A New Technique for Reduction of Scattered Gamma Photons in Te-99m SPECT Imaging

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Abstract

Nuclear medicine imaging is a non-invasive radiomolecule technique which is widely used for diagnosis of abnormalities in patients. In clinical studies, it is always desired to obtain better quality images and accurate quantitative information from the gathered data, in order to provide better diagnostic and treatment services to patients. Quality of images and quantitative accuracy of clinical data primarily depends upon performance parameters of gamma camera, such as, energy resolution, spatial resolution, over all sensitivity, uniformity and linearity.

There are some factors that affect performance parameters of gamma camera systems. Scattered gamma photons are among those factors. Presence of scattered gamma photons in the image data results the overall degradation of image quality. Also makes quantitative information unreliable if data are not corrected for.

MATERIALS AND METHODS

For SPECT data acquisition, Toshiba GCA 90A/4HG gamma camera either with LEQP or LEHR collimators is used. R. A. Carlson’s phantom filled with water and hot cold regions inserts are placed in the phantom tank. Radioactivity Te-99m is distributed.

RESULTS AND DISCUSSION

Energy resolution for most systems is approx. 8 - 12% for 140 keV energy gamma photons. Hence, no total scatter rejection via energy discrimination (20% window). Approx 20 - 40% of the detected events in SPECT data are present due to scattered photons (Larsson et al. 1986). 70 - 80 % of the total scatter in 126 - 154 keV window is present in the region of 126 - 139 keV (Kojima et al. 1991).

The new SPECT scatter reduction technique introduced here absorbs some fraction of scattered gamma photons prior to their registration in the data. Hence, it may be called as “pre-processing” scatter reduction technique. Another advantages are, filter material is easily available, low cost, easy to mount on top of the surface of gamma camera, compact.

Working of the technique is explained by the following figure.

The scattered gamma photons in the image data results the overall degradation of image quality. Also makes quantitative information unreliable if data are not corrected for.

Analysis of hot and cold region detectability, perceived image quality and image contrast.

Hot region analysis: Figure 5(i) shows the transverse slices of hot regions insert in a uniform cold background with LEQP collimator. In figure 5(ii) B, C and D more hot regions can be seen clearly as compared with the image 5(i)(A). There is little blurring around all the hot regions [5(i) B, C and D] related to image 5(i). A. This suggests that scattered gamma photons have been absorbed by the physical filter. The gap between the smaller diameter hot regions is not that obviously visible though the blurring effect is reduced with the physical filter.

Figure 5(ii) shows the image contrast of different sized hot regions. Improvement in image contrast of hot regions is achieved with physical filter as compared to without filtered data images. The same trend is observed in the results of hot regions obtained with the LEHR collimator as shown in Figure 6(ii) and 6(i) respectively.

Cold region analysis: Figure 7(i) and 7(ii) indicates reduction in the effects of scattered gamma photons on images. Also cold region detectability is improved using physical filters with LEQP and LEHR collimators installed on gamma camera. Figure 7(iii) and 8(ii) shows image contrast values. A significant contrast enhancement has been recorded with physical filters as compared to no filter is used – LEQP and LEHR collimators.

Further, comparing the collimators, LEHR provides better results as compared to LEQP collimator with physical filter.

CONCLUSION

Findings indicate improvement in parameters those were investigated when physical filters are used, e.g. hot and cold region detectability, perceived image quality and image contrast. Therefore, the technique may have important applications in clinical studies.