

EFFECT OF STRESS ON ORGAN WEIGHT IN RATS

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Abstract : The effect of 90 minute supine restraint or forcedswim stress, on weights of various organs in sixty adult male albino rats was studied. One group of twenty rats served as control; second group of twenty was immobilized and third group of twenty was forced to swim in water at room temperature.

The animals were studied for a period of 15 days. During this period, they were subjected to 90 minutes of stress everyday at the same time. Both the groups of stressed animals showed a statistically significant increase in weight of cerebrum, cerebellum, pituitary, thyroid, and adrenals. Testes and seminal vesicles showed no significant change in weight. There was an apparent increase in weight of liver after immobilization stress, and a statistically significant increase in its weight in forced swim group. Therefore, immobilization and forced swim stresses produce an increase in the weight of braincerebrum and cerebellum, endocrine organs and liver.

Key words : stress immobilization force-swim organ weight

INTRODUCTION

Stress is defined as "Non specific result of any demand upon the body" (1). Stress can be either physical or psychological. The response to stress in humans is varied - some overcome stress, while others succumb. This difference depends upon the levels of hormones secreted over a period of time.

Stress can be induced in experimental animals in various forms e.g. immobilization forced-swim, exposure to cold environment, starvation etc. The various physiological changes seen in response to stress are primarily due to increased hypothalamo pituitary action (2), which in turn induces activation of pituitary adrenal system, both cortical and medullary and also the opio-melanocortin system among others (3). Increases in CRH is the hallmark of stress but secretions like catecholamines, enkephalins, endorphins, TSH and prolactin are also released in greater quantities (4, 5, 6, 7, 8). When prolactin levels are increased, it was shown to decrease gonadotropin secretion resulting in hypogonadism (9). The various end organs thus react to the changed levels of hormones.

Extensive research has been done on the effects of stress on the levels of various hormones in the blood but information about stress-induced alterations in the weight of various organs is lacking.

The present work was undertaken to study the effect of stress on weight of cerebrum, cerebellum, pituitary, thyroid, adrenals, gonads and liver in rats.

METHODS

Sixty adult male albino rats of more than 90 days old, weighing between 180 and 240 grams were used. They were housed in separate individual plastic cages. They were divided into three groups of 20 animals each. The first group of animals served as controls while the other groups were subjected to stress for 90 mts. daily - the second group of animals to supine restraint stress and third group was forced to swim in water at room tempertaure.

Everyday between 0900 and 0930 hrs the rats were weighed and their food and water intakes were measured. The control rats were returned to their home cages and no food or fluid was made available to them

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till 1130 hrs. The animals belonging to stress group were subjected to stress from 1000 to 1130 hrs. The rats were immobilized in supine position by restraining them in wire-mesh cylinders which can be adjusted to snugly fit the body of the rat (Fig.1). Forced swim stress was exerted by putting the rats in cylindrical vessels (length 48 cm and diameter 30 cm) filled with water to a height of 25 cm (Fig. 1). At 1130 hrs animals belonging to both the stress groups were then put back in their home cages. From 1130 hrs to 0900 hrs the next day all animals were provided with well balanced rat feed (Hind-Lever Pellets) and water *ad libitum*. Each rat was studied for a period of 15 days.

