Stereoscopic Digital Mammography: Improved Accuracy of Lesion Detection in Breast Cancer Screening

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Abstract. We report on a clinical trial comparing stereoscopic full-field digital mammography to standard (non-stereo) full-field digital mammography for detection of true breast lesions in a screening population. Each of 1458 enrolled patients received both a standard screening examination and a stereoscopic screening examination, which were read independently by different radiologists. Compared to standard digital mammography, stereo mammography significantly reduced false positive lesion detections by 46% (p< 0.0001), and significantly increased true positive lesion detections by 23% (p< 0.05).

Keywords: stereoscopic digital mammography, digital mammography, breast cancer screening, lesion detection.

1 Introduction

With the advent of digital mammography, high quality stereoscopic digital mammography is now a practical possibility, providing direct, in depth views of the internal structure of the breast and a potentially improved technique for breast cancer screening (1-3). Two-dimensional x-ray mammography is currently the primary screening approach for the early detection of breast cancer in women. However, it suffers from three basic limitations, which we predict stereo mammography can overcome.

The first limitation with standard mammography is that a true focal abnormality may often be undetected when masked in the 2D projections by overlying or underlying normal tissue. Masking is likely to affect the detection of focal soft tissue abnormalities that present as a mass, architectural distortion or an asymmetric density, but is perhaps even more likely to affect the detection of microcalcifications. Masking may be reduced with stereo mammography because the lesion or elements of calcium can be seen in the stereo image as separated in depth from the normal tissue aligned with it in the breast volume. This gives stereo mammography a potential advantage over standard mammography with respect to sensitivity.

The second limitation with standard mammography is the chance alignment of normal tissue, or isolated elements of calcium, at different depths within the breast, which in the 2D projected image may mimic a true focal lesion. Many of the
false-positive detections that arise in this way with standard mammography may be eliminated with stereo mammography because the superimposed tissue or calcification particles can be seen in the stereo mammogram as separated in depth. This gives stereo mammography a potential advantage over standard mammography with respect to specificity.

The third limitation is in regard to the ability to derive information about the volumetric structure of a detected lesion, information particularly important in suggesting the presence of architectural distortion and the significance of calcification clusters. For standard mammography, volumetric information can be obtained only in a limited way by cognitive merging of information taken separately from the two orthogonal 2D images. With stereo mammography, a lesion’s volumetric structure is immediately and directly visualized. This difference gives stereo mammography further potential advantage over standard mammography with respect to both sensitivity and specificity.

We report here results from a clinical trial comparing standard digital mammography with stereo digital mammography for detection of true breast lesions in a screening population.

2 Methods

2.1 Subjects

Over a three year period, 1458 patients were enrolled in the clinical trial at the Emory University Breast Imaging Center in Atlanta, GA. Only female patients were eligible for enrollment, and then only if they were at elevated risk for the development of breast cancer. Our reasons for using elevated risk as a criterion for inclusion were to maximize the number of lesions and cancers detected in the study and to provide reasonable justification for the additional x-ray exposure the patients received.

2.2 Study Design

Image Acquisition. Each woman enrolled in the trial received both a standard digital mammographic screening examination and a stereoscopic digital mammographic screening examination in a single visit. The standard exam was performed using a clinical full-field digital mammography unit (GE Senographe 2000D). The stereo exam was performed on a research GE Senographe 2000D with modified x-ray collimation. Each screening exam consisted of the usual two views of each breast: cranio-caudal (CC) and medio-lateral-oblique (MLO) views. For the stereo exam, each of those two views was acquired as a stereo pair comprised of two images captured with the x-ray tube rotated by 10-degrees between the two acquisitions while the breast remained compressed and unmoved.

Image Display. The standard digital mammograms were viewed on a standard, FDA-approved, dual-monitor GE Review Workstation. The stereo mammograms were viewed on a prototype medical stereo display, the StereoMirror SD2250, developed by Planar Systems Inc (16). This stereo display, shown in Fig. 1, consists of two 5 megapixel, grayscale monitors mounted one above the other with an angular separation of 110 degrees between the two faces. The two images, each displayed on one of