

Relation between Heat Stress and Some Hormones in Alloxan Induced Diabetic Rats

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Abstract: The current study carried out to evaluate the levels of corticosterone, epinephrine, insulin and thyroxine accompanied induced diabetes mellitus in rats. Therefore, ninety six rats were divided into two main groups: control group which exposed to normal temperature (21 ± 2) °C and second group which exposed to high temperature (40 ± 2)°C each main group subdivided into three subgroups exposed to temperature for one, two and four hours respectively, also each subgroup composed of healthy rats and diabetic rats equally. At the end of experiment blood samples were collected for determination of corticosterone epinephrine, insulin and thyroxine.

Results revealed significant increase in corticosterone and epinephrine and insulin in heat stressed group compared with control group while there was significant decrease in thyroxine in healthy and diabetic rats in heat stressed group compared with control group. Results showed significant increase in corticosterone in diabetic rats compared with healthy rats in both groups, while the significant increase in epinephrine and insulin in diabetic rats was only in heat stressed group. Results reported significant decrease in corticosterone and thyroxine according to the increase in heat exposure duration, while epinephrine and insulin increased according to the duration. These findings indicated that heat stress may be increase harmful effects in alloxan induced diabetic rats.

Keywords : Diabetis mellitus, Heat stress, Hormones, Rats

I. Introduction

Heat stress refers to exposure to sudden high temperature for short a term duration or chronic exposure to heat (Emery, 2004). OSHA (2004) indicated that heat stress occurs when human body unable to loss the heat by sweating, also heat stress caused by high temperature and humidity direct exposure to sun, physical exertion and certain medications. Heat stress cause heat exhaustion, heat shock and healthy risks resulted from uncomfortable continuous tension (Riddell and Perkins, 1999). Stress is general and heat stress in particular has greatest influence on endocrine system and in particular hormones that play an important role in heat production and loss.

Collerir *et al.*, (2005) reported that heat stress has led to decline esterone level and increased progesterone in heat-stressed calves and that the exposure to high temperatures for short term led to elevate the levels of corticosterone and catecholamine, also found that there is an increase in prolactin and a decrease in aldosterone. In another study conducted by (Sinha, 2007) cortisol was elevated in rats after acute heat stress, but it did not occur any change after chronic heat stress also (Farooq *et al.*, 2009) indicated that heat stress whether acute or chronic led to increase cortisol initially but this decrease did not continue to long duration. Opaszawski *et al.*, (2001) found increase in growth hormone after sauna path.

Diabetes mellitus DM, defined as chronic clinical disease resulted from genetic and environmental factors (WHO, 2002) also it's hormonal disorder and unbalance in metabolism of saccharides, proteins, fats, water and electrolits accompanied with abnormal elevation in glucose level in blood, either because dysfunction in insulin secretion or defect in insulin action (Limaye *et al.*, 2003; King, 2004). DM accompanied by some disorders such as general weakness, polyuria (Allen, 2003) also lead to cardiovascular disease (Hermansen *et al.*, 2003) neuritis and skin disease (Votey and Peters, 2002), retinopathy (Oh *et al.*, 2005) and nephropathy (Azadbakht *et al.*, 2003).

Hormonal changes occurred in patients with diabetes mellitus, thyroid gland influenced by diabetes mellitus by defect in hypothalamus pituitary thyroid axis, also the increase in glucose level inhibits the enzyme deiodinase that responsible for conversion T4 to T3 (Snigh *et al.*, 2011). Also porjan *et al.*, (2010) found low levels of noradrenaline in patients with DM suffered from disorders which made them more effected by environmental conditions, in particular thermal changes, therefor current study aimed to evaluate hormonal changes in diabetic rats after exposure to heat stress for short – term

II. Materials and Methods

Experiment's animals:-

ninty six albino rats weighing (250–200) g with age (2-3) months were used in the current study, rats were underwent to standard conditions with light and temperature and given water and diet ad libitum.

