PRELIMINARY IMAGING STUDIES WITH A LARGE CRYSTAL SCINTILLATION CAMERA

Michael Hayes

UCLA School of Medicine, Harbor General Hospital Campus, Torrance, California

A limitation of the standard scintillation camera is its field size. At present there are at least three general approaches to increasing useable field size: One is to use a divergent collimator; another is to use a larger basic crystal adding another ring of photomultiplier tubes (for a total of 37); and a third is to use a large crystal with the standard 19 photomultiplier tubes spaced more widely than usual. The third method would theoretically degrade inherent resolution in proportion to the increase in field size, but with improvements in light piping and electronics it might be possible to compensate for this theoretical loss. The capabilities of the third system* are the subject of this paper. Some comparisons with a divergent collimator system† will be made. A detailed study of these and other camera systems will be presented in a future publication.

METHOD

Field size was demonstrated by obtaining images of a series of parallel radioactive lines on 1-in. (2.54-cm) centers.

Resolution was measured with a modified Kakehi phantom (*1*) which consists of a series of radioactive lines with decreasing intervals from 4.0 to 0.75 cm placed at a 45-deg angle from 0 to 7 in. (18 cm) from the collimator face. Resolution studies were performed in "fast analog" mode.

Imaging geometry was illustrated with scans of a three-dimensional phantom containing three radioactive tubes which are placed at a 45-deg angle to the collimator face (*2*).

Imaging speed was studied by determining the time to attain 200,000 counts (or 1,000 counts/cm^2) from an Anger liver slice phantom containing 1 μCi of ^{99m}Tc or ^{113m}In placed 4 in. (10 cm) from the collimator face and using a symmetrical 20% analyzer window.

The method and phantoms used have been described in more detail in previous papers (*1–3*).

RESULTS AND DISCUSSION

Field size: Both low- and high-energy collimators have a useable field size of approximately 11½ in. (29 cm) exclusive of crystal edge packing. In comparison, a divergent collimator system† has a useable field size of 13 in. at 4 in. from its face (*3*).

Resolution of the high-energy collimator is sufficient to distinguish two ^{113m}In-containing lines 1 cm apart at its face, and 2 cm apart 4 in. from its face (Fig. 1). This ability is closely comparable to that of the divergent collimator system (*3*).

Imaging geometry: Images of a three-dimensional phantom show no distortion with any radionuclides on either collimator (Fig. 2); mild to moderate distortion was introduced by the divergent collimator system (*3*).

Depth response: As a small extended source is moved away from the face of either low- or high-energy collimator, there is little reduction in counting rate. At 7 in. from the face, there is 5% or less loss in counting rate with either ^{99m}Tc or ^{113m}In using the appropriate collimator. This is illustrated by using the three-dimensional phantom; the image of the radioactive tubes at 7 in. is nearly as bright as when the tubes are touching the collimator face (Fig. 3). The divergent collimator system, however, shows approximately a 25% loss in counts 7 in. from its face (*3*).

Imaging speed: At a distance of 4 in., the low-energy collimator attains an image of 1,000 counts/cm^2 in 0.74 min with 1 mCi of ^{99m}Tc (140 keV) compared with 2.0 min for the divergent collimator system. The high-energy collimator attains a similar

Received June 23, 1970; original accepted Sept. 3, 1970.

For reprints contact: Michael Hayes, Box 311, 1000 W. Carson St., Torrance, Calif. 90509.

* Picker Nuclear Dynacamera 2.

† Nuclear Chicago Pho/Gamma III equipped with a 1,200-hole divergent collimator (negative 56-cm focus).

