Valve-Like Action of Segment of Aorta Communicating Between Chambers of Left Atrium and Left Ventricle.* (20371)

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This is a report of the experimental testing of a concept which may prove to be useful in the surgical correction of mitral valve insufficiency. It was reasoned that a simple flexible tube leading from the atrium, through the mitral valve orifice and opening into the chamber of the left ventricle would itself function as a primitive valve. What was meant by a primitive valve was merely that the flow of fluid from the atrial end of the tube into ventricle during diastole would be unimpeded whereas retrograde flow through the communicating tube during systole would not take place. It was felt that retrograde flow would be prevented by the abrupt elevation of pressure within the ventricular cavity, which being exerted equally on all sides of the ventricular end of the tube, would simply collapse the lumen by apposing the walls. When the ventricular pressure declined at the termination of systole and finally fell below that existing within the atrial end of the tube, the walls would again be forced open and the lumen restored.

Methods. Adult dogs were anesthetized with Nembutal and the heart was exposed by removal of the 5th and 6th ribs on the left side. Respiration was maintained by a pneumatic balance respirator supplying intermittent positive pressure oxygen. In these acute experiments, the intracardiac tube was fashioned from sections of aorta. Both dog and cattle aortic segments have been used. The latter were employed because of their greater diameter. The insertion into the heart of these tubes was arranged so as to yield data concerning the validity of the anticipated valve-like action. Problems of the behavior of this system under long term conditions were not approached. A blunt probe bearing a heavy silk suture was inserted through the left ventricular wall at the apex and was passed through the mitral valve into the left atrial appendage and brought out through the atrial wall at this point. The suture was removed from the probe and joined to the lower end of the aortic segment. The wall of the atrial appendage was cut open around the initial probe opening and the aortic segment was drawn through this atrial opening into the ventricular cavity. The suture was then fixed to the ventricular myocardium to hold the ventricular end of the aortic segment in place and the atrial appendage was sutured to the adventitia of the proximal end of the aorta to effect a water-tight closure. Pressure within the aortic segment was determined through a No. 8 F cardiac catheter which was inserted into the portion of the aortic segment lying within the ventricular cavity and then slowly withdrawn into the atrial portion. The portion of the aorta which protruded through the atrial chamber and opened to the outside was kept sealed about the catheter during the determinations of pressure. The recordings of pressure were obtained with a Sanborn electromanometer and a direct writing 4 channel Polyvisocardiograph. The volume of flow of fluid through this intracardiac tube was determined by attaching its open end to wide lumen polythene tubing which led to a saline filled reservoir. The pressure at which flow took place was ascertained by measuring the height of the column of fluid at the start of a one-minute flow period and its height at the conclusion. The average of these 2 values was taken at the mean pressure for that particular flow period. Intraventricular injections of l-arterenol were given to observe the effect of great increases in ventricular pressure upon the pressure within the atrial end of the segment. In order to eliminate any possible valve-like action of the mitral valve or annulus fibrosis upon the aortic segment, flows were determined through a rigid tube passed into the aortic segment to a point just beyond the mitral valve. Animals were sacrificed at

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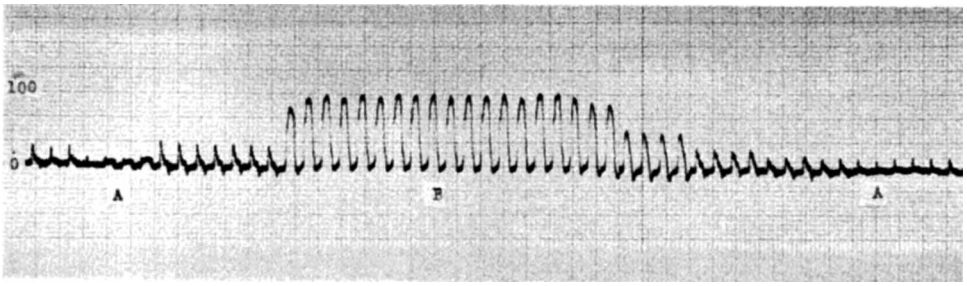

FIG. 1. Pressure pulses within the intracardiac aortic segment. These pressures were recorded as a cardiac catheter was slowly advanced from the atrial portion of the aortic segment (A), into the ventricular portion (B), and then withdrawn into the atrial portion (A). Pressure in mm of Hg is shown at the left. Speed of paper = 10 cm/sec.

the conclusion of the determinations and the proper position of the aortic segment was verified in all experiments.

Results. Pressure values were obtained in 9 dogs within the ventricular and atrial portions of the aortic segment. The mean value and standard deviation of the systolic pressures within the ventricular portion were 104 ± 12.5 mm Hg. Diastolic pressures in the same area ranged between zero and 4 mm Hg. The mean value and standard deviation of pressures within the atrial portion were 12 ± 3.4 mm Hg. The average pressure of 12 mm Hg within the atrial portion is not much greater than that observed normally in the left atrium of dogs (2-10 mm Hg) and would be compatible with a pulmonary capillary pressure well below that necessary to produce pulmonary edema.

