Quantitative Scanning

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To evaluate the distribution of radioisotope in the human body precisely, it is esesntially important that scan image is delineated quantitatively. For this purpose coupling of the concept of isosensitive scanning to gammagraphic photorecording with light source having spatial distribution correspondent to isoresponse curve of collimator were achieved.

Three following conditions are necessary for the success of quantitative scanning.

Firstly, it should be possible to detect any radioactivity in the body with an equal opportunity independent of depth. It can be achieved by isosensitive scanning.

Secondly, counts detected must be recorded quantitatively. For this purpose, we used gammagraphic photorecording. Photorecording is superior to the other mode of scan recording since it can record the difference of counting rate as the difference of film density. The important thing in quantitative scanning is to get a precise information as a primary record without cut off erasing and/or other contrast enhancements. It is desirable that there is a relationship between counting rate and film density and it was possible to proportion film density to logarithm of counting rate within the range of 1 : 500.

Third problem is how to evaluate the primary record quantitatively. It is true that gammagraphic photoscan can be read intuitively by itself and contrast enhancement by recopying is also convenient to qualitative reading of scan. However, to analyze gammagraphic photoscan quantitatively, 8 rescans of different cut off level were made in different colors and these were superimposed to make a color rescan demonstrating quantitative radioisotope distribution in vivo. For the convenience of practice, rescanning was repeated twice with use of scan recorder having four recording heads.

Area Scanning for Quantitative Measurement of Radioactivity in Internal Organs

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The quantitative scans demnostrated by many autors display the scan records using color contrasts or a digital computer, but the scan records do not indicate the quantity of radionuclides deposited in paticular portions of internal organs.

However, scanning can supply additional information towards the quantitative measurement of radionuclides deposited in internal organs. This fact was demonstrated by a lot of scan experiments on plexiglass phantoms containing solutions of radionuclides of medical interest. The radioactivity demonstrated was measured by counting the dots on the scan records. If counts are summed over a selected portion of the scan record, these counts depend upon the depth of the source but not upon its size. The average of the counts measured from opposite directions, for instance, from supine and prone, is less dependent on its depth, but is dependent on the thickness of the water phantom dipping the source. These results were confirmed by the measurements on sources of non-uniform activity and on the organ in a human-sized manikin. This study suggests that by using radioisotope scanners, it is possible to quantitate the activity of organs, in addition to a thyroid gland, when the scan counts are summed and averaged over a selected area, and corrections are applied for nearby activity.

Differential Radioisotope Image

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The radioisotope image (area image) obtained with various imaging devices consists of an array of counting-rates in elemental areas over the entire image-plane. The counting-rate is an integral count during the unit time interval. So, the usual radioisotope image can be called as "integral image."

Here we present a new method of image visualization, "differential imaging," in which the rate of change in counting-rates in elemental areas is calculated from the "integral image" and plotted as a function of positions.

As an "integral image," the digital image obtained from a thyroid phantom using a rectilinear scanner was employed,[1] and differential calculation was carried out using a digital computer, Burroughs 5500.

The resulting digital "differential image" was smoothed by averaging the values in 9 neighboring areas, and then plotted as a function of positions using symbols of different densities.

The "differential image" thus plotted were compared with the "integral image," and the contour of the phantom was more clearly demonstrated.

Although there are several problems left to be solved, we think the "differential image" could be used together with conventional "ingral image" in actual clinical practice.

(1) T. Nagai, T. A. Iinuma, and S. Kida: J. Nucl Med. to be published.

The Differentiated Radioisotope Image

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The radioisotope scintigrams are constituted of basic points with variable amplitude in static scanning or variable density distribution in movable scanning, and have one to one correspondence to the radioisotope intensity distribution. Their image quality is basically worse than x-ray image qualtiy. Therefore, the former requires many displaying systems of radioisotope scintigrams; multi-scanning, re-scanning, photoscanning color-scanning and television-retrieving, etc. Now, I propose the differentiated radioisotope image as a method of reconstruction of radioisotope image.

The increasement ΔI of radioisotope in the range of $\Delta \times$ is proportional to the gradient of radioisotope intensity distribution:

However strong radioisotope intensity distribution may be, its gradient is zero if it is definite.