Induction of diabetes mellitus type: rats were prevented the food for 24 hours and injected with alloxan at dose (100 mg/kg) (katsumata and katsumata, 1990). glucose solution (5%) was given for prevention acute glucose deficiency, determination of glucose was conducted by blood glucose strips test to choice rats which infected with diabetes mellitus

Experiment design:

Rats randomly divided into tow main groups:

1- control group: 48 male rate exposed to normal temperature (21±2) °C and subdivided to three subgroups, each subgroup consist of healthy and diabetic rates equally and exposed to the normal temperature for 1, 2 and 4 hours respectively

2- Heat stressed group: 48 male rats exposed to high temperature (40± 2) °C and subdivided into healthy and diabetic rate equally, which exposed to high temerature for 1, 2 and 4 hours respectively

Determination of hormones :

after each duration of the exposure to normal or high temperature, healthy and diabetic rats were sacrificed and blood samples were collected for hormonal assays. Levels of corticosterone epinephrine and insulin were determinate by use Elisa and according to method in kits (ABO, Switzerland) thyroxine level was measured by radioimmunoassay method.

III. Results

Corticosterone increased significantly(P <0.05) in heat-stressed group in comparison with control group either in healthy or diabetic rats also results showed significant increase(P <0.05) in diabetic rats compared with healthy rats in all three different duration of the heat exposure in both groups. On other hand , epinephrine also elevated significantly (P <0.05) in heat stressed subgroups compared with control group either the diabetic and healthy, rats in three different durations, epinephrine was not change significantly between healthy and diabetic rats after one hour of heat exposure, while there was significant difference(P <0.05) in epinephrine in diabetic rats compared with healthy rats in heat stressed group after two and four hours of heat exposure in addition, there was non significant difference within control group.

Results showed there was non significant difference in insulin in healthy and diabetic rats in heat stressed group compared with control group after one hour while after two and four hours there was significant increase(P <0.05) in insulin level in heat stressed group in comparison with control group Insulin decreased significantly in diabetic rats compared with healthy rats in heat stressed group for one hours while after four hours there was significant increase in diabetic rats compared with healthy rats in the same group.

On the other hand, thyroxine did not differs significantly in diabetic rats in heat stressed group for one hour compared with control group while there was significant decrease in healthy rats in heat stressed group after one hour of heat exposure but after two and four hours there was significant decrease (P<0.05) in diabetic and healthy rats in heat stressed group compared with control group. In regarding to the effect of induced diabetes mellitus there was significant

increase(P <0.05) in diabetic rats compared to healthy rats in heat stressed group for one hour while there was significant decrease (P<0.05) in thyroxine in control group after one , two and four hours. Results reported significant decrease in corticosterone and thyroxine according to the increase in heat exposure duration, while epinephrine and insulin increased according to the duration.

Table (1): Levels of corticosterone in healthy and diabetic rats exposed to different temperatures

Duratin	Control group		Heat stressed group	
	Healthy	diabetic	healthy	diabetic
One hour	2.86 ± 0.24 A	*4.03 ± 0.22 A	4.73 ± 0.20 B	*6.26 ± 0.35 B
	2.76 ± 0.16 A	*4.16 ± 0.11 B	5.15 ± 0.81 C	*6.53 ± 0.42 C
	2.10 ± 0.12 A	*3.86 ± 0.21 B	4.80 ± 0.15 C	5.06 ± 0.70 C

* indicates the presence of significant differences(P<0.05) between healthy and diabetic rats for each temperature and duratin, large different letters refer to significant difference between groups, small different letters refer to significant difference among durations. • values represent averages ± standard error.

LSD=0.38 (among different durations in each group)

Table (2): Levels of epinephrine in healthy and diabetic rats exposed to different temperatures

Duratin	Control group		Heat stressed group	
	Healthy	diabetic	healthy	diabetic
One hour	3.56 ± 0.14 A	3.60 ± 0.11 A	10.06 ± 0.16 BC	10.01 ± 0.35 C
	3.49 ± 0.11 A	3.53 ± 0.36 A	10.63 ± 0.27 B	*12.43 ± 0.52 B
	3.63 ± 0.13 A	3.83 ± 0.13 A	12.43 ± 0.12 B	*12.00 ± 0.19 B

A. * indicates the presence of significant differences(P<0.05) between healthy and diabetic rats for each temperature and duratin, large different letters refer to significant difference between groups, small different letters refer to significant difference among durations. • values represent averages ± standard error. LSD=0.45 (among different durations in each group)

