone/iodine reduction, low dose, and improved 3D multiplanar reconstruction (MPR).
  6. Superior spectral separation over SECT in DLCT and DSCT.

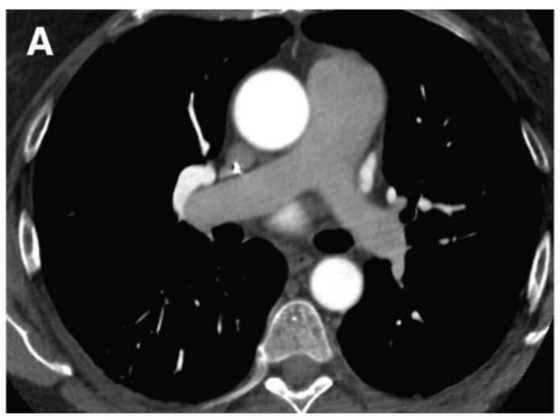


*Image 3: The same patient as in Image 2, scanned with DECT 2.5 mm with 13 g, 70% less than the average SECT dose of iodine, and reconstructed at 50 keV.* (Schuman et al., 2017).

## CONS OF DECT (CONT.)

- **Cons**
  1. Patient size limitation of gantry.
  2. DECT implementation in a department is more expensive than SECT.
  3. DECT is underutilized due to limitations in technology and the full diagnostic advantages are unknown because DECT is still relatively in its infancy compared to SECT.

## CONCLUSION

- The purpose of this research was to determine the advantages and disadvantages of DECT and SECT systems. The project included the specifications for each configuration, and the pros and cons of both SECT and DECT.
- DECT is preferred over SECT in patients who have metal prostheses because of its metal reduction protocols.
- DECT is also the favored configuration for any cardiac studies due to its superior temporal resolution, which can complete a gantry rotation in fractions of a second to better visualize the heart without motion.
- DECT has proven a dose reduction as much as 30% compared to SECT in one study (Shuman et al., 2017).
- While SECT is the tried and true original CT scanner, when compared to DECT it subjects the patient to larger doses of iodine, radiation, and in some cases is not as specific in its discrimination of subject contrast in areas of many attenuators such as the abdomen.
- Further research should be conducted to keep up with the advances that are being discovered in regards to DECT in all forms – KVSCT, DLCT, and DSCT – and as more improvements are made to these scanners.

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