NAMI-962

MEASUREMENT OF LEFT CIRCUMFLEX CORONARY FLOW, CARDIAC OUTPUT, AND CENTRAL AORTIC PRESSURE IN THE UNMEDICATED GREYHOUND DOG

LeRoy S. Wirthlin and E. Peter Beck

May 1966

U. S. NAVAL AEROSPACE MEDICAL INSTITUTE
U. S. NAVAL AVIATION MEDICAL CENTER
PENSACOLA, FLORIDA

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Electromagnetic flowmeter

Blood pressure

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Myocardial metabolism

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Bureau of Medicine and Surgery
MR005.13-7004.5.17

Approved by	Released by
Captain Ashton Graybiel, MC USN Director of Research	Captain H. C. Hunley, MC USN Commanding Officer

2 May 1966

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SUMMARY PAGE

THE PROBLEM

To study coronary flow dynamics under basal and changing environmental conditions, it was necessary to develop a standard animal preparation in which left circumflex coronary flow, phasic systemic cardiac output, and central aortic pressure could be measured in the awake, unmedicated state.

FINDINGS

A technique involving the surgical implantation of electromagnetic flow probes and chronic sampling catheters was successfully applied to nine greyhound dogs. Left circumflex coronary artery (LCCA) flow data, cardiac output, and central aortic blood pressure determinations are presented. In addition, coronary sinus blood determinations for five of the animals (together with the flow data) are included. LCCA flow ranged from 57 to 130 ml/min (35 to 57 ml/100 gm left ventricle/min). Twenty to forty-seven per cent of flow occurred during left ventricular systole. Oxygen usage ranged from 7.6 to 11.9 ml/min (4.8 to 9.8 ml/100 gm left ventricle/min). The LCCA flow patterns and the range of flow values agree closely with those reported previously by Gregg. It was felt that our measurements were made in the resting but not necessarily basal state.

ACKNOWLEDGMENTS

The technical assistance of Michael L. Walker is greatly appreciated. We also acknowledge the support of Eugene New, CAPT VC USAF, and the veterinary department of the Naval Aerospace Medical Institute. The assistance of Mrs. P. T. Blake in record analysis is also appreciated. We are grateful to Dr. Erich Elliot for the design of the teflon occlusive snare device. The pressure check valve was modified by Mr. Oscar Atwell, O&R, NAS Pensacola, Florida.

INTRODUCTION

With the development of the electromagnetic flowmeter, there has been great interest in the measurement of coronary flow dynamics (1-3), and with miniaturization of the flow probes it has become possible to study coronary flow in animals several weeks after surgical implantation of the probes (1,4). The purpose of this report is to describe techniques used in this laboratory for such a study and to present data obtained from the simultaneous measurement of left circumflex coronary flow, phasic cardiac output, and central aortic blood pressure in the awake, unmedicated greyhound dog. Determinations made on arterial and coronary sinus blood samples are also presented.

PROCEDURE

Nine adult greyhound dogs ranging in weight from 25 to 45 kg were obtained in peak physical condition and observed for several months before study. A Medicon 4000 sine wave electromagnetic flowmeter system with associated flow probes in conjunction with an Electronics for Medicine DR-12 recorder were used throughout the study. Medicon series "K" bivalve probes were used for implantation about the ascending aorta. Required probe sizes ranged from 17 to 22 mm i.d., with 20 mm being the most common size used. To ensure optimal flow signals the probe diameters matched the aortic diameter between systolic and diastolic extremes. Medicon series "S" iron core probes were found to be suitable for implantation about the left circumflex coronary artery but too wide for the main left coronary and less suitable for the left anterior descending branch. Left circumflex coronary arteries ranged from 3.0 to 4.5 mm in width. Both types of probes proved reasonably sturdy and with care could be reused in subsequent experiments.

CALIBRATION OF THE PROBES

Probes were frequently calibrated on freshly excised bovine and dog arteries of appropriate size. A good fit of the probe on the artery was crucial for reproducibility of the calibrations. Errors in calibration were found to result from the use of vessels preserved in formalin and from the use of saline as the perfusing fluid; therefore, all calibrations were made with whole blood of approximately the same hematocrit as dog blood. Figure 1 illustrates that although the calibration curves remain linear for identical flows, saline indicates a 20-25 per cent greater value than that of whole blood.

The larger "K" probes were calibrated using a gravity flow system and the smaller "S" probes using a pulsatile pump system. Over a period of months calibration values agreed to within 5 per cent with occasional determinations of 10 per cent of their initial values. There were two cases of disagreement of calibrations greater than 10 per cent, one in a probe which had been repaired at the factory in the interim and in another probe for which no reason could be found for conflicting calibration values.

