On the Device of Nuclear Image Tube Camera

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Conventional scintiscanner visualize the body distribution of radioisotopes by spending 30 to 40 min. for the larger organs such as lung and liver. Therefore it is neither suitable for the dynamic record of the body distribution of radioisotopes which changes time by time nor the visualization of organ from different angles.

The stationary camera device such as scintillation camera by Anger, autofluoroscope by Bender & Blau, spark chamber camera by Horwitz & Lansiaart & image tube scintillation camera by Ter-Pogossian are deviced to overcome the disadvantage of the scinti-scanner technique.

Authors are performing further improvetube scintillation camera and applied this camera for the visualization of the body distribution of ^{99m}Tc labelled compound and others.

This camera consists of multi-hole collimator with 3,600 pieces of 3mmϕ × 30mm & 0.4mm thick lead cylinder, x-ray image tube (9″ϕ), optical system and polaroid camera.

γ rays which is directed towards the surface of the image tube by multi-hole collimator is intensified by the factor of 2,000 times and is focused on the final photoelectric cathod. The final picture was recorded by polaroid camera (ASA 3,000 or 10,000) with tandem lens system.

Using phantoms 10 min. for 2mCi ^{125}I, 2 min. for 10mCi of ^{99m}Tc, 2 min. for 17.5 mCi ^{197}Hg and 1 min. for 15mCi ^{133}Xe were found to be necessary.

Three hours after i.v. injection of 200 μCi ^{197}Hg into rat, kidney was visualized by 5 min. exposure.

After seven mCi of $^{99m}Tc_2S_7$ colloid injection human liver was visualized by 5 min. exposure. The process of $^{99m}Tc\ O_4^-$-gastric absorption was recorded 3, 8, 15, 22, 30 & 54 min. after oral administration of this solution.

Authors has recent manufactured the image ment of this camera by modifying tube, lens-system and collimators.

Sciniti Camera

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Recently, the development of scintiscanner makes a great progress in the field of diagnosis. But the scanning methods has a great disadvantage, that is, it takes a long time to get a result.

This disadvantage could not neglect as far as using the scanning technic. To avoid the disadvantage, many trials are offered as fibrid scanning which improve the scanning method and stationary apparatases which are scinticamera, image technic, mosaic crystal technic, spark chamber and special tubes.

In our clinic, a scinticamera is discussed and built for reserches. Some improved points and ideas are summerized here.

Our scinticamera is a pinhole type containing a 5" NaI (Tl) crystal which is previously reported.

The pinhole type has an advantage to cover a large field according to the distance between pinhole and subject, but has disadvantages about the resolution and sensitivity. On the other hands, multihole type has an economical disadvantage just as needs a large diameter crystal.

Present status of recording system is mainly by oscilloscope with polaroid camera and sometimes with movie camera. Our apparatus has a memory tube to have a scintigram on an oscilloscope tube. About the light points, a defocusing technic is combined to avoid the statistical infrequency.

About the energy range of γ-rays, it is desirable to cover between the energies of ^{125}I and ^{131}I, but our apparatus could cover only between that of ^{99m}Tc and ^{131}I because of the limit of electronical circuits.

For the examination, the morphological dynamics are expressed. Presently its main purposes are on liver dynamics by labeled rosebengal and recently heart dynamics are reported.

This technic is desired to be improved because of its special mechanism.

RI Scanning and Modulation Transfer Function (I)

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In RI image transmission system there is no treatment of Fourier analysis. Then, making up the ^{131}I paper Siemens star, the authors measured the modulation transfer function (MTF) in its system, which confirms our theoretical calculation.

Now let the intensity distribution of RI in the patient be F (x, y), the directionality of the collimator be f (θ, φ), and the intensity d distribution of RI image h (x', y'), then the following equation is obtained:

$$h(x', y') = \iint_{-\infty}^{\infty\infty} F(x+\xi, y+\eta) f(\theta, \varphi) d\xi d\eta \quad \cdots(1$$

where (θ, φ); a point in the x-y plane.

$$\theta = \cos^{-1}(\ell/r) = \cos^{-1}(\ell/\sqrt{\ell^2+\xi^2\eta^2}),$$

$\varphi = \tan^{-1}(\eta/\xi)$, ℓ; a distance from the collimator to the x-y plane.

And now $F(x) = \frac{1}{2}\left\{1 + a\cos(\pi x/L)\right\}$, $f(\theta) = \cos^2\theta$, then

$$h(x', y') = \frac{1}{2}\left[1 + a\ \exp(-\pi\ell/L)\ \cos(\pi x/L)\right] \quad (2)$$

Moreover

$$h(f_s/h(o) = \exp(-2\pi f_s\ell) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots(3)$$

$$G(w) = \exp(-w\ell_1) [1 - \exp\{-(w+\alpha)\Delta\ell\}]/\Delta\ell(w+\alpha) \quad (4)$$

where f; 1/2l (spatial frequency), w; $2\pi f_s$, l; thickness of the object, and α; linear absorption coefficient. Namely, the above equations of (1), (2) and (3) show that the directionality of the collimator is the MTF in FI scanning system, and that G(w) is the MTF in its system taking account of absorption by tissue.

As the object becomes thicker and α is larger, the MTF become worse. When $\alpha = 0.1\ cm^{-1}$, and object is 3, 5 and 10 cm thick, the 0.1 MTF of perceptible limits of routine scintigram has the spatial frequency of 0.13, 0.19 and 0.24 lines/cm. Their limits are completely correspondent to the clinical limits of hole defect size. And, efficiency of collimator is quantitatively determined; the MTF of 30% down in honey cone type (5 cm focused), honey cone type (10 cm focused) and cyrindrical cone (diameter of 1 cm) has the frequency of 0.3, 0.26 and 0.4 lines/cm.

These treatment is indispensable to the RI quantitative diagnosis as well as comprehension and improvement of every factor and relations to the spectra of the object.