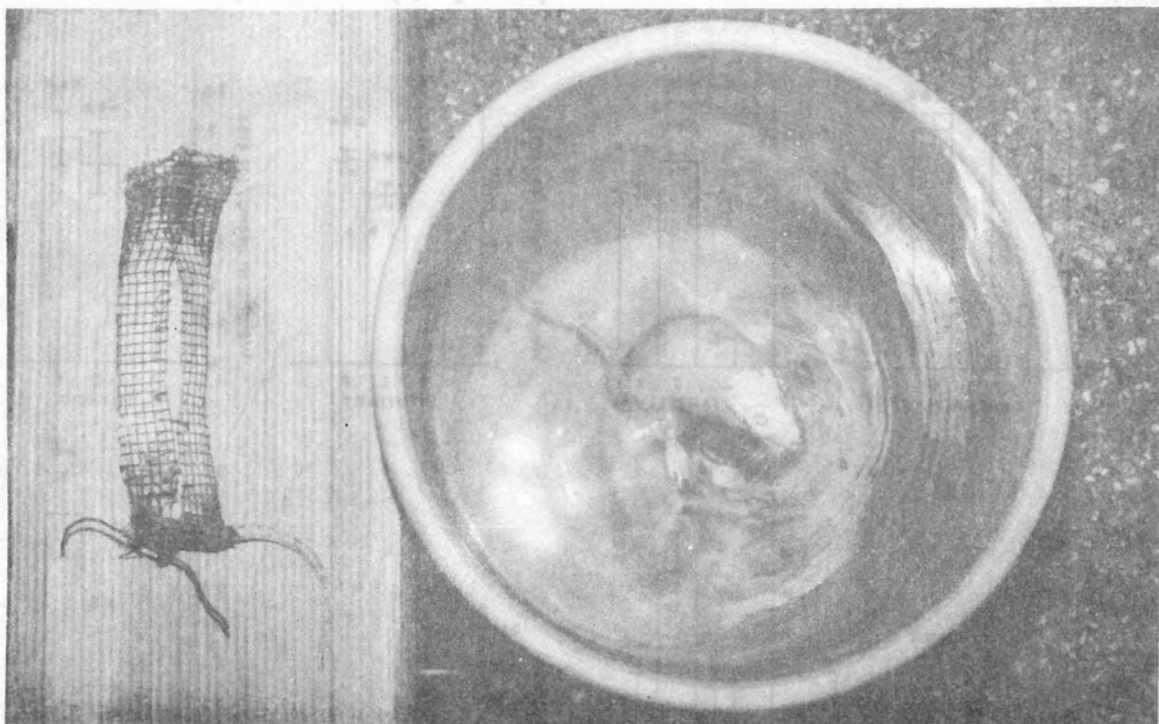


Fig.1 : Types of stress. Immobilization in a snugly fitting wiremesh cylinder and forced swim stress in a smooth walled cylindrical vessel filled with water.

After 15 days the rats were sacrificed with an overdose of nembutal. Various organs were removed, dried on filter paper and weighed on a sensitive balance to the nearest 0.1 mg.

RESULTS

The weights of various organs were computed per 100 gms body weight.

Brain weight : Weight of cerebrum increased in both the stress groups. This increase was statistically significant ($P < 0.001$). Similarly the weight of cerebellum both in immobilization stress group and forced swim group showed a highly significant increase ($P < 0.001$).

Weight of endocrine organs : Weight of pituitary showed highly significant increase in case of immobilization stress and forced swim stress ($P < 0.001$). Thyroid also showed similar significant increase in weight in both the groups ($P < 0.001$) compared to controls. Adrenals of both groups showed a significant

increase in weight ($P < 0.01$) for immobilization stress and ($P < 0.001$) for forced swim stress.

Weight of genital organs : In case of immobilization stress, testes showed a slight increase in weight but this increase was not statistically significant. In some animals of the immobilization stress group a hypertrophied testis was found on one side. Therefore

mean gonadal weight showed a marginal increase. In case of forced swim stress, there was a marginal decrease in mean weight of testes, but this decrease in weight was not statistically significant.

Seminal vesicles showed an apparent decrease in weight in case of immobilization stress and an apparent increase in case of forced swim stress.

Weight of liver : Liver weighed more after immobilization stress but this increase was not statistically significant. In case of forced swim stress, the weight of liver showed statistically significant increase compared to control ($P < 0.01$) (Fig. 2 and Table I).

DISCUSSION

In our study, the animals were subjected to $1\frac{1}{2}$ hr of forced swimming (F-S) or supine restraint (SR) stress, everyday for 15 days. F-S produces a greater physical and metabolic stress than restraint which is more a psychological stress (10).

Both cerebrum and cerebellum showed significant increases in their weight. SR stress produced a greater increase in the weight of cerebrum and cerebellum than F-S stress. Koob and Bloom, and Meyer have shown that an increase in the weight of brain could result from either an increase in neuronal pathways (2) or from myelination of the already

