Case Report: The Phantom of the Bar Phantom

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Prior to imaging the morning's patients, a 37-PMT standard-field-of-view, stationary scintillation camera was tested for intrinsic resolution, using a bar phantom and 500 μCi of sodium [^{99m}Tc] pertechnetate as a point source. The face of the camera was 1 meter from the test source, located on the floor. A standard four-quadrant bar phantom was attached by three bolts to the camera.

On the particular morning in question, no patients or personnel had been in the room since the previous day. A peculiar computer-acquired image was obtained (Fig. 1). Only the technologist, the physician attending the clinic, and a camera repairman (present to repair another camera in another room) were present at the time of acquisition of Fig. 1. Upon seeing the film from which Fig. 1 was obtained, the repairman stated, "I think the problem is in the 'head' (of the camera); I can fix that." Twenty min after the origin of the problem was discovered, it was corrected (Fig. 2).

This article involves determining the origin of the phantom of the bar phantom. We have all seen artifacts such as burned-out photomultiplier tubes, cracked crystals, and the "starburst" of septal penetration. We had never seen a bar phantom image such as this prior to this isolated occurrence. We found a similar cause yielding an artifact on a flood field image (*1*).

We wondered how others would explain this rare "phantom of the bar phantom." The explanations offered by several faculty and resident physicians and staff technologists not familiar with the incident are presented in Table 1. One, several, or none of these explanations may be correct. What is your explanation?

Solution

We noted that the center of the bona fide image of the bar phantom appears correctly in the field of view at x = 0; y = 0. The center of the "phantom" image appears to the left and slightly above x = 0; y = 0. But there were not two different fields of view; thus, the "film moved in the cassette" and "defect in the CRT" are unlikely, because two *distinct* and correctly registered images are illustrated. Because no collimator was used in the testing procedure, "problems with" and

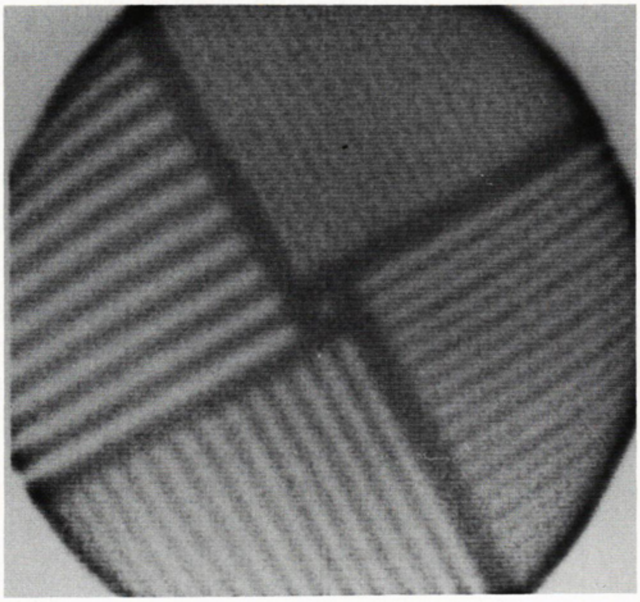

FIG. 1. Computer-acquired image of bar phantom and displaced yet similar phantom image.

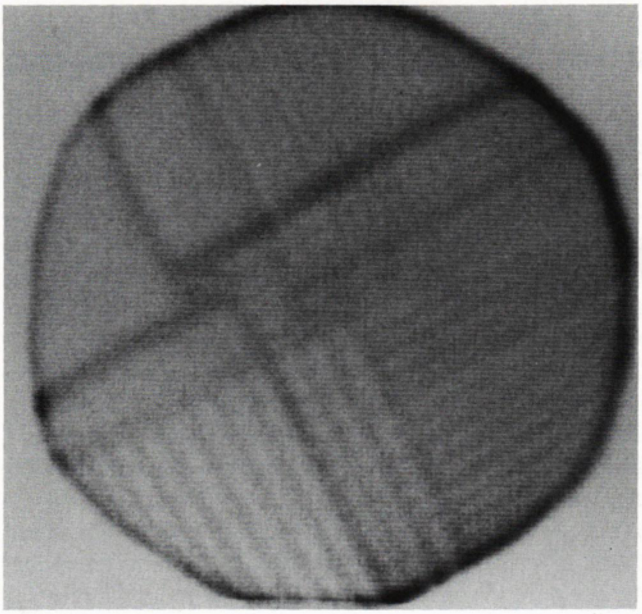

FIG. 2. Computer-acquired solitary image of bar phantom obtained after corrective action.