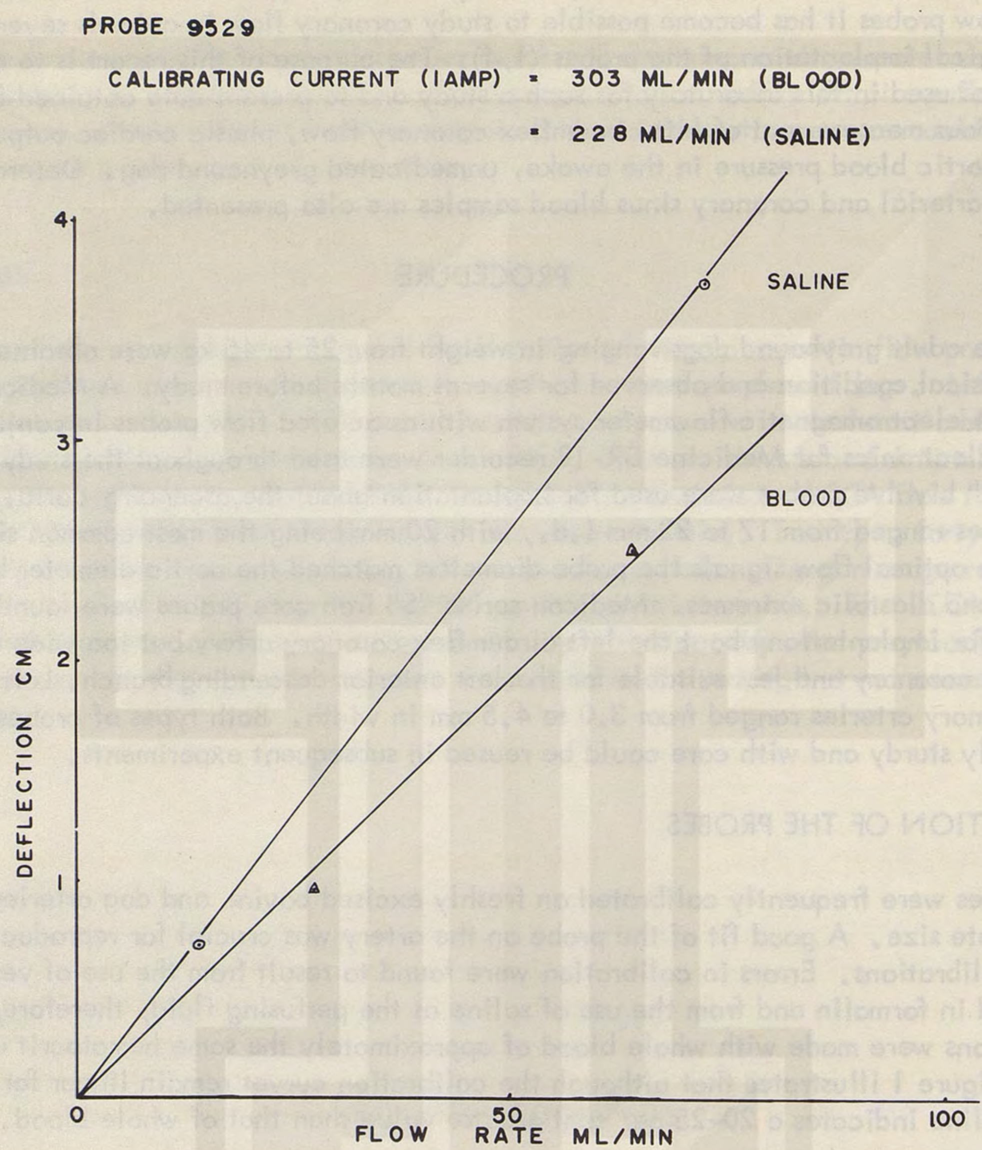

Figure 1

Graph of a probe calibration showing the different results obtained using saline versus blood as perfusing fluid.

INDICATION OF ZERO FLOW

Zero aortic flow was taken as that position of the aortic trace inscribed during late diastole. True zero coronary flow was obtained by mechanical occlusion of the vessel distal to the flow probe. Base line drift of the series "S" probes was found to vary between 1mm and 3mm during the course of an experiment.

Mechanical occlusion of the left circumflex coronary artery was obtained using a snare device of the type described by Eckstein and Driscol (5) and modified by Elliot (6). This snare consisted of a short flanged segment of PE 150 polyethylene tubing (i.d.0.045"; o.d. 0.062"). One end of a length of nylon monofilament fishing line (35 lb test; o.d. 0.022") was secured to the flanged polyethylene, and the other end was threaded through the spaghetti tubing from the flanged end, thus forming a loop at the flange (Figure 2). The distal end of the snare was capped with a short, sealed segment of PE 200 polyethylene tubing to prevent any possibility of pneumothorax during the first three days, after which time it was found unnecessary to cap the snare.

SURGICAL PROCEDURE

The animals were premedicated with morphine sulfate and atropine sulfate before the operation. They were given sodium pentothal intravenously (20mg/kg) and intubated. Surgical anesthesia was induced with 3 per cent Halothane and oxygen in a closed circuit apparatus, after which the animals were maintained on nitrous oxide and oxygen. Anectine (0.03 mg/kg) was given and respiration was manually controlled throughout the procedure.

A left thoracotomy through the fifth intercostal space was performed under surgically aseptic conditions. The pericardium was opened, a well formed, and the fat pad dissected from the ascending aorta. The aorta was dissected from the pulmonary artery to its base. Aortic diameter was determined with calipers, and the appropriate sized probe selected and placed about the ascending aorta. The proximal aorta was buttressed with Ivalon sponge to protect the wall from erosion by the probe. The left circumflex coronary artery was dissected free for a distance of one centimeter from its origin. Arterial width was determined with calipers; the proper fitting probe was selected and placed about the circumflex proximal to any branches. Figure 3 shows the position of the probe on the vessel. The implant was found to be self-supporting. We encountered no problem with mechanical occlusion of the vessel as the result of the probe twisting from side to side, and it was unnecessary to anchor the probe to the heart with sutures. After two to three days the left atrial appendage was found "cemented" over the probe by fibrinous adhesions, adding further stability to the implant. The snare was placed 1-2 mm distal to the probe and proximal to any branches. The probe cables were brought out the pericardiotomy, led posterior to the left lower lobe of the lung and through the posterior margin of the incision. Probe connectors were then tunneled subcutaneously to the back and brought through the skin (Figure 4). Probe connectors were not buried subcutaneously.

