

EFFECTS OF HEAT STRESS ON RAT'S KIDNEY

Yadav G, Jha C B, Baral P, Pandey N, Awasthi J R

**Department of Human Anatomy B P Koirala Institute of Health Sciences, Dharan, Nepal
Gandaki Medical College, Pokhara, Nepal**

ABSTRACT

Background: Heat stress is one of the most important stressors especially in hot regions of the world. Adaptation to heat stress requires the physiological integration of many organs and systems viz. endocrine, cardio respiratory and immune system. The aim of the study was to observe the effect of heat stress on rat's kidney.

Materials and Methods: The study was conducted in sixty adult albino rats at department of human anatomy, BP Koirala Institute of Health Sciences, Dharan, Nepal. Rats were randomly divided into two groups i.e. control and experimental each consisting of 30 rats. Rats belonging to control group and experimental group were kept in controlled room temperature of 25 ± 0.5 °C and 35 ± 0.5 °C for two weeks. On 15th day all rats sacrificed and both kidneys from each rat were removed.

Results: Heat stress caused decrease in body weight, kidney weight and volume of kidney. Histological study showed decrease in diameter of renal corpuscle, glomerulus, proximal convoluted tubule, distal convoluted tubule and increase in dimension of Bowman's space.

Conclusion: Heat stress caused both morphological and histological changes in kidney.

Key words: kidney, heat stress, rats, light microscopy and histology.

stress is one of the most important stressors especially in the hot regions of the world. Adaptation to heat stress requires the physiological integration of many organs and systems viz. endocrine, cardio respiratory and immune system². Exposure to high



Fig 1:- Photograph showing kidneys of control group of rat.



Fig -2: Photograph showing kidneys of experimental group of rat.

INTRODUCTION:

Stress denotes the magnitude of external forces which tends to displace the body system from its resting or ground state¹. Heat stress occurs in animals when there is an imbalance between heat production within the body and its dissipation. Heat

ambient temperatures augments the efforts to dissipate body heat, resulting in the increase of respiration rate, body temperature and consumption of water, and a decline in food intake³. When body temperature rises above normal range, the parenchyma of many cells begins to damage⁴. It also results in high blood pressure might which may

Corresponding Author :
gitayadav@yahoo.com

cause hemorrhage in various organs such as lung, kidney, liver and heart. These effects are also augmented by a stress activated autonomic nervous system response. Stress also causes fatty degeneration which is the accumulation of neutral lipids in the cytoplasm. Many people lives in hot climatic condition of earth and many people are exposed to heat stress due to their occupation like coal mine, bakery and many other industries. The

were anesthetized and both kidneys were removed. Weight of kidneys was measured by electronic balance, size by Vernier's caliper and volume by water displacement method respectively. After tissue processing slides were prepared by H&E staining and were observed for histological changes. The diameters of renal tubules and glomerulus were measured by oculomicrometer. One way ANOVA was used for data analysis and the data were

Table 1- showing body weight, kidney weight and volume of kidney in control and experimental group.

Parameters	Experimental status	Control (Mean± SD)	Experimental(Mean± SD)
Body Weight (gm)	Before experiment	172.06 ± 21.8	174.7 ± 23.34
	After experiment	182.06 ± 23.053	151.88 ± 17.87
	% change	5.81	7.38
Kidney weight (gm)	After experiment	0.74 ± 0.13	0.59 ± 0.07
Volume of kidney (cm ³)	After experiment	0.94 ± 0.15	0.70 ± 0.14

temperature of earth is also increasing day by day due to global warming. Because of this, many studies have been conducted on effect of heat stress in kidney in animals like rat, rabbit and dog at different temperature for different duration. The present study was conducted in rat at 35⁰ c for two weeks to see both morphological and histological changes in kidney.

considered statistically significant at 95% confidence interval. All the experimental works were carried out as per ethical guidelines of Nepal Health Research Council (NHRC) and ethical clearance was obtained from Institutional review board, BPKIHS.

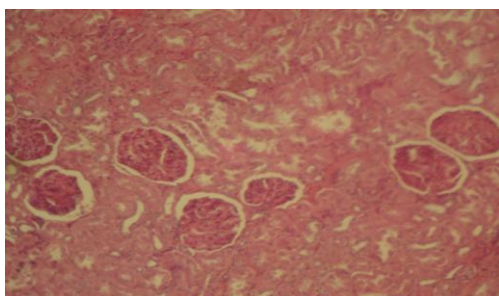


Fig -3: Photomicrograph of kidney (control group) showing renal corpuscle, PCT and DCT (H&E stain 10X).

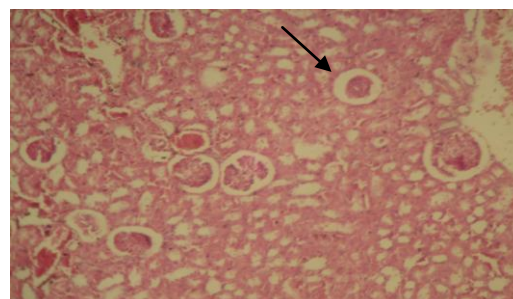


Fig-4: Photomicrograph of kidney (experimental group) showing widening of Bowman's space arrow marked (H&E stain 10X).

