AN AUTOMATED METHOD FOR THE EVALUATION OF NONFOCUSED COLLIMATOR PERFORMANCE IN WATER MEDIUM

Vladimir Bosnjakovic and Leslie R. Bennett

The Center for Health Sciences, University of California, Los Angeles, California

An automatic method for scanning the efficiency distribution of single-bore, nonfocused collimators in a water medium is presented. The scintillation probe with the collimator to be studied is kept stationary but connected to the scanner display while the scanner arm is used to move the point source of radioactivity transversely and longitudinally through a water phantom within the field of view of the collimator.

Scintillation probes coupled with single-bore (cylindrical, flared, or tapered) collimators are currently employed for dynamic in vivo clinical and experimental studies despite the development of and possibilities offered by gamma-ray scintillation cameras. Several reports (*1,2*) have described the use of scintillation probes for quantitative dynamic cardiac in vivo studies with short-lived ^{113m}In. The scintillation probe, because of its thicker NaI(Tl) crystal, has a greater counting efficiency for ^{113m}In (390 keV) than the thin (½-in.) crystal used in the gamma camera.

The usual procedure for obtaining isocount lines for display of the efficiency distribution of the nonfocused collimator is based upon stationary measurements of a radionuclide point source at various distances. However, this well-established procedure is cumbersome, time consuming, and relatively inaccurate (*3*). Where isotopes with very short half-lives are concerned, these disadvantages make it difficult to visualize the efficiency distribution of single-bore collimators by the usual method of obtaining isocount lines.

To overcome these disadvantages, an "automatic" method using the rectilinear scanner and a point source of radioactivity for the visualization of the counting field of nonfocused collimators was developed and is the subject of this report.

METHOD

The scintillation probe (including the photomultiplier tube) and the nonfocused collimator studied were separated from the scanner and held in a fixed

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For reprints contact: Leslie R. Bennett, Dept. of Radiological Sciences, The Center for Health Sciences, University of California, Los Angeles, Calif. 90024.

FIG. 1. Automated method for scanning of efficiency distribution of single-bore, nonfocused collimators. Probe combined with collimator separated from scanner is held in fixed position. Probe is electronically connected to scanner display. Point source of radionuclide attached to scanner arm is moved through water phantom in collimator field of view.

position. The probe and collimator, however, remained electronically connected to the scanner display. The dimensions of the collimator tested are length, 10 cm; internal opening diameter, 5 cm; and external opening diameter, 6 cm. A point source attached to the scanner arm was moved transversely and longitudinally through a water phantom in the field of view of the collimator (Fig. 1). Thus, the detector-to-"skin" distance remains constant while the depth of the source in "tissue" varies. This arrangement appears necessary; while in air the probe coupled with a nonfocused collimator can be moved by the scanner over a stationary point source. The Picker-Nuclear Magnascanner II with a 3 × 3-in. NaI(Tl) crystal scintillation probe was used for the study.

A point source of ^{131}I, having a principal gamma energy (364 keV) similar to that of ^{113m}In (390 keV) was used in this study. The longer half-life of ^{131}I (8.1 days) as compared with ^{113m}In (1.7 hr) provides easier handling for investigative purposes. The source was counted in a 364 ± 30-keV "window" to give 80,000–100,000 cpm for maximum (100%) sensitivity on the central axis at the external opening of the collimator. A time constant of 0.5 sec and maximum scan speed were used. The efficiency distribution of the collimator studied was displayed by the Adams-Jaffe color-readout (*4*).

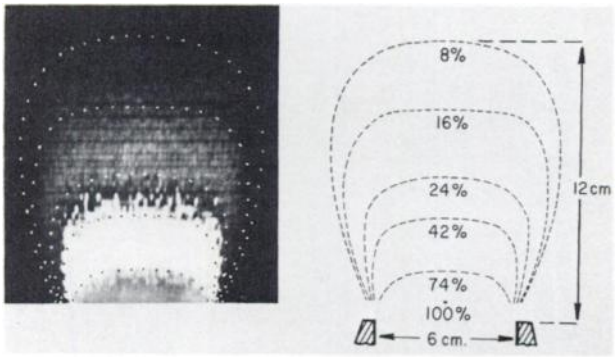

FIG. 2. Black-and-white reproduction of color scan of collimator studied. Indicated isocount lines (left); same isocount lines derived from color areas with percentages of maximum value with their spatial distribution in centimeters (right).

RESULTS

The final visual display of the study consisted of Polaroid color prints obtained with the Adams-Jaffe color-readout system. There were seven colors and each color represents a percentage (14%) of the maximum sensitivity. Thus, a display enabled isocount lines to be expressed in terms of percentages of 100% value by relatively clearly outlined separation. By featuring a magnification–minification factor, such a display also shows the spatial distribution ("tissue depth") of each isocount line.

A black-and-white reproduction of the color scan is shown in Fig. 2. The isocount lines derived from the color areas with percentages of the maximum value as well as their spatial distribution in centimeters are outlined on the same figure.

SUMMARY

The method presented describes a different scanning approach for obtaining the efficiency distribution of single-bore, nonfocused collimators in water phantoms.

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