Comparative Study of the Gamma Camera and Rectilinear Scanner for Detection of Superficial Lesions

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SUMMARY

A study has been made comparing the performance of the gamma camera and rectilinear scanner in detecting the presence of a superficial brain lesion. Experiments were conducted to compare resolution and sensitivity of both devices; they showed that at the usual distance of a superficial lesion from the collimators of the devices, the gamma camera had superior resolution and sensitivity. Both patient and phantom studies were performed, which demonstrated the superiority of the gamma camera, and it is suggested that if superficial lesions are suspected, the gamma camera should be used for imaging these lesions.

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A patient with hemiplegia owing to a cardiovascular accident, was recently examined. The brain scan on the rectilinear scanner (Picker Magna-Scanner) was equivocal, but a repeat study, at the request of the physician, on the gamma camera (Nuclear Chicago Pho Gamma III) was positive.

The superior visualisation of a lesion causing hemiplegia by the gamma camera has been commented on before,[1] but it is the intention of the following study to demonstrate, in a quantitative manner, the difference between the two devices in detecting superficial lesions.

MATERIALS AND METHODS

The patient was injected with ^{99m}Tc-pertechnetate at the usual dosage of 200 μCi/kg body weight. Premedication included 200 mg potassium perchlorate and 0,6 mg atropine to reduce, respectively, thyroidal and salivary gland uptake of ^{99m}Tc. The imaging studies were performed approximately 45 minutes after the injection of the dose.

The right lateral brain colour scan (Fig. 1) was obtained with a 12,7-cm diameter, 7,6-cm focus, 31-hole, 0,63-cm resolution, focusing multihole collimator placed at the standard 3 cm away from the lateral aspect of the patient's head. The pulse height analyser window was set to cover the photopeak region of the pulse height spectrum of

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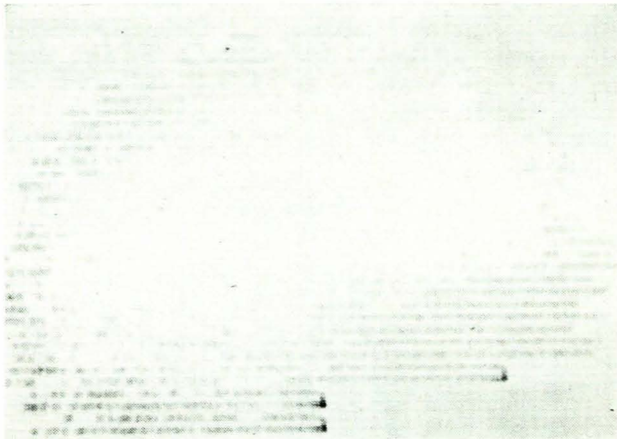

Fig. 1. Equivocal brain scan on patient with hemiplegia.

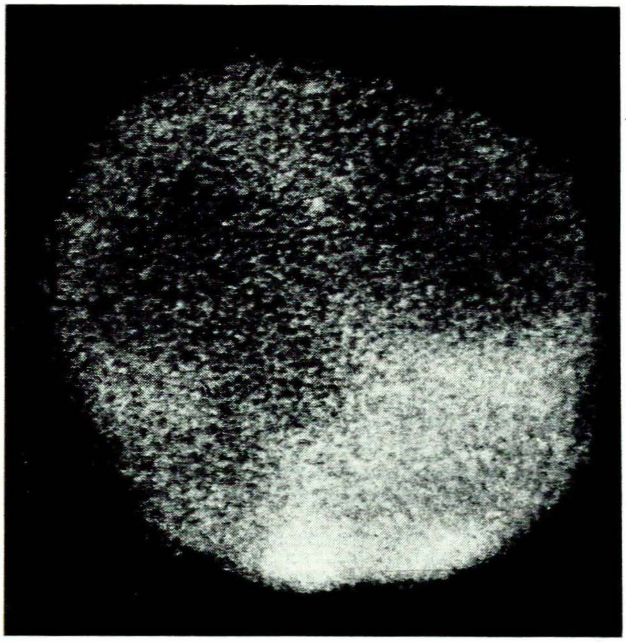

Fig. 2. Scintigram showing area of increased uptake superiorly situated in the parietal region.

^{99m}Tc. The scanning information density used was 400, and the background cut-off was set so that random dots could still be seen over the region of the brain (Fig. 1).

The brain scintigram (Fig. 2) was obtained using the low-energy (150 keV on less γ-ray energies), 4 000-parallel-hole collimator, 20% window, and a total of 200 000 counts was accumulated.

To compare the performance of the two devices in a more quantitative manner, it was decided to measure resolution and sensitivity at various source-to-detector distances.

