The Effect Of Immersion In Water On Some Physiological Parameters In Rats

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ABSTRACT

This work was applied on 21 male albino rats, divided into 3 equal groups. Group 1 was left in air for compalitable period of time (2 hours). Group 2 were subjected to water immersion for 2 hours at 4°C. Group 3 were subjected to water immersion for 2 hours at 40°C. Immersion was conducted in a large container filled with water, heated or cooled. Blood samples were collected at the end of the immersion period and the serum was separated from all rats for biochemical examination. There were insignificant decrease in serum sodium and potassium, significant increase in calcium and phosphorus with reduction in the testosterone concentration in both amerced groups.

INTRODUCTION

It has been reported that immersion was associated with a marked suppression of plasma rennin activity and plasma aldosterone concentration, together with an increase in urinary prostaglandin excretion *(1)*. Rennin is secreted in response to a fall of renal afferent arteriolar pressure and reduction in supply of Na^+ to the distal tubules *(2)*. It converts angiotensinogen in plasma to angiotensin I, which in turn is converted to angiotensin II by angiotensin converting enzyme (ACE). Both angiotensin II and its metabolic product angiotensin III are pharmacologically activated and stimulated the release of aldosterone from the adrenal cortex. Aldostesone acts on the distal tubules to promote Na^+ reabsoption in exchange for urinary loss of H^+ or K^+. Therefore the previous data stimulate for more study the effects of immersion on renal handling of some experimental animals at different temperatures. Erosion after exercise in heat was studied on muscle function and effect of cold water immersion, body temperatures, and vessel diameter *(3)*. EMLA and water immersion both cause vasodilatation and no skin wrinkling in replanted fingers *(4)*. These results imply that intact sympathetic nerve function is required to induce the vasoconstrictive effect of EMLA.

The aim of the current study was to delineate the effects of immersion on some electrolytes, Na, K, P, Ca, together with Hb, RBCs, alkaline phosphatase and testosterone concentration.

MATERIAL AND METHODS

Twenty one healthy male albino rats were used as experimental animals, weighting 250-300 gm. They were divided into three equal groups. 1st group was left in air for compalitable period of time (2 hours). 2nd group was subjected to water immersion for 2 hr at 4°C. 3rd group was subjected to water immersion for 2 hrs at 40°C. Immersion was conducted in a large glass container, filled with water, heated or cooled to the desired temperature by means of thermostat.

The animals were kept in water with heat out using a thread at chest the of each animal. Blood was collected at the end of the immersion period (2hrs), similar to period in air in the control groups, they were slaughtered and blood samples were collected in polyetheline tubes containing heparin. Data for HB and RBCs count using Neubauer and method and Haymes technique. Na and K were estimated using flame photometer *(5)*. Ca, P and Testosterone were measured *(6&7)*. Alkaline phosphatase activity was measured according to *(8)*.

Statistical analysis was a comparison of obtained results between control, cold and hot immersion using the paired difference *(9)*.

RESULT

Table 1. Alkaline phosphatase, Hb, RBCs and testosterone in control and in hot immersion rats.

Parameters	Control	Hot water	Change T calculate
Alkaline phosphatase (U/100mg)	16.8±6.7	15.32±5.02	-8.81%
Hb (g/100ml)	14.7±9.1	13.9±3.7	-5.44%
RBCs (Mill./mm^3)	5.3±0.40	4.9±0.7	-7.54%
Testosterone (mg/dl)	1.06±6.06	0.56±0.038	-47.17%

Table. Alkaline phosphatase, Hb, RBCs and testosterone in control and in cold immersion rats.

Parameters	Control	Cold water	Change T calculate
Alkaline phosphatase (u/100mg)	16.8±6.7	15.76±4.36	-6.19%
Hb (g/100ml)	14.7±2.1	12.7±4.2	-13.6%
RBCs (Mill./mm^3)	5.3±0.40	4.8±0.9	-9.43%
Testosterone (mg/dl)	1.06±0.06	0.61±0.044	-42.45%

Table. Alkaline phosphatase, HB, RBCs and testosterone in control in cold and in hot immersion rats.

Parameters	Cold water	Hot water	Change T calculate
Alkaline phosphatase (u/100mg)	16.8±6.7	15.32±5.02	-2.79%
HB (g/100ml)	14.7±2.1	13.9±3.7	-8.63%
RBCs (Mill./mm^3)	5.3±0.40	4.9±0.7	-2.04%
Testosterone (mg/dl)	1.06±0.06	0.56±0.038	-8.19%

Table. Sodium, K, Ca and phosphorus in control and in hot water immersion rats.

Parameters	Control	Hot water	Change T calculate
Na^+ (mg/L)	12.8±4.1	10.89±2.3	- 15.97%
K^+ (mg/L	3.6±0.12	2.7±0.11	- 25%
Ca^{+2} (mg/100ml)	8.7±0.021	10.1±0.034	+ 13.86%
P. (mg/100ml)	5.38±0.31	6.32±0.91	+ 14.87%

Table 5. Sodium, K, Ca and phosphorus in control and in cold immersion rats.

Parameters	Control	Cold water	Change T calculate
Na^+ (mg/L)	12.8±4.1	10.62±2.9	- 18.5%
K^+ (mg/L	3.6±0.12	2.04±0.09	- 33.3%
Ca^{+2} (mg/100ml)	8.7±0.021	9.8±0.047	+ 11.22%
Pho. (mg/100ml)	5.38±0.31	6.75±0.82	+ 20.29%

Table 6. Sodium, K, Ca and phosphorus in control, cold and in hot immersion rats.