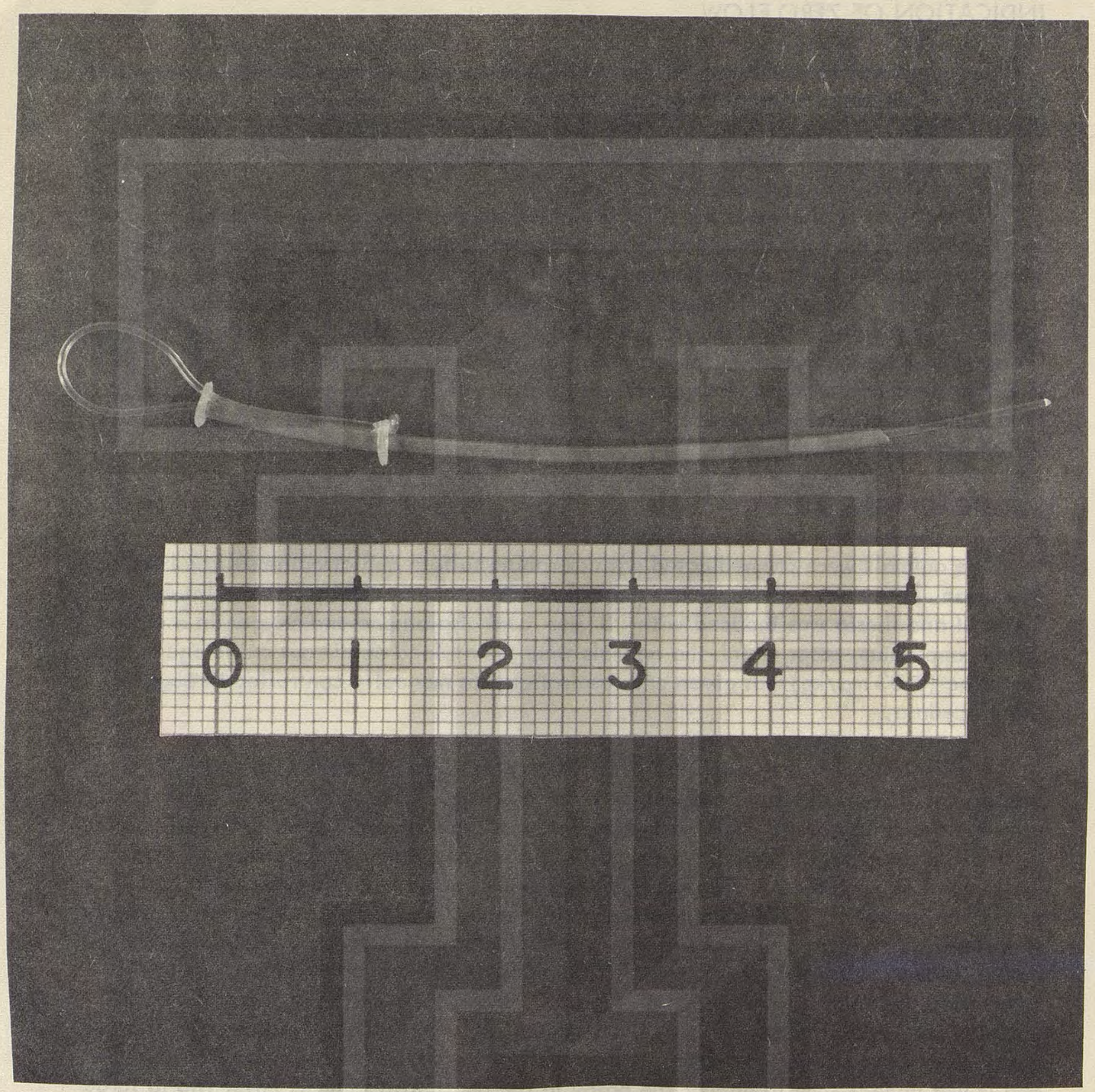

Figure 2
Photograph of the teflon snare device.
Markings on the rule are in centimeters.

