EFFECT OF POSTURE ON HEART RATE AND CARDIAC AXIS OF MICE

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Summary : Effect of change in body posture on cardiac electrical axis has not been well documented. Hence the present work was undertaken to study the effect of passive head-up and head-down postures on ventricular QRS axis and heart rate of anesthetised mice. During head-up posture, there was a statistically significant ($P<0.02$) increase in heart rate whereas during head-down posture, the heart rate decreased insignificantly. These changes in heart rate can be explained on the basis of synus and aortic nerve mediated baroreceptor reflexes. Ventricular QRS axis showed a significant increase ($P<0.02$) during head-up posture and an insignificant decrease during head-down posture. A change in the posture is likely to produce a change in anatomical orientation of heart within the thorax resulting in alteration of electrical axis of the heart.

Key words : ECG ventricular axis heart rate posture mice

INTRODUCTION

The normal electrocardiographic pattern of small animals like rat is essentially similar to that of man (7,11,13). Hence, these animals are very useful in studying the effect of various influences on electrocardiogram (ECG). Although many workers (1,2,7, 9,11,13,15,16) have studied different aspects of rat ECG, there are only a few reports on the ECG of mice. The effect of standing on the heart rate (HR) of man is well known. However, mice differ from human beings in that they rarely assume upright posture. Hence, it might be interesting to study the effect of postural stress on HR of mice and the time course of these changes.

Change in posture is likely to alter the electrical axis of heart due to alteration of its anatomical orientation within the thorax. But to our knowledge, the effects of head-up and head-down postures on the ECG of mice have not been previously reported. In an earlier study from our laboratories (12), it was found that in supine as well as prone position, alteration in forelimb alignment to trunk produces a significant changc in mean electrical axis of rat ventricle. In the present paper, we report on the effect of head-up and head-down postures on HR and ventricular axis of mice.

MATERIAL AND METHODS

Sixteen adult albino mice (24.6 - 31 g) of either sex and maintained on food and water *ad libitum* were used for the present study. After an overnight fast, the animals were anaesthetised by ip iniection of urethane (500 *mg/kg*) and chloralose (50 *mg/kg*). The animals were fixed on a wooden board in supine position with all the four limbs gently extended. The fore limbs were kept at right angles to the body whereas the hind limbs were extended with an angle of 30° in between them. Needle electrodes constructed from 26 gauge hypodermic needles were placed in distal parts of the limbs subcutaneously for 1cm to give uniform contact. Standard limb leads of ECG (leads I, II and III) were recorded on Grass Model 7 polygraph at a paper speed of 100 mm/sec and a sensitivity of 20 mm/mV. Tracings were also simultaneously displayed on a Tektronix Oscilloscope to ascertain that the ECG components displayed were faithfully reproducible on the Grass polygraph. HR was measured from RR interval of lead II. Electrical axis for QRS was determined by plotting the net QRS amplitudes in millivolts on the hexaxial reference system, by employing leads I and III.

Control ECG was recorded in supine posture 30 min after anaesthetising the mice. After the control recordings were made, the wooden board was gently turned to allow recordings with animal in the 90° head-up position. After taking the measurements in position, the animal was turned to supine position and the recordings were taken after 15 min. Next, the animal was turned 90° head-down and the ECG recorded again. In head-up as well as head-down positions lead II was recorded at 5 15, 30, 60 and 120 sec for measuring heart rate. For the calculation of ventricular axis, leads I and III were also recorded after 120 sec of the tilt.

Statistical significance was calculated using students "t" test. P values of less than 0.05 were accepted as indicating a significant difference between the compared values.

RESULTS AND DISCUSSION

The results are given in Fig. 1 and 2 and Table I and II.

TABLE I : Effects of 90° head-up tilt on heart rate and ventricular QRS axis. Axis was determined 120 sec after the tilt. Values are mean ± SE. NS : not significant.

	HEART RATE					QRS AXIS	
Supine	*Seconds after head-up tilt*					*Supine*	*Head-up*
	5	*15*	*30*	*60*	*120*		
413.81	441.94	453.25	460.13	465.69	468 25	58.75	68.63
±13.01	±13.19	±16.85	±17.39	±18.06	±17.08	±2.18	±2.94
P value	NS	NS	<0.05	<0.05	<0.02		<0.02

TABLE II : Effect of 90° head-down tilt on heart rate and ventricular QRS axis. Axis was determined 120 seconds after the tilt. Values are mean ± SE. NS : not significant.