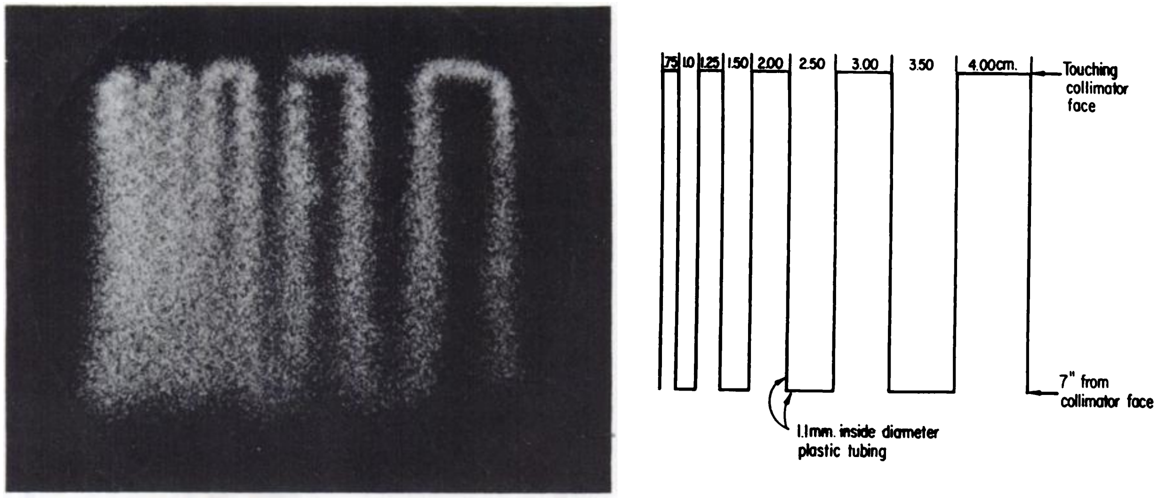

FIG. 1. Image of the Kakehi phantom in air (250 K with ^{113m}In, high-energy collimator).

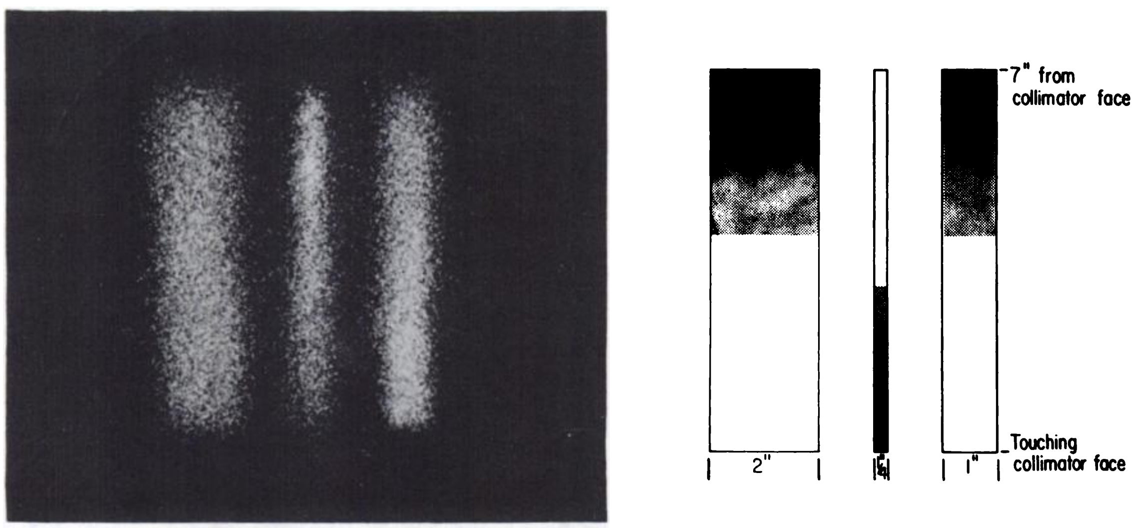

FIG. 2. Image of the three-dimensional phantom of radioactive tubes in air (100 K with ^{113m}In, high-energy collimator).

image in 2.6 min with 1 mCi of ^{113m}In (393 keV) compared with 6.3 min for the divergent collimator system.

SUMMARY

The large-crystal scintillation camera achieves a 11½ in. useable field size and is able to resolve 2 lines 2 cm apart at 4 in. on a Kahehi line source phantom without introducing significant image distortion. In an imaging speed determination, 200,000 counts were attained in 0.74 min with 1 mCi of ^{99m}Tc and in 2.6 min with 1 mCi of ^{113m}In.

By comparison, a divergent collimator system provides a larger field size, closely similar resolution but slower imaging speed and mild to moderate image distortion.

ACKNOWLEDGMENT

These studies were supported in part by contract AT (04-1) GEN-12 between the U.S. AEC and UCLA.

REFERENCES

1. KAKEHI H, ARIMIZU N, UCHIYAMA G, et al: Test patterns to determine sensitivity and resolution of scintigraphy. In *Medical Radioisotope Scintigraphy*, vol. 1, Vienna, International Atomic Energy Agency, 1969, pp. 509–521

2. HAYES M: Comparison of gamma-ray imaging devices with a new three dimensional phantom. In *Medical Radioisotope Scintigraphy*, vol. 1, Vienna, International Atomic Energy Agency, 1969, pp. 523–528

3. HAYES M: Is field size enlargement with divergent and pin hole collimators acceptable? *Radiology* 95: 525–528, 1970