Analysis of the Hepatic Hemodynamics by RI Tracer Technique

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Measurement of ^{198}Au colloid uptake rate has been usually performed as a routine hepatic function test for diagnosis of liver cirrhosis, however, this index is not available for diagnosis of localized liver diseases such as liver tumor, liver cyst and liver abscess, because no characteristic finding can be obtained. To identify these space occupying lesions, we have tried to measure regional hepatic blood flow by use of regional uptake curve of ^{198}Au colloid which can be taken by 4 inputs multiscaler and 4 scintillation probes with narrow angle collinators.

Distribution of regional hepatic uptake rates (K_L), "regional flow indexes", which have been taken in normal and cirrhotic cases were demonstrated. In a normal liver, the regional flow indexes measured in many places of the liver and the uptake rate of the whole liver showed nearly the same values; however, the indexes and the uptake rate of the whole liver in cirrhotic cases showed low and indefinite values.

It was concluded that the uptake rate of the whole liver by a single detector showed average value of the regional flow indexes.

To analyze the above mentioned uptake curves, the following articles should be considered:

1) The correlation between K_L and $T\frac{1}{2}$ shows Hyperbolic curve, so the changes of the values of K_L are not so remarkable as the difference of $T\frac{1}{2}$. In case of severe circulatory impairments such as liver cirrhosis, $T\frac{1}{2}$ should be applied for evaluation of the liver function.

2) The size of colloid particles is the most important factor in obtaining constant uptake curves in the same patient.

6) Kidney

Calculation of Renal Plasma Flow Rate and Glomerular Filtration Rate by an Analog Simulation of Radioisotope Renograms with Concomitant Measurement of Urinary Excretion Rate

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Radioisotope renography has been practised for more than ten years. It is well established and recognized as a more sensitive indicator of renal impairment, unilateral or bilateral, than the conventional intravenous pyelogram.

A radioisotope renogram reflects rapidly-changing kinetics in the concentration of the serum isotope carrier (^{131}I-Hippuran or ^{131}I Sodium Iothalamate) and the dynamic "effective" volume of its distribution in body fluids, but principally its accumulation in renal fluids and its further elimination.

The diffusion and accumulation processes are given as

$$V_{pe}(t)\cdot C_p(t)=1-\int\sum RPF\cdot C_p(t)dt \qquad (1)$$

where I=the isotope injected, C (t) =its plasma concentration, and $V_{pe}(t)$ =distribution space with some correction on the initial portion.

The excretion process is given as

$$V_{ue}\cdot C_{ui}(t)=\int[(RPF)_i\cdot C_p(t)-F_i\cdot C_{ui}(t)]dt, \quad i=R \text{ or } L \qquad (2)$$

where V =the equivalent volume of urinary tract, F =urine flow rate, and C =urinary concentration.

A renogram record $r_i(t)$ is given as

$$r_i(t)=k[\int(RPF)_i\cdot C_p(t)dt-\int F_i\cdot C_{ui}(t-\tau_i)dt+(\text{background})_i] \qquad (3)$$

where k=a proportional constant, τ=transportation lag time. Urinary excretion is represented by the following equations:

$$e(t)=e_R(t)+e_L(t)$$
$$e_i(t)=\int F_i\cdot C_{ui}(t-\tau_i)dt \qquad (4)$$

The backgroud is

$$(\text{backgroud})_i=b_i\cdot V_{pe}(t)\cdot C_p(t) \qquad (5)$$

To enable an estimate of renal plasma flow rate in each kidney on ^{131}I-Hippuran renograms, and glomerular filtration rate on ^{131}I-sodium iothalamate renograms to be made, a special purpose analog computer was designed based on equations (1) to (5), equipped with input of 100V equivalent to the total amount of injected isotope, and output of four curves, r (t) (renogram curves, equation (3), right and left) and e (t) (excretion curves, equation (4), right and left) to simulate measured renogram records as well as measured urinary excretion rate. When there is a good agreement between the renogram records and the computer results obtained on a recorder, and concurrently, between the measured percentile excretion in the urine and the computer results obtained, total and individual renal plasma flow rate or glomerular filtration rate, V_{ui}/F_i (time constant of the excretory system), τ (time delay) and b_i (background) can be read from the set values of potentiometers in the simulator. Those renogram-computer-derived RPF's or GFR's were compared to PAH clearance or TS clearance values measured on the same subject at different occasions.

In 17 patients, 2 with normal kidneys, 13 with unilateral, 1 with bilateral renal diseases, 1 with essential hypertension, 18 direct measurements of individual renal plasma flow rate by standard PAH clearance method with unilateral ureteral catheterization technique were performed, and right to left ratios of C_{PAH} were comparable to that of renogram-gram-computer-derived RPF's (r=0.97). This result shows that when the renogram curves and the urinary percentile excretion are known, renal plasma flow rate in each kidney can be estimated with accuracy comparable to that of the conventional cumbersome clearance procedure, which is a steady-state observation in equation (2) in the mathematical model. In 19 subjects, renogram-computer-derived GFR's were compared to TS clearance values (single shot method) with a close correlation (r =0.95).

In this model, the renal exceretory process was simulated by a first-order diffusion process with a pure delay time. The close coincidence between the results obtained from the model and the clinical findings suggests that the modelffi might be sufficient, in spite of its simplicity, to describe he dynamic renal excreory process observed in renogram records.

A Study on the Kidney Dynamics from the Standpoint of Clinical Radioisotope Laboratory

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As far as the radioisotop technique is concerned, renography is, at present, most frequently applied to the renal function study. There have been many approaches to analyze the patterns of renograms in their details. However, the renogram pattern obtained on the recorder is always influenced by many factors such as type of collimator used, ori-