

HTC™ Grids Improve Mammography Contrast

Joel E. Gray, Ph.D. and James A. Princehorn

This is one in a series of research overviews on advanced technologies in women's imaging. For copies of other "white papers" in the series please contact marketing@hologic.com

Introduction

Scattered radiation reduces contrast in all radiographic images. High contrast is especially important in mammography where cancerous tissue and normal tissue appear quite similar since the densities of the tissues are almost the same.

Reducing the effects of scattered radiation has been achieved through the use of scatter absorbing grids. Linear, focused Bucky grids have been the established standard in radiography and mammography. However, linear grids only reduce scatter in the direction perpendicular to the grid absorption material (septa), i.e., there is little or no reduction in the direction parallel to the grid lines. Absorption of the scattered radiation can be increased by using a cross-hatch designed grid as first developed in 1913 by Dr. Gustav Bucky. (Figure 1)

The cross-hatch grids were normally used as stationary grids. Although more scatter was absorbed, the cross-hatch resulted in a significant grid pattern artifact in the image, which degraded image quality. Even when cross-hatch grids were moved during the exposure it was difficult to remove the appearance of the grid pattern completely from the image because of the continuous overlap of the grid intersections.

A unique, micro-processor control design developed by the Hologic Lorad Division overcomes the problem of moving the grid and eliminates all traces of the grid pattern in the image. A highly precise servo-motor and electronics mechanism moves the grid an exact distance during the mammographic exposure, regardless of the duration of the exposure. The High Transmission Cellular (HTC) grid results in higher subject contrast while the micro-processor controlled movement eliminates grid artifacts, resulting in higher quality mammographic images. (Figure 2)

The grid ratio (the ratio of the height of the grid to the distance between the septa) is usually considered an indication of the ability of the grid to eliminate scattered radiation and improve image contrast. (Figure 3) The higher the grid ratio the more scattered radiation is removed, with an accompanying increase in image contrast and image quality, usually at the expense of increased patient dose. However, since the HTC grid is a cross-hatch design, this grid ratio can not be used to compare the ability of the HTC grid to the ability of a linear grid to remove scattered radiation. Consequently, it is necessary to carry out several measurements to appropriately compare the HTC grids to the conventional linear grids used in mammography.

There are no characteristics that directly compare these two types of grids, therefore we have used a performance-based evaluation.

Imaging and Measurement Methods

Images were made and measurements produced using a Lorad M-IV mammographic imaging system with a Kodak MIN-R 2000 screen-film system. Films were processed in Kodak RP developer using a Kodak X-OMAT 480RA processor with a development temperature of 95° F and a processor cycle time of 90 seconds. Two types of grids were used: a conventional 31 lines per centimeter, 5:1 ratio linear grid with lead septa; and an HTC 23 lines per centimeter, 4:1 ratio grid with copper septa. An ACR Mammography Accreditation Program Phantom (RMI #156 or Nuclear Associates #18-220) was used for comparison data collection. The phantom represents an average composition breast, compressed to 4.2 centimeters.

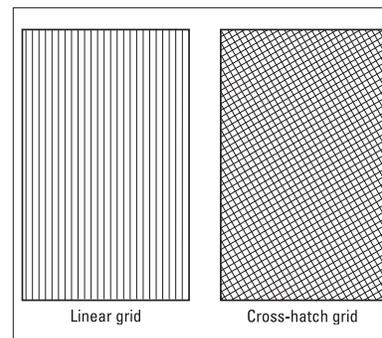


Figure 1. Grids for reducing scattered radiation typically use a linear or cross-hatch grid pattern of radiation absorbing septa

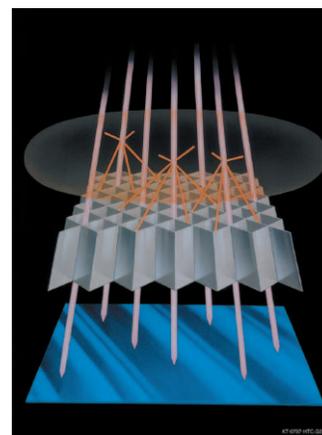


Figure 2. The HTC grid's cross-hatch design reduces scatter in two directions, while the microprocessor controlled movement eliminates grid artifacts, for higher quality images

The phantom was imaged first without any additional absorber and then imaged with 1, 2, and 3 centimeters of additional breast tissue equivalent material (CIRS 50/50 tissue equivalent material), representing compressed breast thicknesses of 4.2, 5.2, 6.2 and 7.2 centimeters. The mammographic system was operated in the AutokV mode emulating normal clinical technique factors. These images were then scored using the ACR protocol, and the optical density was measured at the contrast dot and its surrounding area to derive a relative contrast measurement.

Results

Differences in contrast between mammographic images of the ACR Accreditation Phantom made with the HTC and linear grids are apparent in the original images. The total number of objects visible on the films of the phantom without additional absorber was 13 for the HTC grid images and 12 for the linear grid images, an improvement due to the increased contrast with the HTC grid. In addition, the contrast (density difference) between the acrylic disc and the background is 0.48 for the HTC grid images and 0.46 for the linear grid images. Again, this improvement in contrast results from the ability of the HTC Grid to eliminate more scattered radiation, yielding better (higher contrast) mammographic images.

