Comparative assessment of three scatter correction techniques in ^{99m}Tc and ^{131}I planar imaging

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Introduction

The main purpose of this study is to evaluate and compare the methods of single (SEW), dual (DEW), and triple energy window (TEW) scatter correction techniques, on ^{99m}Tc and ^{131}I planar images, based on signal-to-noise ratio (SNR) criterion. The most significant outcome of the research would be the identification of optimal scatter correction technique.

Methods

Initially, four reference sources filled with known activities of ^{99m}Tc and ^{131}I were prepared in order to achieve the goals of this project. Voxel size for 256x256 matrix during planar acquisition was defined. Serial planar acquisitions of the reference sources were performed on a SOPHA DST-Xli, dual head γ-camera and single head γ-camera. Furthermore, planar images of patient's sample that have been administered with ^{99m}Tc and ^{131}I were analyzed. During acquisition of ^{99m}Tc images, in order to perform TEW scatter correction, main window was centered 140 keV, whereas the windows used to estimate the scatter contribution were placed at 93 keV (^{67}Ga) and 173 keV (^{111}In) with a width of 20%. Having received the three different planar images of these energies, the spectrum of ^{67}Ga was removed from that of ^{99m}Tc reaching the DEW and then the energy spectrum of ^{111}In was removed from the result of DEW ensuing the TEW image. In the case of ^{131}I images DEW scatter correction was performed after setting the main window centered 364 keV, whereas adjacent window was placed at 280 keV (^{75}Se). TEW and DEW scatter correction and background subtraction was applied to all planar images and this energy-window removal processing was performed through ImageJ software. Moreover, a study about SNR was performed to achieve quantification of the obtained images. For this processing counts for a specific irradiated volume of interest and background were obtained, both for each window image.

Results

A sufficient amount of planar images for both radioisotopes were acquired in order to enhance the comparison of energy windows. Initially, selecting a specific area in source and at background via the ImageJ software for each window image, the corresponding mean counts in these regions were collected. The mean counts then multiplied with the area to reach the total amount of measurements in the area under consideration. Thereafter, the SNR values, as the ratio of the counts at source to the counts of background, were calculated. The increase of SNR was proportional to the growth of energy windows indicating that as the number of energy-windows increases, the more noise is reduced. Here, an example of ^{131}I source and a patient who have been administered with ^{99m}Tc were presented, with the corresponding values in tables and the graphical representations of the energy windows spectra.

- **Processing of ^{131}I planar images**.

Table 1: Values of area, mean counts and the SNR for each window image of ^{131}I source.

	Area	Mean	SNR
SEW source	305	52.305	39.15
SEW background	300	1.357	
DEW source	305	42.420	54.30
DEW background	300	795	

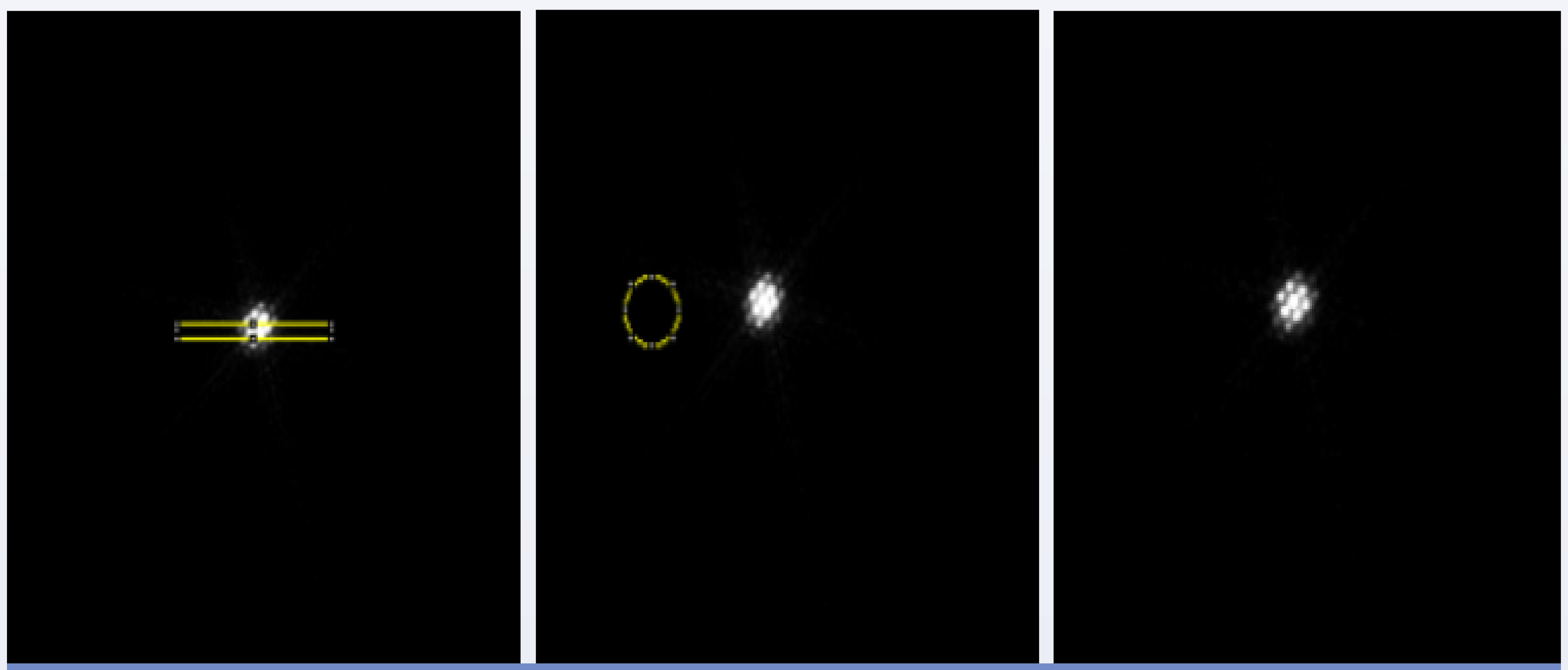

Figure 1: To the left the SEW planar image of ^{131}I source with area of interest while in the center is located the SEW planar image with the area of background. To the right, the DEW planar image.

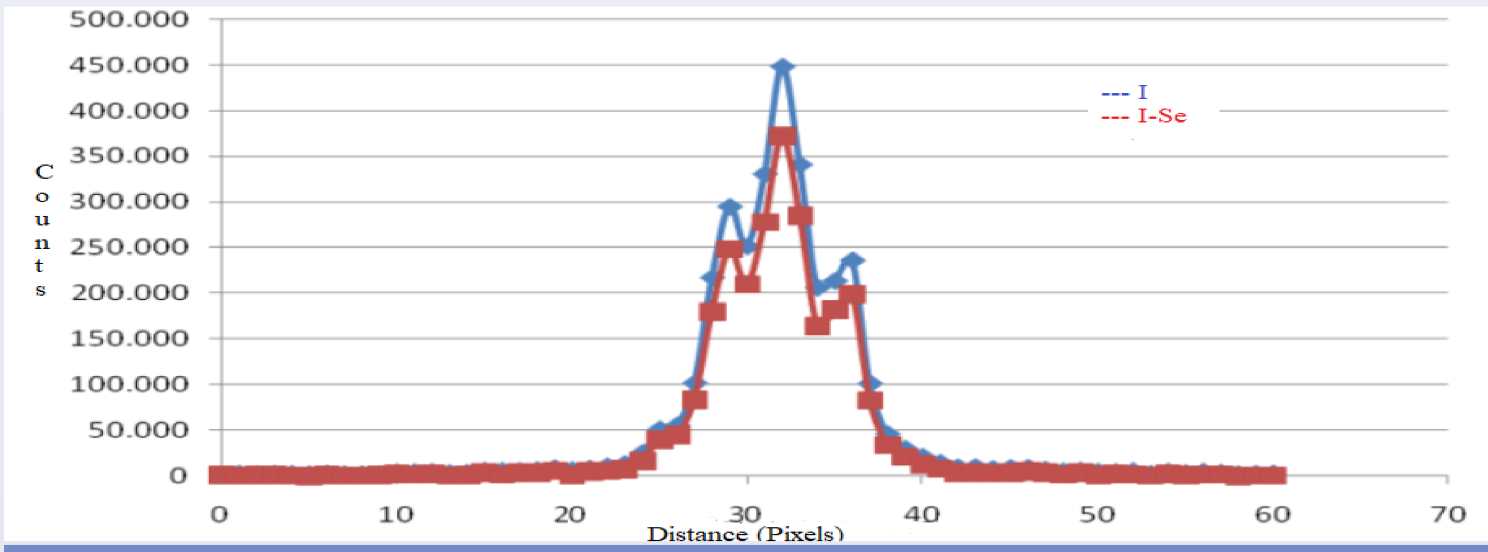

Figure 2: Spectral comparison of the 2 windows in relation to distance of pixels.

- **Processing of ^{99m}Tc planar images**

Table 2: Values of area, mean counts and the SNR for each window image of ^{99m}Tc planar images.

	Area	Mean	SNR
SEW source	402	8.072	3.50
SEW background	224	4.142	
DEW source	402	3.341	4.50
DEW background	224	1.331	
TEW source	402	3.266	4.81
TEW background	224	1.218	

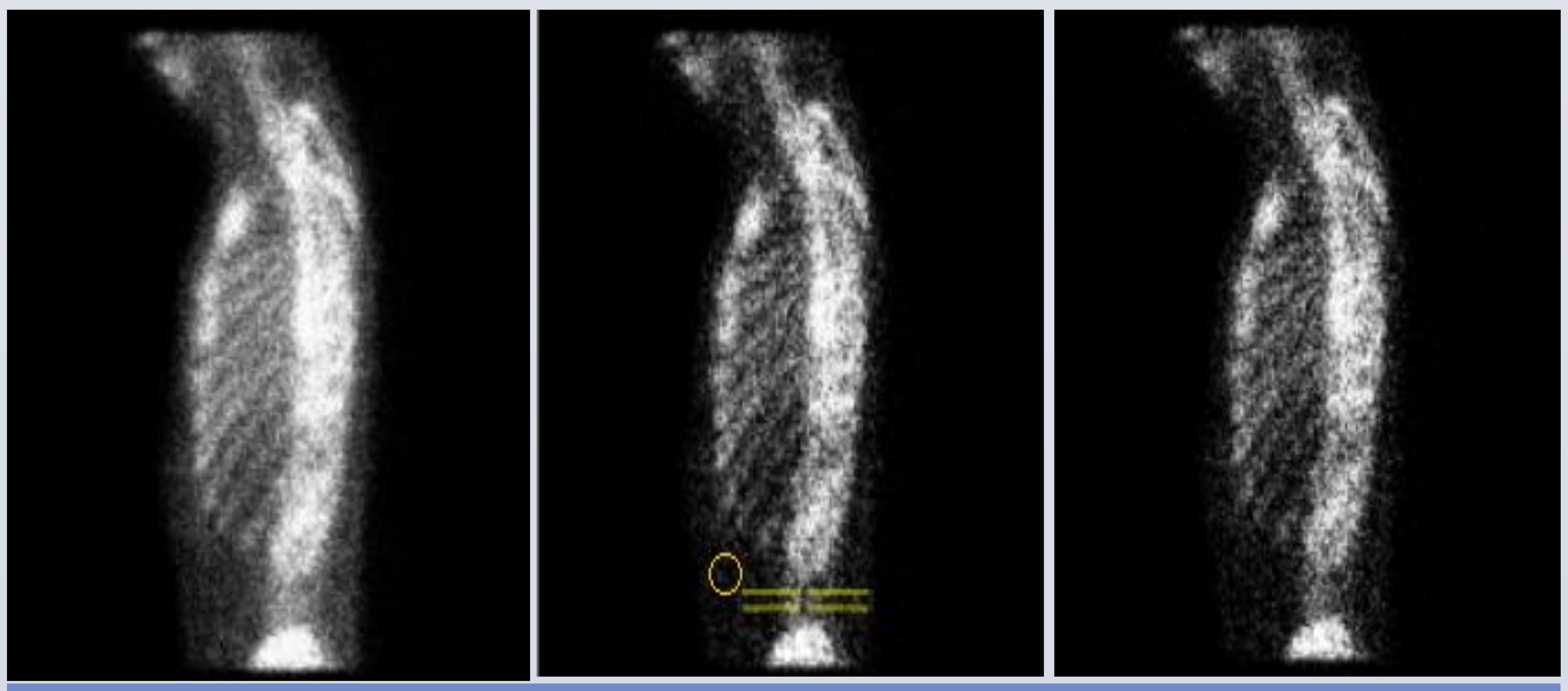

Figure 3: To the left the SEW planar image of ^{99m}Tc, while in the center is located the DEW planar image with area of interest and the area of background. To the right, the TEW planar image.

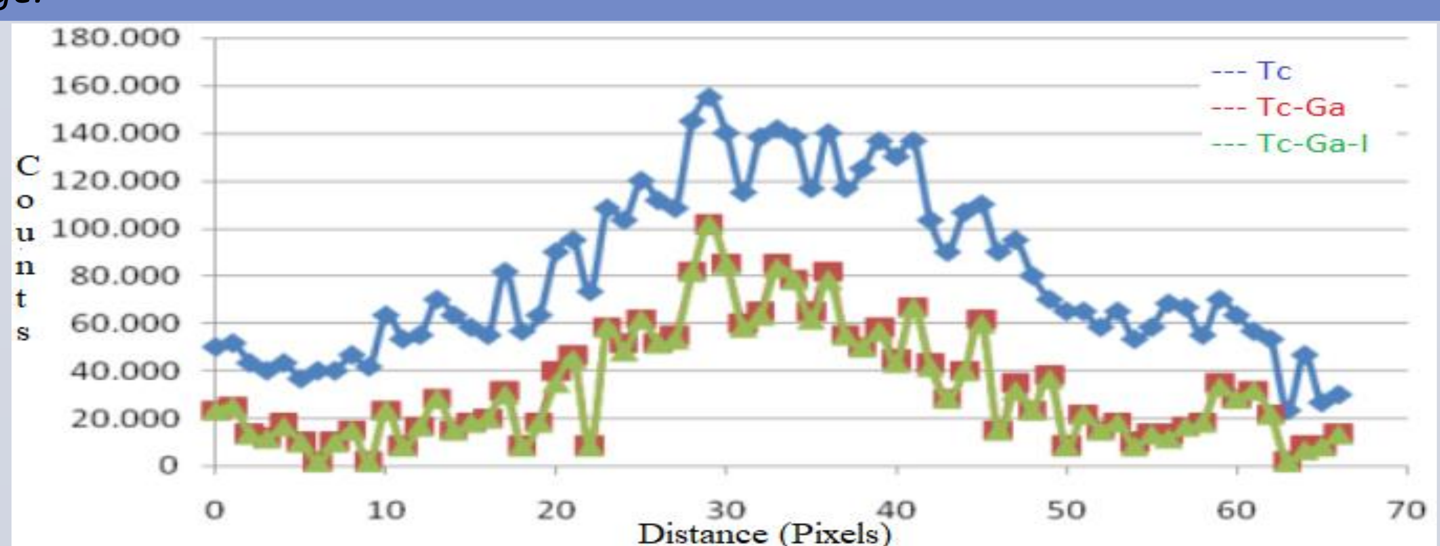

Figure 4: Spectral comparison of the 3 windows in relation to distance of pixels

Conclusions

The analysis indicates that TEW method was more precise than DEW one for both radioisotopes. This method produces significant improvement of scatter correction leading to development of nuclear medicine images with high quality.