Mismatch in Breast and Detector Size during Screening and Diagnostic Mammography Results in Increased Patient Radiation Dose

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Rationale and Objectives: When using mammographic detectors of different sizes, it can be difficult to match patient breast size to optimal detector size. We studied whether a mismatch between breast size and optimal detector size resulted in increased radiation exposure.

Materials and Methods: All screening and diagnostic (Dx) mammography patients during a 6-week period in November–December 2009 (864 patients) were evaluated (institutional review board exemption for quality assurance studies). Data gathered included breast size (large or small), detector size used, number of views obtained, mean glandular dose (MGD) per breast, and patient waiting time. Average MGD and average waiting time was calculated for imaging performed on appropriately matched or mismatched breast size–detector size pairs.

Results: Screening mammography patients with large breasts imaged on a small detector received a significantly higher radiation dose (4.9 vs. 3.3 mGy, $P < .05$) and a greater number of views (5.9 vs. 4.6, $P < .05$) compared to optimally matched breast–detector pairs. Dx mammography patients with large breasts imaged on a small detector received a higher radiation dose (8.2 vs. 6.7 mGy, $P < .05$) compared to optimally matched breast–detector pairs, although without an increased number of views. Waiting times were longer for a large detector.

Conclusions: A mismatch in breast–detector sizes results in a significantly greater radiation dose to patients with large breasts imaged on a small detector. Pressure to minimize patient waiting time may inadvertently result in increased radiation dose. Detector size should be matched to breast size whenever possible, but particularly for patients with larger breast sizes.

Key Words: Radiation dose; mammography; detector size.

The goal of mammography is to identify and evaluate breast cancer and breast disease (1). The reduction in mortality from breast cancer attributable to screening mammography has been shown to outweigh risks related to radiation exposure (2). However, in accordance with the general practice mandate of minimizing all diagnostic radiation doses to patients and personnel (the As Low As Reasonably Achievable concept), mammography strives to minimize the examination's radiation dose. Conventional two-view screening mammography should result in a mean glandular dose per breast on the order of 3–4 mGy (1,3). Appropriate imaging should use equipment that minimizes radiation exposure and provides images of diagnostic quality (4).

Digital mammography has now been routinely integrated into a number of practices, and detectors exist in four basic designs: phosphor-charge coupled devices (CCD), photostimulable phosphors, flat panel phosphors, and selenium flat panel imagers (5). Each has its benefits and limitations. CCD, the most common type of detector, provides high spatial resolution; however, because of manufacturing constraints CCD-type mammographic detectors are available only in preset sizes (small and large detectors). When using mammographic detectors of different sizes, it is often difficult to match patient breast size to optimal detector size. Our goal was to determine if increased radiation exposure occurs when there is a mismatch between breast size and optimal detector size. To our knowledge, no prior study has evaluated this question.

MATERIALS AND METHODS

This study was conducted at an urban academic medical center and was performed under an institutional review board

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exemption for quality assurance studies. A total of 886 patients presenting for screening and diagnostic (Dx) mammography during a consecutive 6-week period in November and December 2009 were evaluated. Twenty-two patients were excluded for insufficient data. This yielded 2000 screening mammogram images and 2538 diagnostic mammogram images for evaluation. The following data were prospectively collected at the time of imaging by the mammography technologist: patient age, breast size (large or small, defined as optimally imaged with the large or small detector), actual detector size used, and number of views obtained. Mean glandular dose (MGD) of radiation per breast, per view, was automatically calculated using effective tube current, peak kilovoltage, and breast thickness. To calculate MGD per breast, the MGD of each view was added together for a total MGD for each breast.

Screening mammograms were performed as standard two-view mammograms, with additional views obtained at the technologists' discretion, usually to optimize patient positioning. Diagnostic mammograms were performed according to patient history and preset departmental standards.

Optimal detector size was determined by the technologist at the time of imaging by viewing prior images or if unavailable, by estimation based on patient body habitus. Breast–detector pairs were categorized as appropriately matched (e.g., large breast imaged with large detector or small breast imaged with small detector) or mismatched (e.g., large breast imaged with small detector or small breast imaged with large detector). For all mammograms (performed on appropriately matched or mismatched breast–detector pairs), both the average MGD and the average number of views per breast were calculated. Statistical significance was determined using a two-tailed, two-sample, equal variance *t* test.

Additional data were gathered at the time the mammogram was performed: bra size (for patients who knew or were willing to disclose their bra size) and the time delay between arrival in the department and the time of first imaging. For each bra size, MGD was calculated for both appropriately matched and mismatched breast–detector pairs to determine if patients could be prescreened based on bra size for scheduling with the appropriate detector. The time delay between arrival in the department and time the first image was obtained was averaged for each detector size to determine whether patients waited longer to be imaged using an optimal detector for their breast size or whether imaging with a particular detector size was associated with a longer waiting time in general.

To determine whether patients with small breast sizes encountered difficulty in obtaining proper positioning in a large detector, we evaluated a subset of screening mammogram patients with small breast sizes: 56 patients who had previously been imaged with the appropriate small detector compared to 68 patients who had been imaged with a breast size–detector size mismatch, that is, imaged with the large detector on the current study (total of 124 patients). This evaluation was limited to patients who underwent screening mammography to ensure that standard views were available on both the current and prior mammograms. We used the posterior nipple line (PNL), a standard measurement tool for evaluating the quality of mammographic positioning, as a means to quantitate whether a mismatch between detector size and breast size might compromise positioning. The PNL is a line drawn from the nipple to the chest wall, perpendicular to the pectoralis muscle. The length of the PNL in one view should be within 1 cm of the length of the PNL in the orthogonal view. We calculated the difference in the length of the PNL (the "PNL difference") between the craniocaudal (CC) and mediolateral-oblique (MLO) views of the right breast for each patient. We then compared the PNL difference on the current study to the PNL difference on the prior study to determine whether difficulty was encountered with patient positioning.

RESULTS

The mean age of all patients was 56.3 years (range, 25–93 years). The mean age of patients categorized with large breast size (57.7 years; range 30–92 years), versus small breast size (55 years; range 25–93) was not significantly different.

Screening Mammography

Four hundred twenty-six patients underwent screening mammography. A total of 229/426 (53.8%) screening patients were categorized as having large breast size; 206/229 (90%) were imaged with a large detector and 23/229 (10%) were imaged with a small detector. A total of 197/426 screening patients (46.2%) were categorized as having small breast size; 143/197 (72.6%) were imaged with a small detector and 54/197 (27.4%) were imaged with a large detector.

Diagnostic Mammography

Four hundred thirty-eight patients underwent diagnostic mammography. A total of 161/438 (36.8%) were categorized as having large breast size; 125/161 (77.6%) were imaged with a large detector and 36/161 (22.4%) with a small detector. A total of 277/438 diagnostic patients (63.2%) were categorized as having small breasts; 230/277 (83%) were imaged with a small detector and 47/277 (17%) with a large detector, Table 1.

Percent Optimally Matched Versus Mismatched

Optimally matched patients underwent imaging with a detector size appropriate for their breast size (large breast size with a large detector or small breast size with a small detector). Among screening mammography patients, 349 patients (81.9%) were optimally matched: 206 patients with larger breasts were imaged with a large detector and 143 patients with smaller breast sizes were imaged with a small detector.