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Biomechanics of Stress Induction, Stroke and Cardiovascular Disorder

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ABSTRACT

Stress is a factor of depression that initiates changes in biophysiology systems. Stress is the fundamental initiator of diseases and aging. Organisms devoid of stress could be investigated by scientists to understand effects this will have on existence. Several factors have been implicated as initiators of stress. However in the laboratory, effect of stress on animals are investigated using laboratory Wistar rats.Forced swim testis a stress or test used on laboratory rats to study effects of stress on animal's behavioural activation.Animal and human health are prone to stressful events. This could be life-threatening and can alter cognition, learning, memory, emotional responses, and mental balances.Our study was carried out to investigate the effects of stress on laboratory animals. Twelve apparently healthy albino Wistarrats of approximately 150-180gms were used for this study. Test animals were randomly divided into two groups of six animals each. Rats in group I were the control while group II rats passed through stress test. Rats in group II passed through stress test when placed in plastic tanks for 45 minutes every day for 15days. The plastic tank was filled with water and water temperature maintained at 20^{o}C. During stress test, animals were observed for behavioural changes in open field apparatus and elevated plus maze for anxiety.We observed that forcedswimstress teston rats caused a significant change ($p<0.05$) on their cognitive functions. Forced swim stress causes immobilization of test animals. Our study further indicated that repeated forced swimming stress activates free radical processes which increased lipid peroxidation in tissues.Our study has indicated that repeated forced swim stress on animal causes initiate changes in the central nervous system (CNS). This change in the CNS results to the elevation of serotonin (5- HT) metabolism.

Keywords: Stress, Biomedicine, Forced swim, Aging, Cardiovascular disorders.

INTRODUCTION

Many factors which encourage globalization could be adversely affecting human and animal health. These globalization effects could be diagnosed using modern technology. Correct diagnoses of diseases are fundamental in the treatment and management of any disease [1,2]. Thus, in this modern era with high rate of cardiovascular disorders coupled to poor government policies, especially in third world developing nations, simple basic diagnostic tools are vital in curbing the increased rate of cardiovascular diseases, which mostly are induced by stress [3,4]. Stress is a factor affecting every animal and human health and is prominent in all third world developing nations. Stress initiates depression [5] and is implicated in causation of various changes in body systems [6]. If untreated or properly managed, animal and human health are prone to stress which affects both cognitive, learning and emotional health resulting to severe mental disorders like anxiety, depression and maniac [7,8]. Stress could be defined depending on what initiates it and when not properly managed, could be lethal. It affects physiological, hormonal, and biochemical functioning of the entire system resulting to threatened homeostasis and cardiovascular system dysfunction [9,10], which may vary from mild to severe and from acute to chronic form. Meanwhile, behavioural tendencies and stress in animals and man could exacerbate cardiovascular dysfunctions. Therefore, stress research using laboratory animals is vital since findings could be correlated to understanding the initiation and progression of cardiovascular disorders

in humans. [11,12,13,14] had reported a relationship between environmental changes and the susceptibility of initiating high blood pressure and hypertension in stressed laboratory rats. Stress is an inducer of physiological and behavioural changes in affected organism. These changes alter homeostasis of the organism. When humans and animals are exposed to stressful situations, several biophysiological, neurological, and physiological changes take place [15] and induce the aging process [16]. According to the model developed by [17], forced swimming stress has generally been accepted for studying the effects of physical stress in laboratory animals. Swimming test used in laboratory animals studies bio-physiological changes associated withanimals' response to stress [18]. This test is experimentally important since swimming, which is not a simple exercise, requires emotional and neuro-physiological factors to maintain balance [19]. [20] has reported the importance of water temperature in forced swimming test indicated rats have high survival potential up to 80 hours in lukewarm water of 36°C. This survival potential, however, influences behavioural patterns of these animals by changing concentrations of their glucocorticoids [21]. In laboratory animals, swimming is used to elicit stress responses [22], which increases their corticosterone levels [23]. Increased corticosterone levels initiate rapid increase in oxygen intakeleading to release of toxic free radicals [24] with induction of patho-physiological changes like myocardial infarction [25],cardiovascular diseases, cancer, metabolic disorders, and aging [26].