	HEART RATE					QRS AXIS	
Supine	*Seconds after head-down tilt*					*Supine*	*Head-down*
	5	*15*	*30*	*60*	*120*		
421.06	417.13	410.63	394.06	399.19	414.94	57.90	53.69
±13.44	±14.36	±13 07	±8 86	±10.47	±11.22	±2.29	±1.91
P Values	NS	NS	NS	NS	NS		NS

The control heart rate of our anesthetised mice in supine posture was 413 81± 13.01 (SE) per min. Schaefer and Haas (14) have reported that the average normal heart rate of white mouse is about 376 per min. This compares with the mean heart rate of albino rats which varies between 334 and 423 per minute (4. 7, 9, 10). For accurately recording the ECG of animals having such a rapid heart rate, a sensitive equipment with frequency response and paper speeds sufficient to resolve the various components of ECG is necessary. Grass model 7 polygraph used in the present study is a sensitive instrument with a high frequency response. At a paper of speed of 100 mm/sec, it recorded all the components of ECG that were displayed simultaneously on a Tektronix oscilloscope. The needle electrodes gave a standard contact surface, could be of ECG that were displayed simultaneously on a Tektronix oscilloscope. The needle electrodes gave a standard contact surface, could be easily applied and permitted rapid handling. With this recording technique, serial records were reproducible with good resolution. Earlier workers (1, 2, 4, 7) have used ether anesthesia for recording ECG of small animals like rat. But cardiovascular compensatory responses to postural changes are less favourable under ether anesthesia (6) and ether produces disorders of cardiac rate and rhythm (8). It has also been reported that carotid sinus reflexes are absent under deep ether and barbituric acid anesthesia (6). Nembutal is known to increase heart rate (8). Hence we have used urethane and chloralose mixture to anesthetise our mice.

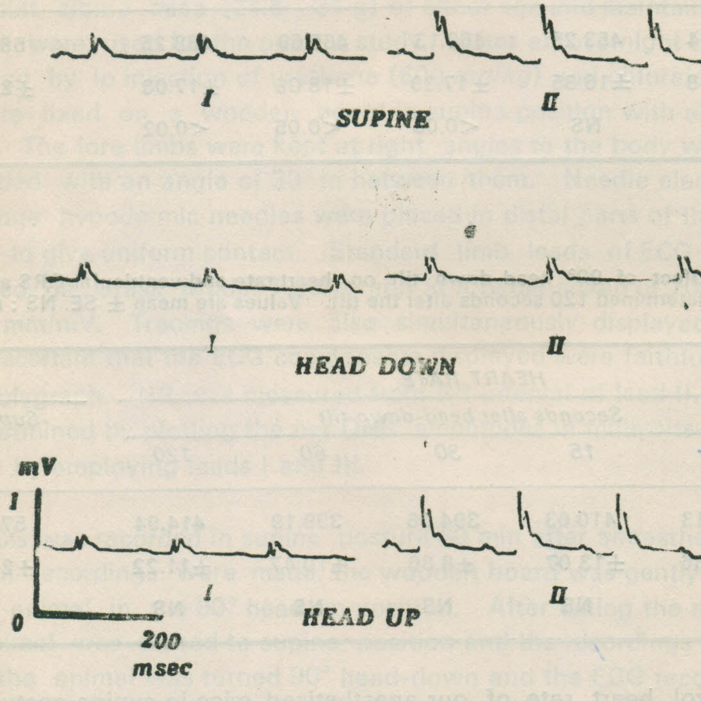

Fig. 1 : Lead I and lead II electrocardiographic tracings of mice. Upper tracing was recorded in supine posture. Middle tracing recorded during head-down posture shows bradycardia and a decrease in ventricular axis. Lower tracing during head-up posture shows tachycardia and an increase in ventricular axis.

During head-up posture, the heart rate showed an immediate and progressive increase throughout the 120 sec period of study. The techycardia was statistically significant at 30 sec (P<0.05), 60 sec (P<0.05) and 120 sec (P<0.02). This increase in heart rate can be explained by sinus and aortic nerve ("buffer" nerve) mediated baroreceptor reflex (3). Change from supine to standing posture produces a gravity—dependent downward shift of blood volume from the intrathoracic space. This leads to decrease in venous return to heart with consequent reduction in systemic arterial pressure as a result of decrease in stroke volume and cardiac output. The result is baroreceptor reflex induced cardioacceleration and vasoconstriction which are of utmost importance for maintaining systemic arterial pressure and cerebral circulation in face of reduced stroke volume in standing posture (3). Thus the role of cardioacceleration during head-up posture is that it actively assists the circulatory defence against gravitational stress. It is believed that these compenstory regulatory mechansims in erect posture are better developed in humans than quadrupeds who tolerate head-up tilting poorly (5). But the reflex techycardia observed in the present study was statistically significant. This indicates that the "buffer" nerve mediated tachycardia during erect posture is significant in mice. During head-down posture, there was a progressive bradycardia upto 30 sec after which the heart rate returned towards the control value. But these changes in heart rate were not statistically significant (Fig. 2). The bradycardia during head-down posture is