When data is compared between normalized non-grid images, linear grid images, and HTC grid images, it shows the relative improvement in subject contrast due to scatter removal versus compressed breast thickness. The curves in figure 4 were generated from data collected using an ACR Mammographic Accreditation Phantom imaged first without additional absorber, then elevated using 1, 2, and 3 cm additional breast tissue equivalent material (50/50 composition). Relative contrast is defined as the difference in optical density between the contrast dot and surrounding area. Contrast Improvement Factor (CIF) is defined as the ratio of the contrast with grid relative to the contrast without grid.

Typical CIF curves are shown in the Figure 4. Note how the improvement in contrast increases as the compressed breast thickness, and hence the amount of scatter, increases. The contrast improvement of HTC relative to linear grid is 4% for a 4-cm increasing to 18% for a 7-cm compressed breast thickness.

Conclusion

High Transmission Cellular grids have been shown to significantly reduce scattered radiation in mammography. This has been achieved with essentially the same patient dose as compared with a conventional 5:1 ratio linear grid. Consequently, images produced with the HTC grids have significantly higher subject contrast than those produced with conventional grids. A result of the increase in subject contrast is the perceived increase in sharpness of small details such as micro-calcifications, spiculations, etc. The HTC grids showed a higher Contrast Improvement Factor as compared with a conventional linear grid, resulting in highly improved imaging.

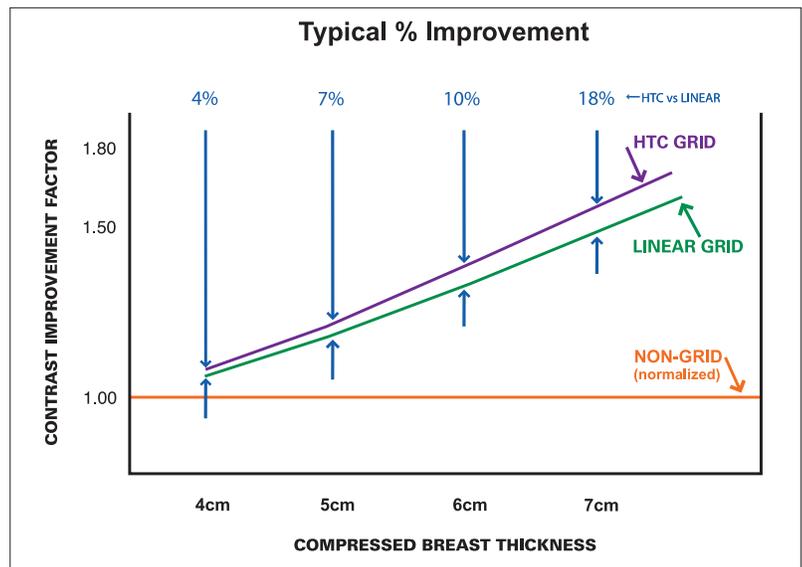


Figure 4. Contrast Improvement Factors for HTC and Linear grids are shown as a function of compressed breast thickness

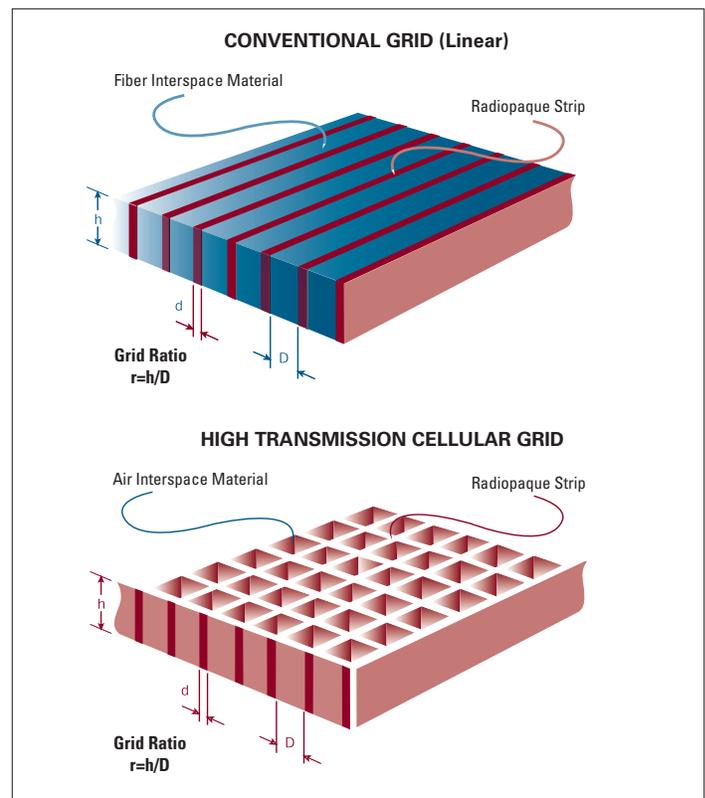


Figure 3. Details of the construction materials, and the calculation of grid ratio $r = h/D$, are shown for linear and cellular grids

For further information on the Hologic proprietary grid technology contact Nikos Gkanatsios, PhD or Andrew Smith, PhD at 781-999-7300 or send an e-mail to marketing@hologic.com.

Hologic, Inc.
35 Crosby Drive
Bedford, MA 01730 U.S.A.
T: 781.999.7300
www.hologic.com

W-BI-HTC (08/04)