Measurement of Regional Blood Flow in the Golden Hamster[1] (36197)

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The cheek pouch of the golden hamster (*Mesocricatus auratus*) has been used extensively in both microcirculatory studies and tissue transplant experimentation (cf. 1). Data on the blood flow to various tissues and particularly the cheek pouch and cremaster muscle would be valuable in the interpretation of many types of experiments, but these data are not available. The purpose of this study was to obtain relative blood flow measurements in the hamster. In addition, we have measured the cardiac output by a simplified indicator dilution method.

Methods. Animals were 90–120 g, male golden hamsters obtained from Chickline Animal Supply. Five hamsters were anesthetized with 60 mg/kg pentobarbital, ip. Rectal temperature was measured with a Yellow Springs Instruments telethermometer and was maintained at 38° with an external heat lamp. A carotid artery and femoral vein were cannulated with polyethylene tubing and the cannulae were passed into the aorta and inferior vena cava, respectively.

Regional blood flows, as fraction of total cardiac output, were measured with the Sapirstein cardiac-output fractionation technique using ^{86}Rb as the indicator (2). At zero time, 0.1 ml of isotonic ^{86}Rb (10 μCi/ml) was injected into the femoral cannula and at 45 sec the animal was killed with 1 ml of 3 *M* KCl injected into the femoral venous cannula.

Tissue samples were obtained from the cheek pouch, cremaster, gastrocnemius muscle, ventricles and diaphragm and were weighed and digested in 0.5–1.0 ml of nitric acid at 80°. Arterial blood samples were hemolyzed with distilled water. All samples were diluted to a final volume of 2 ml with distilled water before counting. ^{86}Rb activity was determined in a Baird-Atomic well scintillation counter. Fractions of cardiac output per gram wet weight of tissue were calculated from the ratios of counts per gram in tissue to total counts injected.

Additional information was obtained in these experiments through the use of a simplified method of cardiac output determination. Because of the very small blood volume of the hamster a modification of the standard dilution procedure was used. A syringe-withdrawal pump was connected to the carotid arterial cannula and withdrawal of blood begun at a rate of 0.8 ml/min just before injection of the isotope. Withdrawal was continued for 25 sec after injection of the tracer. The quantity of isotope taken up in the withdrawal syringe approximates the time integral of the aortic isotope-dilution curve. This quantity can be used in the calculation of the cardiac output according to the following formula:

$$\text{cardiac output} = \frac{\text{Total } ^{86}\text{Rb injected}}{\text{Total in withdrawal syringe}} \times 0.8 \text{ ml/min}$$

To the extent that the tail of the dilution curve is not included in the arterial sample, or that recirculation may add to the isotope in the syringe, the absolute values for regional blood flow will be in error. However, based on the shape of the dilution curves reported by Sapirstein (2) we estimate this error to be not more than 10%.

Results. Table I illustrates the results of five determinations. Values are expressed as percent of cardiac output per gram of tissue wet weight and blood flow in ml/min/g tissue wet weight. The mean cardiac output calculated from the modified dilution technique was

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TABLE I. Regional Blood Flow in the Golden Hamster.

	Ventricle	Diaphragm	Cremaster	Cheek pouch	Gastrocnemius
% Cardiac output/g	7.76 ± 0.12[a]	1.40 ± 0.04	0.39 ± 0.06	0.28 ± 0.02	0.15 ± 0.04
Flow (ml/min/g)	3.67 ± 0.06	0.66 ± 0.02	0.18 ± 0.03	0.13 ± 0.01	0.08 ± 0.02

[a] All values are means plus or minus standard errors. Mean cardiac output was 47.3 ± 3.4 ml/min. Mean body weight for the 5 animals was 103 g.

47.3 ± 3.4 ml/min.

Discussion. This study was stimulated initially by an interest in the blood flow in the hamster cheek pouch. On the basis of comparisons of the percent of cardiac output for the various organs tested (Table I) it can be seen that this tissue falls in the range between an active skeletal muscle, the diaphragm, and a relatively inactive muscle, the gastrocnemius. These values are independent of the absolute value of the cardiac output, since they are ratios and are therefore not influenced by the use of the modified cardiac-output determination procedure.

There are no other reports in the literature of cardiac-output determinations in the hamster and therefore, these data have been included in the present study. A comparison of our data with values for the rat indicates that the cardiac output in the hamster is substantially higher when normalized for the body weight. The mean cardiac output per kilogram body weight which we obtained was 461 ± 29 ml/min/kg, as compared with an average value of 250 ml/min/kg in the rat (2–7). A portion of this discrepancy may be explained by assuming that the cardiac output varies with weight to the ¾ power (cf. 8). However, based on this assumption and an average cardiac output of 62 ml/min for a 250 g rat, the extrapolated cardiac index would be 319 ml/min/kg. This figure is still substantially lower than the cardiac index measured in the hamster. We have no explanation for the high cardiac index of the hamster. It may represent simply a species peculiarity in this animal. In connection with this, it might be noted that the hamster has also been observed to have an exceptional oxyhemoglobin dissociation curve, in that both the half-saturation oxygen tension (9) and the Bohr shift (10) are lower than would be predicted for an animal of this size. Given these observations, it might be expected that the hamster would have a relatively high cardiac output if it is to supply similar amounts of oxygen to the tissues at comparable oxygen tensions.

The high cardiac output might also be attributed to the modified dilution technique used for the measurement of cardiac output. The measured cardiac output using this method would probably tend to underestimate rather than overestimate the true cardiac output, however. This is due to the fact that isotope recirculation, which is the most probable source of error, would tend to lower the measured value. On the other hand, if all of the tracer bolus were not included in the syringe sample, the cardiac output would be overestimated. However, based on the curves presented by Sapirstein (2, Fig. 2), it seems unlikely that the entire aortic bolus would not be included in a 45 sec sampling interval. This follows from the fact that the entire curve for the rat would be included in this interval, and the absolute value for the hamster is about the same as that for the rat. Verification of our findings on cardiac output must await the use of standard techniques for the determination of cardiac output such as the direct Fick.

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