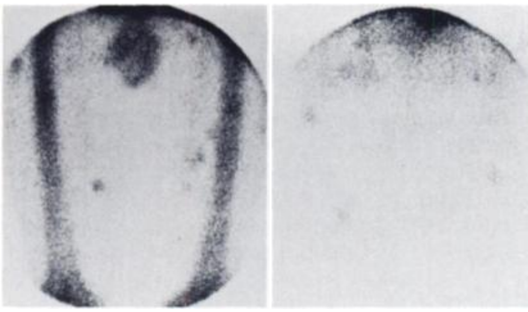

FIG. 3. Anterior thighs: Bone image (left): Multiple foci of soft-tissue accumulation of MDP, corresponding to subcutaneous nodules. Gallium image (right): Several nodules concentrate gallium, some of which also concentrated bone-imaging agent.

not visible even when the MDP images were re-evaluated in retrospect.

Gallium imaging of the lower extremities demonstrated abnormal soft-tissue accumulation in the same nodules that previously concentrated the bone agent (Fig 3).

Extraosseous localization of the technetium phosphate bone imaging agents is known to occur in a variety of soft-tissue lesions, including primary breast carcinoma (*1*), interstitial pulmonary calcification (*2*), extraosseous metastases from osteogenic sarcoma (*3*), and hepatic metastases from colon carcinoma (*4*). The mechanism of localization of these radiopharmaceuticals in such lesions is not completely understood, but there is evidence to suggest that local alterations in mineral metabolism in the lesions account for the soft-tissue accumulation of the bone-imaging agents (*5*).

In the 14 yr since the discovery of Ga-67 accumulation in soft-tissue tumors by Edwards and Hayes (*6*), this agent has become the most widely used tumor-imaging agent in current practice. Multiple studies attest to its usefulness, not only for tumor detection, but for evaluation of inflammatory lesions as well (*7*).

Despite several years of research, the exact mechanism of gallium localization in malignancy and inflammation is still not clear. It has been demonstrated that the intracellular binding of Ga-67 occurs primarily in the lysosomes (*8*). It has also been noted that lactoferrin binds Ga-67, and while little is known about tumor lactoferrin, it is speculated that the affinity of lactoferrin for gallium may play a role in the tumor localization of this imaging agent (*9*).

Gallium imaging has met with great success in a variety of neoplasms, especially the lymphomas and bronchogenic carcinomas, but the reported range of gallium sensitivity in tumors of the gastrointestinal tract is very low, ranging from about 15% to 40% (*10*).

This case not only adds another instance of abnormal soft-tissue accumulation of both the technetium bone-imaging agents and Ga-67 citrate to the literature, but also serves to remind those of us who must interpret these studies of the importance of evaluating the entire image, not just the organ system on which a particular study is focused.

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Polarity in a Hexagonal Collimator

Recently, a strange artifact image of a point source was observed using a low-energy parallel-hole collimator. The collimator holes are hexagonal, therefore, an image of a point source due to septal penetration was expected to be star-shaped, with six projections. However, the image seen had eight projections instead (Fig. 1). The following experiments were carried out to explain the finding, and also to evaluate the effect on the system resolution.

Experiment 1. A small quantity of Tc-99m at the tip of a small syringe was used as a point source. A star image with eight projections was seen (Fig. 1). As expected, these projections became more prominent when the point source was placed farther from

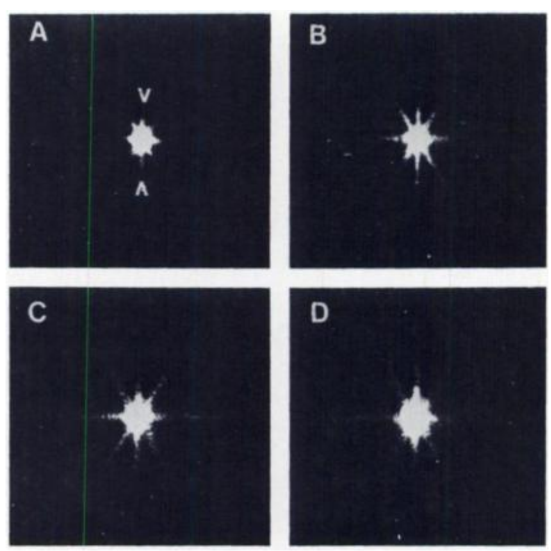

FIG. 1. Shows point source images on hexagonal collimator at distance of 7 cm. Note star-shaped image with eight projections. Arrows indicate two unexpected projections that cause polarity of collimator.

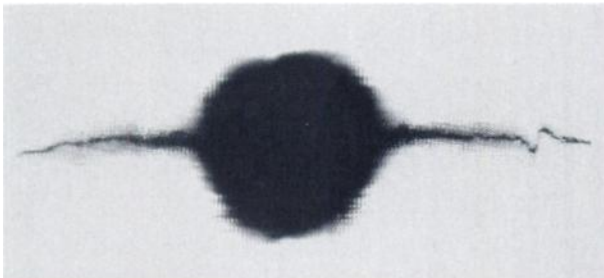

FIG. 2. Shows radiograph of collimator. Note two long projections corresponding exactly to polarity of collimator.