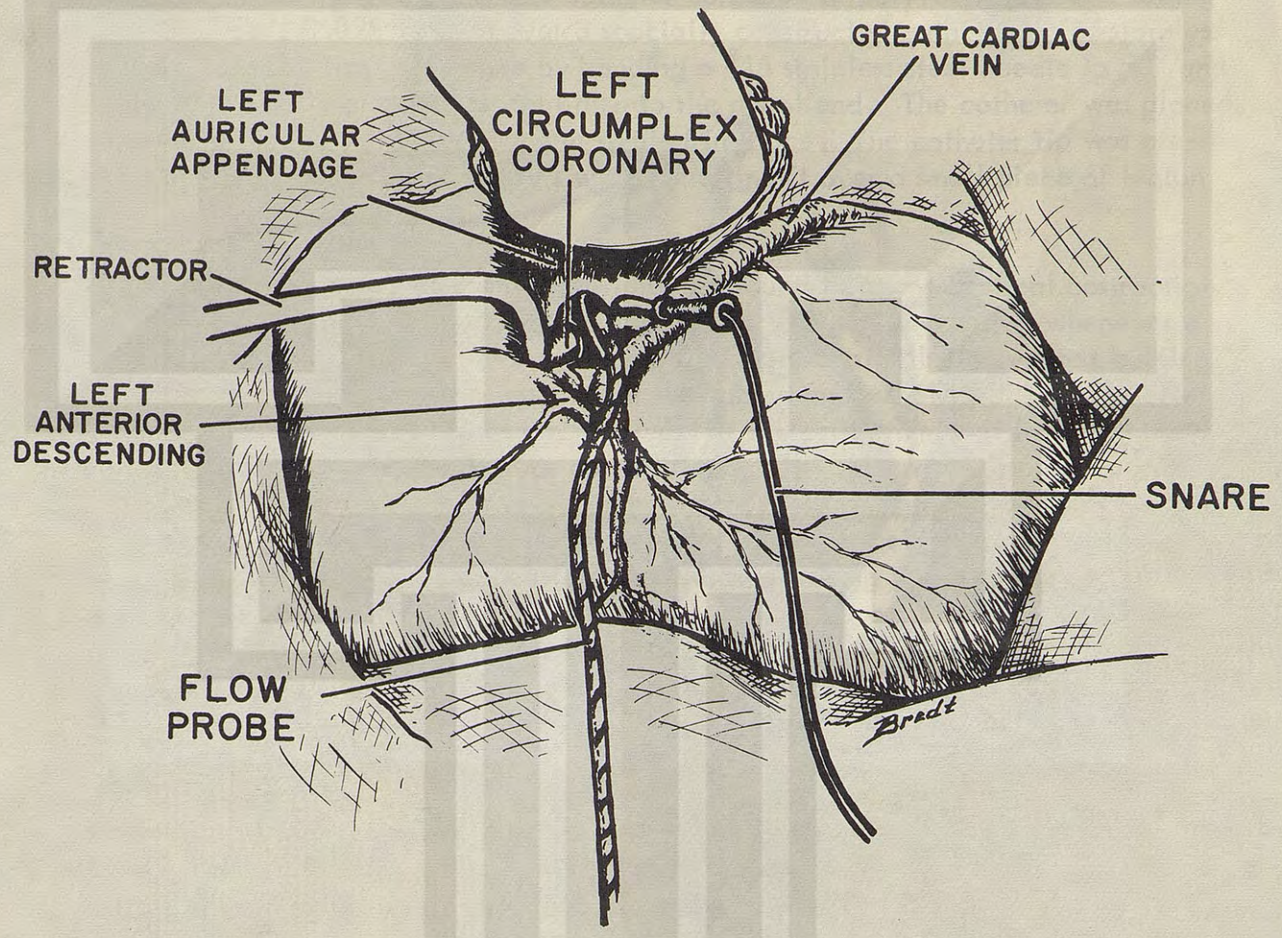

Figure 3

An artist's conception of the surgical field during the LCCA probe implantation. With the left auricular appendage and the pulmonary artery retracted, a short segment of left circumflex coronary artery is exposed before it passes beneath the great cardiac vein. The left anterior descending branch marks the position of the interventricular septum. The teflon snare is placed 1-2 mm distal to the probe with an epicardial tissue bridge remaining between the probe and snare (4).

Figure 4

Photograph showing the probe cables and connectors, snare, and coronary sinus catheter (attached to the check valve) sutured to the skin. The snare and catheter are located cephalad to the probe connectors.

All attempts to bury the connectors or catheter check valves resulted in skin infection with eventual extrusion of the connector ends. It was also found that burying the connector ends resulted in discomfort to the animals.

A coronary sinus sampling catheter was sutured in place using the technique described by Rayford and colleagues (7). The catheter consisted of polyvinyl spaghetti tubing (i.d. 0.058"; o.d. 0.095") fitted over a specially constructed catheter tip of stainless steel (Figure 5). The tips were made by bending a #15 stainless steel needle to 90° and silver soldering a 3.5 mm stainless steel disc to the distal end. The catheter was placed 2 cm above the coronary sinus ostium and sutured in place. The catheter tip was prevented from slipping into the coronary sinus by suturing it over a small piece of Ivalon sponge.

The most common cause of catheter failure was found to be mechanical obstruction of the catheter tip against the opposite coronary sinus wall which resulted whenever a straight catheter tip was used. Bending the tip to a right angle also prevented kinking of the soft polyvinyl tubing at the junction of the tubing and metal tip. The catheter was led along the left side of the heart, through the pericardiotomy; it followed the probe cables to the posterior back, was pushed through the skin with a metal obturator, and connected to a pressure check valve. The aortic pressure catheter was similar to that described by Gregg (4) and others (8) and consisted of a stiff Kel F* tubing with a polyvinyl chloride tubing sleeve. The catheter was inserted by exposing the left common carotid in the neck and passing the tip through this vessel to within one centimeter of the aortic arch. The catheter tip was always checked by palpation#. The distal end of the catheter was tunneled subcutaneously to the back and connected to a pressure check valve (Figure 5).

The valve originally used was one designed by Khouri and co-workers (9). Since these were not buried subcutaneously, the design was modified to suit our conditions (Figure 6). This particular version has the advantage of greater stability of the "O" ring seal but requires a long stem fitting for flushing the catheter.

After all probes and catheters were in place the pericardium was closed, one chest tube placed in the right chest, a second chest tube placed to the apex of the left lung,and the wound closed in layers. Probe connectors and check valves were taped to the skin which was covered with a vest. Chest drainage was continued six hours postoperatively after which time the tubes were removed. Animals were given penicillin and streptomycin daily for four days. The catheters were flushed daily with saline and filled with heparin 10 mg/cc. Beginning the first postoperative day, the animals were trained to lie quietly on their right side.

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#At times it was found more advantageous to place the catheter several days after the implantation procedure to avoid clotting of the catheter before an experimental run. This was done through an incision in the left neck exposing the left common carotid and passing the catheter to the aortic arch under flouroscopy.

