95.5%, 21 of 22 neoplastic cases. This is because the injected MAA was comparatively more increased in the tumor region than in the normal tissue. But, in non-neoplastic cases pseudopositive cases were also increased, 3 of 9 cases (33.3%). Proximal branches of celiac artery were more easily injected than distal branches in the non-neoplastic cases.

Using scinticamera, serial scintiphotos were taken as soon as ^{99m}Tc-pertechnetate was injected into the arteries. This method was named "Rapid Serial Angioscintiphotography". Positive tumor stains were remained fairly long duration in most of the neoplastic cases, 28 of 29 cases, in 14 of which noradrenalin was also injected before ^{99m}Tc-pertechnetate was injected. In non-neoplastic cases, 6 of 7 cases were negative, 3 with noradrenalin. The possibility of differential diagnosis, benign or malignant, was postulated by the duration of clearance rate, but not yet concluded with this number of cases.

Symposium VII. Clinical Application of γ Camera

(Chairman) H. Kakehi, Univ. of Chiba

Performance of Scintillation Camera and Its Associated Problems

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The theory and performance of Anger type scintillation camera are reviewed and the factors affecting spatial resolution, uniformity, and linearity are analyzed. Since the camera performance is sensitive to the adjustment of the gain of the nineteen photomultipliers, the proper adjustment is very important for the users. The simplest method is to make uniform the oscilloscope pattern of uniformly irradiated gamma-rays with a narrow energy window set at the upper slope of the photo-peak (Wilks, 1963). However, the best condition for one characteristic (for example, uniformity) is not always best for the others (for example, linearity or spatial resolution). Therefore the users should investigate the characteristic of their machine with the particular method of adjustment.

The possibility of improving the camera performance, especially the spatial resolution, by a new position signal computer is discussed. Assuming the position signal (X-axis) X is given by $X = \sum k_i g_i n_i / \sum g_i n_i$ where n_i is the photon number incident on the i-th photomultiplier, k_i the factor to be multiplied to the output of the i-th photomultiplier, the condition of minimizing the spatial resolution is given by

$$g_i\ (k_i - X) = C\frac{dn_i/dx}{n_i}$$

where x is the position coordinate (X-axis) and C the constant.

Numerical evaluations show that, at the centre of the crystal, the resolution of the conventional system is about 35% worse than the ideal one even when there is no light diffusion, and that about 100% worse when 30% of the total light is diffused. It can also be seen from the above equation that the optimum value of ki is not constant but a function of the position of the scintillation. This can not be realized by the conventional system.

An approach to a new position computer is introduced. The outputs of the photomultipliers are fed to a tapped delay line after appropriate wave shaping so that the delay time is proportional to the position coordinate of each photomultiplier, and as the result a waveform similar to the light intensity distribution on the scintillator is obtained at one end of the delay line. The position may be determined as the time dividing the area under the waveform in two equal parts or as the time at the peak of the waveform.

Finally, directions of future development are suggested. They are 1) the production of cameras having larger field of view, 2) improvement of position signal computer, 3) automation or semi-automation of camera adjustment, 4) extending to low energy range, and 5) development of accessory instruments and data processor.

The Comparison of the Scintillation Camera with Other Procedures

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As the scintigram apparatuses, the scintillation camera is also popularized with conventional scanner in our country. There are some opinions that the scintillation camera is superior on the point of examination time, but not on the resolution of the scintigrams. To solve this problem, we compared the scintigram apparatuses mathematically.

For the first procedure, the response curves of each apparatuses are formulated as followings from the practical data not only for the scanner but also for the stationary apparatuses.

$$f(x, y, z) = k1 \cdot \exp\left\{-\frac{\ln 2}{k2^2}(z-k3)^2\right\} \cdot \exp(-k4z) \cdot \exp\left\{-\frac{\ln 2}{k5^2}(x^2+y^2)\right\}$$

In this formula kl means the count rate from the point (0, 0, k3), k2 the resolution width of the half maximum along the z axis, k3 maximum response point on z axis, k4 absorption coefficient and k5 the resolution width of the half maximum on x-y dimension.

When the radioisotopes are placed uniformly in the region surrounded by the coordinate x1, x2, y1, y2, zl and z2 in the water phantom, the count detected through the collimator detector system is calculated as the results of integration of the previous formula as followings when the collimator is placed at (x, 0, 0)

$$F(X) = \int_{x1-X}^{X-x2}\int_{y1}^{y2}\int_{z1}^{z2} f(x, y, z)\, dx\, dy\, dz$$

This calculation is performed easily by using analogue computer.

The supposed organs are calculated in each apparatuses, and the results is as followings. For the thyroid scintigram where the organs are thin and placed on the surface of the body, the pinhole collimator of the camera is superior than the others because the small k3 and small k2 is predominant on the scintigrams, but for the other organs, which are large and placed in the center of the body, most of the procedures show the same result on the detection capacity of the tumor according to the large k2 and k3 values except pancreas scintigram. The pancreas scintigram is in other categoly, because it is placed deep in the body but thin as figure. For the large organs, the count rate through the detector system is predominant comparing with the resolution of the x-y dimension in present.

The results are as followings.

Organ and radioisotopes	Selected apparatuses	Reason
Brain with TC-99m	camera	time, mobility
Thyroid with I-131	camera	resolution
Lung with I-131-MAA	equall	
Heart pool with I-131-HSA	scanner	isometric
Heart pool with Tc-99m	camera	dynamics
Liver with Au-198-colloid	scanner	area
Liver with I-131-RB	equall	