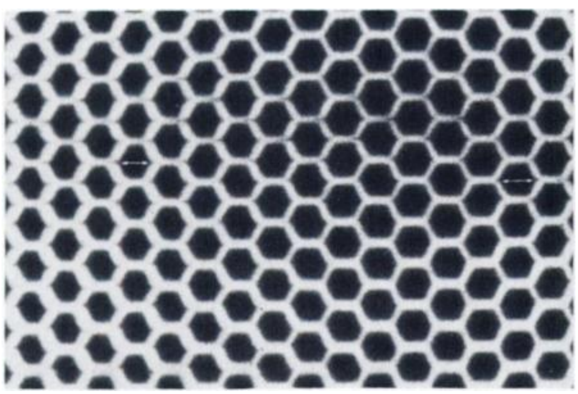

FIG. 3. Shows enlarged radiograph of hexagonal holes. Note tiny spaces at opposite angles of each hole (see arrows), corresponding to polarity of collimator.

the collimator surface. The artifact was the same when the syringe was moved to different parts of the collimator.

Upon careful examination, it became apparent that six of the eight projections of the star image were, as expected, 60° apart due to the septal penetrations through the hexagonal partitions. However, two other projections lying in the vertical plane cannot be explained this way (Fig. 1). The direction of this extra line was changed when the collimator was rotated, but was unchanged when the point source was moved to other parts of the collimator. The result indicates that the artifact is not due to focal defect or damage in the collimator; it has a polarity.

Experiment 2. In order to examine the structure of the collimator without taking it apart, radiographs were made. The beam was aimed first at the center of the collimator, then at the periphery. To my surprise, in both tests the radiograph showed two long projections in the collimator's "polar" direction (Fig. 2).

A radiograph of the collimator was enlarged to show the detail of the hexagonal holes at the center and also slightly off the center of the collimator (Fig. 3). The holes are not perfectly hexagonal. There are two very tiny clefts at opposite angles of each hexagonal hole (arrows, Fig 3). The directions of the tiny spaces correspond exactly to the two extra projections of the star image of the point source (Fig. 1). These clefts may be due to imperfect fabrication; in any case, they account for the collimator's polarity.

Experiment 3. This study was performed to evaluate the significance of the collimator's polarity on the camera's resolution. Images of the bar phantom were made at different orientations to evaluate the effect of the polarity. The bar phantom was placed 10 cm from the collimator surface, in air. The bar sizes are approximately 6, 5, 4, and 3 mm in Quadrants 1, 2, 3, and 4, respectively. A Co-57 flood source was used. An image was made when the bars in Quadrant 1 were parallel to the polarity of the collimator (Fig. 4A), the bars in Quadrant 2 being perpendicular to those in Quadrant 1. Another image was made with the collimator rotated 45° clockwise (Fig. 4B). Finally, the bar phantom was rotated another 45°, making the bars in Quadrant 1 now perpendicular to the collimator polarity, and the small bars in Quadrant 2 parallel to it (Fig. 4C).

The resolution of the bar-phantom images seems to be best when the bars are parallel to the collimator's polarity: Quadrant 1 image seems better in Fig. 4A than in 4C. Aside from the Moiré pattern (1), the bar image in Quadrant 2 looks better in Fig. 4C than 4A. The resolution in Fig. 4B lies between that in Figs. 4A and 4C. This study suggests that the distortion of the image due to polarity of the collimator probably impairs the resolution of the scintillation camera.

Another low-energy hexagonal collimator was also evaluated. However, a point-source image using this collimator showed a star shape with only four projections instead of six, and no polarity was demonstrable. Two sides of each hexagonal hole have septa of double thickness, and essentially no photons could penetrate those sides.

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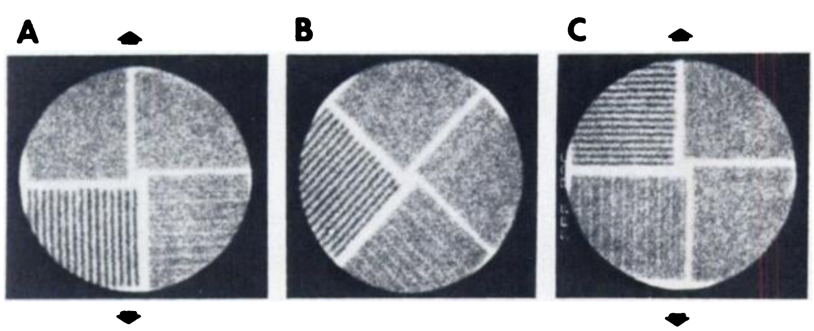

FIG. 4. Shows bar-phantom images at different orientations to collimator polarity (arrows). Note best resolution in quadrants with bars parallel to polarity.