Workflow Considerations for Incorporation of Contrast-Enhanced Spectral Mammography Into a Breast Imaging Practice

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DESCRIPTION OF THE PROBLEM

Contrast-enhanced spectral mammography (CESM) is an adaptation of digital mammography that uses intravenous (IV) contrast to evaluate for breast cancer using a dual-energy technique. Using this method, high- and low-energy acquisitions are obtained in each standard projection entirely after contrast administration. The low-energy image provides morphologic detail similar to conventional 2-D digital mammography, and the high-energy image highlights areas of contrast uptake but is noninterpretable. The low- and high-energy images are subtracted to create a recombined image that only shows areas of contrast enhancement. The low-energy and recombined images are viewed by the radiologist for examination interpretation (Fig. 1).

Studies have shown that CESM has increased sensitivity for breast cancer detection compared with conventional digital mammography and similar sensitivity compared with breast MRI [1-6]. As such, it received FDA clearance for diagnostic use in 2011. Additionally, CESM is low cost compared with MRI [7] and theoretically straightforward to implement into practice, as the equipment needed is an add-on feature to many mammographic units already in use. Once equipment is in place, the per-patient cost of CESM is similar to that of mammography, with only the addition of iodinated contrast. These features make CESM a promising diagnostic tool, especially in patients who are unable to undergo breast MRI.

However, similar to other new, promising breast imaging technologists, CESM may have a significant impact on the routine workflow in a busy breast imaging practice [8-10]. In this article, we describe the impact of CESM on the clinical workflow at our institution by comparing examination metrics with other commonly performed diagnostic breast imaging examinations. We also identify areas for improvement in workflow by comparing CESM metrics with those of contrast-enhanced CT, which is the departmental gold standard for efficiency in iodinated contrast administration.

WHAT WAS DONE

Institutional review board approval was obtained, and the requirement to obtain patient consent was waived. CESM was first performed in our practice on December 18, 2014. From December 18, 2014, to July 11, 2017, 123 contrast-enhanced spectral mammographic examinations were performed in 121 patients. As part of an internal quality assurance project, time metrics were recorded by the performing technologist for diagnostic CESM beginning May 6, 2016. Recording of information was dependent on the technologist remembering to perform this step. For comparison, similar metrics were also collected for digital diagnostic mammography (DM), breast MRI, and contrast-enhanced CT (CTIV) during the period from October 24, 2016, to March 5, 2017. CTIV included chest, abdominal, and pelvic studies. Inpatients or those patients already with peripheral or central venous access were excluded.

Metric Definitions

Time metrics included equipment setup time, patient setup time, examination time, postexamination time, and total aggregate time. These metrics were collected for CESM, DM, and MRI. Although all metrics were recorded for CTIV, only equipment setup, patient setup, and

1546-1440/18/$36.00 ■ https://doi.org/10.1016/j.jacr.2018.02.012

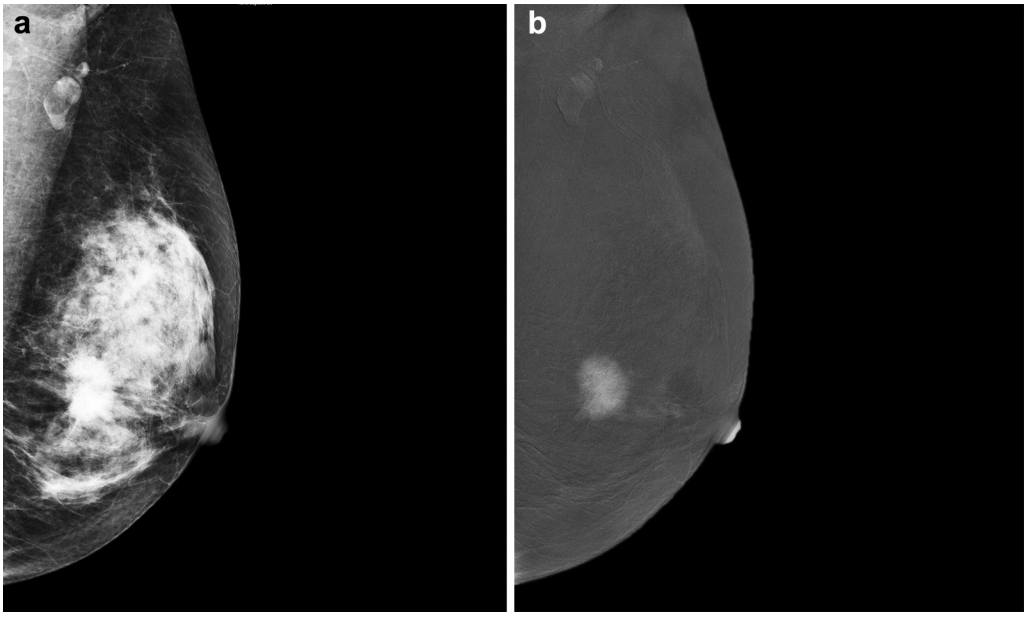

Fig 1. (a) Low energy and (b) recombined mediolateral oblique projection images in a 55-year-old woman with heterogeneously dense tissue show a left breast spiculated mass with associated enhancement that extends anteriorly toward the nipple by 3 cm.

postexamination times were compared with the other modalities. This was due to variations in the length of the CTIV examinations, which are unrelated to breast imaging.

Equipment setup time included the time needed to assemble the power injector for those examinations requiring IV contrast. Patient setup time included review of the patient intake sheet to confirm no contrast contraindications, IV line placement, point-of-care creatinine testing, if applicable per departmental policy, and patient positioning. Examination time was defined by the amount of time needed for image acquisition. For CESM, images acquired include a four-view mammogram including low energy and high energy and any additional views requested by the radiologist. Diagnostic mammography includes multiple different views of either one or both breasts as indicated by the reason for the examination. A breast MRI examination includes scout images, T2-weighted images, precontrast T1-weighted images, serial postcontrast T1-weighted images, and diffusion imaging. A CT examination includes variable imaging sequences, all postcontrast. Postexamination time involved postprocessing of images, technologist verification of a completed study, and IV line removal. Aggregate time was defined as the total study time should each step in the imaging process occur sequentially and was calculated as the sum of the other metrics. How each metric is defined per specific examination type is outlined in Table 1.

Collection Methods

Time metrics were collected using four different time forms, which documented various imaging steps unique to each modality. CESM time forms were completed by two imaging technologists who have been trained to perform CESM at our institution. One of these technologists also completed all of the DM time forms in consecutive patients during the study period of October 24, 2016, to March 5, 2017. MRI and CTIV time forms were collected by a research assistant during this study period and were chosen on the basis of scheduling availability of the assistant. Once data collection began, time metrics for the study were recorded in their entirety regardless of any challenges with the examination.

Data Analysis

Data were entered into a hospital controlled REDCap database and analyzed anonymously. The time metrics for the different modalities were compared using analysis of variance (ANOVA). Pairwise differences were assessed using a two-sample two-tailed t test using a Bonferroni-corrected significance level of .0083.