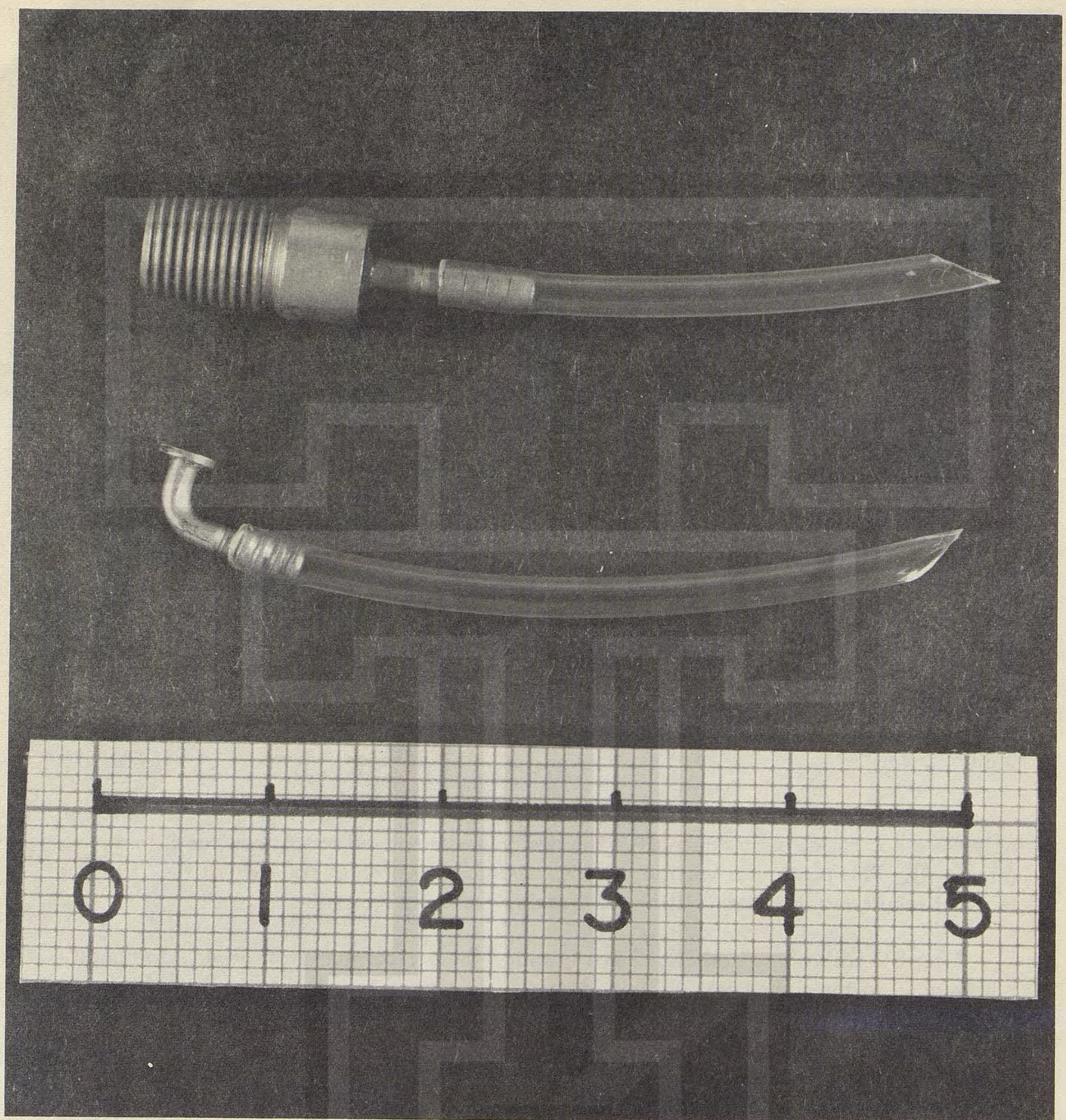


Figure 5

Photograph showing the pressure check valve (top) and coronary sinus catheter tip (bottom). Markings on the rule are in centimeters.

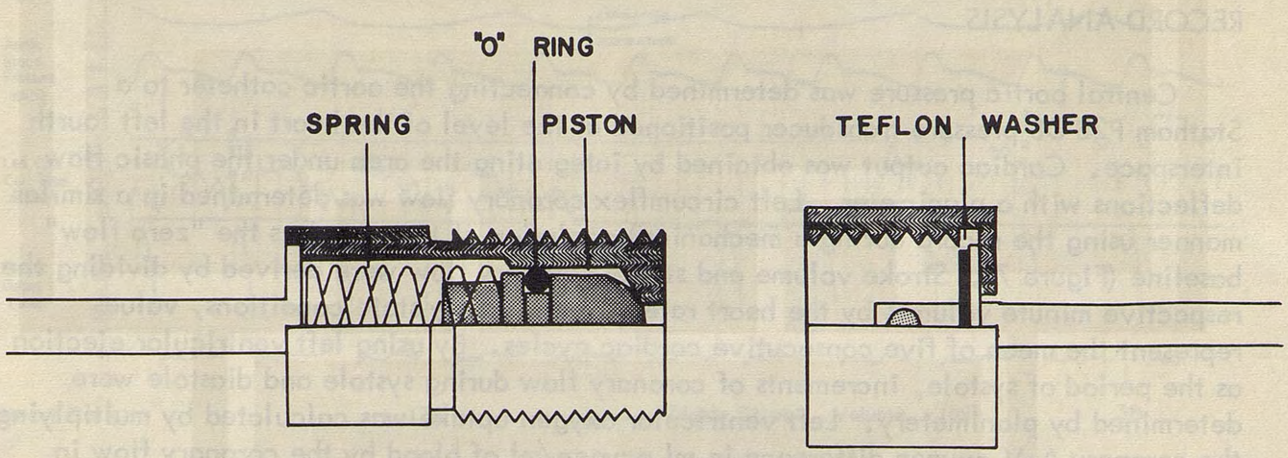


Figure 6

Drawing of the pressure check valve used on coronary sinus and aortic catheters. The position of the "O" ring seal is maintained in the shoulders of the piston.

BLOOD DETERMINATIONS

Blood samples from the coronary sinus and aortic sampling catheters were collected in lubricated heparinized syringes. The pO_2, pCO_2, and pH of the samples were determined with oxygen and carbon dioxide electrodes (10) and a Metrohm pH meter at 37° C. Oxygen contents of blood samples were determined by the manometric technique of Van Slyke (11).

RECORD ANALYSIS

Central aortic pressure was determined by connecting the aortic catheter to a Statham P23 DB pressure transducer positioned at the level of the heart in the left fourth interspace. Cardiac output was obtained by integrating the area under the phasic flow deflections with a planimeter. Left circumflex coronary flow was determined in a similar manner using the record during a mechanical occlusion of the vessel as the "zero flow" baseline (Figure 7). Stroke volume and stroke coronary flow were derived by dividing the respective minute volumes by the heart rate. Under steady state conditions, values represent the mean of five consecutive cardiac cycles. By using left ventricular ejection as the period of systole, increments of coronary flow during systole and diastole were determined by planimetery. Left ventricular oxygen uptake was calculated by multiplying the coronary A-V oxygen difference in ml oxygen/ml of blood by the coronary flow in ml/min. Olsson and Gregg (12) have shown that coronary sinus blood is representative of blood in the great cardiac vein and that with the catheter tip positioned 2 cm above the coronary sinus ostium, the blood sample is not significantly contaminated by right atrial blood.