Resolution is often defined as the distance between two lines which is barely resolvable. This distance can be measured directly from the image of the line sources by simple geometry.[2] Two microhaematocrit tubes were filled with ^{99m}Tc and separated at an angle of 30° to form a V-shape (Fig. 3). Scans and scintigrams of the tubes were obtained in air, using the same imaging conditions as for the patient.

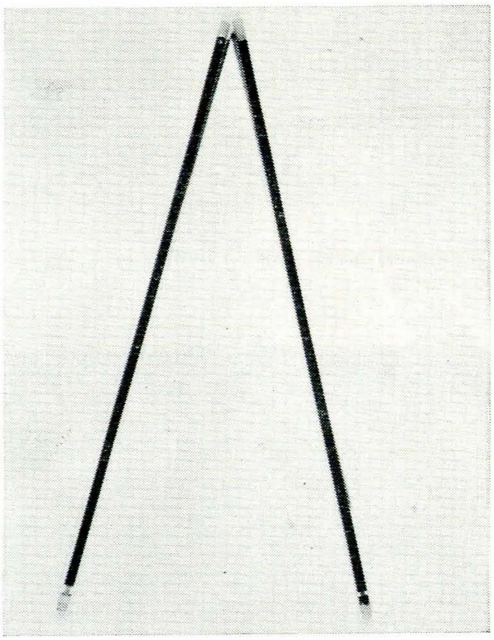

Fig. 3. Microhaematocrit tubes used to measure the resolution.

For increased accuracy, profile curves of the radioactivity in the V-shaped source were obtained, using a linear recorder to monitor the rate meter output of the scanner (Fig. 4), and an Intertechnique cine scintigraphy system to analyse the data from the camera (Fig. 5). It was found that visual resolvability occurred when the profile curve at the midline between the sources was between 65% and 75% of its peak value (Figs 6 and 7). A drop in the profile curve to 70% of its peak value was therefore used as a criterion to determine when the sources were resolvable, and the distance between the two tubes at this level was taken as the resolution distance.

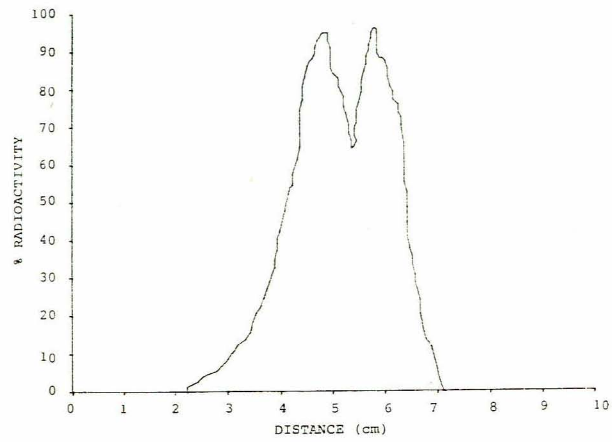

Fig. 4. Profile curve of the radioactivities of the line sources (at the level of visual resolvability shown in Fig. 6) using a linear recorder to monitor the rate meter output of the scanner.

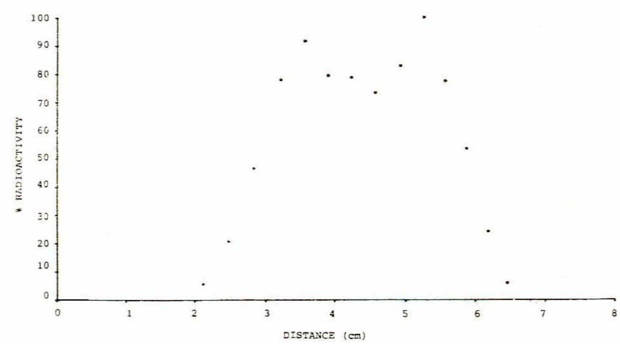

Fig. 5. Profile curve of the radioactivities of the line sources (at the level of visual resolvability shown in Fig. 7) using an Intertechnique cine scintigraphy system to analyse the data from the camera.

The sensitivities of the camera and the scanner were measured in air, using a sponge source, 3-cm diameter by 1 cm thick, soaked with a solution of ^{99m}Tc, to represent the approximate size of the lesion under observation.

Phantom studies were also performed with a 1 050-ml perspex brain phantom filled with a solution of 100 μCi of ^{99m}Tc. This radioactivity was similar to that expected for normal brain imaging. The same sponge source used for the sensitivity measurements was soaked with a solution containing 1 μCi of ^{99m}Tc and fastened to the wall of the phantom, to represent the superficial lesion.

