Sensitivity of the Scintillation Camera

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Parameters having relation with system sensitivity of the scintillation camera involove efficiency of the detector, efficiency of the collimator, window width of the pulse height analyzer and energy resolution of the detector. As efficiency of the collimator also has relation to the spacial resolution, system sensitivity should be considered in connection with spacial resolution.

Photopeak efficiency of the detector is a function of its thickness. The efficiency of a NaI scintillator of 9 mm thick is 9.1% lower than the one of 12.7 mm thick by 150 keV gamma ray, and is 25% lower by 500 deV gamma ray.

Actual efficiency is lower than the photopeak efficiency when the window width of the pulse height analyzer doesn't cover enough the photopeak. The window width as equal as the full width half maximum (FWHM) of energy resolution of the detector causes 24% lowering of the photopeak efficiency, and the window width 1.5 times larger than FWHM also causes 8% lowering.

Therefore, onergy resolution of the detector can compete with thickness of the detector in the effect on system sensitivity.

Efficiency of the collimator has relation which was described by H. O. Anger to its spacial resolution. As system resolution is a function of intrinsic resolutions of both collimator and scintillation camers, two scintillation cameras having each value of intrinsic resolution can be realized the same value of system resolution by altering each value of intrinsic resolution of collimators. Therefore, above two scintillation cameras having same value of system resolution have different values of efficiency of collimator, accordingly have different values of efficiency of collimator, according y have different values of system sensitivity.

Assuming that window width covers full of the photopeak of the 150 keV gamma ray, system sensitivity of a scinti ation camera having a NaI scintillator of 9 mm thick and intrinsic resolution of 4 mm FWHM is 2.3 times larger than that having a 12.7 mm thick scintillator and intrinsic resolution of 6 mm FWHM provided the system is set at 7 mm FWHM. Former is 1.1 times larger than later provided the system resolution is set at 12 mm.

Basic and Clinical Evaluation of LFOV Gamma Camera

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A large field of view (LFOV) gamma camera (Searl Inc.) was used in combination with 3 types of collimators (P.H.R.; parallel high resolution, L.E.A.P.; low energy all purpose, and C.H.R.; converging high resolution), whole body scanning table and micro dot imager. The gamma camera is composed of 37 3 inch ϕ PMT and a 17×0.5 inch NaI (Tl) crystal. The field size is 15.25 inch in diameter.

Basic evaluation including uniformity, lineality, resolution and sensitivity were satisfactory both in static and whole body images. Deviation from the mean in count rates on 5×5 matrix areas was less than 8.3% and 10.9% in static and whole body images of flat phantom, respectively. Deformity of the images werelless than 4.3% within the field of 36 cm in diameter. C.H.R. showed best resolution without losing sensitivity as compared with P.H.R. and L.E.A.P. Focal length of C.H.R. was calculated to be 38 cm. When C.H.R. was used, position and size of images changed according to the position of the source in a phantom showing significant difference from parallel collimators.

Clinical evaluation of the gamma camera was demonstrated in representative studies of hepatic dynamic and static images in a patient with liver metastasis, static brain images in a patient with tumor of pons and cardiac dyanmic images.

The characteristic features of LFOV gamma camera are: (1) arge effective field size, which enables imaging of large organ like the lung and easy positioning of a organ in dynamic study, (2) good spatial resolution without sacrificing sensitivity with the use of C.H.R., (3) magnified images with C.G.R., which makes it easy to set R.O.I. in a small organ such as the heart. However, change in relative position and size according to the depth of the lesion has to be carefully taken into consideration when converging collimator is used.

Basic and Clinical Assessment of a Large Field of View Scintillation Camera

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The LFOV has 37 photomultiplier tubes with a field of view of 15.25 in. using parallel-hole collimator.

A comparative assessment of the Pho/Gamma LFOV scintillation camera was made with the Ohio Nuclear 100 and Pho/Gamma III.

Measurements were made with ^{99m}Tc, 140 keV energy by using a 30 keV window width.

Spatial resolution; The parameters of resolution measured were full width at half-maximum (FWHM) of the line-source response function and phantom images.

The radioactive line source was made with a 0.8 mm×20 cm tube. System resolution of the LFOV collimators for ^{99m}Tc as a function of distance from the surface of the collimators are shown in Table 1 by FWHM which was computed by a minicomputer (best results of the high resolution collimator (HRC) can be seen in Table 1).

The results of bar phantom images at the surface of the collimators were also obtained. All the images contained a total of 999 k counts. The HRC of the LFOV resolved a 4 mm bar lead but not 2.3 mm. The HRP of the Ohio Nuclear 100 resolved a 5 mm bar. The parallel-hole collimator of Pho/Gamma III resolved a 6 mm bar lead.

Sensitivity with collimator: The relative sensitivity per ^{99m}Tc flood-field source was obtained by recording the counts per 10 seconds. Among the 5 collimators of the LFOV camera HEC gave the best results, followed by HEP.

The field of the LFOV was sufficient to encompass both lungs with better definition of pulmonary structures.

The increase in sensitivity and field size also made it possible to accomplish total-body surveys in about 4 images.

The LFOV converging collimator demonstrated better depth response than the parallel-hole collimators. Static brain images revealed a marked improvement in resolution for deep structures.

Table 1. System resolution (FWHM) for ^{99m}Tc versus distance from collimator surface for each collimator

Collimator	HRC	HRP	MARC	HEP	HEC
0	7.0	7.8	7.8	7.8	8.7
5	7.7	8.1	9.7	11.7	10.5
10	8.0	10.0	12.6	15.5	15.0
15	9.9	11.7	15.6	18.8	17.9