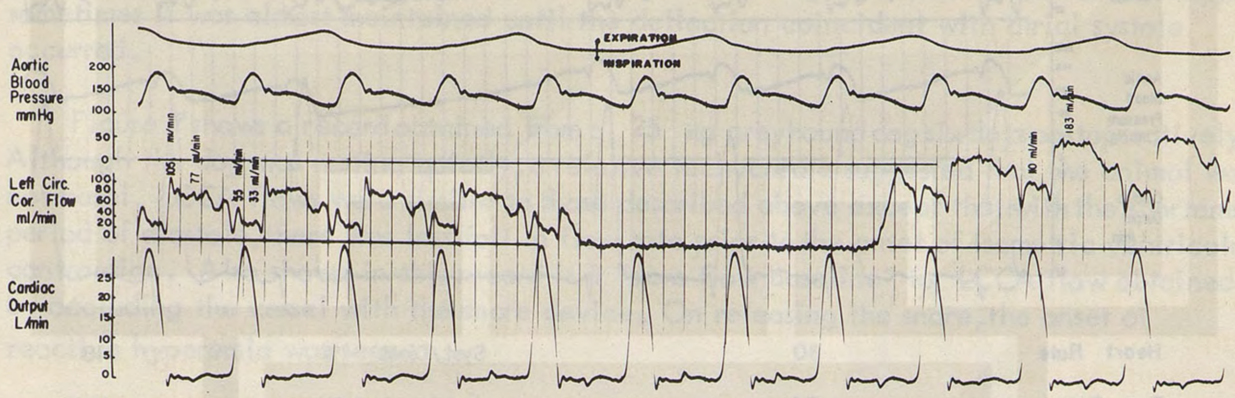
VISCERAL EXAMINATION

At the termination of an experiment, animals were sacrificed by giving sodium pentothal intravenously. Examination of the viscera showed no signs of infection or mediastinitis. In all cases the left circumflex coronary probe was well sealed in place by fibrinous adhesions. In several animals, that portion of the left ventricle supplied by the left circumflex coronary artery was determined by perfusing basic fuchsin through the vessel, removing the stained portion of the ventricle, and recording its weight. There was no evidence of myocardial infarction or thrombosis of the circumflex branch.

RESULTS

LEFT CIRCUMFLEX CORONARY ARTERY (LCCA) FLOW PATTERNS

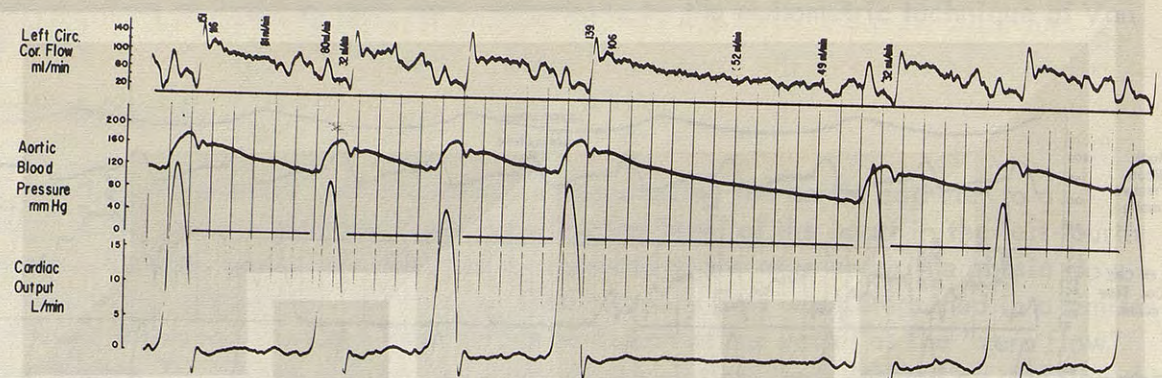
Figure 8 shows a typical record of LCCA flow, central aortic pressure, and phasic aortic blood flow. This record was obtained seven days postoperatively from a 33 kg greyhound dog resting on his right side and apparently asleep. The LCCA trace has the same pattern described by others (1,2,4,9,12,13). With the closure of the aortic valves, there was a sharp rise from zero to peak flow of 151 ml/min, dropping quickly again to



Heart Rate		132	Diast. Stroke Volume	(ml)	.38
Resp. Rate		73	Syst. Stroke Volume	(ml)	.08
Blood Pressure	(mm Hg)	191/123	Syst./Diast.	%	21
Mean Pressure	(mm Hg)	151	Arterial pO_2	(mm Hg)	90
Cardiac Output	(L/min)	6.26	pCO_2	(mm Hg)	37.2
Stroke Volume	(ml)	47	pH		7.44
Left Circ. Cor. Flow	(ml/min)	60			
Stroke Cor. Flow	(ml)	.46			

Figure 7

Photograph of a record demonstrating a snare occlusion of the left circumflex coronary artery in a greyhound dog six days after implantation. Time lines are 0.1 second apart. Weight of animal is 25 kg.



Heart Rate		80	
Resp. Rate		24	
Blood Pressure	(mm Hg)	168/110	
Mean Pressure	(mm Hg)	138	
Cardiac Output	(L/min)	2.98	
Stroke Volume	(ml)	37	
Left Circ. Cor. Flow	(ml/min)	68	(43)*
Stroke Cor. Flow	(ml)	.85	
Diast. Stroke Volume	(ml)	.72	
Syst. Stroke Volume	(ml)	.13	

Syst./Diast.	%	18
$A-VO_2$	(vol %)	13.0
Cor. Sinus O_2	(vol %)	8.7
Oxygen Usage	(ml/min)	8.8 (5.5)*
Arterial	pO_2 (mm Hg)	84.0
	pCO_2 (mm Hg)	29.3
	pH	7.34
Cor. Sinus	pO_2 (mm Hg)	28.5
	pCO_2 (mm Hg)	38.2
	pH	7.39

#Values are expressed in terms of cc/100 gm of left ventricle/min.

Figure 8

Photograph of a record taken at rest in a greyhound dog nine days after implantation. Dog weight 33.8 kg. Time lines are 0.1 second apart.

116 ml/min and then gradually reaching 80 ml/min flow. During the later part of diastole there was a drop in flow that coincided with atrial systole (4,13). At the onset of isometric ventricular contraction LCCA flow fell, approaching the zero flow baseline, spiking again to a peak of 80 ml/min with the onset of ventricular ejection, and dropping to a level of 30 ml/min during peak systolic pressure. Flow then dropped to the zero baseline during the protodiastolic period. With slower heart rates the phasic changes in LCCA flow were similar except that initial rate of fall in flow during early diastole was not maintained throughout the period of diastole. Instead, LCCA flow fell more slowly; sometimes it was almost maintained until the deflection coincident with atrial systole occurred.

