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Automatic Calculation to Evaluate SNR of Micro Calcifications in Phantom Images Obtained for Quality Control of Mammography

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INTRODUCTION

It is important for the quality control of mammography system to evaluate the visualization of micro calcifications on phantom images. Image quality of calcification specks, as well as other test objects in a phantom, is usually evaluated and classified by visual method. We developed a quantitative evaluation method of test objects on digitized phantom images. Concerning calcification specks, signal intensity of a speck has been measured by its minimum pixel value which is a value easy to get on NIH Image software routinely. We have used that method in image analysis for the purpose of quality control. To evaluate the signal intensity of a speck, average of the pixel values of a speck would be less sensitive to an image noise than the peak (minimum, in this case) pixel value. In this study, the method we developed for automatic analysis of calcification specks will be described followed by the comparison of the two methods.

MATERIALS and METHODS

The mammography phantom we used was type RMI 156, which contains five calcification groups with six specks each in the configuration of pentagram with its center. The largest (C1) and the third largest group (C3) of calcifications were selected for analysis. Diameter of a speck in C1 and C3 were 540 μm and 320 μm, respectively.

Monochrome film digitizer VXR-12 plus (VIDAR Systems Co.) was used for digitization with spatial resolution of 300 DPI (85 μm) and the depth of 8 bits per pixel. Digitized image was saved on TIFF format without compression. Analyzed phantom images were 26 in total; 21 were obtained in the regional quality control survey of 21 institutions in 1998, and 5 as the standard of image quality.

We used Macintosh personal computers (Apple computer Inc.) with Photoshop (Adobe Systems Inc.) plug-in function for a digitizing software customized for VXR-12, NIH Image (National Institutes of Health, U.S.A.) to measure pixel values, and Excel (Microsoft Co.) to analyze measurement data imported from NIH Image.

Matrices of pixel values were obtained by NIH Image for a region selected manually so as to include a speck closely at its center. The size of matrices were approximately 15 to 20 pixels for their columns and rows.

To obtain the signal intensity of a calcification speck, two methods[1] were compared: (A) Let minimum peak pixel value in a speck be the speck signal, and (B) let average of pixel values less than or equal to the half peak value (HPV) be the speck signal.

In both methods, matrix of pixel values measured on NIH Image was copied-and-pasted to a designed work sheet of Excel in order to perform calculation automatically. Calculation was done in the following steps: (1) Search minimum peak value (MPV) in the matrix, (2) calculate average of left three columns as a base pixel value (BPV), (3) calculate sample standard deviation of a BPV as a noise, (4) calculate HPV, (5) sum up values of pixels with equal to or lower than HPV in a speck, (6) calculate average of (5), (7) subtract BPV from MPV for method A and from (6) for method B, and (8) divide (7) by a noise to get signal-to-noise ratio (SNR).

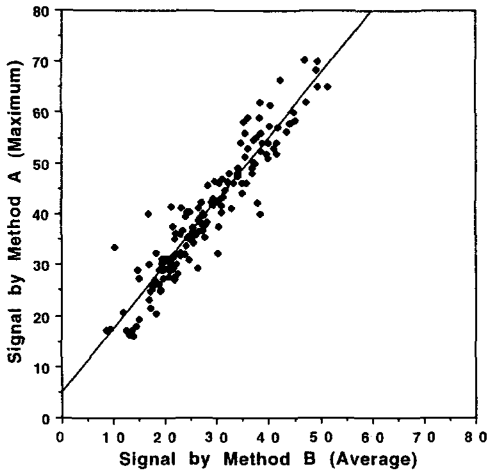
A signal intensity of one calcification group is the average of signal intensities of six specks in the group in both methods.

RESULTS

Numbers of pixels used for averaging in method B were about 30 in group C1 and 10 in C3. The scatterogram and the regression line between the two methods are shown in Fig. 1, method A on the ordinate, method B on abscissa. In the figure, plotted were all specks of C1s analyzed. The correlation coefficients between the two methods were 0.94 for C1 and 0.85 for C3.

Phantom images from institutions participated for the survey are evaluated by a relative SNR to that of the standard images, designated as a "performance level," and the correlation coefficients of performance level obtained by the two methods were about 0.9.

Fig. 1 Specks in Group C1



DISCUSSION and CONCLUSION

Method A which we have used in routine quality control of phantom images is well correlated with method B concerning with both signal of calcification specks and performance level. In the determination of BPV, the value might depend on the location of selected region due to Heel effect. Matrix of pixel value, however, showed that Heel effect was not significant as the dimension of the region-of-analysis is in the order of 2 mm.

The automatic calculation developed in this study reduced the processing time and get rid of the operational error. And it made the method B, which is essentially superior to method A, a useful tool for speck analysis in quality control where a number of images need to be handled.

REFERENCE

1. K. Imamura, N. Ehara, et al: Comparison of Evaluation Methods of Micro Calcifications for Quality Control of Mammography Using Phantom Images. The 77th Congress of Japanese Association of Radiological Physicists, 1999.