AAPM 2021 Breast Imaging 2: Possible Future Directions
Speakers: Jordana Philips, MD, Reyhaneh Nostati, PhD, Peymon Ghazi, PhD, Kai Yang, PhD
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Speaker 1: Jordana Philips, MD

Presentation Title: Future Directions for Contrast-Enhanced Mammography (CEM)

Synopsis:
CEM is a new imaging modality that harnesses the power of enhancement for cancer detection and combines it with standard mammographic imaging. It is increasingly being used as a diagnostic tool in the clinical setting to evaluate screen-detected abnormalities, to determine extent of disease for newly diagnosed breast cancer patients, to measure neoadjuvant treatment response, and to serve as an alternative to breast MRI. CEM’s markedly improved cancer detection rate compared to standard mammography has led to a growing interest in using CEM for breast cancer screening, particularly in women with dense breast tissue. A large multicenter prospective clinical trial called CMIST is currently being developed to study outcomes of CEM compared with tomosynthesis in a screening population. In addition, contrast-enhanced tomosynthesis (CET) is being developed that employs a post-contrast dual-energy technique during the tomosynthesis acquisition. Studies are underway to determine whether CET provides added value beyond a two-dimensional CEM. As CEM utilization grows, the need for sampling lesions seen only on the enhanced images is necessary. As a result, CEM-directed biopsy was recently developed and is being incorporated into some practices. More information on its ease of use and performance will be forthcoming. Lastly, several groups are evaluating whether radiomics can improve CEM ability to detect cancers. Overall, CEM is an exciting technology that improves cancer detection with several developments on the horizon that will only add to its value in clinical practice.

SAM question set 1:

1. The Contrast Enhanced Mammography Imaging Screening Trial (CMIST) is designed to do what?

(A) Determine cancer detection rate on CEM in high-risk women
(B) Compare performance of CEM to the combination of tomosynthesis and whole breast ultrasound
(C) Evaluate CEM performance in women with a history of breast cancer
(D) Identify causes of false positives in screening CEM exams

Answer B.

Reference:
CMIST | American College of Radiology (acr.org)
2. Radiomics analysis for CEM includes evaluation of:

(A) Hormone receptor status

(B) DCIS

(C) Tumor size

(D) Nuclear pleomorphism

Answer (A)

Reference:


Speaker 2: Reyhaneh Nostati, PhD

Presentation Title: A New Framework to Assess Localization Accuracy of Tomosynthesis Guided and Stereotactic Breast Biopsy Units

Synopsis

Stereotactic breast biopsy (SBB) is an alternative diagnostic approach for surgical biopsy in women with suspicious lesions and uses digital mammography for lesion identification and guiding the biopsy procedure. Tomosynthesis-guided vacuum-assisted breast biopsy provides a significantly higher clinical performance compared to the conventional SBB approach. For both SBB and tomosynthesis-guided breast biopsy, the localization accuracy of the biopsy system is of high importance, due to the often subtle and small nature of the imaging targets. This presentation will (1) review the physical principals behind the targeting system of a stereotactic/tomosynthesis guided breast biopsy unit; (2) review the routine quality control procedures to evaluate the localization accuracy; (3) describe a novel framework for quantitative assessment of the localization accuracy of Stereotactic and tomosynthesis-guided biopsy units; and (4) illustrate a simple Excel-based tool that automatically calculates various localization error metrics of a mammogram breast biopsy unit.

SAM question set 2:

1. To determine the 3D position of a target on a stereotactic guided breast biopsy unit, ±15° projections are acquired and the 2D coordinates, (x, y) of the target on the projections are (53, 57) and (53, 101) respectively. What is the depth (z) of the target?
   a. 82.1
   b. 164.2
   c. 38.1
   d. 76.2
   Answer: (a)
   Reference:
   The Essential Physics of Medical Imaging (Chapter 8), Bushberg J. T. et al., 2012.

