

Symposium III. Measurement of RI Distribution

Use of Whole Body Counter as a Screening Test for Progressive Muscular Dystrophy and Wilson's Disease

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It is important to study siblings of patients with progressive muscular dystrophy (D.M.P.) or Wilson's disease to determine whether they are normal, are carriers of the disease, or actually have the disease. The purpose of this paper is to present the results of the retention study of radiorubidium or radiocopper with the whole body counter and the reliability of this method as a screening test for D.M.P. or Wilson's disease.

The first part of this paper deals with ^{86}Rb retention study in D.M.P. Thirteen patients with D.M.P., 9 carriers, and 19 normal subjects were measured total body potassium and were injected $5\ \mu\text{Ci}$ of ^{86}Rb intravenously, and the total body radioactivity was determined with the Kyoto Univ. whole body counter. The 100% retention value in this study was taken as the value at 10 minutes following injection. Further counting of body radioactivity was done by the whole body counter for a period of 3 to 9 weeks after injection. The potassium concentration was markedly decreased in the patients with D.M.P.. A continuous decrease of the potassium concentration with the duration of disease was observed. The statistically significant correlation between decrease in potassium concentration and serum creatine phosphokinase (C.P.K.) values was seen in carriers and patients with D.M.P.. The mean half-time for decrease in ^{86}Rb retained in the body ($T_{1/2}$) of the patients with D.M.P. was 26.4 days. The mean for carriers was 39.6 days. The mean for normal subjects was 50.0 days. The mean values in all three groups were statistically significant with the exception of the cases with limb-girdle type of D.M.P.. The percentage of injected radiorubidium retained in the body at 21 days was least in the patients with D.M.P.; it averaged

56.1%. The mean value for carriers was 64.1%. In the normal subjects the mean was 74.1%. The mean values in all three groups were statistically significant. A significant correlation exists between $T_{1/2}$ or ^{86}Rb retention and reduction of potassium concentration or timelapse from onset of disease in the patients with D.M.P.. There is a significant correlation between $T_{1/2}$ of ^{86}Rb retention and serum CPK in normal subjects, carriers and patients with D.M.P.. From these observations, the study of the body retention of radiorubidium was considered to make it possible to distinguish between carriers and normal subjects, to grasp the stage of the disease, and to observe the effect of therapy.

In the second part of the study, retention of radiocopper measured with the whole body counter and the reliability of this method as a screening test for Wilson's disease were investigated. The Mayo Clinic whole-body counter with a plastic scintillator system was used with the geometric design of the upper and lower detectors in a parallel configuration which is most suitable for the whole body counting in which the distribution pattern in the body varies with time. Eight patients with Wilson's disease, 12 carriers, and 10 normal subjects received $5\ \mu\text{Ci}$ of ^{64}Cu intravenously. Immediately after injection, radiocopper was measured for 1 hour and average value was taken as 100% of the dose. Further counting of ^{64}Cu was done in the whole body counter at 3, 6, 24, 36, 48, and 72 hours after injection. The percentage of injected radiocopper retained in the body at 72 hours was greatest in the patients with Wilson's disease; it averaged 97.5%. The mean value for carriers was 93.9%. In normal subjects the mean was 87.8%. The mean values

in all three groups were statistically significant. The mean $T_{1/2}$ in the patient with Wilson's disease was 97.0 days. The mean for carriers was 39.6 days. The mean for normal subjects was 17.1 days. These were also statistically significant. We believe that the study of the body retention of radioactive

copper will make it possible to distinguish easily between heterozygous carriers and homozygous normal individuals and may be useful as a screening test. This would likely be a screening method sufficiently simple that it could be applied to large numbers of subjects.

Clinical Application of Whole Body Counting

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Although calcium kinetics gives bone formation rate (BFR), bone resorption rate (BRR) and miscible pool size, these are not always sufficient information for the calcium metabolism. Whole body counting adds further important information of diagnostic value.

Calcium kinetics data of four normal subjects in average were BFR=8.1, BRR=8.1, miscible calcium pool size=75.4 mg/kg. Whole body retention of Ca-47 of a normal subject gave a half value $T_{1/2}$ =25 days, and 67% of total loss was found in feces, and 33% in urine. In patient with hyperthyroidism having BFR=54, BRR=64, miscible pool size=90.6, loss in urine within 24 hours reached to 10%, and $T_{1/2}$ was 21 days thereafter. In postmenopausal osteoporosis, having BFR=7.4, BRR=13.9, and miscible pool size=60.6, $T_{1/2}$ was 13 days and 78% of whole body loss was found in urine. There found no initial large loss as observed in patient with hyperthyroidism. In patient with Cushing's syndrome, having BFR=4.5, BRR=12.3 and miscible pool size=58.3, whole body loss $T_{1/2}$ was 8 days and 94% of total loss was found in urine. In this case, the difference between BFR and BRR was too small to suggest such a large amount of whole body loss. In patient with pseudohypoparathyroidism, having BFR=29.0, BRR=44.2, and miscible pool size=169, whole body loss $T_{1/2}$ was 56 days, and loss in feces

was larger than in urine. Before the information of whole body counting was obtained, this patient was supposed to have secondary hyperparathyroidism from large BFR and BRR value and the difference between them. However it was ruled out by the smallest whole body loss rate. In this patient, 62% of total loss was found in feces and 48% in urine.

From these observation, it is obvious that the loss in urine played an important role for the large amount of whole body loss. Total amount of whole body loss was recovered in total excreta of urine and feces. Furthermore, the general trend that the larger the miscible calcium pool size, the smaller the whole body calcium loss.

The quantitative body section counting with our Ring-type total body counter which scans patient from head to foot with 6 detectors around the body showed the completion of distribution of Ca-47 after 4 hours in proportion to the distribution of bone, and there found no significant change in the distribution pattern after 24 hours.

The difference of BRR minus BFR divided by the average of BRR plus BFR would imply the ratio of negative balance in general calcium metabolism, and the ratio seems to correlate to whole body loss rate in % per day.