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STUDIES ON MONOAMINE LEVELS IN RAT MYOCARDIUM IN DIFFERENT STRESSES

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Summary : Albino rats were exposed to isolation, haemorrhagic, and psychic stress. The myocardial norepinephrine (NE), epinephrine (E), dopamine (DA), 5-hydroxytryptamine (5HT) and 5-hydroxy indole acetic acid (5HIAA) were quantitatively estimated at varying periods of time. The results indicate that 5HT, E, and DA are the common denominators in various types of stress and show similar qualitative changes in all the stresses studied whereas norepinephrine shows both quantitative and qualitative differences in the various stresses studied indicating thereby a differential modulatory mechanisms operating for the release of noradrenaline.

INTRODUCTION

It is well known that Epinephrine (E) acts as the first line of defence in a stressful condition. It has been shown that various stressors increase the circulating epinephrine level due to enhanced release from adrenal medulla. In addition several organs of mammals contain small quantities of epinephrine in their resting condition (1, 2, 3, 4) and stress has shown to increase the adrenaline content in heart and liver of rats exposed to swimming stress (2). This may be due to the enhanced uptake phenomenon of the tissue in response to increased circulating level of epinephrine (5, 6).

It is however not known whether similar changes are seen in the other catecholamines and indole amines content in the heart during stress : and if so whether different types of stress produce similar temporal pattern of changes ?

To elucidate these points we have studied the steady state levels of norepinephrine (NE), epinephrine (E), dopamine (DA), 5 hydroxy tryptamine (5 HT) and 5 hydroxy indole acetic acid (5 HIAA) in myocardium of animals exposed to isolation, haemorrhagic and psychic stress. Such a study will clearly indicate the participation of other biogenic amines on the stress induced myocardial damage.

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MATERIALS AND METHODS

Male albino rats of Wistar strain (100-120 G) were kept in standard laboratory conditions, fed with food and water ad libitum. The animals were divided into four groups as indicated below.

Group 1 : Control (n=12)

This group of animals were not subjected to any type of stress and were housed in two cages with six animals per cage.

Groups 2, 3 & 4 (18 animals in each group) were exposed to isolation, haemorrhagic and psychic stress respectively as described in our previous work (7). The stressed animals (six animals in each group) were sacrificed by decapitation at varying time

intervals according to the type of stress. Immediately after sacrifice the heart was dissected out, weighed after removing the clots in the chambers, cut into small pieces (2 * 2 mm) mixed with 0.5 G of sterile silica, ground in a mortar manually for 30 minutes with (1 : 10 w/v) cold acidified n-butanol. The mixture is centrifuged at 300 rpm for 15 min, supernatant collected for the estimation of catecholamines by Kari's method (8).

RESULTS

None of the experimental animals died during the course of this study. Our preliminary experiments have shown that concurrent controls maintained under identical conditions to that of the test animals (except stress) for the duration of the study did not show any variations in the parameters studied, compared to the common controls and hence common controls were used throughout to compare the results. The results are summarized in Table I.

In general the results indicate that irrespective of the type of stress the pattern of response of 5 HT and 5 HIAA were similar whereas quantitative differences existed in the steady state levels of the catecholamines studied.

In isolation stress the NE level showed a significant decrease after 6 & 13 weeks and the pre stressed level was reached at 26 weeks. The DA and E showed a persistent rise in all the three stages of stress. The 5 HT level showed a decrease at 6 and 13 weeks, rose back to normal at 26 weeks. The 5-HIAA showed a persistent increase throughout the period of observation.

In haemorrhagic stress the NE level showed an initial rise followed by a fall at the end of 120 minutes. The levels of E and DA showed a significant increase in all the three stages of stress. The 5 HT

TABLE I : The Monoamine Concentration (μg/g Wet Weight) in the Rat Myocardium after 6,13 and 26 Weeks of Isolation Street compared with Control.

Monoamine Conc. In μg/g Wet Weight (Mean ± Sem)	*Control*	*Isolation stress in weeks*		
		6 (n-6)	13 (n-6)	26 (n-6)
Norepinephrine	0.336±0.052	0.154±0.078*	0 115±0.035**	0.394±0.101
Epinephrine	0.155±0.053	0.193±0.074	0.169±0.041	0.227±0.094*
Dopamine	0.068±0.023	0.172±0.089*	0.364±0.104**	0.142±0.038*
5-Hydroxytryptamine	0.313±0.061	0.147±0.062*	0.107±0.021**	0.362±0.098
5-Hydroxy Indole Acetic Acid	0.073±0.017	0.133±0.021*	0.321±0.083**	0.342±0.087**

* P<0.01; ** P<0.001.

and 5 HIAA changes were similar to the isolation stress. (Fig. 1).

