PROCEEDINGS OF THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE 146, 263–264 (1974)

Measurement of Renal Blood Flow with Radioactive Microspheres (38083)

JOSE A. L. ARRUDA, SAMPANTA BOONJARERN, CHRISTOF WESTENFELDER, AND NEIL A. KURTZMAN

University of Illinois Abraham Lincoln School of Medicine, and Veterans Administration West Side Hospital, Sections of Nephrology, Chicago, Illinois

Various methods have been used to measure total renal blood flow. Of these the most commonly employed are the clearance of paraamino-hippurate (PAH) and techniques that make use of the electromagnetic flowmeter. PAH clearance (corrected for extraction ratio) is a cumbersome method requiring catheterization of the renal vein. It would be desirable to have a method which is simple and less traumatic but equally reliable. Neutze *et al.* (1) have shown that total renal blood flow can be determined using a radioactive microsphere (MS) technique, and that values so obtained correlate well with renal blood flow as determined by using the electromagnetic flowmeter. Neutze and co-workers measured renal blood flow by multiplying cardiac output by the ratio of counts in the kidney to total body counts. Thus, their technique involved determination of cardiac output and total body counting and is obviously no less cumbersome than any of the other commonly used techniques.

Using the Fick principle we reasoned that total renal blood flow could be obtained by the ratio of radioactivity in the kidney to that in arterial blood sampled immediately after the injection of microspheres. This report describes this technique and the results obtained using it as compared to PAH clearance.

Methods. Twelve female dogs were anesthetized with sodium pentobarbital and catheters were placed in the left ventricle (for microsphere injection), the femoral artery (for blood sampling), and the femoral vein (for PAH infusion). The left kidney was exposed through a flank incision and the renal vein catheterized via the ovarian vein. The ureters were cannulated by a suprapubic approach. Renal plasma flow was measured by the clearance of PAH using Wolf's equation (2): $RPF = (U - R) \times V/(A - R)$ (A, R and U represent PAH concentration in arterial, renal venous and urine samples, respectively; V is the urine flow expressed in ml/min).

Radioactive microspheres 15 ± 5 μm in size, labeled with ^{85}Sr or ^{141}Ce were injected into the left ventricle within 10 sec; a total amount of 15 μCi (400,000 MS) was injected. Immediately following the administration of the microspheres, peripheral arterial blood was drawn at a constant rate using a Sage infusion pump over a 1-min period and the volume withdrawn noted; usually 30 ml were removed. At the end of the experiment the left kidney was removed. The blood sample and the left kidney were digested in concentrated HCl, the volume of each sample was measured and 1 ml aliquots were counted in a Beckman gamma counter; in this manner the total counts in each sample were determined.

Since the concentration of MS following the injection will be the same in any artery (1), if the removal rate of the blood from the femoral artery equalled the rate of renal blood flow, the total amounts in the kidney and the femoral blood sample would be the same; thus renal blood flow can be calculated using the following formula:

Renal blood flow = (Total Kidney Counts/ Total Femoral Blood Counts) × Blood Removal rate (ml/min).

Renal plasma flow can be calculated by

multiplying blood flow by 1 minus the hematocrit.

Results. The renal blood flow as determined by the MS technique was compared with the mean of two to three 10-min PAH clearances. Twenty-four determinations of total renal blood flow were made simultaneously by PAH clearance and the MS technique. The mean total renal blood flow as measured by the MS method was 128.7 ± 7.8 ml/min (SEM), and by PAH was 129.7 ± 6.8 ml/min (SEM) ($p > 0.8$ paired t test). The results obtained are presented in the figure.

Discussion. The data presented in this report demonstrate that measuring total renal blood flow using the MS method produces results which are identical to those obtained using the conventional PAH clearance corrected for extraction. The MS technique is commonly employed to measure changes in the distribution of intrarenal blood flow. In order to quantify the results obtained using this technique it is necessary to multiply them by the total renal blood flow. Thus the technique presented in this paper offers the marked advantage of allowing such quantification to be performed without using an additional technique to determine total renal blood flow. In an animal already prepared for MS study no additional procedures need to be performed save that of catheterization of an artery when one measures total renal blood flow by the microsphere technique. Multiple blood flow determinations can also be performed by using differently labeled microspheres. Thus this procedure presents a simplified but accurate alternative to the PAH clearance or the electromagnetic flow meter in the measurement of total renal blood flow in dogs already prepared for microsphere study.

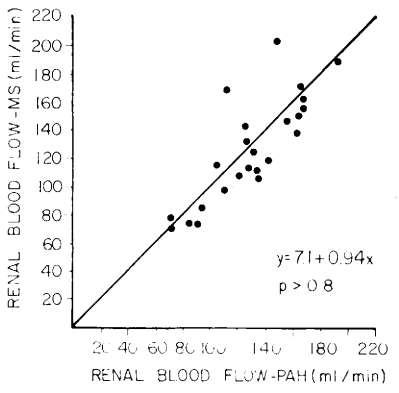

FIG. 1. Twenty-four determinations of renal blood flow measured by the microsphere technique are plotted against 24 simultaneous determinations of renal blood flow measured by PAH clearance. The line of theoretical identity is drawn.

1. Neutze, J. M., Wyler, F., and Rudolph, A. M., Amer. J. Physiol. **215**, 486 (1968).

2. Wolf, A. V., Amer. J. Physiol. **133**, 496 (1941).

Received Nov. 2, 1973. P.S.E.B.M., 1974, Vol. 146.