JOURNAL OF NUCLEAR MEDICINE 6:528-530, 1965

PRELIMINARY NOTE

Liver Scans With Digital Readout[1]

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This is a report of one conclusion reached in a study undertaken to evaluate how much additional information can be obtained in liver scanning from a quantitative readout as compared with that provided by photographic film data presentation. Interpretation of the photoscan is complicated by the fact that the ability of the human eye to distinguish differences in density not only varies, but this ability decreases with an increase in density (6).

A quantitative readout avoids this difficulty and brings out the statistical significance of apparent variations. Of equal importance, a quantitative readout gives the absolute levels of uptake and allows comparison of these levels between different scans. This provides a basis for classification of different clinical conditions, not only with respect to pattern of uptake, but also with respect to the absolute level of uptake. It is concluded that significantly better diagnostic information is available from this type of readout than from conventional analog readouts.

A group of 30 patients was studied with the HEG Scanner (1-4) to evaluate the ability of the digital scan record of radioactive isotope uptake to illustrate the presence of space-occupying disease of the liver. Each patient studied received approximately 250 μC of ^{131}iodine labeled Rose Bengal. Scanning was routinely commenced from the lower edge of the liver 15 minutes after injection. Total scanning time was about 40 minutes.

The system of digital data collection employs a punched paper tape recording system. The actual number of counts accumulated over preselected intervals (every cm in liver scans) is punched in coded form on the tape and, on replay through a paper tape recorder and servo-positioned electric typewriter, a digital distribution pattern of uptake is printed out in one-to one-scale with the original scan. The paper tape is adaptable to an existing computer facility and provides data for automatic contour plotting and further data analysis. Various data smoothing techniques are currently being compared on a Control Data 160A computer for the purpose of improving the contour plotting operation. The contours from the first 30 scans reported here were plotted on a point by point basis, without averaging or cross correlation with other data points. This procedure gives reasonable results when the number of counts in each 1

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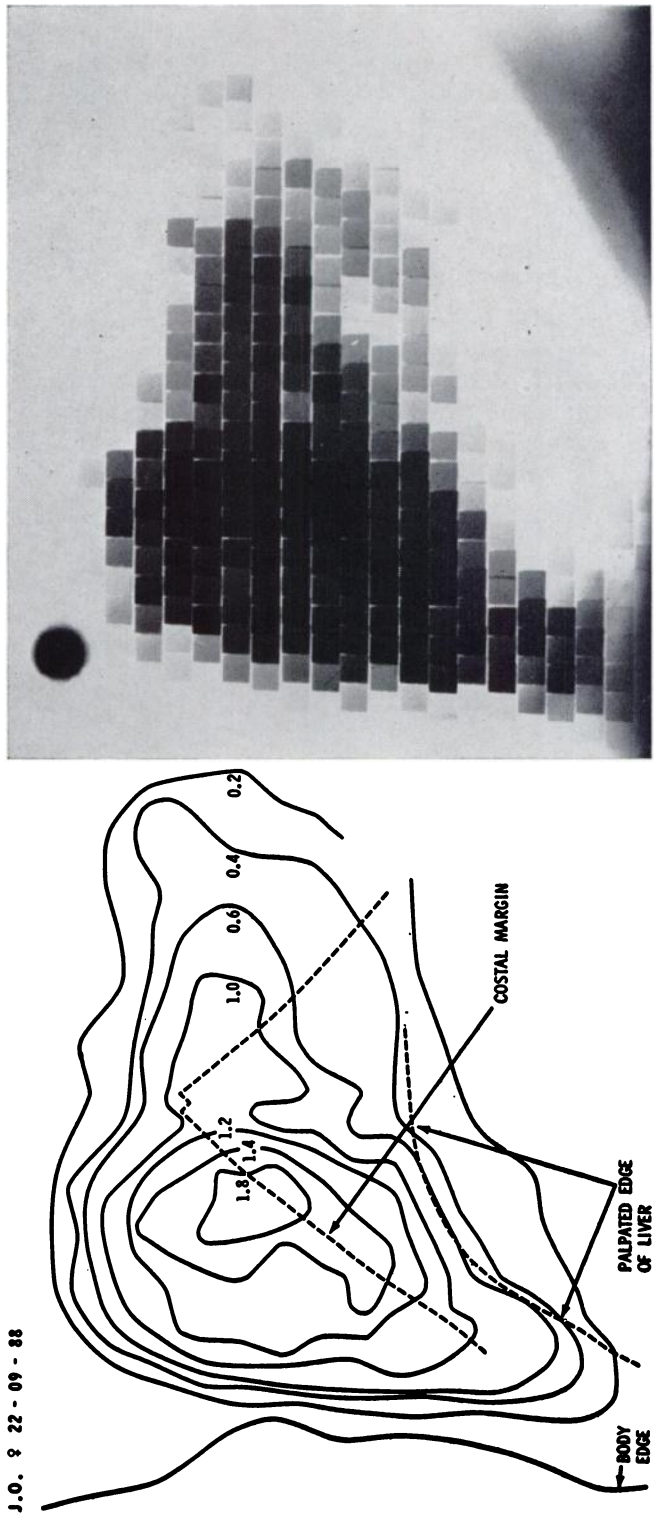

Fig. 1. Quantitative and analog representation of liver scan following injection of 250 μC of radioactive ^{131}iodine labeled Rose Bengal. The range of densities on the photoscan is approximately from 0.3 to 1.8. The isocount contours are labeled in multiples of counts per sq cm scanned per microcurie injected. For example, the 1.0 contour joins all points which showed 250 counts. Smaller resolution areas have also been used on the analog display for this comparison. The basic condition applies to these scans also: to estimate the significance of a change in density on the photographic display it is necessary to know the corresponding absolute count rates.

sq cm data interval is on the order of 100 or more. A photographic unit designed with extremely flexible controls permits a sensitive evaluation of the capabilities of the photographic readout for displaying small significant variations in the count rate (6). Clinical, chemical and radiographic findings on each patient were compared with the scan findings.

Figure 1 shows a comparison of a photoscan and isocount contour lines drawn from a digital scan of a liver. Both the photoscan and the digital scan were recorded simultaneously. The isocount contours were plotted immediately following the scan. Each contour is labeled with counts per μC injected per sq centimeter scanned on the liver. The digital record from which these contours were drawn shows an area with six numbers significantly decreased in the right lobe and three in the left lobe. The significance of the variations in photographic density in these two areas on the photoscan is impossible to establish without quantitative information on the count rates to which they correspond.

In Fig. 1 the irregular broadening of the contours from 1.4 to 1.2 in the mid right lobe, and the irregular indentations of contours 1.0 to 0.6 in the left lobe at the approximate midline of the patient, correspond to metastatic disease in these areas confirmed at surgery.

A survey of the liver scans completed to date indicates that definite and distinctive characteristics in the isocount contour pattern and absolute uptake values of the contours distinguish the normal liver, and some liver disease. In the first 20 patients where accurate diagnostic follow-up has been made, 19 digital scans have accurately predicted the presence or absence of disease. This evaluation is based on either positive surgical or autopsy findings within a year of scan and/or elevated chemistries, *i.e.*, elevated bromsulpthalein retention and elevated alkaline phosphatase with enlarged liver or palpated nodules at time of scanning. The interpretation of the scans was made without previous knowledge of other clinical tests. The ability to demonstrate absolute uptake with respect to the amount of injected material provides the accurate record necessary for serial study and comparison of scans. More detailed information on the paper tape system and scan analysis may be obtained from the authors.

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