MASTER

PROGRESS REPORT

**In Vivo Measurement of Regional
Circulation Using Radioisotopes Contract AT (11-1)-1267
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I. Technical Progress Report

A. The work in regional blood flow in the colon has been completed. Quantitative techniques for measuring regional blood flow using $\text{Na}_2\text{HP}^{32}\text{O}_4$ (1, 2) and regional blood volume using P^{32} labeled red blood cells (3) have been developed and published. Studies of these regional blood flow in the bowel as well as the effect of ionizing radiation on colon blood flow have been studied in both dogs and humans. (2) It was found that the late effects of ionizing radiation on colon is a reduction in blood flow that does not increase in response to augmenting cardiac output with a volume load. These results are interpreted to indicate anatomic destruction and scarring of the vascular supply to the colon resulting in probably permanent vascular insufficiency to the radiated region. This has been shown for dogs receiving graded doses of radiation directly to the bowel and in humans receiving bowel radiation as an unavoidable side effect of radiation treatment of cancer of the cervix (cobalt⁶⁰ and x-ray). These results have been published (3).

B. It should be noted that the mathematical models developed for quantitation for regional blood flow and volume in a definable geometry has general applicability and may be used to measure these parameters in other organs and regions vascular

beds. We are presently studying regional circulation in the left ventricular myocardium in relation to regional metabolism and contractile strength. In vitro studies of the distribution of coronary blood flow in the canine left ventricle carried out in our laboratory utilizing a double label control technique for regional distribution of Rb^{86} and K^{45} suggests that coronary circulation is regionally heterogeneous. In the left ventricle we found regional heterogeneity in blood flow from base to apex as well as from epicardium to endocardium.

We are now working on in vivo methods for documenting regional blood flow in the myocardium. Two approaches are currently being evaluated. In collaboration with Dr. Donald Van Dyke of the Donner laboratory in Berkeley we have attempted to use the Anger (scintillation and position camera for this purpose. This method permits direct visualization of the uptake of various appropriate isotopes by the myocardium. Movie films of the uptake and washout of the radioactivity are made. The film is projected on a movie screen and photometer is used to scan various parts of the screen to obtain regional uptake and washout curves continuously of the cardiac shadow (running the film over each time). Recording the light reading from the photometer at each site on a sanborn polyviso to get the washout curves provides an index

of regional blood flow.

A more promising approach is now under study. Gerald Ruth of General Electric Company has developed solid state detectors that are very sensitive for low energy particles and can be mounted in a needle and inserted into the left ventricular muscle in vivo. These detectors are very small. By placing a number of such detectors in various regions of the left ventricle the regional uptake and washout of low energy beta emitting (such as Ca^{45} or C^{14}) injected into the blood can be localized regionally in the myocardium. Quantitative estimates of regional flow, distribution and washout may be obtained using the same mathematical model we used for the colon blood flow measurement. I have just received the first prototype detector and the pilot studies using Ca^{45} in the isolated dog heart are very encouraging. Mr. Ruth is making a number of detectors for me and expects to have them for me within the next 4 to 6 weeks.

11-13-1967

Monkey #3
Subject

Isotope Rb⁸²
Chemical form NH₄Ac
Amount μ C
Time of injection

X-ray

Exposure Time minutes
Start End
Counts
View
Collimator
Focal Plane
Scope Focus Intensity

Scintiphot

4 cc
Exposure Time 8 minutes
Start 2 1/2 End
Counts 18,000
View A-P
Collimator β^+
Focal Plane 1
Scope Focus 5 Intensity 28

The area of activity in the lower edge of the scintiphot is the right kidney. The bright area toward the center is the heart.

Exposure Time minutes
Start End
Counts
View
Collimator
Focal Plane
Scope Focus Intensity

10/15/77 1967

Day # 00003

Subject

Isotope Rb^{82}
Chemical form NH_4Ac
Amount μc
Time of injection

X-ray

Exposure Time _____ minutes

Start _____ End _____

Counts _____

View _____

Collimator _____

Focal Plane _____

Scope Focus _____ Intensity _____

Scintiphoto (control)
The white lines were traced
from the X-ray. Exposure Time 8 minutesStart 2 1/2 End _____Counts 37,000View Left LateralCollimator β^+ Focal Plane 5Scope Focus 5 Intensity 50Scintiphoto one day after
acute ligation of distal half
of anterior descending coronary
artery. Exposure Time 8 minutesStart 2 1/2 End _____Counts 28,000View Left LateralCollimator β^+ Focal Plane 5Scope Focus 5 Intensity 50

9-27 1967

Rabbit and Rat

Subject

Isotope Rb^{82}
Chemical form NH_4Ac
Amount μC
Time of injection

Rabbit

Head

Tail

Exposure Time 1 minutes

Start 1 End 2

Counts 11,000

View A-P

Collimator B^+

Focal Plane 3

Scope Focus 5 Intensity 60

Above: The area of activity at the top of the photo is the heart. The two less intense spots are the kidneys.

Below: The heart shows weakly in the center of the photo. The kidneys are to the left.

Exposure Time minutes

Start End

Counts

View

Collimator

Focal Plane

Scope Focus Intensity

Rat

Head

Exposure Time 1 minutes

Start 1 End 2

Counts 14,000

View P-A

Collimator B^+

Focal Plane $2\frac{1}{2}$

Scope Focus 5 Intensity 60

9-29 1967

Day #1

Subject

Isotope Rb⁸²
Chemical form NityAc
Amount μc
Time of injection

X-ray

Exposure Time minutes

Start End

Counts

View

Collimator

Focal Plane

Scope Focus Intensity

Scintiphoto (control)

Exposure Time 8 minutes

Start 2½ End

Counts 41,000

View Left Lateral

Collimator β⁺

Focal Plane 5

Scope Focus 5 Intensity 50

Scintiphoto one hour after acute ligation of left circumflex coronary artery.

Exposure Time 8 minutes

Start 2½ End

Counts 56,000

View Left Lateral

Collimator β⁺

Focal Plane 5

Scope Focus 5 Intensity 50

10-25 1967

Day # 00003

Subject

Isotope Rb⁸⁶
Chemical form NH₄Ac
Amount μ C
Time of injection

Scintiphoto one week
after ligation.

Exposure Time 8 minutes

Start 2 1/2 End

Counts 12,000

View Left Lateral

Collimator β^+

Focal Plane 5

Scope Focus S Intensity 50

Exposure Time minutes

Start End

Counts

View

Collimator

Focal Plane

Scope Focus Intensity

Exposure Time minutes

Start End

Counts

View

Collimator

Focal Plane

Scope Focus Intensity