Table (3): Levels of insulin in healthy and diabetic rats exposed to different temperatures

Duration	Control group		Heat stressed group	
	Healthy	diabetic	healthy	diabetic
One hour	0.80 ± 0.02 B	*0.66 ± 0.01 A	0.80 ± 0.10 B	*0.70 ± 0.05 A
Two hours	0.82 ± 0.10 A	*0.60 ± 0.07 A	0.96 ± 0.07 C	0.93 ± 0.02 B
Four hours	0.82 ± 0.03 A	*0.63 ± 0.06 B	0.96 ± 0.01 C	*1.10 ± 0.10 C

* indicates the presence of significant differences ($P < 0.05$) between healthy and diabetic rats for each temperature and duration, large different letters refer to significant difference between groups, small different letters refer to significant difference among durations.
• values represent averages $\pm$ standard error.

LSD=0.06 (among different durations in each group)

Table (4): Levels of thyroxine in healthy and diabetic rats exposed to different temperatures

Duration	Control group		Heat stressed group	
	Healthy	diabetic	healthy	diabetic
One hour	11.13 ± 0.58 A	*9.10 ± 0.91 A	8.80 ± 0.60 B	*9.63 ± 0.85 A
Two hours	10.99 ± 0.75 A	*9.23 ± 0.90 B	8.56 ± 0.66 C	*5.26 ± 0.91 A
Four hours	10.83 ± 0.23 A	*8.96 ± 0.33 B	5.86 ± 0.45 C	6.13 ± 0.75 D

* indicates the presence of significant differences ($P < 0.05$) between healthy and diabetic rats for each temperature and duration, large different letters refer to significant difference between groups, small different letters refer to significant difference among durations.

• values represent averages $\pm$ standard error.

LSD=0.81 (among different durations in each group)

IV. Discussion

Different types of stress such as thermal stress activate hypothalamus pituitary adrenal axis this response was induced by ACTH releasing (Paris *et al.*, 2010). ACTH stimulates adrenal gland to produce glucocorticoids such as corticosterone and catecholamines to increase glucose level (Bhattacharya *et al.*, 2000; Silberman *et al.*, 2002) demonstrate that corticosterone increased and returned to normal level in mice exposed to heat stress. All these studies agreed with the result of the current study that corticosterone level increased after heat exposure for one

two and four hours. On the other hand, induced diabetes mellitus affect in corticosterone increase, which may resulted from oxidative stress caused by DM which stimulate hypothalamus pituitary axis there by ACTH release (Djordjeric *et al.*, 2003).

Regarding to the effect of heat stress on diabetic rats, stress hormone such as (corticosterone) in particular increase in case of exposure to different types of stress, and thus heat stress affect and increase the effect of DM (Goldstein *et al.*, 1994; Radahmadi *et al.*, 2006). In previous study, cortisol increased after the exposure of diabetic rats to another type of stress (Dutour *et al.*, 1996). Heat stress play role in stimulation hypothalamus pituitary adrenal gland axis and sympathetic nervous system and releasing glucocorticoids and catecholamines (AL-Khalil, 2003), Epinephrine is one of stress hormones increase in particular acute stress (Goldstein *et al.*, 1994) also (Marco *et al.*, 2008) indicated that diabetes mellitus affect most function in body and causes defect in catecholamines metabolism.

Diabetes induced by alloxan, led to decrease insulin because degradation of B- cells (Subbiah *et al.*, 2005), in addition to oxidative stress associated with diabetes cause reduction of B-cells (Szkudelski, 2001). Heat stress doesn't affect insulin level compared with control group but the decrease in insulin level continued in diabetic rats compared with healthy rats in heat stressed group. Diabetes mellitus has inhibiting effect on deiodination and then decrease T3 production (Jatwa and Kar, 2006; Hamendra and Anand, 2007), on the other hand, alloxan injection lead to effect on hypothalamus. Pituitary thyroid axis. (Moura *et al.*, 1986; Udoing *et al.*, 2007) found that insulin modified the secretion of TRH and TSH in patients with DM. The decrease in thyroid hormones in rats exposed to heat stress due to homeostasis mechanisms which aimed to decrease metabolism rats and heat production (Horowitz, 2002)

V. References

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