Performance Evaluation of Scintillation Camera System Case of High-contrast Objects

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A performance characteristics of a scintillation camera system is represented with the relation between the product aT of radioisotope density in an object a by its imaging time T and critically resolvable distance with human eyes in the obtained scintigram. This relation, in which the object was defined as a bar phantom, was theoretically introduced at the last Meeting.

In the present time, four commercially available scintillation camera systems are experimentally evaluated with above mentioned criterion. Bar phantoms accompanied by a ^{99m}Tc filled flood source are placed 10 cm away from the collimator surface of the system. The window-width of the pulse-height selector is adjusted, so that all pulses involved in the photopeak are caught just in the window. Images of bar phantoms are classified in three categories "resolved", "critical", and "unresolved". When two adjacent bars in a bar phantom image are resolved over 70–80% of the image area, the image is classified as "critical." Better images than the critical image are classified as "resolved", and worse images as "unresolved".

Experimental results are in agreement with theoretical one within the range of the experimental error.

The system having the best intrinsic resolution shows the best performance among four evaluated systems in the range of imaging conditions of the experiment. The best system has a 9 mm thick scintillator, and meanwhile, each of the other systems has a 12.7 mm thick scintillator. These facts mean that thickness of the scintillator hardly affects the performance characteristics of the scintillation camera, at least, when the gamma ray energy used is not so high.

Evaluation of Scintillation Camera Performance for Low-Contrast Objects

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Scintillation camera imaging performance for low-contrast ^{99m}Tc or ^{131}I distribution patterns is investigated theoretically. The method is based on an evaluation of "scintigram resolution", which is a complex function of the intrinsic resolution and sensitivity of the camera, collimator performance, imaging time, radioactivity and object pattern contrast. A "characteristic curve" is defined as the relation between distance to be resolved (x) and the minimum product (aT) of radioactivity (a) and imaging time (T). A mathematical expression of the curve is derived from an expansion of the semi-empirical expression which has been confirmed experimentally for bar-phantom images.

Typical characteristic curves for recent high-resolution systems are presented. The critical aT value for recognizing a certain x increases remarkably as object contrast decreases.

When the characteristic curves are obtained for various collimators, a collimator which gives the minimum scintigram resolution in a certain aT region is the optimum collimator for that aT region. An optimum collimator can be determined when aT and the object contrast are given beforehand. Generally, a high-resolution collimator is optimum for high-contrast objects, whereas a low-resolution, high-sensitivity collimator is optimum for low-contrast objects.

The effect of both the intrinsic resolution of scintillation cameras and detection efficiency of scintillation crystals on the characteristic curves, are evaluated. The former and latter are determinant factors for ^{99m}Tc and ^{131}I imaging, respectively.

Comparative evaluation for different systems reveals little variation due to the object contrast.