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TABLE 1. Explantions of the Phantom of the Bar Phantom

1. "Bar phantom movement."
2. "Damage to the bar phantom."
3. "Problem in the collimator."
4. "Damage to the collimator."
5. "Point source not centered under the camera."
6. "Movement of the point source during acquisition."
7. "A crystal problem."
8. "The problem is in the PM tubes."
9. "The problem is in the electronics."
10. "Two energy windows set at different energy levels."
11. "Someone changed the energy window."
12. "The camera moved."
13. "The yoke moved."
14. "Orientation switch moved."
15. "Defect in the CRT."
16. "The film moved in the cassette."

"damage to" the collimator and "point source not centered under the camera" are not tenable explanations. Also, because no collimator was used, "movements of the point source," "the camera moved," and "the yoke moved" are not reasonable explanations, because slight movements would have resulted in relatively small changes in the radiation field striking the bar pattern. Since both images are well defined, "damage to the bar phantom," "someone changed the energy window," "two energy windows set at different energy levels," "a problem in the PM tubes," and "a crystal problem" are similarly unlikely explanations. "Bar phantom movement" is unreasonable, because, as stated, the bar phantom was bolted to the camera face.

Had the "orientation switch moved," the centers of both bar phantom images would have appeared in the same area, i.e., the center of the field of view. More importantly, a reversal of the (x+, x−), (y+, y−), or a reversal of both axes would have resulted in a cross-hatched pattern, not merely a displacement pattern.

Thus, only the explanation, "the problem is in the electronics," remains a consideration, if there were not a more obvious solution to the phantom of the bar phantom image.

In gathering the responses quoted in Table 1, we observed that several respondents thought the problem through in an orderly (yet incomplete) step-wise fashion. Without exception, however, all respondents eliminated consideration of the number of sources; in fact, there were *two* radiation sources. Referring again to Fig. 1, note that the phantom (or ghost image) appears as a shadow of the bar phantom image. Indeed, there was a contaminant on the floor (found by the use of a Geiger counter), located approximately 2 meters from the point source. Merely placing a lead apron between the contamination and the camera caused the phantom of the bar phantom to disappear from the persistence oscilloscope (Fig. 2). The patient roster from the previous day indicated that Yb-169-DTPA had been used in the room for radionuclide cisternography.

After the source of the aberrant image had been discovered, there remained one disturbing feature of the phantom image: the magnitude of the displacement caused by the second radioactive source was too great, considering the geometry involved. That is, both sources were at floor level, and the camera face was 1 meter from the floor. The shadow image was displaced too far, if one assumes that the bar phantom was in contact with the face of the crystal. The solution to this problem was obvious after an inspection of the bar phantom. Although secured by three bolts, the bar phantom was approximately 1 cm away from the camera face. Thus, the two sources simultaneously created two different projections of the bar phantom.

In summary, the image of the phantom of the bar phantom had two contributing factors; the presence of two radioactive sources (the point source and the Yb-169-DTPA contaminant) and the separation distance between the face of the crystal and the bar phantom.

The case of the phantom of the bar phantom has an interesting epilogue. We now conduct quality assurance testing with the camera facing the ceiling, the source between the camera and the ceiling, and the bar phantom placed directly in contact with the camera face.

If "intrinsic" bar pattern imaging must be performed with the phantom facing down, the bar pattern must be held in intimate contact with the face of the crystal.

Review of the uniformity flood field image failed to reveal findings compatible with an extraneous radioactive source. A pixel-by-pixel analysis might have revealed the artifact, but this maneuver was not performed. Background counts or a sensitivity measurement would have disclosed the second source of radioactivity. However, these measurements are not commonly performed on a daily basis, and when performed, are of greatest value when the collimator is attached, and still may not identify extraneous radioactive sources.

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Reference

1. Wells LD, Bernier DR. *Radionuclide imaging artifacts.* Chicago: Year Book Medical Publishers, 1980:78.