AbstractID: 8002 Title: New Issues in Breast Imaging

Screen film mammography will gradually give way to digital mammography systems, which have been shown in the DMIST trial to have slightly better performance for women with dense breasts. New developments in breast imaging technology have advanced beyond mammography towards potentially interesting and potentially better technologies. In this presentation, some of the basic science foundations for these advanced technology systems will be discussed. Mimicking the changes which are occurring in general radiology practice, where tomographic imaging modalities such as computed tomography (CT) are replacing more traditional projection radiographic techniques, tomographic methods for breast imaging are also becoming practical with advancements in digital detector systems and computer-based algorithms. The presentations in this symposium will highlight some of the advancements which have taken place in these and other areas.

A number of groups around the country have been developing computed tomography systems for breast imaging based upon flat-panel detectors, using cone-beam CT of the pendant breast. While demonstration of the comparative performance of breast CT compared to digital mammography is perhaps several years into the future, clinical images acquired during Phase II breast CT trials may shed light on the ultimate performance of breast CT in relationship to digital mammography. One of the central motivations for tomographic imaging of the breast is that the anatomical noise due to the normal breast parenchyma is reduced, due to the tomographic nature of breast CT. Although the noise power spectrum (NPS) is typically used to characterize the quantum and electronic noise characteristics of an imaging system, this metric can also be used to evaluate the anatomical noise characteristics of imaging systems. Towards this end, a Phase II clinical trial on breast CT was used to acquire projection imaging data (mammographic equivalent) as well as reconstructed CT images of the breast. NPS analysis was used to characterize the frequency-dependent noise characteristics of the anatomical noise in these different imaging modalities. Consistent with the work of Burgess, it was found that mammographic projection image data has a noise power spectrum which obeys a power spectrum, where NPS (F) = alpha x F^–beta, where the beta term is approximately 2.8. Theoretical predictions suggest that breast CT images would result in a similar power law relationship with the anatomical noise in the breast, although the value of beta would be reduced by a numerical value of 1 (beta' = beta – 1). Using a dataset of images from 40 patients undergoing breast CT, the NPS was calculated on projection breast images ("mammograms") as well as the reconstructed breast CT images, and the results indicate that the reduction in the value of beta is on the order of 1.3 (beta' = beta – 1.3). These data will be presented, and following based upon Burgess' work, it is argued that breast CT images may have better detection performance than digital mammography, based upon these assessments of anatomical noise.

One of the limitations of mammography as well as breast CT is that these modalities image the anatomical nature of the breast. Breast cancer lesions, therefore, must be identified based upon their morphologic characteristics. With the advent of molecular medicine techniques, positron emission tomography (PET) of the breast is being explored in a number of institutions. A PET/CT system designed specifically for imaging the breast was evaluated in a number of patients. A high resolution PET detector system was fabricated and integrated into an existing breast CT scanner. In this preliminary investigation, a number of patients were imaged using the PET/CT system for the breast. A description of the technology development, as well as an expose of the hybrid image datasets will be presented. While these data are too preliminary to make statements about the ultimate clinical utility of PET/CT of the breast, the incorporation of molecular imaging techniques for breast cancer evaluation and staging represents a significant step towards the development of more sensitive and patient-specific imaging protocols.

The incorporation of computer-aided diagnosis (CAD) systems into digital mammography systems has been a significant advance of the use of image processing to augment the observer detection performance of radiologists. While recent publications have described the limitations of CAD routines in the hands of radiologists who may not specialize in breast imaging, there is a general consensus in the breast imaging community that CAD has a role to play and will most likely have an increasingly important role to play in breast cancer detection. The development of CAD routines, with a description

of past and present performance levels, will be described. While the use of CAD in projection digital mammography is most common, researchers in this field are developing advanced CAD algorithms for the detection of breast cancer in 3-dimensional tomographic data of the breast, including magnetic resonance imaging (MRI) and breast CT. The development of CAD routines in projection mammography as well as tomographic breast imaging systems will be described.

Breast imaging is at an interesting crossroads, where the advancements in technology in other areas of human imaging are being applied to breast cancer screening, diagnosis, and staging. In this symposium, a description of the potential advancements based upon these new technologies will be presented by leaders in their respective fields. While there is some degree of speculation in these research-oriented presentations, this symposium may well chronicle the advancements of breast CT imaging and diagnostic systems 10 years into the future.