SCINTIGRAPHY - ADVANCES CONTINUE

Scintigraphy is the science, or art, of using radioactive materials to produce a picture of their distribution within the human body. It has provided a unique method of obtaining special types of medical information, has created a multi-million dollar instrument industry and is one of the most widely used peaceful applications of atomic energy.

Medical radioisotope scintigraphy makes use of the capability of certain organs to accumulate either for a short time or permanently some radioactive substances after they have been administered to a patient by mouth or by injection. The pattern of their distribution allows some diagnostically useful conclusions to be drawn as to the size of the organ and its normal or abnormal position within the body. Irregularities of the distribution - either concentration of radioactivity in a place where normally there is none, or absence of concentration where normally there should be some - may indicate the presence of lesions which could otherwise not be detected. Ordinary diagnostic radiology is dependent on differences in density of tissues, and is often incapable of demonstrating useful information about such organs as the brain or the thyroid gland.

The main problem has been to develop efficient instruments. The first attempts at depicting the distribution of radioactivity within an organ of the human body date back to 1951. A small radiation detector, at that time a Geiger-Muller counter, was used to record the gamma radiation emerging from the organ which had concentrated the radioactive substance administered. A manual plot of the counting rates and the drawing of count lines between points of equal radiation intensity provided rather crude information. Apart from replacing the Geiger-Muller counter by the more sensitive scintillation crystal detector, the next and decisive step was the introduction of mechanical means of depicting the count-rate distribution. To this end, the detector was made to "scan" line by line the whole region of interest; a mechanical printer, mounted on the same arm as the radiation detector, printed a mark on paper each time a predetermined number of counts had accumulated. The resulting picture was called a "scan" and the technique became known as radioisotope scanning.

REFINING THE TECHNIQUES

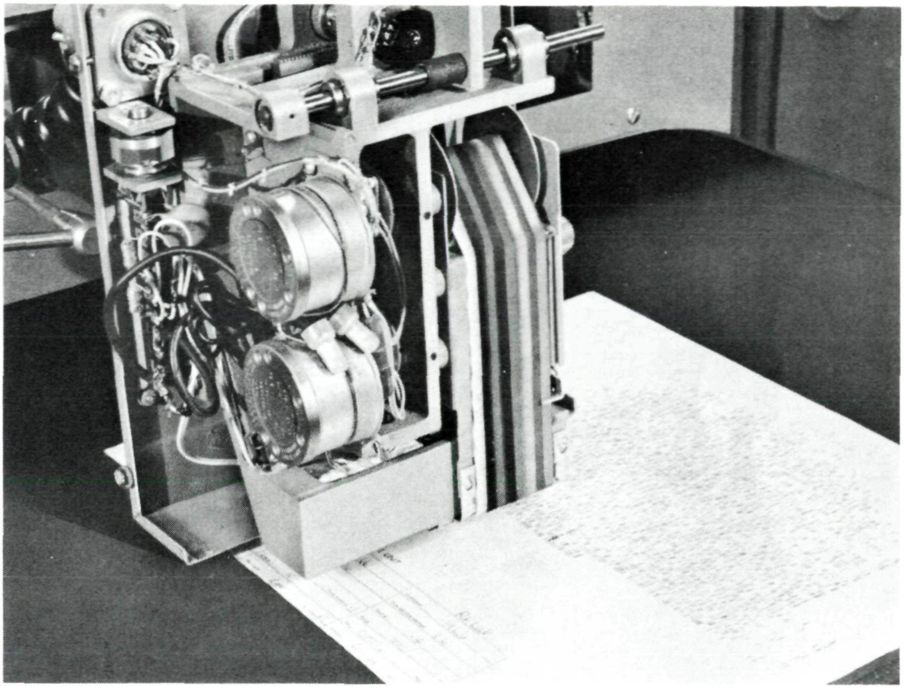
In subsequent years, several technical improvements were introduced. The crystal detectors became larger in diameter and thicker, thereby increasing the sensitivity of the device. Multi-channel collimators put in front of the detector have improved lateral resolution so that smaller lesions within an organ can be detected with increased probability. At the same time their maximum sensitivity is focused at several inches from the face of the detector; this improves resolution in depth when organs deeply situated in the human body have to be scanned. The addition of single-channel pulse-height analysers to the electronics led to reduced background counts and the elimination of scattered radiation, giving a further improvement of the quality of the picture. The introduction of colours to indicate different levels of radioactivity has helped the doctor to interpret the results. Scans produced on radiographic films rather than on paper have permitted an enhancement of contrast which is important when small differences in count-rate have to be recognized. Lately, the use of computers has been introduced for a refined presentation and evaluation of scintigraphic information. This allows for a more objective and quantitative interpretation in difficult diagnostic situations.

