An Experimental Model for Evaluation of Dual Isotope Subtraction Techniques

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We present an experimental model for the study of dual isotope subtraction techniques that uses inexpensive, disposable plastic laboratory containers, available in many microbiology laboratories. The model can simulate either a subphrenic abscess, where the abnormal activity is adjacent to a normal structure, or a parathyroid adenoma, where the abnormality is within the normal structure. Representative containers and example images are illustrated.

Dual isotope subtraction techniques are assuming increasing importance in nuclear imaging. They permit recognition of significant, and even life-threatening, lesions that otherwise might be undetectable without surgical exploration. Common examples are detection of subphrenic abscesses with gallium-67 (^{67}Ga) or indium-111 (^{111}In) leukocytes and technetium-99m (^{99m}Tc)-sulphur colloid as well as parathyroid adenomas with ^{99m}Tc and thallium-201 (^{201}Tl). Performance of these subtraction studies requires computer manipulation of data with normalization and subtraction of images. It is important to have a convenient and inexpensive model that allows evaluation of the many facets that comprise an adequate study. We present such a model.

MATERIALS AND METHODS

Our method employs cheap, disposable, covered plastic containers that are available in a huge variety of sizes and shapes. They are illustrated in large clinical laboratory supply house catalogs (under the headings of petri dishes and tissue culture or microtiter plates), and many are routinely available in clinical microbiology and serology laboratories. Representative items we have found useful are petri dishes that vary in diameter from 35 to 150 mm, and tissue culture or microtiter plates and slides with single or multiple wells that vary from 5 to 45 mm in greatest extent (Fig. 1).

We simulated a dual isotope subtraction study as performed for detection of a parathyroid adenoma. The isotopes used were ^{201}Tl followed by ^{99m}Tc. A 100-mm petri dish was placed on top of a parallel-hole low-energy all purpose (LEAP) collimator and secured with scotch tape. The top and side of the dish were marked with an ink line so the top could be removed and replaced in the same position. A tissue culture slide that had eight wells, each 5 mm on a side, was fastened to the cover of the petri dish with scotch tape (Fig. 2). For clarity, two of the tissue culture wells have been filled with ink.

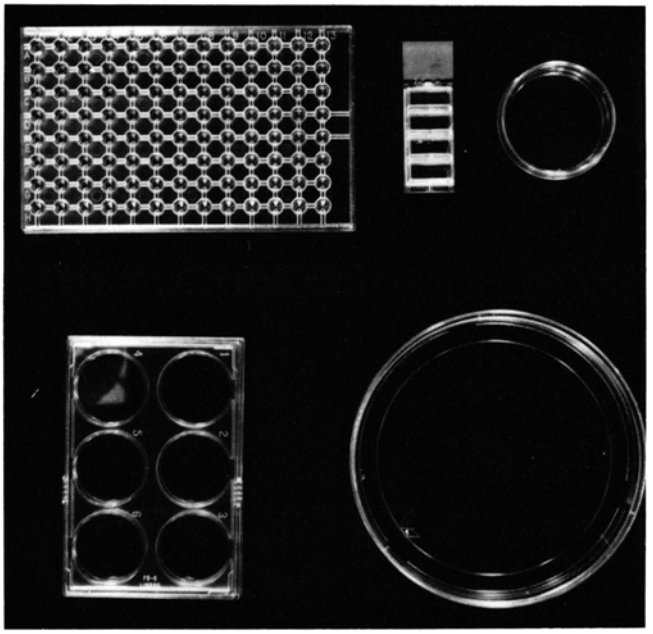

FIG. 1. Five disposable plastic laboratory containers. From the top right, clockwise, they are: 60 × 15 mm petri dish; 150 × 10 mm petri dish; plastic plate containing six wells, each 35 × 10 mm; plastic plate containing 80 wells, each 6 × 9 mm (these are available with either "U" bottom or "V" bottom wells); a slide with four wells, each 7 × 19 × 10 mm. All come with covers except the 80-well plate. A simple device to cover these with a plastic film is available.

Thallium-201 was added to the 100-mm petri dish, and to four of the tissue culture slide wells (in varying concentrations), and an image was obtained. Technetium-99m was then added to the petri dish and another image was obtained. The ^{99m}Tc image was subtracted from the ^{201}Tl image. An area of interest away from the simulated parathyroids was placed on the initial ^{201}Tl image (Fig. 3A) and the maximum number of counts/pixel in the ROI obtained (C1). The maximum number of counts/pixel in the ROI of the ^{99m}Tc image (Fig. 3B) was obtained (C2). The counts/pixel in the ^{99m}Tc image were normalized by multiplying the technetium image by C1/C2 prior to subtraction (Fig. 3C).