Recordings of pressure were made in 3 animals during acute hypertension resulting from injection of l-arterenol. Ventricular systolic pressures were raised to heights of 360, 280 and 330 mm Hg. The corresponding pressures within the atrial portion of the aortic segment were, respectively, 16.0, 16.3, and 20.0 mm Hg. The existence of a great pressure differential between the ventricular and atrial portions of the aortic segment is offered as evidence as the predicted valve-like action. It might be pointed out that this change in pressure occurs abruptly. This is shown in Fig. 1 which is a typical tracing obtained by slowly advancing a cardiac catheter from the atrial to the ventricular portion of the aortic segment and then slowly withdrawing it.

TABLE I. Flow Values in 8 Dogs.

	Flow (cc saline), min.	Mean pressure, mm Hg
	250	10
	240	24
	185	17.6
	400	17.6
	197	15.8
	220	15.6
	225	15.1
	125	19.0
Avg	230	16.8

In order to demonstrate that ventricular filling would take place through this aortic segment, observations were made on the volume of saline which flowed from a reservoir through the aortic segment into the left ventricle. By raising or lowering the reservoir various levels of pressure could be maintained. The average flow per minute was 230 cc with a range of 125 to 400 cc and the average pressure at which these flows took place was 16.8 mm Hg with a range of 10 to 24 mm Hg (Table I). During the period of saline flow from reservoir to ventricle, no reverse flow of blood from ventricle to reservoir was observed. Ventricular systole merely caused an abrupt cessation of orthograde flow, at which time, a marked water-hammer effect was observable. If the protruding end of the aortic segment remained open to the atmosphere some back flow of blood was observed. This was the result of retrograde filling of the tube during diastole and the expulsion of this blood when ventricular systole reduced its volume. The maintenance of a modest continuous pressure from the saline reservoir completely prevented this back flow.

Summary. The valve-like action of a sim-

ple segment of aorta leading from the left atrium into the cavity of the left ventricle has been demonstrated. Orthograde flow from a reservoir of saline through the aortic tube into the left ventricle has been shown to occur in the living animal. No regurgitation has been observed. This observation has been documented by means of pressure determinations obtained within the portion of aorta lying in the left ventricle and that in the left atrium. An average systolic pressure of 104 mm Hg was observed in the ventricular portion and an average mean pressure of 12 mm Hg in the atrial portion. This demonstration of orthograde flow during diastole without retrograde flow during ventricular systole is felt to constitute evidence of an effective valve-like action.

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Influence of Low Protein Diet on Distribution of D-Amino Acid Oxidases in Rats.* (20372)

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In connection with a series of experiments on the influence of nutrition on the development of hepatic tumors, the effect of nutritional factors on the amino acid oxidases was studied. A decrease of amino acid oxidases was found previously in hepatic tumors(1-3) as well as with the livers of rats bearing transplanted liver tumors.

The present investigation attempted to answer the following questions: a) do nutritional factors influence the levels of amino acid oxidases, b) is such an influence general or restricted to any one organ, and c) does the administration of an estrogen together with a low protein diet produce any changes in the level of amino acid oxidase. The impairment of the detoxication of estrogens on low protein diet has been described(4). Experiments on the possibility of the production of hepatic tumors by estrogens added to a low protein diet are being carried out in this laboratory. In the rat, amino acid oxidases are present in appreciable quantities only in the liver and in the kidneys(5). In both organs a general D-amino acid oxidase has been demonstrated. In addition, a specific D-aspartic acid oxidase has been found in pig kidneys(6). In the present experiment the amino acid oxidases were studied both in the liver and in the kidney. Although next to D-L-alanine, D-aspartic acid was used as substrate, no attempt was made to separate the activity of the general D-amino acid oxidase from the specific D-aspartic acid oxidase.

Materials and methods. Young Wistar rats of both sexes, weighing 70-90 g at the beginning of the experiment were divided into 3 groups; one was kept on a full diet, one on a low protein diet, and a third group on a low protein diet with the addition of alpha estradiol. Rats fed on rat biscuits served as control on full diet. The low protein diet consisted of: Protein (vitamin-free casein) 8.5%, carbohydrate (sugar and cornstarch) 70%, fat (lard and vegetable oil) 17%, salt mixture 3.5%, and cod liver oil 1%. Vit. B and E were given to 1000 g of diet in the following amounts: thiamin hydrochloride 6 mg, pyridoxin 20 mg, inositol 15 mg, choline dihydrogenphosphate 100 mg, calcium pantothenate 20 mg, and alpha tocopherol 30 mg. Food and water were given *ad lib.* Alpha estradiol was fed to half the number of the rats on the experimental diet. Each of these rats received orally by eye dropper 5 μg estradiol dissolved in 0.1 ml olive oil daily

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