A major advance was made more recently with the development of stationary detector devices. All these, whether scintillation cameras, autofluoroscopes or spark chambers, view the region of interest as a whole rather than scan it point by point. As a result the doses to the patient could be lowered considerably or, when these were already acceptable, the time for the examination reduced to sometimes a few minutes. In addition the high sensitivity of these techniques now made it possible not only to record the distribution of radioactivity fixed in a particular organ but to follow its movements (usually with the passage of the blood) through a number of organs such as the kidneys, the heart and lungs or the liver.

Originally only the major research centres considered the installation of scintigraphic instruments. Their operation required highly-trained technical staff. Today even small hospitals or private physicians employ scanners and scintillation cameras since new types of these machines can be used successfully without extensive technical training. Manufacturers are producing now a great variety of advanced instruments, and a rapidly-growing industry has been developed in recent years. Scintigraphy is at present one of the most important peaceful applications of atomic energy.

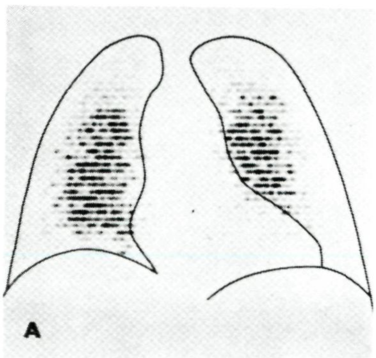
ISOTOPE "COWS"

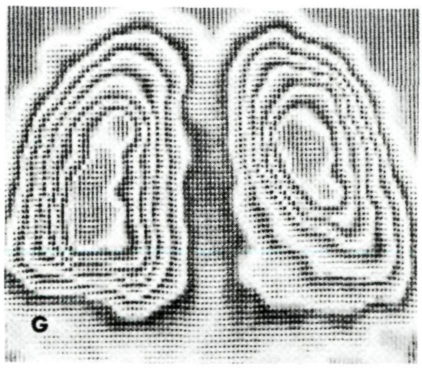
Parallel to these technical improvements considerable progress has been made during the last decade in the development of radioisotopes and labelled compounds for the purpose of localization at various body sites. They have to possess well-defined characteristics, and, ideally, the radioactivity should be eliminated from the body as soon as the study has been completed. According to their composition they may be administered to appear either in the thyroid, the liver, kidneys, lungs, spleen, pancreas, bones or placenta. Some others concentrate in lesions. In general some radioisotopes can presently be concentrated in any of the important body sites, the function of which is either difficult to determine or not accessible by other means.

