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## Imaging of the Radiographically Dense Breast<sup>1</sup>

Despite recent improvements in mammography equipment and technique, the radiographically dense breast remains difficult to image. The problems in imaging the dense breast account for a large percentage of the cases of mammographically "missed" carcinomas. Other imaging modalities—such as ultrasonography, transillumination, thermography, computed tomography, magnetic resonance imaging, and radionuclide imaging—have been investigated for use in breast cancer detection. This overview discusses the current problems associated with imaging of the radiographically dense breast and suggests some avenues for investigation to develop solutions to these problems.

**Index terms:** Breast, MR, 00.1214 • Breast, radionuclide studies, 00.1216 • Breast, US, 00.1298 • Breast neoplasms, diagnosis, 00.32 • Breast radiography, 00.11 • State-of-art reviews

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It is well known that the radiographically dense breast poses a unique challenge to mammographic detection of early-stage breast cancer. When clinical findings are present to direct the focus of the study, physical examination and ultrasonography (US) frequently allow for proper management. For routine screening of asymptomatic women, however, imaging the dense breast is problematic, and the magnitude of the problem is difficult to assess because the false-negative rate for screening mammography is difficult to determine. Approximately 25% of women have dense breasts (1), so this is not a trivial problem. The difficulty in imaging the radiographically dense breast is due to several underlying physical characteristics:

1. Breast lesions have x-ray attenuation properties similar to those of dense glandular and fibrous tissues, making their detection more difficult. Experience suggests that most breast lesions are detected when some part of a soft-tissue lesion appears in contrast to adjacent tissue of different x-ray attenuation. The lesion is optimally visible when superimposed or outlined by fat rather than entirely by glandular tissue. Large amounts of fibroglandular tissue, whose attenuation is similar to that of cancer, reduce the probability that a lesion will be visible in the dense breast. Routine mammographic screening of the dense breast is more difficult because lesions, if present, are less likely to be detected.

2. The radiographically dense breast produces more scattered radiation, resulting in reduced image contrast.

3. The radiographically dense breast frequently has more tissue inhomogeneities and a greater range of attenuation, making it more difficult to optimally expose all areas of the breast. In addition, positioning of the automatic exposure control (AEC)

detector is complicated in the heterogeneously dense breast because it is difficult to determine the location that will produce proper exposure of all tissue.

4. The radiographically dense breast requires higher exposures to achieve adequate film densities. This sometimes poses the following secondary problems in imaging. For fixed-output units, exposure times are longer for dense breasts, increasing the probability of motion unsharpness. This problem is especially serious for low-output mammography units. Attempts to reduce exposure times for imaging the radiographically dense breast may involve changes that further compromise image quality, including grid removal, use of higher kilovolt-peak (kVp) settings, and use of faster image receptors. Grid removal cuts exposure times by a factor of two or more but reduces contrast by increasing the amount of scattered radiation reaching the image receptor. The use of higher kVp settings reduces both subject contrast and image contrast. The use of faster image receptors increases quantum mottle, reducing the detectability of low-contrast lesions and small structures such as calcifications, and thus decreasing spatial resolution.

While it is well known that imaging of the dense breast is difficult, the true magnitude of the problem is not known, partly because it has been difficult to define or grade the degree of radiographic density. Wolfe was the first to describe a classification scheme for parenchymal density, which consisted of four categories (2,3): N1, the breast is composed primarily of fat, often with a trabeculated appearance; P1, prominent

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**Abbreviations:** AEC = automatic exposure control, kVp = kilovolt peak.