Statement of Problem

Stress is inevitable in human and animal existence. Aging process and diseases/ailments are induced faster by stress. Inability to manage stress can also result to stroke, which is a cardiovascular disorder. Therefore, management of stress is vital to the control of aging, diseases, and cardiovascular disorders.

METHODS

Stress Induction Procedure: Immobilization stress model as described by [12] was used to induce stress on laboratory test animals.As described by [2], food and water were not allowed during the stress induction procedure. A total of twelve apparently healthy male albino Wistar rats, free of clinical signs of short or long-term illness, were used for this study. Ethical rights in animal handling were observed. Laboratory experimental animals were exposed to various environmental stressors and their systolic blood pressures obtained according to the method described by [26]. These environmental stressors included immobilization, individual isolation, forced swimming in a submerged pool of water, and overcrowding. Animals were exposed to stressors in varying days including one day, 7 days, 15 days, and 30 days. Each test animal had five minutes for the stress induction.

MATERIALS

Animal model:Adult Wistar rats of between 150-180g were divided into two groups were used for this study. Food and water were provided *ad libitum* to laboratory animals. Stress procedures: Rats were exposed tof orced swimming stress daily for 45 minutes. Animals were forced to swim in plastic tanks filled with clean water at 20°C temperature and a depth of 30 cm. Two rats were allowed in the tank for each test.Behavioural studies:Open-field test:The open field test measures the quantitative and qualitative explanatory behaviour of experimental animals. The method used for this was as described by [10]. Elevated plus-maze apparatus (EPM):Elevated plus-maze is apparatus used to study anxiolytic response of anti-anxiety agents. Exposure of the animals to maze alley evokes an approach avoidance conflict which is stronger in open arm as compared to enclosed arm. Rodents have a version for high and open space and prefer enclosed arm and, therefore, spend greater amount of time in enclosed arm. Animals freeze and become immobile and hence defecate and show fear-like movements when

they enter open arm. The method used for this study was as described by [10].

Statistical Data Analyses

Results obtained were analysed statistically using computerised analysis of variance version 20.

RESULTS

Table 1: Effect of stress on various behavioural parameters in open filed apparatus

Parameters	Mean SD		P Value
Peripheral ambulation	44.3±25.8	55.2±21.3	<0.03
Central ambulation	21.2±3.63	3.41±0.62	<0.002
Rearing	35.18±11.5	32.1±2.26	<0.004
Grooming	21.3±2.61	31.1±8.14	<0.004
Immobilization	37.2±4.71	31.3±4.31	<0.004
Defecation	1.62±1.12	0.98±1.85	<0.003
Urination	1.21±1.42	3.13±1.34	<0.02

Table 2: Effect of stress on various behavioural parameters in elevated plus maize

Parameters	Mean ± SD		P value
	Control	Stress Group	
Time spent in open arm	49.6±7.97	21.5±2.48	<0.01
Number of open arm entries	3.72±1.63	1.93±1.72	<0.03
Number of closed arm entries	4.42±2.11	1.51±0.28	<0.03

DISCUSSION

According to [21], forced swimming has been used to elicit stressresponse in laboratory albino Wistarrats while psychological stress like foot shock, forced swim test raises levels of corticosterone in rats [8]. A common hormone released during stress is corticosterone, which has been implicated in suppressing food appetite and increasing oxygen intake. Increased intake of oxygen subsequently results to biological generation of oxygen free radicals and other toxic free radicals. These radicals interfere with biological molecules resulting to diseases and increased aging.Our study correlates with other similar works on the relationship of brain neurons in corticosterone utilization [17] and effects of stress depression in neurological studies [5,12,16]. Our study revealed that forced swimming decreased the body weight of laboratory animals and increased their food intake resulting to significant change on cognitive function of animals. This is in agreement with earlier report from [10].

CONCLUSION

With reviews from similar studies in addition to our results, we can conclude from our study thatrepeated forced swim stress induces a wide range ofadaptive changes in the central nervous system. This change leads to elevation of serotonin (5-HT) metabolism and an increased susceptibility to affective disorders. We further conclude that albino Wistar rats are susceptible to cardiovascular aging. Meanwhile, continuous works need to be done to scientifically investigate this and correlate finding on humans.

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