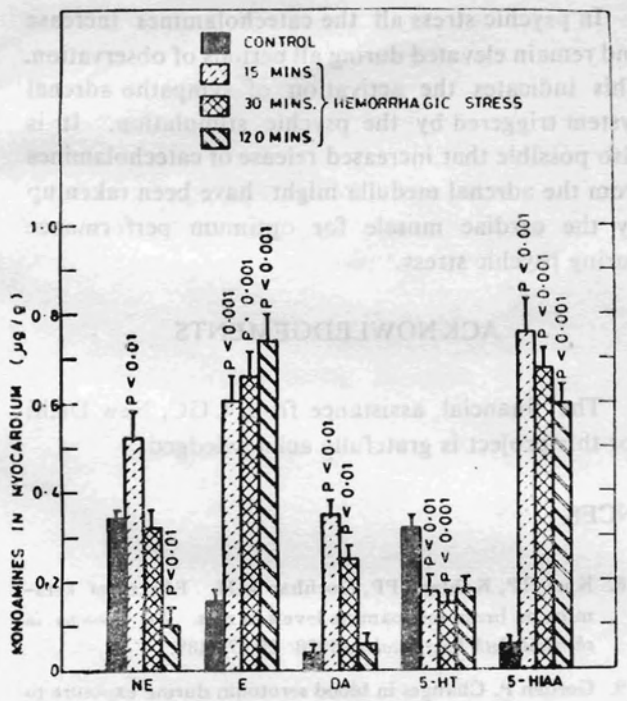

Fig. 1 : Concentration of Norepinephrine (NE), Epinephrine (E), Dopamine (DA), 5-Hydroxytryptamine (5 HT) and 5-Hydroxyindoleaceticacid (5-HIAA) (µg/g wet wt.) in the Myocardium after 15 30 and 120 minutes of Hemorrhagic stress compared with the control.
Vertical Bar Indicate S.E.M.

All the catecholamines in psychic stress showed a uniform increase during the period of observation. 5 HT and 5 HIAA changes were similar to that seen in isolation stress. (Fig. 2).

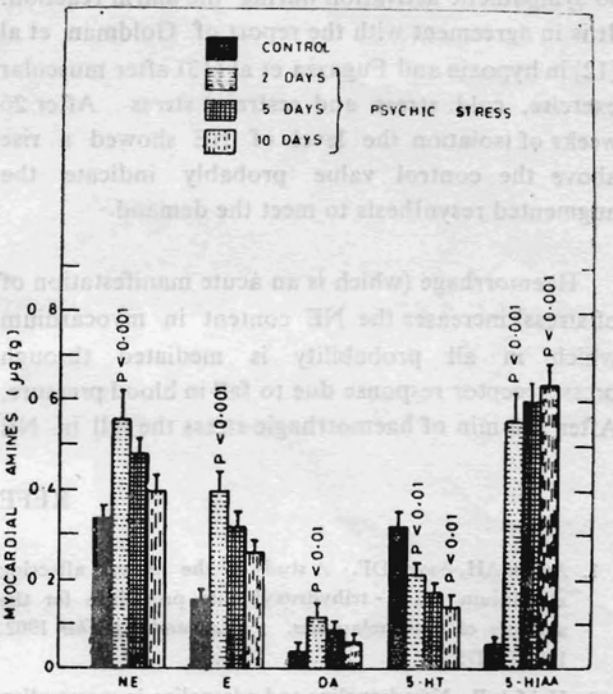

Fig. 2 : Concentration of Norepinephrine (NE) Epinephrine (E) Dopamine (DA) 5-Hydroxytryptamine (5-HT) and 5-Hhdroxyindole Aceticacid (5-HIAA) (µg/g wet wt.) in the Myocardium after 2,5 and 10 days of Psychic stress compared with the control.
Vertical Bar Indicates S.E.M.

DISCUSSION

From the results it is clear that a decrease in 5 HT along with a concomitant increase in 5 HIAA is seen in all three types of stresses studied showing that this is the final common denominator in stress of any type. The exact mechanism of these changes is not known at present. It has been reported that 5 HT is released in acute stress (9) and its involvement in regulation of intracellular calcium is well documented (10, 11). In our study a decrease in 5 HT and an increase in 5 HIAA simply denote the activation of serotonergic mechanisms in the animal during stress. Studies on the turnover rates of 5 HT will throw more light on this aspect.

Another common denominator in all the three types of stress is the increase in DA and E levels. It has been shown already that stress causes an increase in the circulating adrenaline level due to its enhanced release from the adrenal medulla (3). Hence the increased E and DA content in the myocardium may be attributed to the increased uptake of these amines by the cardiac muscle fibres.

Discrepancies are seen only with NF level after stress. The decreased level of NE after 6 and 13 weeks of isolation is suggestive of increased release of endogenous amines from the heart, probably due to sympathetic activation during the alarm reaction. It is in agreement with the report of Goldman et al (12) in hypoxia and Fugazza et al (13) after muscular exercise, cold stress and restraint stress After 26 weeks of isolation the level of NE showed a rise above the control value probably indicate the augmented resynthesis to meet the demand.

Haemorrhage (which is an acute manifestation of of stress) increases the NE content in myocardium which in all probability is mediated through pressoreceptor response due to fall in blood pressure. After 120 min of haemorrhagic stress the fall in NE level might be due to the decreased synthesis initiated by the stagnant hypoxia as suggested by Glaviano and Coleman in rabbit ventricle. (14, 15)

In psychic stress all the catecholamines increase and remain elevated during all periods of observation. This indicates the activation of sympatho adrenal system triggered by the psychic stimulation. It is also possible that increased release of catecholamines from the adrenal medulla might have been taken up by the cardiac muscle for optimum performance during psychic stress.

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