Theoretical determination of the collimator geometrical transfer function for the reconstruction of spect data with algorithms based on the numerical inversion of the Radon transform

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Several authors have shown that accurate modeling of the system PSF (Point Spread Function) improves SPECT reconstruction [1, 2]. The PSF of a SPECT device is mainly determined by the collimator and it is dependent on the source location in a way which is particular to the type of collimator. It is very usual to approximate the system PSF by means of a Gaussian function and to describe the spatial variability by finding some simple relationship between the FWHM of the Gaussian function and the source location. This Gaussian approximation is based on the assumption that both the camera intrinsic response and the collimator response may be described with Gaussian functions. However, while this is fairly true for the intrinsic component, the PSF of a multihole collimator is quite different from a bell shaped function. Usually the approximation works because, except in regions close to the collimator face, the smearing effect of the intrinsic component masks the more complicated structure of the collimator's PSF.

When modeling the PSF for SPECT reconstruction, the dependence on the source location has to be determined experimentally in order to take into account the actual conditions in which the patients studies will be made (camera type and setup, collimator type, radius of rotation). This requires an additional experimental procedure which, besides other factors, hampers the wide spread acceptance of reconstruction methods which use this information to achieve better restoration capabilities. On the other hand, the Gaussian description does not allow one to determine theoretically the PSF for a given acquisition setup. In this paper a general expression for the geometric transfer function (GTF) of a multihole collimator was used so that its PSF can be computed and used for the correct modeling in the reconstruction of SPECT data. The PSF information is calculated in form of weighting factors which are stored in a lookup table to be used by the reconstruction algorithms. Any kind of iterative reconstruction algorithm based on the numerical inversion of the Radon transform may be used. In this work examples are given with a conjugate gradient reconstruction method.

References

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