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ABSTRACT

The use of ^{82}Rb for obtaining definite myocardial images was demonstrated in 7 animal species (rat, rabbit, monkey, dog, pig, goat, and chimpanzee), and experimentally produced infarctions in the dog were clearly delineated. Type or depth of anesthesia (some studies were done on unanesthetized dogs) was not a significant factor in myocardial visualization.

Ten normal human subjects and six patients with myocardial disease failed to show clearly recognizable myocardial images. Severe exercise or increased dose of isotope did not aid in localizing the isotope in the myocardium. The difference in the handling of rubidium by the myocardium of man and by the myocardium of the 7 animal species is unexplained.

The clinical importance of visualizing myocardial infarcts has prompted the investigation of several isotopes as possible cardiac scanning agents. Carr and associates (1, 2) have shown that both rubidium and cesium concentrate in the normal myocardium. The high energy gamma of ^{86}Rb (1.08 MeV) makes it unsuitable for scanning an organ the size of the heart. ^{131}Cs decays by electron capture and produces a 29.4 KeV X-ray. Myocardial scans obtained with ^{131}Cs and commercially available scanners are good except for marked soft tissue attenuation and rib shadows due to the very low energy of the emitted radiation.

With the superior resolution of the positron camera and a good positron emitting isotope, the quality of myocardial scans might be significantly improved. Positron-emitting isotopes of rubidium have been studied. Both ^{84}Rb (half life, 33 days) and ^{82}Rb (half life, 75 seconds) have been evaluated in dogs, with and without acute coronary artery ligation. While both isotopes allow clear visualization of the heart (infarcted tissue appears as an area of decreased isotope uptake), ^{82}Rb, shown in Figure 1, is preferable for several reasons: 1) its short half life allows repeated studies without background buildup and very little radiation dose to the subject; 2) its greater abundance of positron emission (96% compared to 19% for ^{84}Rb); and 3) it is easily obtained from its parent isotope, ^{82}Sr, by elution from an ion exchange resin (3). ^{82}Sr (half life, 25.5 days) is cyclotron produced via ^{85}Rb (p, 4n) ^{82}Sr.

A specially constructed ion-exchange column was made of Pyrex glass 11 mm i.d. and 60 mm high. Bio-Rex 70 of 100 to 200-mesh particle size was slurried into the ion-exchange column and washed with 0.3 M

$NH_4C_2H_3O_2$. The resin column was connected to a 20-ml syringe which was automatically filled from an eluant reservoir and emptied through the isotope generator by an electric motor drive and automatic two-way valve. With this automatic elution system, controlled flow of the eluant solution under sterile conditions is achieved through a closed system. The flow rate of the eluant was set at 0.33 ml/sec to allow for resistance to flow from the ion-exchange resin and yet deliver ^{82}Rb to the desired site before it decayed away. As the eluant came from the column it was delivered through intramedic polyethylene tubing of about 0.030 inch i.d. to a sterile three-way valve and 0.22 μ Millipore filter and into a peripheral vein. In the studies illustrated in the figures, 4 ml of 0.3 M $NH_4C_2H_3O_2$ and ^{82}Rb solution was given and pictures started 2.5 or 3 minutes later and exposed for 5-8 minutes. The first subject shown in Fig. 3 received 2 infusions of 4 ml each, the picture being started 3 minutes after and exposed for 5-1/2 minutes in each case (total exposure 11 minutes) without moving the subject.

The feasibility of ^{82}Rb for myocardial visualization has been demonstrated in 7 animal species (rat, rabbit, monkey, dog, pig, goat, and chimpanzee). Type or depth of anesthesia was not a significant factor. Uptake in the normal monkey heart is shown in Fig. 2B.

Ten normal humans and 6 patients with myocardial disease studied to date have shown little uptake of the isotope in the myocardium. Three of the sixteen subjects showed some uptake of ^{82}Rb in the myocardium and one showed very good uptake in the myocardium. The remaining twelve patients

showed poor uptake of the isotope. Figure 3 illustrates the failure of the isotope to localize well in the myocardium within the first 3-8 minutes after injection. These two subjects were normal adults with no history of myocardial disease. Severe exercise or increasing the dose of ^{82}Rb did not aid significantly in localizing the isotope in the myocardium.

These studies demonstrate an unexplained difference in the handling of rubidium by the myocardium of man and that of the seven different species of animals studied.

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DESCRIPTION OF FIGURES

Fig. 1. A. Lateral roentgenogram of a dog's chest for orientation of lateral positron scintillation camera picture (B) of ^{82}Rb localization in the normal myocardium of the dog. A ^{82}Rb study of the same dog 10 days after coronary artery ligation is shown in (C). Pictures were started 3 min. after infusion of the isotope and exposed for 8 min.

Fig. 2. B. ^{82}Rb uptake in the myocardium of a monkey. The roentgenogram (A) was taken through the detector head shielding after rotating the detector head to the side and without moving the monkey. 4 ml of the eluted isotope was infused over a minute period. The picture was started 2.5 min. later and exposed for 8 min.

