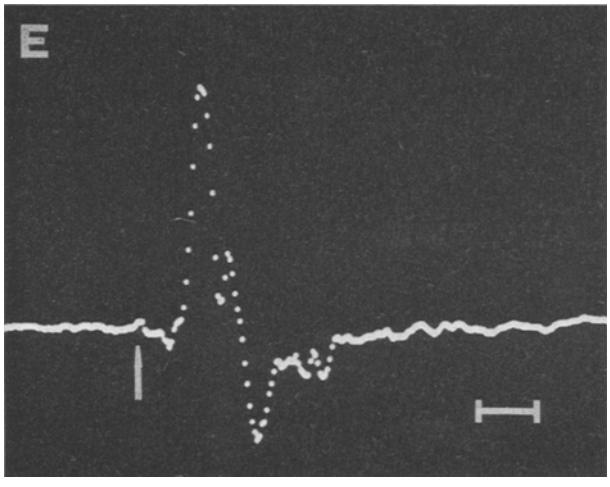
The bulbar and cervical sites influenced by stretch of extrinsic eye muscles could also be activated by single-shock electrical stimulation of the cells of the semilunar ganglion representing the first order neurons of the eye muscle proprioception with a latency of about 1.5 msec (Figure E).

In 2 lambs the experiment was carried out with the same procedure as that mentioned above, but under aseptical conditions. Only the left eye muscles were isolated and no tracheotomy was performed. After identification of a good response to stretch of single eye muscles within the bulbar portion of the descending trigeminal nucleus, a discrete electrolysis was made of the recorded site; then the cranial operation wounds and the 2 eyelids of the left side were sutured together and the animals were kept alive for 10 days. Subsequently the lambs were sacrificed in excellent general conditions under deep anaesthesia; the brain stem was perfused with saline solution and then with 10% formalin solution. The brain stem was removed and stained according to the Nauta-Gygax method for searching degeneration of nervous fibres. The histological examination showed degenerated nervous fibres along the remaining bulbar portion of the descending trigeminal nucleus down to the first cervical segment. The degeneration involved fibres of different diameter which were not collected in bundles but scattered within the nucleus.

In conclusion, the results of the present investigation show for the first time that cells responding to stretch of single extraocular muscles are present not only in the pontine oral pole of the descending trigeminal nucleus but also in its bulbar and cervical portions. Such cells could mediate both the excitatory and the inhibitory influences of the stretch of the eye muscles on the extensor muscles of the neck, as recently shown in the cat and in the lamb[11–14].



E) The same animal as in D). Average of 64 potentials recorded from the descending trigeminal nucleus before the electrolysis, evoked by electrical stimulation (1/sec, 0.1 msec, 0.1 V) of the extraocular muscle representation in the ipsilateral semilunar ganglion. The arrow points to the stimulus artifact. Calibration time 2.5 msec.

Summary. Units responding to stretch of single extraocular muscles were found in the bulbar and cervical portion of the descending trigeminal nucleus of the lamb. The electrolysis of these bulbar sites provoked degeneration of nervous fibres which could be followed till the first cervical segment of the spinal cord.

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Elevated Left Ventricular Stiffness by Noradrenaline in Myocardial Ischaemia

Despite their extensive cardiac effects, catecholamines apparently do not affect the resting ventricular distensibility[1]. At the same time there is a well-documented increase in the left ventricular wall stiffness during myocardial infarction and anginal attacks[2,3]. These phenomena are closely associated with or even precipitated by an enhanced release of the sympathetic transmitter in the cardiac tissue.

The question arises as to whether an indirect effect of the catecholamines plays a role in the development of the wall stiffness increase during myocardial ischaemia. The aim of the present study was to test the role of the combined effects of noradrenaline and tissue hypoxia in the genesis of the ventricular stiffening.

Methods. 24 experiments were carried out on open chest, pericardiectomized dogs (10–16 kg) of either sex, under chloralose anaesthesia. Pressures were measured by gauges Db 23, Statham, through rigid catheters introduced into the ascending aorta and left ventricular apex, respectively. The pressure curves were recorded simultaneously with cardiac output curves (thermodilution method) on an Elema Mingograph.

The diastolic pressure-volume curve of both the normal and infarcted ventricle is exponential at physiologic pressure[4,5]. Considering this fact, the stiffness of the left ventricle was characterized by the slope of the linear relationship between diastolic $\Delta P/\Delta V$ and $\bar{P}_D$ at various segments of the exponential P-V curves, where ΔP is the arithmetic difference between end-diastolic and end-systolic pressure, ΔV is the stroke volume, while $\bar{P}_D$ is the mean intraventricular diastolic pressure.