MATERIALS AND METHODS:

Sixty healthy Wistar Albino rats weighing 150-200gm were randomly divided into 2 groups i.e. control and experimental each consisting of 30 rats. Rats belonging to control group and experimental group were kept in controlled room temperature of (25±0.5⁰ C) and (35 ±0.5⁰ C) respectively for two weeks in a well ventilated room with a 12 hours alternating light-dark cycle. All rats were fed standard pellet diet, bengal gram and tap water ad libitum. On 15th day after weighing the rats, they

RESULTS:

In the present study, parameters like body weight, kidney weight, kidney volume, diameter of renal corpuscle, glomerulus, proximal convoluted tubule (PCT), distal convoluted tubule (DCT) and dimension of renal space were included. Heat stress caused decrease in body weight, decrease in kidney weight and decrease in volume of kidneys of the experimental rats (Table1). Histological study showed decrease in diameter of renal corpuscle, glomerulus, proximal convoluted tubule, distal convoluted tubule and increase in dimension of Bowman's space (Fig.4). All of these changes were

Table 2 – Showing diameter of PCT, DCT, renal corpuscle, glomerulus and renal space.

Parameters	Group		P value
	Control (Mean ± SD)	Experimental (Mean ± SD)	
Mean diameter of PCT(μm)	41.90 ± 6.77	36.30 ± 7.74	<0.001
Mean diameter of DCT(μm)	32.40 ± 6.05	29.40 ± 7.74	<0.001
Mean diameter of renal corpuscle(μm)	104.4 ± 22.35	83.00 ± 23.55	<0.001
Mean diameter of glomerulus (μm)	89.70 ± 20.57	59.60 ± 22.51	<0.001
Mean dimension of renal space (μm)	10.90 ± 2.88	16.20 ± 8.14	<0.001

statistically significant (P value <0.001) (Table 2). Change in the color and shrinkage was noted in gross appearance of experimental kidney as compared to control kidney (Fig. 2). Hemorrhagic area was seen in slide of experimental kidney (Fig. 5).

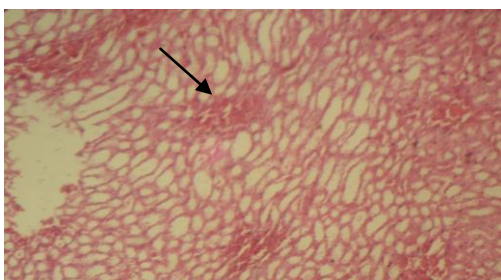


Fig-5: Photomicrograph of kidney (experimental group) showing hemorrhagic area in medulla arrow marked (H&E stain 10X).

DISCUSSION:

In present study significant reduction in body weight was observed which was similar to the observation by other workers⁵. This reduction in body weight might be due to decrease in anabolic activity and the increase in tissue catabolism caused by high elevated temperature. Significant decrease in weight and volume of kidney in experimental group compared to control group was observed in this study. Similar had been reported earlier in the study by other researchers⁶. In the present study, heat stressed kidney showed degenerated glomeruli associated with widening of capsular space and atrophy of the glomerulus which corroborates with the findings of study done by Sabah S.A. in 2011⁹. In our study, hypertrophic changes in the epithelium of proximal and distal convoluted tubules with epithelial desquamation and deposition of luminal debris & hemorrhage with blood congestion plus necrotic cells in the collecting tubules were

observed. The present study also showed reduction in diameter of proximal and distal convoluted tubule. Similar changes were also reported by Sabah S.A.⁹. In the present study hemorrhagic and necrotic area were observed in the medulla. Kidney of heat-exposed rat neonates showed glomerular, tubular and even vascular areas of necrosis associated with edema and infiltration of inflammatory cells as observed by Ahmed RR¹⁰.

CONCLUSION:

The present study showed that heat stress caused both morphological and histological changes in kidney. Reduction in body weight, kidney weight, kidney volume of rat was observed in experimental group. Heat stress caused loss of normal architecture of kidney. Histological study revealed decrease in diameter of renal corpuscle, glomerulus, proximal convoluted tubule and distal convoluted tubule and increase in dimension of Bowman's space. Hemorrhagic and necrotic areas were also seen in the medulla.

REFERENCES:

1. Lee DHK. Climatic stress indices for domestic animals. *Int J Biometeorol.* 9 (1965) 29
2. Altan O, Pabuçcuoğlu A, Altan A, Konyalioğlu S, Bayraktar H. Effect of heat stress on oxidative stress, lipid peroxidation and some stress parameters in broilers. *Br Poult Sci.* 44 (2003) 545
3. Murad H, El-Bedawy T, Salem S. Effect of heat stress on feed intake, rumen fermentation and water turnover in relation to heat tolerance response by sheep. *Egypt J Anim Prod.* 31 (1994) 317

4. Guyton AC, Hall JE. *Textbook of Medical Physiology*. (W.B.Saunders Company, Philadelphia) 2010
5. Gonzalez-Alonso J, Calbet JAL, Nielsen B. Metabolic and thermodynamic responses to dehydration-induced reductions in muscle blood flow in exercising humans. *J Physiol*. 520 (1999) 577
6. Mostafa S, Abu-Sinna G, Hassan I. Biochemical and histological changes induced by whole body hyperthermia in rabbits. *Egypt J Biochem Mol Biol*. (2002) 75
7. Al-Tekrity SSA. Effect of heat stress on histopathological alterations in kidneys of albino rats. *Res Opin Anim Vet Sci*. 1 (2011) 118
8. Rr A, Kh M. Histological , Histochemical and Biochemical Changes in the Liver , Kidney , Lung and Spleen under the Effect of Repetitive Hyperthermia in Rat Neonates. *Iranian J of Cancer Prev*. 2 (2009) 91
9. Sabah SA Al-Tekrity. Effect of heat stress on histopathological alterations in kidneys of albino rats. *Research opinions in animal & veterinary sciences*. 1 (2011) 118
10. Ahmed RR, Mazher Kh. Histological, Histochemical and Biochemical Changes in the Liver, Kidney, Lung and Spleen under the Effect of Repetitive Hyperthermia in Rat Neonates. *IJCP* 2 (2009) 91