Fig. 3. A comparison of roentgenograms of the chest with positron scintillation camera pictures of ^{82}Rb localization in two normal human volunteers. An explanation for failure of the isotope to localize well in the myocardium of man as compared to all other species studies has not been found.

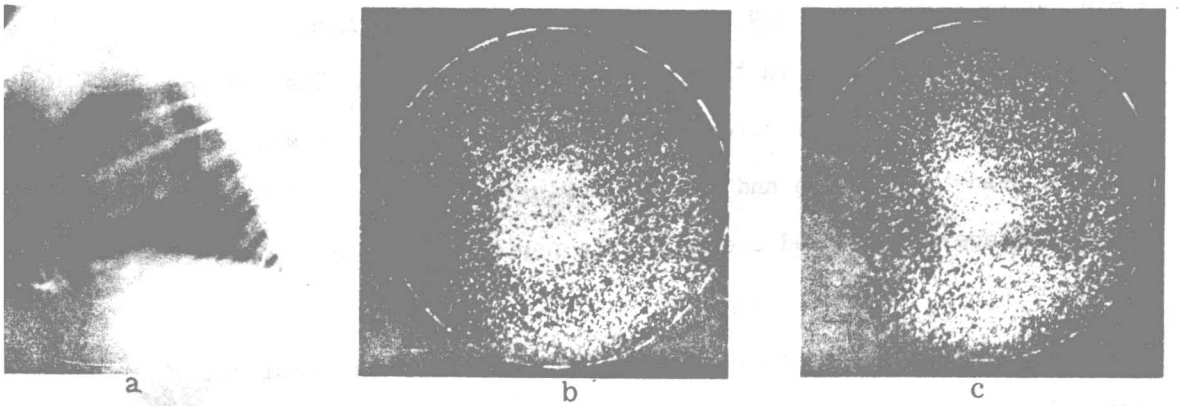

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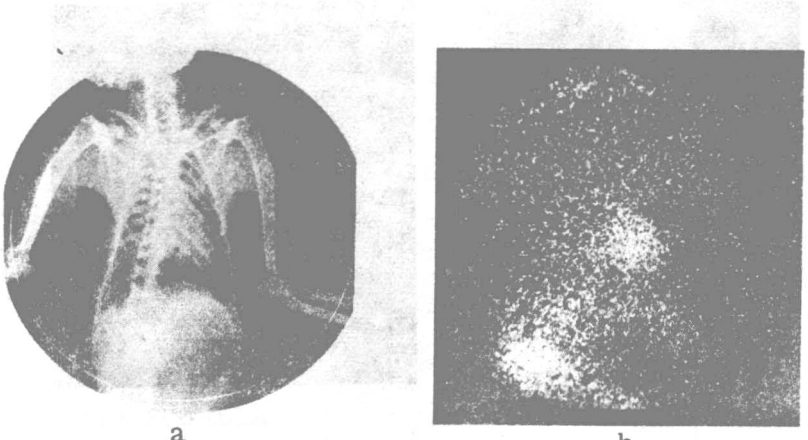
Fig. 1



a b

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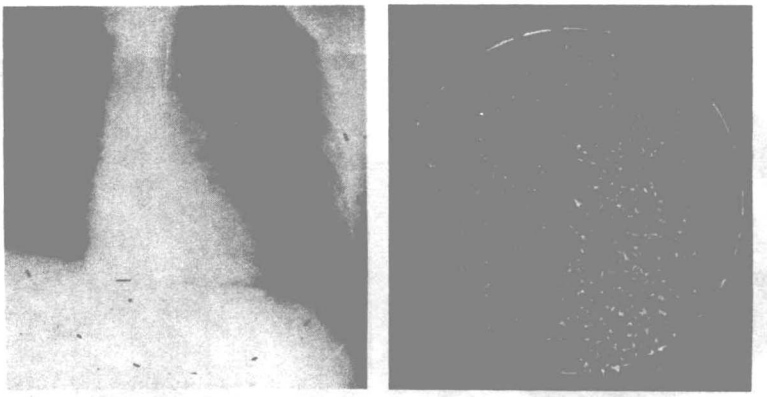
Fig. 2



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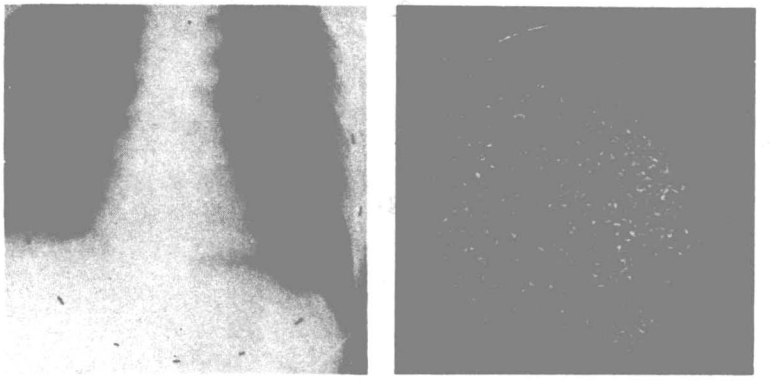

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Fig. 3