RESULTS

Figs 8 and 9 show the variations of the resolution and sensitivity with source-to-detector distance. In the normal

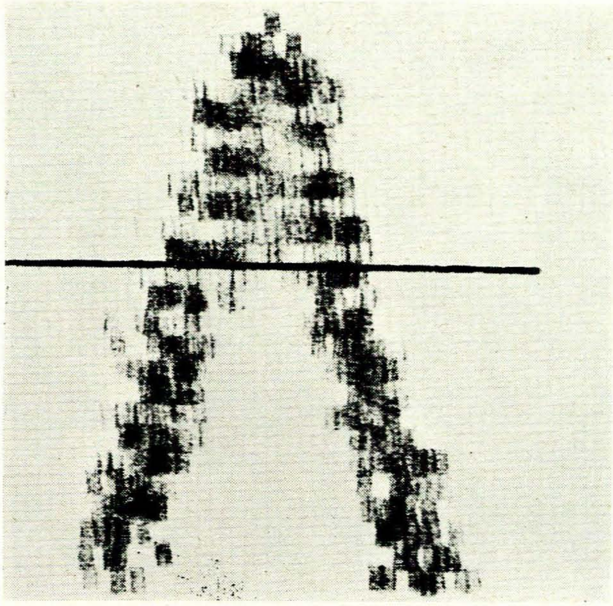

Fig. 6. Scan of V-source. A horizontal line marks the position where the two-line sources become resolvable.

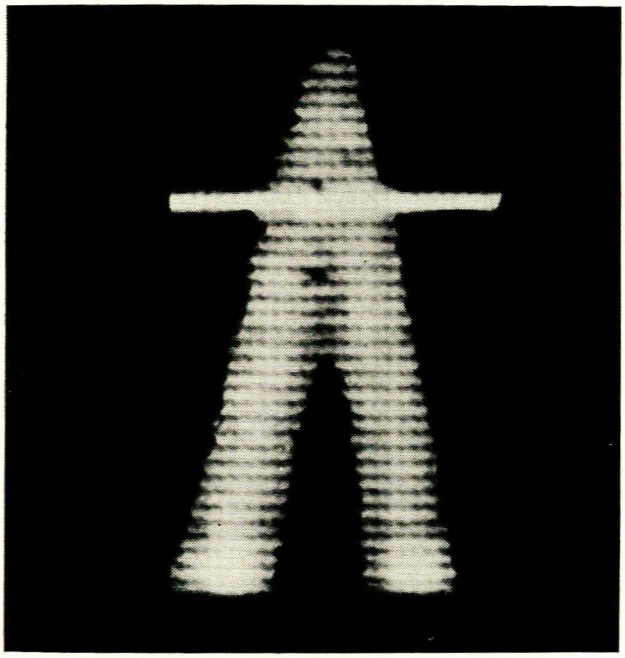

Fig. 7. Scintigram of V-source. A horizontal line marks the position where the two-line sources become resolvable.

TABLE I. COMPARATIVE MEASUREMENTS OF THE RESOLUTION AND SENSITIVITY OF THE SCANNER AND CAMERA FOR THE DETECTION OF SUPERFICIAL LESIONS

Device	Resolution distance (mm)	Sensitivity (cps/mCi $\times 10^3$)
Scanner	**22**	**2,6**
Camera	**15**	**4,9**

setting-up procedure for brain scanning, a superficial lesion would be located 3 cm away from the collimator face. At this distance the camera has better resolution and sensitivity than the scanner (Table I).

These superior properties of the camera were well demonstrated by the images of the brain phantom and the

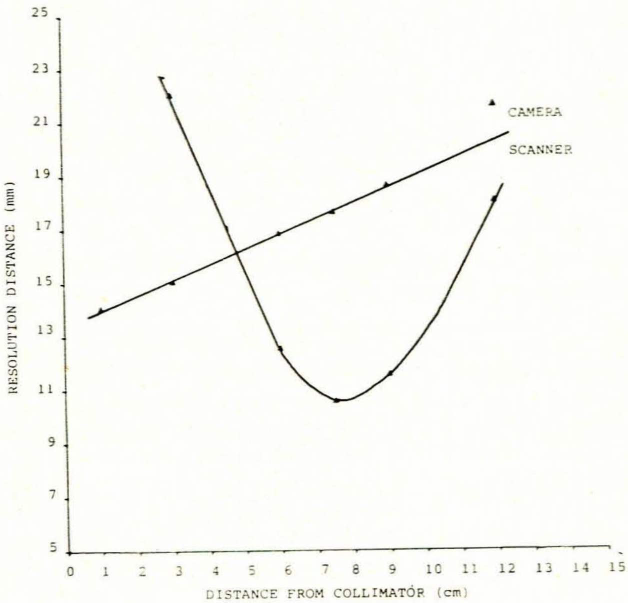

Fig. 8. Variation of resolution with source-to-detector distance.

