LETTER TO THE EDITOR

A small number of reports of quantitative procedures in radioisotope scanning have appeared (1-8), but only one of these (4) includes a statistical test for the significant differences from a normal scan. The value of a quantitative approach to scanning remains a controversial question.

The crucial point is the extent of patient-to-patient variations in the pattern of radioisotope uptake of normal subjects. In investigating this for brain scans, we have found a striking constancy of pattern in normal scans, not reported quantitatively before.

METHODS

We have compared quantitatively the patterns of counts in 35 "normal" lateral scans of heads, made, using ^{197}Hg neohydrin (R. R. Squibb and Sons, New York) and a Picker Magnascanner with a three inch diameter crystal. By "normal" we mean that the scans were reported as normal after visual inspection in the usual way. 500 microcuries of radioisotope were injected intravenously and the scans were usually started 4-6 hours later. A lateral scan took about 40 minutes. The collimators used had 19 or 31 holes and a resolution diameter of 1.25 cm. A line spacing of 0.2 cm was used.

Heads were classified according to size. Of 50 heads measured, all were found to have maximum diameters of the skull, anterior-to-posterior, between 20 and 24 cm on the X-ray photoscan; these dimensions included a magnification of 1.3. The 35 scans analyzed were divided into 3 groups, with 15 scans in the 21 cm group and 10 each in the 22 and 23 cm groups.

A 2 × 2 cm grid was constructed (with magnification unity) making a fixed angle with a base line drawn from the nasion to the posterior border of the foramen magnum. The error in total length of scan line which passes through each square, caused by divergence between the grid lines and the direction of scan was calculated. It was found, at worst, to be 5% in one square out of a linear array of four and on average, to be less than 2%. This error could be eliminated with automatic data processing. The total number of counts in each square was recorded manually (multiplying the number of dots by the dot factor); 120 to 150 counts were usual.

The total number of counts in the corresponding grid squares of all the heads of a given size were added together. The result was a "composite normal ^{197}Hg head scan" for each of the three head sizes. This pattern was then normalized, by expressing the number of counts in each square as a ratio of the mean counts per square averaged over the whole scan (Fig. 1). Each individual head scan in the group was then normalized in the same way and the ratios were compared square by square with the ratio for the "composite normal ^{197}Hg scan." The spread of the deviations from the "composite normal" for a given position of square was the parameter of interest. This process was repeated for the other two groups of head size.

RESULTS

It was found that the standard error of the spread for all 35 patients (i.e., 1,300 areas) was only 1.25 times the standard error due to the finite number of counts in each square, i.e., 11% instead of 9% when applied to a single area in an individual patient. This means that the patient-to-patient variation had a *smaller standard error than the counting error* (7% instead of 9%).

Further, a more detailed analysis of the scans showed that more of the patient-to-patient variation occurred in the areas at the edge of the head than in the areas at the centre of the head. This is due either to positional error, or to differences in shape or size within the size categories used, or both. The patient-to-patient variation over the 64 central areas taken from all three groups (i.e., about 21 per group) was 0.6 times as large as the counting error, i.e. 5.3% for one area. Of the 35 scans, four were scanned at 15 hours, instead of 4-6 hours, but there was no significant difference between any of these patterns and the composite normal.

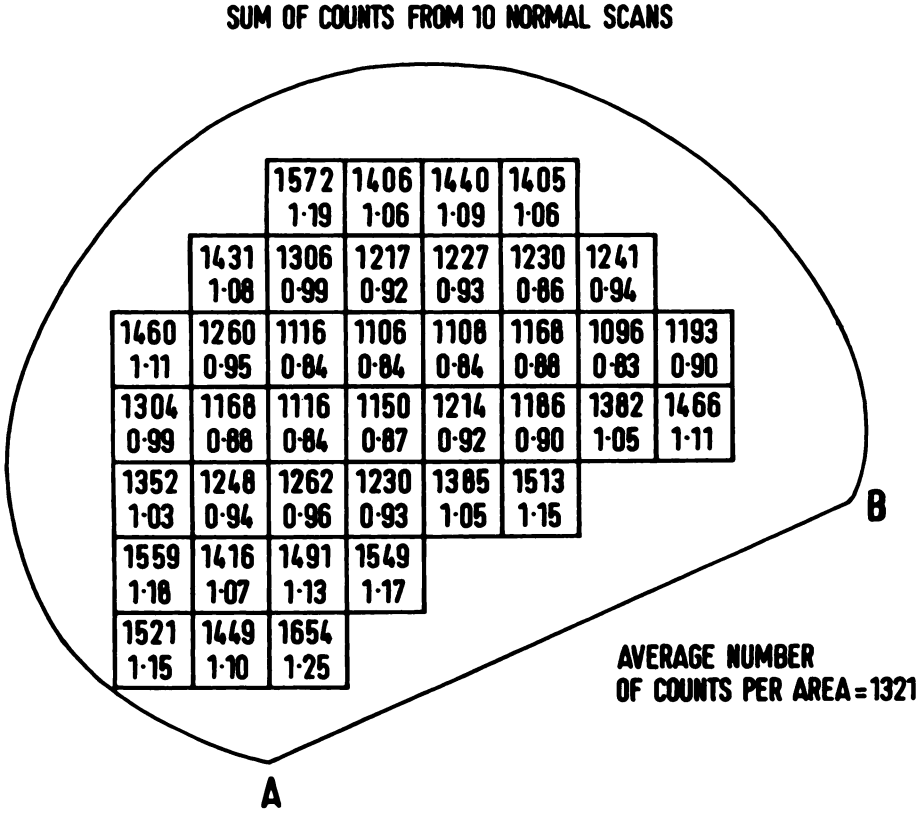

Fig. 1. Sum of counts from the 10 scans of the 22 cm head size. A—Posterior border of foramen magnum; B—nasion. The first number in each square is the sum of counts for that square from the 10 scans. The second number in the square in the normalized value, i.e. the ratio of counts in the area to the average number of counts per area. The normalized error on the counts is 0.03 in each area for the sum of ten heads. The outline is a tracing of the X-ray image of the skull and has a magnification of 1.3.

CONCLUSION

The significance of the finding is that the patient-to-patient variation over the central areas is sufficiently small, compared with the counting errors, that the establishment of a usefully constant pattern of normal uptake for this radioisotope is a possibility. Quantitative subtraction techniques, with a statistical test for abnormalities in individual scans, therefore appears, to be feasible.

A method for doing this has been developed using an Elliott 803 computer and will be described elsewhere, together with results on some abnormal cases (9). Automatic tape output is being added to our scanners, to facilitate such quantitative analyses (10).

The results given above and in Figure 1 apply to scans with ^{197} Hg neohydrin; further normal scans are, of course, being accumulated. It is a matter of great interest whether scans using ^{99m}Tc pertechnetate, with their smaller counting error per unit areas, but their greater display of vascular structure in the scan, will also show a usefully constant pattern.

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