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Delayed effects of noradrenaline on left ventricular wall stiffness and systemic circulation (Mean values ± SE)

	Normal		Myocardial infarction					
	Group 1 ($n = 6$)		Group 2 (2 h, $n = 6$)		Group 3 (24–48 h, $n = 6$)		Group 4 (30–72 h, $n = 6$)	
	A	B	A	B	A	B	A	B
Passive elastic modulus (ml^{-1})	0.035 ± 0.007	0.045 ± 0.008	0.036 ± 0.010	0.106 ± 0.012[c]	0.056 ± 0.012	0.104 ± 0.015[b]	0.072 ± 0.022	0.070 ± 0.011
End diastolic pressure (mm Hg)	4.8 ± 1.0	6.0 ± 0.9[a]	6.1 ± 1.6	8.6 ± 1.9[a]	9.1 ± 2.3	11.7 ± 2.8[a]	6.3 ± 0.8	6.5 ± 1.6
Cardiac output ($ml\,min^{-1}\,kg^{-1}$)	117 ± 13	109 ± 27	98 ± 10	96 ± 7	98 ± 16	76 ± 18	113 ± 8	90 ± 13
Heart rate (min^{-1})	171 ± 9	168 ± 13	147 ± 8	151 ± 11	160 ± 7	168 ± 12	124 ± 11	127 ± 13
Mean blood pressure (mm Hg)	85 ± 6	70 ± 11	81 ± 6	71 ± 7	76 ± 4	72 ± 4	73 ± 5	63 ± 6

A) before, B) after noradrenaline infusion (1.0 ug/kg/min for 10 min). [a] p 0.05; [b] p 0.01; [c] p 0.001.

The numerical value of this slope, termed the passive elastic modulus, was found to be directly and predominantly determined by wall stiffness[6]. In order to measure $\Delta P/\Delta V$ as well as $\bar{P}_D$ in a wide range, flow in the descending aorta was gradually blocked by means of step-by-step inflation of an embolectomy catheter introduced through the femoral artery. Bilateral vagotomy and thoracic sympathectomy was performed to prevent reflex influences on cardiac activity during this manoeuvre. Since P–V relationship is not exponential at low values of P, data obtained at pressures less than 2.5 mm Hg were excluded.

Four groups of experiments were performed: 1. Dogs with intact heart. 2. Dogs subjected to segmental myocardial ischaemia 2 h prior to the measurement; ischaemia was produced by ligating the left anterior descending (LAD) coronary artery just proximal to its first major oblique branch. 3. Dogs in which the occlusion of the LAD artery was performed 24–48 h prior to the experiment. 4. Dogs subjected to the LAD artery occlusion 30–72 days prior to the experiment.

After the control determination the dogs were given noradrenaline (1.0 µg/min/kg body weight) i.v. for an infusion period of 10 min. Systolic pressures in the systemic circulation were usually doubled during the loading period. After noradrenaline infusion at least 5–10 min were allowed for the establishment of a new circulatory equilibrium, then the determination was repeated again. The results were examined statistically using Student's t-test for paired data.

Results. The experiments showed that the value of the diastolic $\Delta P/\Delta V$ relationship increases linearly as a function of the mean diastolic pressure, $\bar{P}_D$. An example is shown in the Figure. These results validate the method used in this study for the determination of the ventricular wall stiffness and confirm the previous similar observations of DIAMOND and FORRESTER[4,6]. At the same time, in dogs subjected to acute cardiac infarction, the slope of the linear plot, the passive elastic modulus, increased considerably after the noradrenaline infusion, thus revealing an augmentation in the left ventricular wall stiffness/see Figure and Table, summarizing all the results obtained, indicates that a similar increase of stiffness could not be observed either in the normal dogs or in the chronic (4) group, although the latter animals exhibited an elevated pre-load value of the wall stiffness as compared to the normal level. It appears from the data in the Table, moreover, that noradrenaline strongly affecting ventricular elasticity in acute myocardial infarction, did not produce lasting post-infusion changes of similar extent in other circulatory parameters, with the exception of a moderate left ventricular end-diastolic pressure increase in some groups.

Conclusion. From the data obtained, it would appear that diastolic wall stiffness is a variable and dynamic rather than a static parameter of the relaxed left ventricle (a) and that adrenergic influences may play a decisive though indirect role in its adjustment (b). Basic preload values presented in this report for left ventricular wall stiffness were slightly elevated in acute myocardial infarction induced by coronary ligation (experimental group 3), while they were found to be considerably elevated in the healing phase of the infarction (group 4). Apparently this is due to the progressive increase of the volume of the connective and/or fibrotic tissue in the ventricular wall during the regenerative process. In the chronic phase, however, the heart is clearly less susceptible to the stiffning

