

Imaging Characteristics of X-ray Capillary Optics for Application to Digital Mammography

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The application of digital mammography is expected to be the most significant improvement in clinical mammographic screening in the future. Digital systems including computer radiography (CR), suffer from the detection of unwanted x-ray scatter as well as inadequate spatial resolution when compared to film-screen mammography. The scatter problem is normally addressed by the addition of an anti-scatter grid, which rejects some fraction of the scatter. Focused capillary optics consist of hexagonal packed stacks of glass capillaries. If a capillary optic is placed between the breast and detector, virtually only primary radiation will be transmitted to the detector. Digital systems can increase their effective resolution by sampling a magnified x-ray signal. Unfortunately, as geometric magnification increases, the blurring factor from the x-ray source also increases. With the addition of a post-patient capillary optic, the primary x-ray signal is captured by individual capillaries so that magnification is possible without focal spot blurring.

Both scatter fraction (SF) and image contrast improvement factor (K) were measured for three imaging methods. The anti-scatter grid allows 23% higher contrast than no grid, but the capillary optic provides 72% higher contrast due to the virtual elimination of scatter. Using the 5% MTF level as the indicator of limiting resolution, the scanned optics resolution limit was 56% higher than the best resolution for normal mammography using CR. The stationary optic provides a limiting resolution which is 70% higher than the normal mammographic method.

The results of this study show the feasibility of x-ray capillary optics for clinical application in mammography. While the test optic is smaller than a clinical application would require, the manufacturing process is being improved rapidly. Larger diameter, longer optics with magnification factors of two or more are now possible which will greatly reduce the scan time necessary and should additionally improve the resolution over that measured with the test optic.