DISCUSSION

We were motivated to develop this technique for simulating radionuclide subtraction studies because the first few examinations we performed on patients with suspected parathyroid

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adenomas were negative, and confirmation of the validity of the method was desired.

The usefulness of this experimental model is limited only by the ingenuity of the technologist. It can easily be configured to simulate a subphrenic abscess where the abnormal activity is adjacent to the liver, or a parathyroid adenoma where the abnormality is embedded in the thyroid gland. By adjusting the quantities of radioactivity the sensitivity of a procedure can be evaluated. There is disagreement in the literature as to whether the thallium or technetium image should be obtained first when looking for a parathyroid adenoma. Clearly this model can answer the question. We are currently examining this.

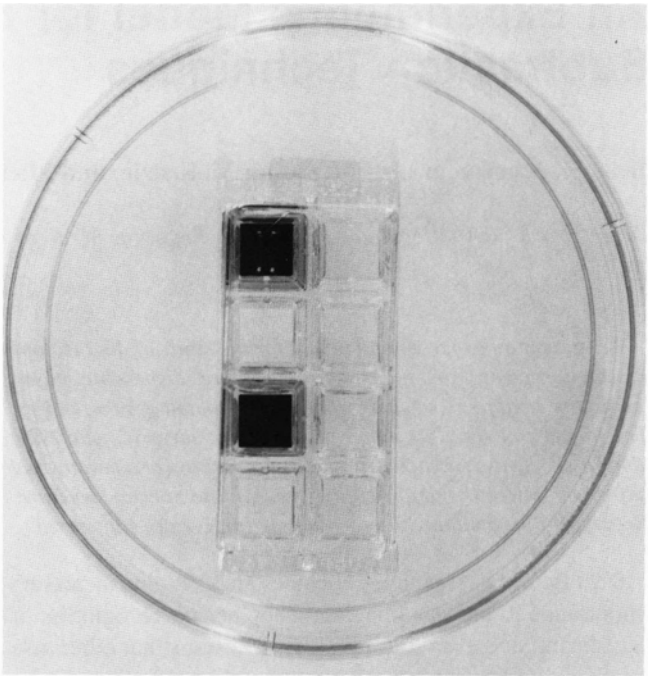

FIG. 2. A 150-mm petri dish on which is a slide with eight wells, each 7 × 7 × 10 mm. Two of the wells have been filled with ink for clarity.

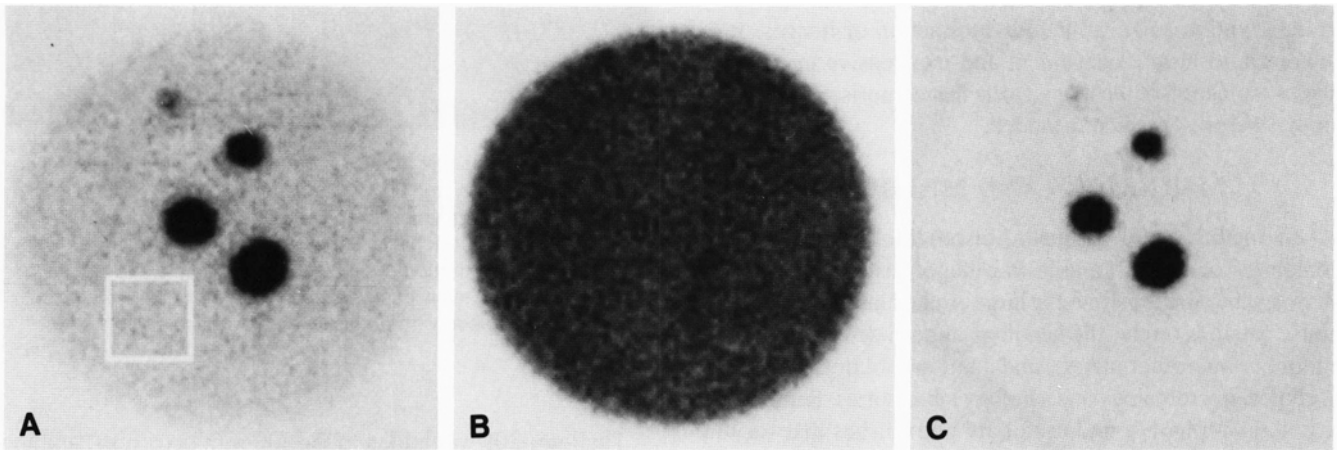

FIG. 3. (A) An image of a 100-mm petri dish and slide with eight wells. Four of the slide wells have been filled with different amounts of ^{201}Tl, and this isotope is also in the petri dish. The small rectangle represents the area of interest used to determine the brightest pixel for normalization. (B) Technetium-99m has been added to the petri dish and imaged. (C) The ^{99m}Tc image has been subtracted from the ^{201}Tl image by the technique described in the text.