Advances in Digital Chest Radiography: Dual Energy, CAD, and Digital Tomosynthesis

While recent advances in radiologic imaging have focused on CT and MRI technology, progress in digital radiographic techniques has also had significant impact on our ability to evaluate cardiothoracic disease. A number of publications have established the improved image quality of digital imaging systems over conventional film techniques [1]. While image quality has clearly improved with digital techniques, further research has established the superiority of digital radiography (DR) over computer radiography (CR) while significantly decreasing radiation dose. The flat panel detector technology central to DR technology promises further advances in imaging of heart and lung disease. One of the most exciting of these emerging technologies is dual energy subtraction radiography.

The imaging information made possible with dual energy subtraction technology represents a wide variety of cardiothoracic pathology. While the majority of the published literature on dual energy subtraction has focused on the improved detection of lung nodules, we have found that dual energy radiography improves our diagnosis and detection of a wide variety of pathology. We have divided these radiologic findings into four basic categories: 1) improvement in lung nodule detection, 2) evaluation of calcified thoracic structures, 3) evaluation of cardiac disease, and 4) evaluation of miscellaneous cardiothoracic pathology.
Lung Nodule Evaluation

The accurate detection of pulmonary nodules has been an intense and continued focus of radiographic research. The classic study by Muhn showed that up to 90% of lung nodules prospectively missed on a chest radiography could be identified on retrospective review [2]. In a study by Austin, 27 missed lung cancers were retrospectively identified with a mean diameter of 1.6 cms. More recent work analyzed a number of lung cancers missed on initial evaluation. These lesions were commonly in the upper lobes, with a significant number of detection failures to overlapping ribs and clavicles. Several papers have described improved detection of lung nodules with dual energy subtraction radiography. The ability to remove overlying bony structures has markedly improved our diagnostic confidence in the detection of pulmonary nodules.

Thoracic Calcification

One of the most important benefits of dual energy subtraction radiography is the detection of calcification. In a recent article asking radiologists to rate their confidence level for the presence or absence of calcification, radiologists showed significant inter-reader variability in confidence when evaluating standard film screen techniques. The overall sensitivity for the detection of nodule calcification was only 0.50 [3]. Our experience supports several publications showing improved confidence in the detection or exclusion of nodule calcification. The use of dual energy subtraction technology has been used in the evaluation of pleural calcification. Early research has postulated a possible role of dual energy subtraction in the evaluation of calcified pleural plaques and asbestos related pleural disease.

While the accurate evaluation of calcification has been important in the distinction of the calcified and non-calcified pulmonary nodule, dual energy also helps to distinguish underlying skeletal pathology from a pulmonary nodule. This accurate
distinction can help minimize the patient anxiety associated with an indeterminate pulmonary nodule, and avoid the cost and radiation of follow up imaging evaluation with CT. The use of dual energy subtraction has improved the detection of a variety of skeletal pathology. This ability has been especially important in the evaluation of our large hematology-oncology population. The presentation of the “bone” image improves the detection of skeletal abnormalities and has been especially important in the diagnosis of bony metastatic disease.

Cardiac Disease

While plain radiography and fluoroscopic evaluation has demonstrated the value of plain radiography and chest fluoroscopy in the detection of coronary artery disease, other papers have shown poor sensitivity in the ability of plain radiography to diagnose cardiac disease. Our early experience has shown markedly improved performance in the evaluation of coronary artery calcification with dual energy subtraction technology when compared to the standard x ray image. Initial observations have also suggested that assessment of valvular and myocardial calcification is also improved with dual energy subtraction technology.
Future Directions: CAD, Temporal Subtraction and Digital Tomosynthesis.

While the use of breast CAD is widely recognized and clinically adopted, the use of CAD for lung cancer detection is still in its infancy. Early results are promising. In a paper by Li et al., a commercially available CAD algorithm was used to analyze 34 cases of lung previously missed on chest radiographs. These were significantly subtle lesions. Using the CAD algorithm, 35% of the lesions were identified by the CAD algorithm. Other techniques such as temporal subtraction also suggest interesting future applications. Using a prior radiograph as baseline, the current and baseline are digitally subtracted, and any interval change is highlighted on the temporally subtracted image. Recent work by Dobbins et al. also describes exciting results with digital tomographic imaging. Early work demonstrates significantly improved nodule detection when compared to conventional radiographs. The advent of digital techniques will enable further advancement in detection of cardiothoracic disease.