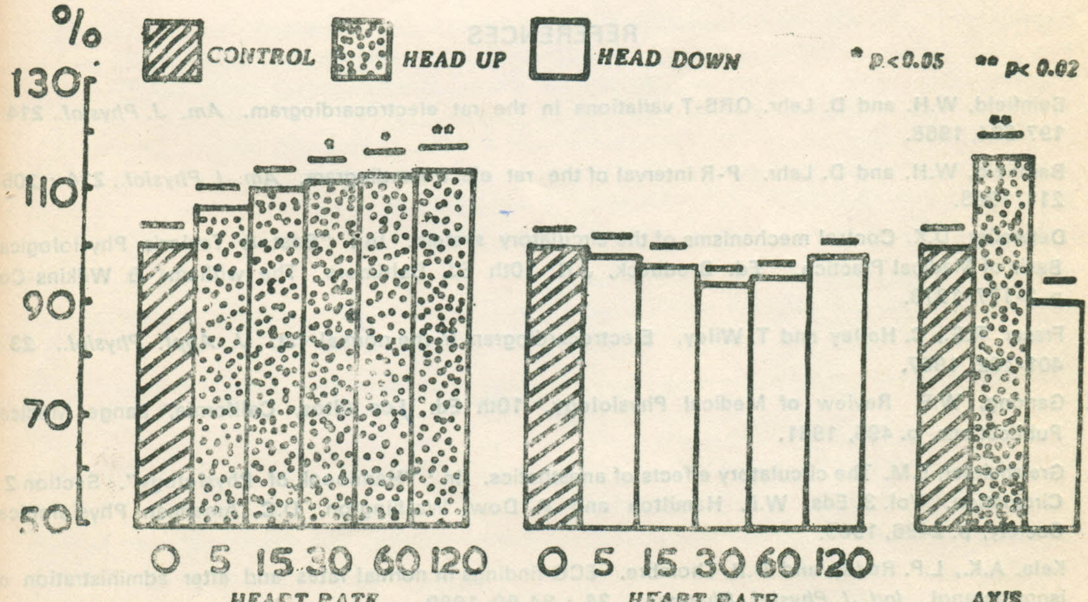

Fig. 2 : Percent change in heart rate and mean ventricular electrical axis during head-up and head-down postures. Horizontal lines above the bars indicate ± SE. Numbers below the bars indicate seconds after change in posture. Axis was measured 120 seconds after change in posture.

due to increase in central blood volume leading to reflex compensatory mechanisms which are reverse to those during head-up posture.

The control QRS axis of our mice was 58.7±2.1 (SE) in supine posture. the range being narrow (+36 to +71). In an earlier study (11) we have found that the mean ventricular axis of normal rat in supine posture is 45±10.2. Other the mean QRS axis was +68.63 compared to the control value of +58.75, the difference being statistically significant ($P<0.02$). In contrast, head-down posture produced an insignificant decrease in the mean QRS axis (Fig.2). These changes in ventricular QRS axis can be explained on the basis of mechanical displacement of the heart. Change in posture is expected to shift the anatomical axis of heart within the thorax and this in turn leads to a shift in the electrical axis of the ventricles.

In conclusion, the present study has demonstrated that in anesthetised mice. head-up tilting produce a significant cardioacceleration and a significant increase in QRS axis. In contrast, during head-down posture, there is bradycardia and decrease in QRS axis, both these changes being statistically insignificant.

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SHORT COMMUNICATION

ACUTE EFFECTS OF NEUROGENIC STRESS ON URINARY ELECTROLYTE EXCRETION

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Summary : Plasma Cortisol and urinary excretion of water, sodium, potassium, calcium and magnesium have been studied in the rat after application of 2 types of neurogenic stress :—(a) tight rubber band tourniquet and (b) electric shock. Plasma cortisol levels increased significantly after application of either type of stress. During both type of stress, there was statistically significant increase in the urinary excrerion of water, sodium and calcium but not of potassium and magnesium. Urinary calcium/magnesium ratio was also significantly elevated. The results suggest that stress may be one of the factors involved in the genesis of urolithiasis.

Key words : stress sodium magnesium calcium cortisol urolithiasis

INTRODUCTION

Urolithiasis is highly prevalent in north-western India as well as in many other parts of the world. Inspite of extensive studies in India and abroad, it is still not clear why, in endemic areas, concretions develop in some persons but not in others. Stress, on clinical grounds, has been considered as one of the etiological factors (4, 5), but little experimental evidence is available in support of the hypothesis. This study was conducted in the rat to observe whether exposure to stress produces any alterations in the urine conducive to calculogenesis.