Chronic thromboembolic pulmonary hypertension (CTEPH) on dual energy CT (DECT)

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Clinical History
A 36-year-old woman with morbid obesity (body mass index 44 kg/m2), bronchial asthma, and a history of pulmonary embolism, underwent evaluation for chronic thromboembolic pulmonary hypertension (CTEPH).

Findings
Nuclear ventilation/perfusion scintigraphy (V/Q) demonstrated large mismatched perfusion defects in bilateral lower lung zones suggesting high probability pulmonary embolism.

Subsequent right heart catheterization revealed pulmonary hypertension, with a PA gram which showed total thrombotic occlusion of the lower branch of the left pulmonary artery and segmental defects in the right lower lobe.

Before surgical thrombectomy, dual energy CT pulmonary angiography (DECT PA) was performed. Virtual monoenergetic images demonstrated narrowing from occlusive filling defects (chronic thrombi) of lobar and segmental pulmonary arteries in the left lower lobe along with narrowing and subtotal thrombi in the lobar and segmental pulmonary arteries in the right lower lobe.

Iodine distribution or pulmonary blood volume (PBV) images derived from the same examination demonstrated marked deficits in pulmonary parenchymal enhancement in bilateral lower lobes. Quantitative analysis demonstrated significant reduction in pulmonary parenchymal enhancement in the lower lobes (3 -5 HU) versus the upper lobes (19-25 HU). The lung attenuation value images demonstrated normal aeration in both lungs, consistent with a mismatch between the pulmonary parenchymal enhancement (with deficits) and aeration (without abnormality). This mismatch was better appreciated on DECT PA as compared to the V/Q study.
**Discussion**

Pulmonary hypertension as a result of chronic thromboembolic pulmonary disease is associated with significant morbidity and mortality. Conventionally, nuclear V/Q scintigraphy and right heart catheterization with PA gram are performed to establish the diagnosis and assess operability.

DECT involves simultaneous scanning at two different energy levels and can be performed on some advanced CT scanners. DECT allows similar or lower intravenous contrast and radiation doses versus single energy CT.

In addition to conventional single energy images, DECT provides virtual monoenergetic and material decomposition images (this enables the separation of materials such as iodine, calcium and water). DECT PA allows three-dimensional qualitative (lobar, segmental and subsegmental) and quantitative assessment of iodine distribution.

Recent studies have reported the potential of DECT PA for evaluation patients with suspected pulmonary embolism as well as pulmonary arterial hypertension, with similar sensitivity (100%) and specificity (92%) versus nuclear V/Q scintigraphy.

**Figure 1 & 2**: Nuclear V/Q scintigraphy: There are perfusion defects in bilateral lower lobes with normal ventilation (mismatched defects).

**Figure 3**: IDECT PA virtual monoenergetic image (40 keV): Significant narrowing of pulmonary arteries in bilateral lower lobes with thrombi consistent with chronic thromboembolic disease process.

**Figure 4**: DECT PA derived 3D iodine overlay image overlays 3D pulmonary parenchymal enhancement information (orange) from PBV data on top of the 3D bronchial airways (white) from conventional CT datasets. The 3D overlay image elegantly demonstrates normal aeration in bilateral lower lobe with lack of parenchymal enhancement (inferred from a lack of orange color in lower lobes) consistent with mismatched defect.

**REFERENCES**