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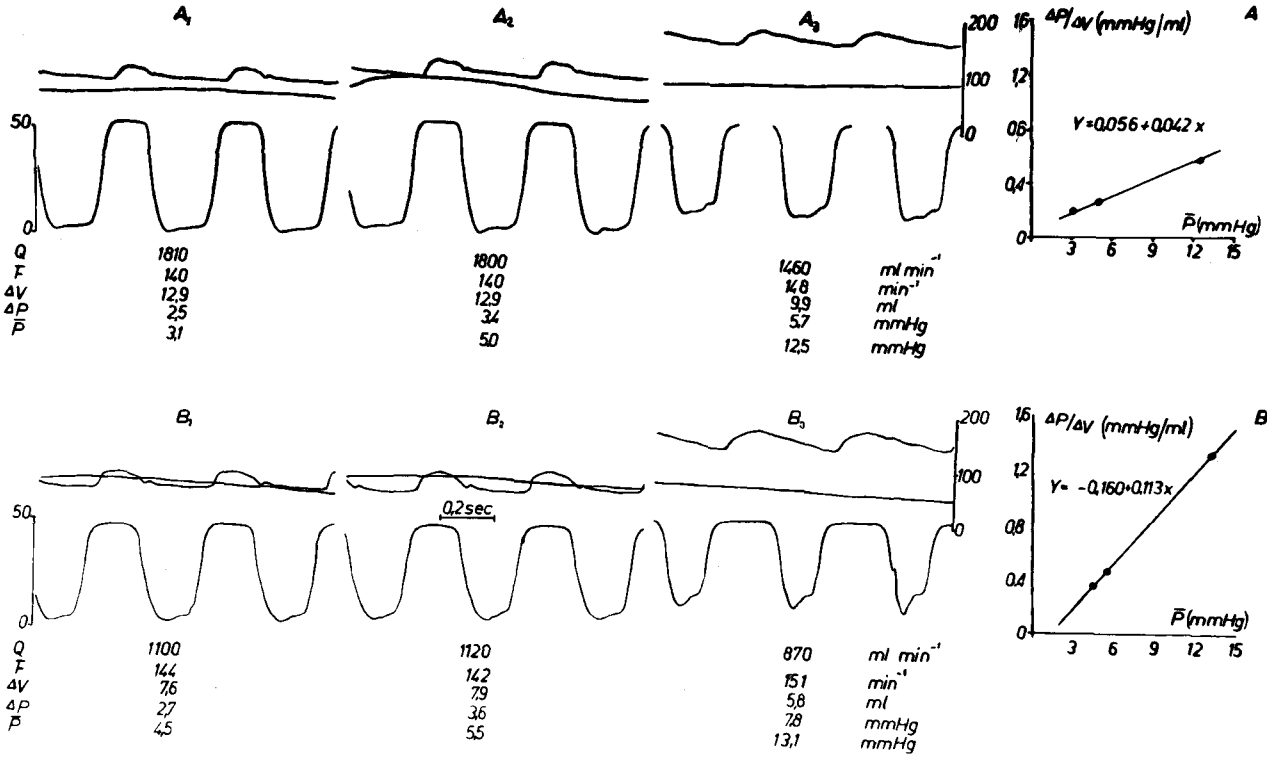

Left ventricular wall stiffness before (A) and after (B) noradrenaline infusion (experiment 3–2, 16 kg, 24 h after coronary ligation). Left: Aortic and left ventricular diastolic pressures at 3 different afterloads (fragments of thermodilution curves also can be seen on the records). Values of cardiac output (Q), heart rate (F), stroke volume (ΔV), intraventricular pressure increase during diastole (ΔP) and mean left ventricular diastolic pressure ($\bar{P}_D$) are in each panel. Right: Plot of the $\Delta P/\Delta V$ ratio againt $\bar{P}_D$. Passive elastic modulus of the left ventricle (slope of the regression line) increased from 0.042 to 0.113.

influence of the sympathetic transmitter. These findings suggest that the increased wall stiffness seen after catecholamine administration is a manifestation of same pathologic pattern induced by myocardial hypoxia. The exact mechanism underlying this pattern remains to be elucidated.

Summary. Infusion of noradrenaline (1.0 µg/kg/min body weight, i.v.) brings about an increase of the diastolic wall stiffness in the ischaemic canine heart. Similar effect is not elicitable in the normal heart.

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Chemical Transfer of Learned Behaviour: No Specific Effect Observed in Rats Trained to Swim Either of two Mazes

The mechanism by which intellectual information is stored in the brain has remained obscure despite many attempts to resolve this important question. One theory holds that brain chemicals might serve as specific memory carriers. Consequently, interanimal transfer of acquired behaviour should be feasible using brain extracts. This has been a controversial issue since the time of the first allegedly successful experiment[1]. Two behaviour-inducing peptides have been isolated from the brains of trained rats; one elicits fear of darkness[2] while the other is sound habituating[3]. It has been argued that both these effects might be non-specific, simply being brought about by alterations in the state of alertness of the recipient animals. Such an argument would not be suitable to invalidate a recent report claiming the successful transfer in mice of detailed spatial information about a maze[4].

The importance of this latter finding, if reproducible, prompted us to repeat the experiment under slightly altered conditions. In particular, a swimming maze with rats was used to minimize the possibility that the animals might exploit odour cues for orienting in the maze. As in the original experiment, 2 different mazes were used to test the specificity of the transferred information, but the 2 mazes were set up as mirror images to facilitate

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