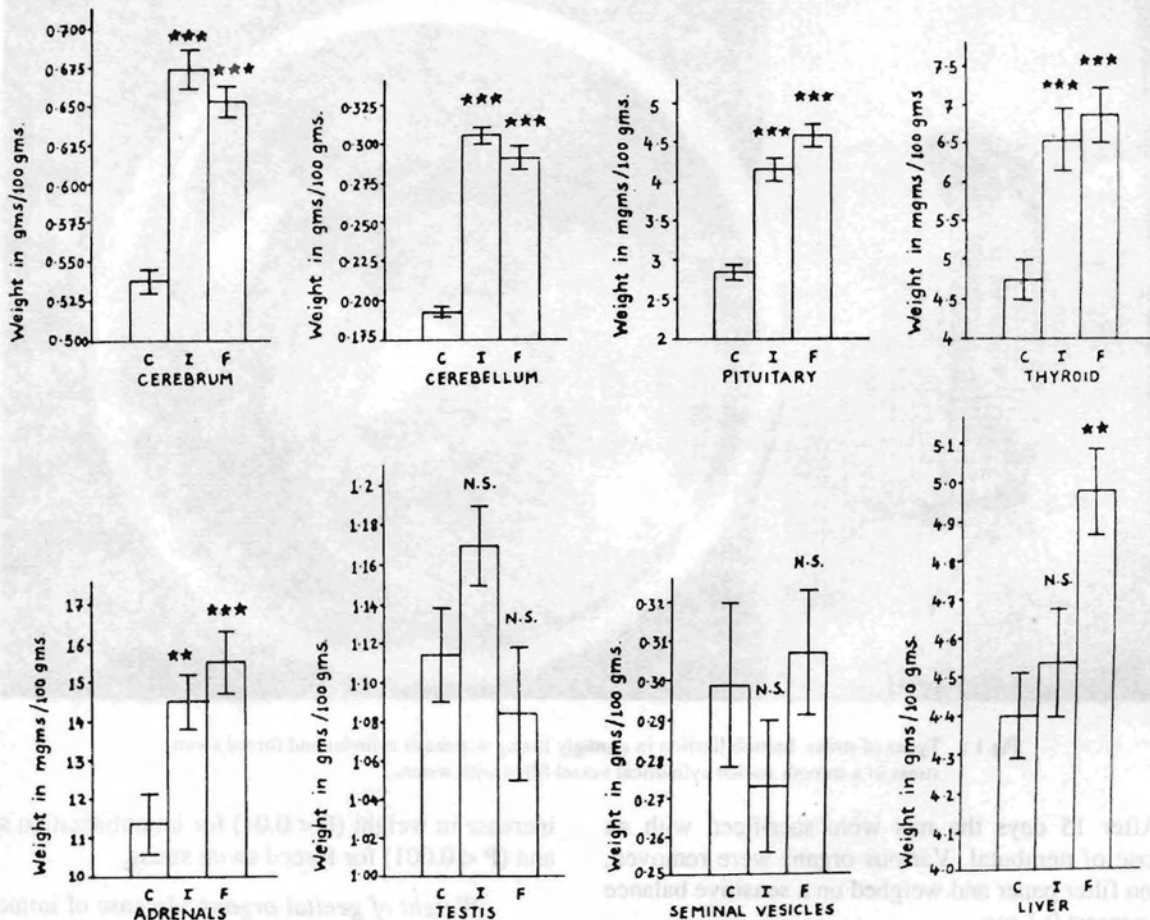


Fig. 2 : Effect of stress on mean weights of the various organs expressed in grams or milligrams per 100 grams of body weight \pm SEM c = control, I = Immobilization stress, F = forced swim stress. NS = Not significant.

P < 0.01 ; *P < 0.001

TABLE I: Effect of stress on mean weights of the various organs expressed in g or mg per 100 g of body weight \pm SEM N.S. (Not Significant).

	<i>Cerebrum</i>	<i>Cerebellum</i>	<i>Pituitary</i>	<i>Thyroid</i>	<i>Adrenals</i>	<i>Testis</i>	<i>Seminal Vesicles</i>	<i>Liver</i>
	(g)	(g)	(mg)	(mg)	(mg)	(g)	(g)	(g)
Control n = 20	0.537 ± 0.008	0.193 ± 0.002	2.842 ± 0.100	4.771 ± 0.256	11.391 ± 0.761	1.114 ± 0.024	0.299 ± 0.021	4.402 ± 0.113
Immobilization stress, n=20	0.674 ± 0.014	0.305 ± 0.006	4.158 ± 0.158	6.553 ± 0.384	14.529 ± 0.693	1.170 ± 0.020	0.273 ± 0.017	4.541 ± 0.138
P Value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.01	N.S.	N.S.	N.S.
Forced-swim stress, n=20	0.652 ± 0.011	0.290 ± 0.007	4.576 ± 0.158	6.920 ± 0.335	15.539 ± 0.768	1.084 ± 0.033	0.307 ± 0.016	4.983 ± 0.107
P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	N.S.	N.S.	< 0.01

existing ones (11). SR being a psychological stress, might have increased the neuronal pathways much more than a more physical stress, which is F-S. Such a significant increase in the weight of brain was also recorded by Monteiro et al (12) after SR stress.

The increase in the weight of pituitary seen was more in F-S than in SR. A similar change was observed in the weight of thyroid also. These increase were highly significant. The levels of CRH and TSH were shown to increase in stress (2, 3, 4, 5). Both are trophic hormones. Since the energy expenditure for muscle activity and thermogenesis is more in F-S than in S-R, the trophic effects are greater in F-S.

Adrenal glands showed a significant increase in weight which was more in F-S than in SR stress. Stress induces adrenomedullary response in man (13). Adrenalin in turn stimulates β_2 -receptors on the pituitary gland causing greater release of ACTH (14). ACTH can stimulate the adrenal medulla as well as cortex (15, 16). F-S being a physical stress causes greater release of adrenalin and greater increase in weight of adrenal gland than that seen in SR stress.

The change in weight of testes and seminal vesicles was not significant. Prolonged and severe stress lowers LH release (17). CRH inhibits the central release of GnRH which mediates the deleterious action of stress on reproductive organs (18). Since the stress in our study was neither prolonged nor severe, we did not observe a significant change in the weight of testes and seminal vesicles.

Liver weight increase was significant in F-S but not in S.R. Cortisol increase m-RNA levels in liver cells (19). Since the protein required for repair of wear and tear in F-S is greater and the metabolic changes are also more, the liver showed a significant increase in weight in F-S.

We conclude that stress in the form of restraint on forced swim increases the weight of various neural and endocrine organs, liver showing a significant increase in weight only in forced swim group. The effect on gonads was not significant.

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