

XII. Symposium II. Analysis and Reduction of Dynamic Data Using R.I. Tracer

Analysis and Reduction of Dynamic Data Using R.I. Tracers

1. Introductory Review

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In-vivo counting methods in dynamic studies using radioisotopes are reviewed, and several problems are pointed out in the radiation detectors and their data-taking equipments. It is expected in the near future

that an on-line computer would be employed for the acquisition of immense amount of data from highly sophisticated apparatuses, such as scintillation camera and autofluoroscope.

2) Brain

Dynamic Study of Human Brain Characteristics with Radioisotopes

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In General, the absolute counting of total organ isotope contents has been attempted by external counting with collimated gamma detector at the organ comparing with that of a phantom organ containing a known amount of the same isotope present in the real organ. Though the human brain fills upper half of the head and is conveniently located well away from other organ, some unwanted isotope in adjacent and overlying tissues such as scalp, skull and dura are seen and the changing counting efficiency at various depth of tissue and at varying distances from the detector introduce significant errors difficult to correct.

We have introduced a detection system for human brain consists of two large crystals bilaterally arranged about 5 cm lateral to the head with their long axes paralleling the brain hemispheres. Also a flat lead plate is introduced between the patient's head and each crystal to flatten the field of efficiency and to partially absorb superficially originating gamma radiation. Since any parenchymatous organ such as brain and kidney can be divided into two compartment, circulation tissue (blood) and non-circulating tissue (brain tissue), two examples of information of dynamic study using radioisotopes are presented below.

1) Hematocrit of the human cranial blood pool

Since the hematocrit of arteriolar and capillary bed is substantially lower than that in large vessels, the mean hematocrit of total organ will be lower than the large vessel hematocrit, about 9% less than the 45% found in large vessel, particularly in organ such as brain, that contains very rich capillarybeds. This is explainable based upon the differential rates of passage of red cell and plasma through the smaller blood vessels. In capillaries red cell is more substantially faster than the plasma. There are, accordingly, less red cell in proportion to plasma in capillaries than in large vessels. Very vascular organ such as brain containing many capillaries having high flow rates, would be expected to contain less red cell than might be expected, knowing the large blood vessel hematocrit.

The method utilizes the separate and sequential intravenous administration of gamma labelled red cell (^{51}Cr red cell) and plasma (^{51}Cr plasma and $^{131}\text{RISA}$). By means of an externally placed collimation system, the red cell and plasma volume in the cranial portion of the head are measured. These cranial volumes are compared with red cell and plasma volumes in venous blood measured in specimens drawn simultaneously from an antecubital vein midway during the cranial counting period.

Thirty two cases were studied, sixteen with ^{51}Cr albumin and sixteen with $^{131}\text{RISA}$. The mean value of the cranial to venous hematocrit ratio is 0.84. This ratio was not found to be unusual in a polycythemic or in an anemic patient.

2) Increased brain radiocopper uptake in in Wilson's disease

There is general recognition of increased

tissue copper content reflecting an increased tissue uptake of dietary copper in Wilson's disease. Presented here are results of clinical radioisotope studies intended to elaborate certain mechanisms related to the increased tissue copper uptake in Wilson's disease.

In the first study, following the single injection the subsequent fall in cranial isotope content and venous blood isotope content are measured. In the second study the isotope is injected by a continuous infusion pump which maintains a nearly constant blood concentration of isotope. From the relationship between the changes in blood and cranial ^{64}Cu content, conclusions are reached regarding the blood brain barrier diffusibility of blood copper.

With single injection the ^{64}Cu blood level fell at a slower than normal rate in Wilson's disease. This has been shown by other to be due to a failure of the liver to remove the copper at the normal rate. This would allow more opportunity for the copper to leak out of the blood into other tissues thus explaining the high tissue copper levels. Another explanation of the increased tissue uptake was that the copper, which is loosely bound to plasma albumin just after injection was either abnormally loosely bound or that the tissue in Wilson's disease had an abnormally high affinity for the copper.

In the presence of a constant blood Cu level the rate of brain uptake was the same in Wilson's disease and normal. This indicated the increased brain uptake was due to the impaired ability of the liver to remove Cu from blood shortly after it has appeared in blood from the intestine.

These studies are examples of physical and biochemical processes that lend themselves to analysis by this method of external counting.