Parameters	Cold water	Hot water	Change T calculate
Na^+ (mg/L)	10.62±2.9	10.89±2.3	2.28%
K^+ (mg/L	2.04±0.09	2.7±0.11	11.11%
Ca^{+2} (mg/100ml)	9.8±0.047	10.1±0.034	2.79%
P. (mg/100ml)	6.75±0.82	6.32±0.91	6.37%

DISCUSSION

Immersion in water for 2 hrs resulted in significantly decrease sodium concentration (Tables 4-6) at both hot and cold compared to control, on the other hand, slight decrease in potassium concentration at 2.5% and 3.3% in both hot and cold immersed groups respectively. The decrease sodium concentration observed after immersion in this study could be due to decrease sodium reabsorption. In addition, the haemodilution accompanying fluid shift from interstitial to intravascular compartment could also contributed. Several mechanisms have been suggested to clarify the exact cause of decreased sodium reabsorption and aldosterone secretion *(10)*. The major actions of aldosterone on Na^+ transport as follows: Na+ from the luminal fluid bathing the apical surface of the renal cell passively diffuse through Na^+ channels. Na^+ is then transported into the interstitial fluid through the serosal side of the cells by the Na^+, K^+ dependent ATPase pump. ATP provides the energy required for this active processes and other mechanisms involving different aldosterone regulated proteins, may be involved in the handling of K^+ and H^+ *(11)*. Potassium level was decreased as result of increased in urine output *(12)*.

As regards the changes of Ca^+ and phosphorus concentration encountered in our study. Tables (4-6) showed a significant increase in both parameters in both groups after water immersion for 2 hrs at different temperatures, this increase can be explained by hemodilution which follows extracellular volume expansion during immersion, lowers Ca^+ level, in turn stimulated the release of parathyroid hormone. The changes in calcium and phosphorus suggest that the parathyroid hormone may be released and increased during immersion with activation of bone reabsorption *(13)*. The increase in phosphorus during immersion could be due to increased in mobilization of bone minerals without proportional increase in urinary excretion *(14)*.

Various studies have demonstrated that rats exposed to conditions that induce and maintain states of anxiety and stress develop a hypersensitive state *(15&16)*. Researches has purred researchers to identify biochemical characterization of particular interest in the discovery of mineralocorticoid sensitive receptors in cerebral areas *(17)*. Besides stresses have vasoconstrictive effect, it have an increased transmembrane exchange of Na/H and altered Na^+/K^+ + Ca^{++} transport and consequent changes in calcium ion content *(18)*. As for phosphate, the importance of phosphate relay to its action in cellular signals and the phosphorylation to produce energy. The minimal decrease in Tables (1-3) about 6.19% and 8.81% in alkaline phosphatase activity after 2 hrs immersion in cold and hot water respectively could be due to dilution by intracellular fluid shift during immersion *(19&20)*. Alkaline phosphatase decline as a result of any stress and related with another biophysiological parameters *(2)*.

The data presented in table (1-3) revealed that decrease of Hb and RBCs, 13.6%, 9.43% in cold and 5.44%, 7.54% in hot, respectively which might be due to dilution by intracellular fluid shift due to haemodilution which follows extracellular volume expansion during immersion. This decrease of Hb and RBCs be due to decrease in oxygen transport to the tissues, hence the increase incidence of fatigue occurring to the rats subjected to immersion in water for 2 hrs at 2 different bath transporter. Following ice-water immersion, hyperventilation induced a marked reduction in middle cerebral artery (MCA) mean to a level which has been associated with disorientation and loss of consciousness *(21)*.

The data presented in Tables (1-3) indicated a lower testosterone hormone concentration in male rats after exposure to water immersion at different temperature for 2 hrs (42.45% and 47.17%). Decrease testosterone concentration in cold and hot immersion water rats respectively was in accordance to the results of *(22)*. The possible cause of this decrease in testosterone levels may be due to haemodilution accompanying fluid shift from interstitial to intravascular compartment. Also, stresses of different origins and causes might decrease testosterone levels and increase cortisol concentration which share in this testosterone declination in the blood *(23)*. In addition, androgens posses an anabolic effect in the body and cortisol can increase the catabolic effect in the body and to transformation of protein to glucose by glyconeogenesis. It has been reported that testosterone has vital action on protein metabolism and respond negatively to stresses *(24)*.

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الملخص العربى

تأثير الغمس فى الماء على بعض القياسات الفسيولوجية فى الفئران
صلاح سليم- محمود عزمى عيد

أجريت هذه الدراسة على ٢١ من ذكور الجرزان البيضاء ، قسمت الى ثلاث مجموعات متساوية ، المجموعة الأولى تركت كضابط للتجربة ، المجموعة الثانيه تم غمسها فى الماء البارد لمدة ساعتين عند درجه حرارة ٤ مئوية ، المجموعة الثالثه تم غمسها فى ماء ساخن عند درجه حراره ٤٠ مئوية لمده ساعتين. تم تجميع عينات الدم من كل الجرزان بعد انتهاء فترة الغمس مباشرة لإجراء الاختبارات عليها.

أوضحت النتائج وجود نقص بسيط فى مستوى تركيز الصوديوم والبوتاسيوم ، مع وجود زيادة معنوية فى نسبة الكالسيوم والفوسفور مع وجود نقص معنوى فى مستوى هرمون التيستستيرون فى كل من المجموعتين الثانية والثالثة.