2. What is/are the main limitation(s) of the current practice to evaluate the localization accuracy of a breast biopsy units?
   a. Lack of a quantitative metric for error analysis
   b. Inability to compare localization uncertainties between different units
c. Inability for error trend analysis and system failure prediction

d. All of the above

Answer: (d)

Reference:


3. What are the required input parameters (direct measurements from images) to calculate different error metrics in the proposed localization accuracy test?

a. Pre-fire Target position, length of the needle’s trough (aperture), post-fire target position

b. Pre-fire target position, pre-fire position of the needle’s tip, post-fire position of the needle’s tip

c. Pre-fire target position, center of the needle’s trough (aperture), post-fire position of the needle’s tip

d. Center of the needle’s trough (aperture), pre-fire position of the needle’s tip, post-fire position of the needle’s tip

Answer: (b)

Reference:

**Speaker 3:** Peymon Ghazi, Ph.D.

**Presentation Title:** Dedicated breast CT: clinical needs, solutions, and remaining challenges

**Synopsis:**

Early and reliable detection of breast cancer remains a challenge, particularly in women with dense and extremely dense breasts. The anatomical noise in mammographic imaging of this subset of women is thought to be the root cause of such deteriorated performance. Dedicated Breast CT (bCT) is a promising solution to this problem as it provides fully tomographic imaging of a breast. To date, two renditions of bCT have been developed and utilized in clinical practice. The results of several studies show that the anatomical noise in bCT is significantly less than that in mammography or tomosynthesis, which translate into increased sensitivity in detecting mass lesions. Despite the gains, however, bCT has not been widely adopted in large part due to the limited visibility of microcalcifications, subpar image quality at screening radiation dose levels, and suboptimal coverage of the posterior breast anatomy. In this talk, we will describe the clinical limitations of the current x-ray-based imaging modalities. We, then, outline the current state-of-the-art technology of bCT and the clinical benefits they offer. We conclude by pointing out the remaining challenges that need to be addressed to make this technology successfully deployed in clinical practice.

**SAM Question set 3:**

1. Compared to mammography and tomosynthesis, in state-of-the-art breast CT,
   
   a) scan time is shorter.
   
   b) breast undergoes similar compression.
   
   c) the coverage of posterior breast anatomy is consistently better.
   
   d) the anatomical noise is reduced.

   Answer: (d)


2. The current image acquisition geometries of breast CT are based on
   
   a) parallel-beam and cone-beam CT.
   
   b) fan-beam and helical CT.
   
   c) helical and cone-beam CT.
   
   d) inverse geometry and helical CT.
Answer: (c)


3. In breast CT systems covered in this talk, radiation dose to breast

   a) is consistently higher than that in mammography and tomosynthesis.
   b) depends on breast size and density.
   c) does not impact the visibility of microcalcifications.
   d) can be accurately determined by using CTDI phantoms.

Answer: (b)

**Speaker 4:** Kai Yang, Ph.D.

**Presentation Title:** Noise power spectrum analysis of breast tissue textures presented in mammographic images

**Synopsis:**

The task of screening mammography is to detect pathological abnormalities among background breast parenchyma structures, which had been extensively and quantitatively studied through spatial frequency analysis of mammographic images, primarily focusing on 2D. Digital breast tomosynthesis (DBT) has been widely adopted as the current state-of-art breast cancer screening modality, with drastically different implementations by different vendors. It will be interesting and important to study breast tissue texture presentation in DBT and compare with 2D mammography. In this talk, we will first review the related literatures on the topic of breast anatomical noise spectrum analysis, and then present updated findings on breast tissue texture presentation from different modalities (focusing on DBT, with comparison between 2D, DBT, synthetic 2D, and cone beam breast CT) and different vendors (Hologic vs. GE).

**SAM Question set 4:**

1. Which one of the below statements about anatomic noise in mammographic images is correct?
   a. It describes the overall noise level of a mammographic image.
   b. Its magnitude is directly affected by the radiation level used.
   c. It describes the statistical fluctuation of breast tissue textures.
   d. It is independent from glandular tissue density.

   **Answer:** (c)

   **Reference:**


2. Which one of the below statements about the exponent of anatomic noise power spectrum, $\beta$, is correct?
   a. It is determined within the spatial frequency range of $(0, \text{Nyquist})$.
   b. It describes the linear relationship between noise power and spatial frequency.
c. Its typical value range for mammographic image is (0,10).
d. Its typical average value is 3 for 2D mammographic images.

Answer: (d)

Reference: