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Extended Triple Energy Window Method for Scatter Correction Using Monte Carlo Simulation

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INTRODUCTION

Scatter correction in SPECT is important for improving image quantitation as well as i mage quality. One of the scatter correction methods is the triple energy window method su ggested by Ogawa et el. However, this method has a disadvantage of using abutted scatter rejection windows. This study has extended Ogawa's scatter correction method into the gene ralized triple energy window method which doesn't necessarily use abutted scatter rejection windows.

METHOD

The comparison studies between Ogawa's method (TEW : triple energy window) and th e extended triple energy window(ETEW) method were performed based on Mote Carlo si mulated data for point sources and hot spheres within a uniform cylindrical water phantom. With the main window, we acquired the total count(C_{total}), which is composed of the count of primary photons(C_{prim}) and the count of scattered photons(C_{scat}) using Monte Carlo simul ation. The count of primary photons is given by $C_{prim} = C_{total} - C_{scat}$. The C_{scat} can be esti mated from the count data C_{left} and C_{right} acquired with the two subwindows which are loca ted at both sides of the main window. If we assume the width of the main window as W_m and those of the subwindows as W_s, the C_{scat} can be estimated from a trapezoidal region having a left height of C_{left}/W_s, a right height of C_{right}/W_s, and a base of W_m.

•TEW method

$$C_{scat} \cong \left(\frac{C_{left}}{W_s} + \frac{C_{right}}{W_s}\right) * \frac{W_m}{2},$$

•ETEW method

$$C_{scat} = \left(\frac{C_{left}}{W_s} - \frac{C_{right}}{W_s}\right)(W_1 + W_2) \cdot \frac{W_m}{2W} + \frac{C_{upper}}{W_{right}} \cdot W_m$$

$W = E_{right} - E_{left}$, $W_1 = E_{right} - E_{upper}$, $W_2 = E_{right} - E_{lower}$

E_{right} is the energy centered at right subwindow and E_{left} is the energy centered at left subw indow. E_{upper} is the upper energy of the main window and E_{lower} is the lower energy of the main window.

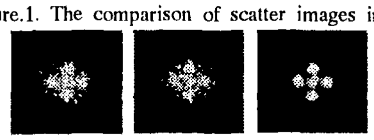
RESULTS

Scatter counts by TEW method were not proportional to energy windows and TEW met hod showed overcorrection of scatter counts by 10 and 15 % energy window. Scatter count s by ETEW method were proportional to energy windows. However, ETEW method showed undercorrection for the scatter counts [Table 1].

Table.1. The comparison of scatter counts for point source.

energy window(%)	Theoretical scatter (counts)	TEW scatter (counts)	ETEW scatter (counts)
10	10.43	16.07	7.32
15	15.56	16.43	10.97
20	20.62	16.38	14.63
30	30.29	21.14	21.95

Figure.1. The comparison of scatter images in 15 % wind ow.



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DISCUSSION

TEW method is one of the simplest scatter correction methods. However, as shown by abo ve results, scatter counts weren't proportional to energy windows because of abutted scatter rejection windows. ETEW method uses fixed scatter rejection windows. Therefore, scatter c ounts were proportional to energy windows. However, scatter counts were underestimated by a selection of inadequate scatter rejection windows. The further studies of scatter rejection windows are to improve image quality and quantification.

CONCLUSION

The results show that the ETEW method estimated scatter counts in main window more correctly and more linearly as a function of width of energy window. In conclusion, ETE W method may be used to improve image quality and more accurate quantification with fur ther studies.