Figure 7 shows a record obtained from a 25 kg greyhound dog six days postoperatively. Although the dog was resting quietly, a relative tachycardia suggested that the animal was not basal. LCCA flows were similar to those described above except that with the shortened period of diastole, there was less fall in flow rate prior to the onset of isometric ventricular contraction. Also shown in this record is a "zero flow baseline" for LCCA flow obtained by occluding the vessel with the snare device. On releasing the snare, the onset of reactive hyperemia was seen.

These traces represent records without significant artifact. In many implants an EKG spike was a common artifact seen on the LCCA trace during late diastole and which persisted for several days postoperatively.

LCCA FLOW AND OTHER RELATED HEMODYNAMIC DATA

Table I contains various data obtained from the nine greyhound dogs. With the exception of subject BgE, which was standing, all data were obtained with the dogs lying at rest on their right side. Mean LCCA flow rates ranged from 57 to 130 ml/min (35 to 57 ml/100 gm left ventricle/min). Stroke LCCA volumes ranged from 0.43 to 1.60 ml (the latter obtained in an unusually large animal), with diastolic stroke volumes of 0.29 to 1.21 ml and systolic stroke volumes of 0.07 to 0.39 ml. The diastolic/systolic ratios ranged from 14 to 47 per cent.

Cardiac outputs ranged from 2.67 to 6.77 L/min and stroke volumes from 28 to 80 ml. Khalil, using a thermodilution catheter technique, has found similar ranges in untrained, unoperated greyhound dogs of comparable size (15).

AORTIC AND CORONARY SINUS BLOOD DETERMINATIONS

The determinations made on aortic and coronary sinus blood samples obtained from five of the dogs are shown in Table II. Arterial oxygen tensions ranged from 82 to 107 mm Hg with the exception of a single value of 66 mm Hg in subject Bgdrp. This dog was later found to have a partial pneumothorax. Arterial carbon dioxide tensions were slightly lower than those reported on postoperative mongrel dogs (8) and reflect the effects of relatively high respiratory rates (panting in most cases) and possible species difference.

Table 1

Coronary Flow and Systemic Data Together with Blood Determinations on Nine Greyhound Dogs[x]

							Blood Pressure mm Hg		Cardiac Output		Coronary Flow					Blood gas & pH values						Oxygen Uptake			
									Stroke vol							Arterial			Coronary sinus						
Dog	Days P. O.	Wt kg	Hct	Hbg	Resp. rate	Heart rate	Syst/Diast.	Mean	ml/min	ml	ml/min	Stroke ml	Stroke diast. ml	syst. ml	% Syst. Diast.	pO_2 mm Hg	pCO_2 mm Hg	pH	pO_2 mm Hg	pCO_2 mm Hg	pH	$A-VO_2$ vol %	Cor-sinus vol %	ml/min	Stroke cc
Hpl	3	25	40	-	-	128	155/90	122	4060	32	101	0.79	0.62	0.17	28	85.0	-	7.38	-	-	-	-	-	-	-
Bgwn	3	36.8	49	-	40	90	155/82	109	6620	69	112	1.24	0.99	0.25	20	82.0	31.0	7.35	31.0	43	7.30	10.6	8.6	11.9	0.13
	6	36.8	46	-	46	144	155/80	100	6160	43	98	0.68	0.52	0.16	30	93.0	-	7.41	25.0	-	7.43	-	-	-	-
Psy	6	25	44	14.7	81	117	179/115	137	5660	48	57	0.49	0.42	0.07	17	90.0	37.2	7.44	-	-	-	-	-	-	-
Grdl	5	32.7	45	15.1	71	170	-	99	4460	26	84 (56)*	0.49	0.35	0.14	40	98.5	27.5	7.35	30.0	38.5	7.30	9.5	9.0	8.0 (5.3)*	0.05
BgE	14	42	44	-	-	82	-	-	6560	80	130	1.60	1.21	0.39	32	84.0	36.7	7.44	-	-	-	-	-	-	-
Btdg	7	33.8	51	16.3	30	72	153/92	123	2680	37	70 (43) *	0.97	0.83	0.14	17	84.0	29.3	7.34	28.5	38.2	7.30	13.0	8.6	9.1 (5.6)*	0.13
	9	33.8	43	13.8	23	68	132/85	104	2670	40	57 (35) *	0.84	0.74	0.10	14	107.0	30.0	7.38	26.0	38.5	7.36	13.5	5.0	7.7 (4.8)*	0.12
Bgls	6	35	44	14.8	72	119	157/89	114	6770	57	73	0.61	0.49	0.12	25	86.5	32.5	7.40	25.0	45.1	7.36	11.3	5.2	8.2	0.07
Hrms	15	36	44	-	14	132	-	-	3650	28	56.3	0.43	0.29	0.14	47	88.0	32.8	7.46	-	-	-	-	-	-	-
Bgdrp	6	40	49	17.0	71	132	159/77	118	5030	39	75 (57)*	0.58	0.41	0.17	41	66.0	22.0	7.45	18.0	39.8	7.33	17.2	3.7	12.8 (9.8)*	0.10

[x]All measurements except those on animal BgE were made with the animal lying on the right side at rest.

*Indicates values expressed in terms of cc/100 gm left ventricle/min.

Table II

Results of Several Blood Determinations Made on Coronary Sinus and Arterial Samples On Five Greyhound Dogs

	ARTERIAL					CORONARY SINUS							
	O_2 Vol. %	CO_2 Vol. %	pO_2 mm Hg	pCO_2 mm Hg	pH	O_2 Vol. %	CO_2 Vol. %	pO_2 mm Hg	pCO_2 mm Hg	pH	AVO_2	% O_2 Extracted	Myocardial RQ
Bgwn	19.2	32.3	82.0	31.0	7.35	8.6	41.7	31.0	43.0	7.30	10.6	55	0.89
Grdl	18.5	30.3	98.5	27.5	7.35	9.0	42.2	30.0	38.5	7.30	9.5	51	1.25
B tdg	21.6	29.2	84.0	29.3	7.34	8.6	39.6	28.5	38.2	7.30	13.0	60	0.80
	18.5	28.6	107	30.0	7.38	5.0	40.3	26.0	38.5	7.36	13.5	73	0.86
Bgdrp	20.9	28.8	66.0	22.0	7.45	3.7	41.4	18.0	39.8	7.33	17.2	82	0.73
Bgls	16.5	34.6	86.5	32.5	7.40	5.2	44.8	25.0	45.1	7.36	11.3	65	0.90

The coefficient of oxygen extraction ranged from 51 to 86 per cent. Myocardial respiratory quotients ranged from 0.73 to 1.25. Oxygen uptakes (Table I) varied from 7.6 to 11.9. Corrected values for oxygen uptake in terms of left ventricular weight varied from 4.8 to 9.8 ml/100 gm left ventricle/min in those animals in which this tissue weight could be determined.