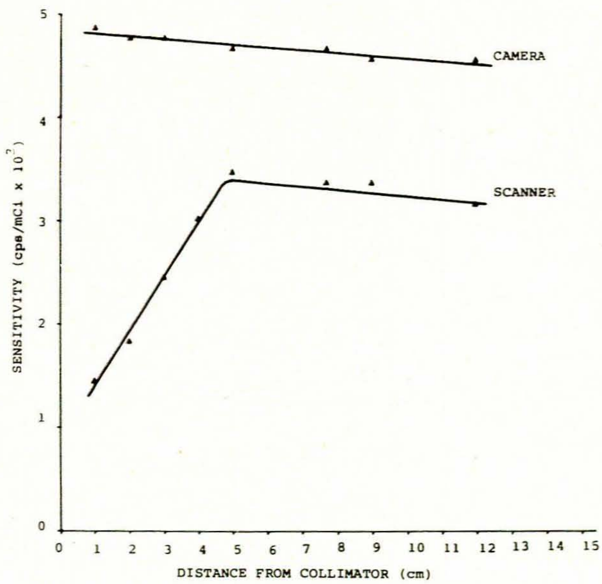

Fig. 9. Variation of sensitivity with source-to-detector distance.

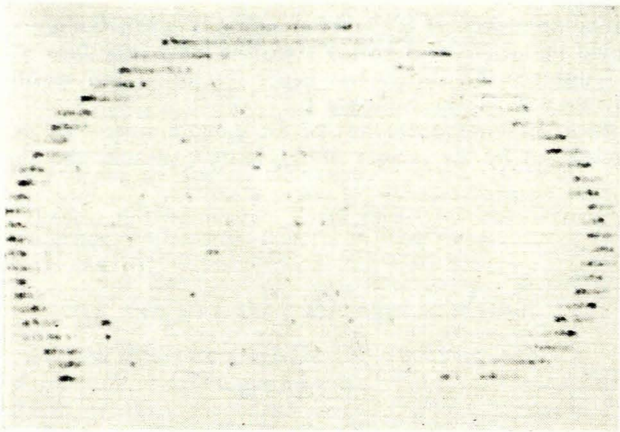

Fig. 10. Scan of brain phantom. The simulated superficial lesion cannot be seen.

simulated superficial lesion. Scans and scintigrams of the set-up were obtained under the same imaging conditions as before (Figs 10 and 11), and it can clearly be seen that demonstration of the simulated lesion is superior with the camera.

It is suggested that for optimal visualisation of superficial lesions, brain imaging should be performed on the gamma camera rather than on the rectilinear scanner.

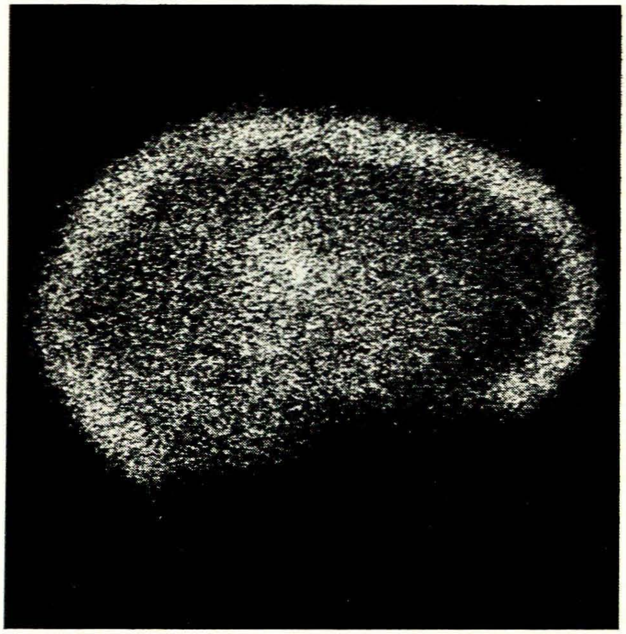

Fig. 11. Scintigram of brain phantom. The simulated superficial lesion is clearly seen.

REFERENCES

1. Deland, F. H. and Wagner, H. N. (1969): *Atlas of Nuclear Medicine*, 1st ed. pp. 10 - 12. Philadelphia: W. B. Saunders.
2. Collins, C., Robinson, T. and Hayt, D. B. (1967): Amer. J. Roentgenol., **100**, 761.