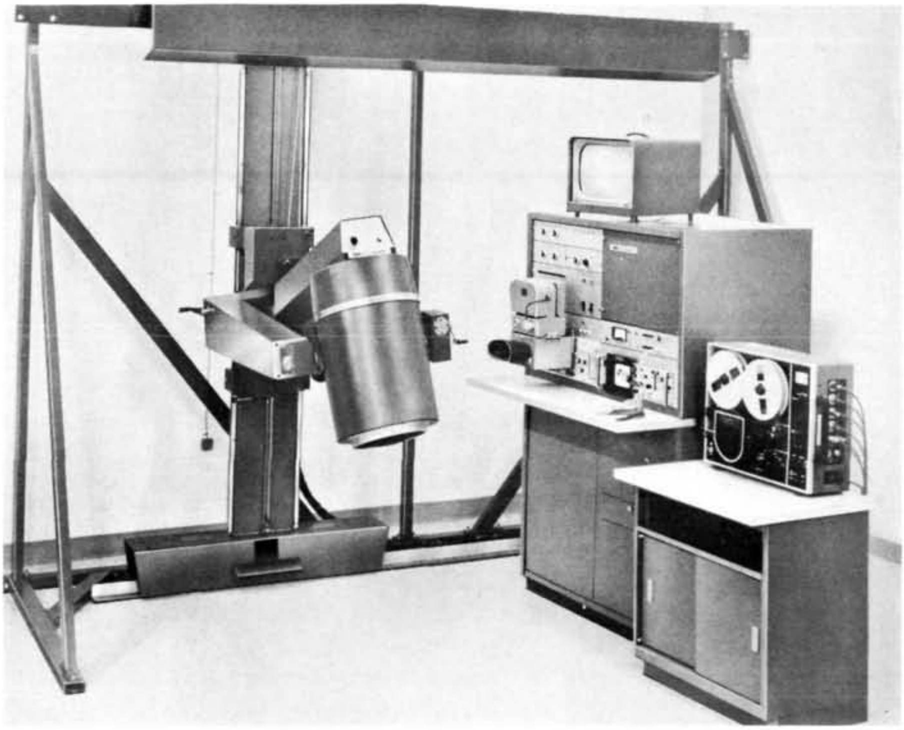


Brain scanning operation in progress using a Hine-Picker colour printer. Use of the 8-colour ribbon enables varying levels of radiation concentration to be indicated immediately. (Photo: UKAEA)

Two ways of showing results of a lung examination by scintigraphy. Photographic presentation is on the left and the same examination presented by computer processing on the right. (Photo: Mayo Clinic and Foundation)







Ter-Pogossian-Picker camera linked with electronic equipment produces photographic presentation, immediate viewing, and data storage. The patient is positioned close to the radiation detector on the left.

Short-lived radioisotopes whose activity reduces by half within a few hours or even minutes are particularly useful; they mean, however, that producer and user of the isotope have to be near each other and that not much time can be spent on the labelling of a suitable compound. The development of so-called "isotope cows" has somewhat eased this problem: a long-lived parent radioisotope is shipped to the user from which he can "milk" repeatedly a short-lived daughter radioisotope.

RAPID PROGRESS

All these developments were discussed extensively at a symposium held during August in Salzburg, Austria. It was the third symposium on this topic organized by the Agency, the first having been held in 1959 in Vienna and the second in 1964 in Athens. Nothing could demonstrate the rapid progress of scintigraphy during these years better than a look at statistics:

in 1959, there were about 40 participants listening to 14 papers; in 1964, there were 160 participants who heard 56 papers; this year 115 papers were presented to an audience of over 400 participants from 36 countries and five international organizations and the meeting had to be extended from five to eight days. Incidentally, the proceedings of the first two symposia are among the bestsellers of the Agency's publications; the proceedings of the third will be available in spring 1969.

Scintigraphy is actively pursued in many developing countries as well as those which are highly industrialized. Some have made their first acquaintance with the method through the Agency's technical assistance and research contracts. Work is also conducted at the Agency's own laboratory to make comparisons between the performance of instruments and to standardize their response.

GAS-COOLED REACTOR DESIGNERS LOOK TO THE FUTURE

In little more than ten years nuclear power stations will be producing nearly thirty times more electricity than now. Growth in demand will continue. Designers of gas-cooled reactors evolved from those which first led the way are confident of their ability to help meet future requirements.

Advanced and high temperature gas-cooled reactors. These are part of the evolution from the original reactors using natural uranium in graphite with carbon dioxide as a coolant which provided the first large-scale production of electricity from nuclear sources.

Advocates of the newer versions of gas-cooled systems were able to present their reasons for confidence at an Agency symposium devoted to the subject and held at Julich, Federal Republic of Germany, at the end of October. Nearly 400 of them attended, about twice the number originally expected, drawn from 24 countries and seven international organizations.