DISCUSSION

The greyhounds used in these experiments were thoroughbred, highly trained animals obtained in peak physical condition from a local race track. The greyhound dog was chosen as the experimental animal not only because of availability but also for reasons of large heart and vessel size which facilitated the implantation of flow probes. Since the vessels were large, the probe could be placed proximal to muscular branches of the left circumflex coronary artery, making it unnecessary to ligate the first small branches. The bulkiness of these particular probes, however, would prohibit use on smaller animals. Male greyhound dogs were found to be more suitable than females for implantation of the coronary probes. While the left circumflex coronary artery was found to lie superficially on the myocardium in the male, the proximal portion of this artery was consistently embedded deeply beneath the epicardium in the female, requiring more dissection to mobilize the vessel for implantation of the probe, invariably with more trauma than was necessary with the males. In addition, it was found more difficult to exclude the presence of deep branches between the flow probe and the occluding snare. Only one female dog (Psy) was included in this series. Apart from the different depth within the myocardial wall described above, there was no consistent difference in coronary anatomy between the male and female dogs.

Although the larger heart and coronary vessel size facilitated implantation, the proportionately large thoracic cavity required longer periods of time for chest drainage. It was found necessary to continue chest drainage for several hours postoperatively to ensure complete evacuation of air and fluid. With adequate re-expansion of the lungs the animals did well postoperatively, were able to maintain their weight, and able to exercise in a reasonable fashion.

Rupture of the aorta due to erosion of the flow probes into the aortic wall was the most common complication, occurring from ten to twelve days postoperatively with our longest survival being twenty-six days. This was due to rather lengthy probes (1.6 - 1.8 cm) and perhaps to a tight fit, having to compromise for the optimum aortic size during systole and diastole and during relative hypotension due to anesthesia in some cases. In those cases of erosion, rupture occurred in the proximal dorsal portion of the aortic arch where there was the greatest stress from rocking of the implant.

The greyhound dog was also found to be a suitable experimental animal because of the long periods of handling and training each underwent prior to procurement; therefore, we encountered little difficulty in training the animals to lie quietly on their right side. However, while there were animals that would apparently sleep during data recording, there were others that demonstrated a degree of apprehension manifested by a relative tachycardia, increased coronary flow rate, increased oxygen uptake, and an increased sensitivity of the coronary flow response to slight changes in the laboratory environment. In those animals incompletely adapted to the laboratory surroundings, a slamming door, new laboratory personnel, or other stimuli were sufficient to cause a marked increase in the coronary flow response (13). Longer periods of training might have overcome this in three dogs reported in Table I.

The data presented in Table I for LCCA flow agree well with those found in other laboratories. In anesthetized intact dogs, left coronary flow values range from 72 - 85 ml/100gm left ventricle/min (14). Gregg and co-workers have reported that in awake unanesthetized trained mongrel dogs with implanted flow probes, flow rates ranged from 37 to 58 ml/100 gm left ventricle/min (4) which compare favorably with the range reported in Table I. Oxygen usage in their series ranged from 4.4 to 8.6 cc oxygen/100 gm left ventricle/min compared to 4.8 to 9.8 cc oxygen/100 gm left ventricle/min in Table I. This is excellent agreement in view of different flow meter systems used. As Gregg has emphasized (4) these values are lower than usually reported for baseline coronary flow in dogs. Since our measurements were made in resting animals, one might expect lower values in an absolutely basal animal. It is felt that the animal preparation herein described is standard for this laboratory and represents one in which measurements of coronary flow, cardiac output, blood pressure, and left ventricular metabolic data can be determined in the resting and in the changing environmental state.

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DOCUMENT CONTROL DATA - R&D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author) U.S. Naval Aerospace Medical Institute Pensacola, Florida	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
	2b. GROUP N/A	
3. REPORT TITLE MEASUREMENT OF LEFT CIRCUMFLEX CORONARY FLOW, CARDIAC OUTPUT, AND CENTRAL AORTIC PRESSURE IN THE UNMEDICATED GREYHOUND DOG		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)		
5. AUTHOR(S) (Last name, first name, initial) WIRTHLIN, Leroy, S. LT MC USNR; BECK, E. Peter, Surg. LCDR RN		
6. REPORT DATE 2 May 1966	7a. TOTAL NO. OF PAGES 19	7b. NO. OF REFS 15
8a. CONTRACT OR GRANT NO. b. PROJECT NO. MR005.13-7004.5 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) NAMI-962 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) 17	
10. AVAILABILITY/LIMITATION NOTICES Qualified requesters may obtain copies of this report from DDC. Available, for sale to the public, from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151.		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY	

13. ABSTRACT

To study coronary flow dynamics under basal and changing environmental conditions, it was necessary to develop a standard animal preparation in which left circumflex coronary flow, phasic systemic cardiac output, and central aortic pressure could be measured in the awake, unmedicated state.

A technique involving the surgical implantation of electromagnetic flow probes and chronic sampling catheters was successfully applied to nine greyhound dogs. Left circumflex coronary artery (LCCA) flow data, cardiac output, and central aortic blood pressure determinations are presented. In addition, coronary sinus blood determinations for five of the animals (together with the flow data) are included. LCCA flow ranged from 57 to 130 ml/min (35 to 57 ml/100 gm left ventricle/min.). Twenty to forty-seven per cent of flow occurred during left ventricular systole. Oxygen usage ranged from 7.6 to 11.9 ml/min (4.8 to 9.8 ml/100gm left ventricle/min). The LCCA flow patterns and the range of flow values agree closely with those reported previously by Gregg. It was felt that our measurements were made in the resting but not necessarily basal state.

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