

SHORT COMMUNICATION

BARORECEPTOR REFLEXES IN POSTURAL CONTROL OF CIRCULATION IN RABBITS

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Abstract : The present study was undertaken to evaluate reflex cardiovascular responses to postural stress in rabbits. The changes in mean arterial pressure (MAP) and heart rate (HR) were monitored in the supine position and following sudden passive head up tilt (HUT), and head down tilt (HDT) to 70 degrees. The results show a significant increase in MAP (18.57%, $P < 0.001$) and HR (2.92%, $P < 0.02$) with HUT; and a marked decrease in MAP (43.48%, $P < 0.001$) and HR (8.21%, $P < 0.001$) with HDT (as compared to the values in supine position). The changes in MAP were found to be more marked than those in HR. The depressor responses to HDT were more marked than the pressor responses to HUT.

It is concluded that in rabbits the baroreflexes are quite sensitive to postural stress.

Key words : baroreceptors central blood volume heart rate postural stress blood pressure

INTRODUCTION

Gravitational stress produces widespread haemodynamic alterations. A sudden change of posture from a supine to an upright position (on a tilt table) initiates reflexly produced pressor responses. A head down tilt activates reflexly produced depressor responses. Maintenance of normal arterial pressure during postural stress is a function of baroreceptor reflexes which respond instantaneously to variation in arterial pressure (1). By varying the sympathetic tone baroreceptors stabilize the blood pressure. Man is very frequently subjected to these changes in gravity every time he shifts his position from supine to standing, and adopting other postures. The human body has an inbuilt baroreceptor reflex system to buffer changes in arterial pressure produced by such gravitational changes. Such responses have been studied by various workers (2,3,4,5).

Quadrupeds differ from human beings in that they rarely assume an upright posture. It was, therefore, decided to study the haemodynamic

changes taking place in rabbits in response to gravitational stresses, and to compare these with reported observations in man.

METHODS

Experiments were performed on albino rabbits ($n=20$) of either sex and weighing 1-2 kg (mean 1.93 ± 0.06). The animal was anaesthetized with sodium nembutol (30-40 mg/kg body weight). After endotracheal intubation the right femoral artery was cannulated and connected to a pressure transducer (strain gauge type) through a three way adapter. The transducer was connected to a two channel recorder (Polyrite INCO). Adjustments in the recording channel were made to record mean arterial pressure (MAP) directly. To avoid errors produced by gravitational forces the pressure transducer was placed at the level of the animal's body. Heart rate (HR) was recorded through ECG on the second channel of the recorder. After the surgical procedure, the limbs were tied to a small table specially designed for the size of the animal.

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Protocol : Resting MAP and HR were recorded in the supine position. The animal was then subjected to sudden (1-2 sec) 70 degree passive head up tilt (HUT) for a period of 2 min; and then brought back to the horizontal position. Enough time was given for MAP and HR to normalize. This was followed by sudden 70 degree passive head down tilt (HDT) for 2 min.

Through these maneuvers, the MAP and HR were continuously monitored. For each change of posture two trials were given, and the mean of the two recordings taken.

Statistical Analysis : The mean and standard error (SE) for MAP and HR at rest and at various times following HUT or HDT were calculated. The alterations in MAP and HR produced after these maneuvers were compared with values at rest by applying paired t-tests. Probability values below 0.05 were considered significant.

OBSERVATIONS

A. HAEMODYNAMIC CHANGES AFTER HEAD UP TILT

Changes in Mean Arterial Pressure : Fig. 1A shows that immediately after HUT, the MAP dropped considerably (21.44 mm Hg, $P < 0.001$) from a resting value of 87.04 mm Hg to 65.60 ± 4.35 mm Hg. This was followed by a significant rise (16.17 mm Hg, $P < 0.001$) which reached its peak at 40 sec. At 2 min, the MAP was well above the resting values (Table I).

Changes in Heart Rate : Concomitant with fall in MAP (with HUT) the HR showed a significant decrease (55.87 beats/min, $P < 0.001$) within 5-10 sec. This was followed by a significant rise in HR (8.67 beats/min, $P < 0.02$) which reached its maximum level at 1 min (Table I).

B. HAEMODYNAMIC CHANGES WITH HEAD DOWN TILT

Changes in Mean Arterial Pressure : The results are shown in Fig. 1B and Table II. The head down tilt was immediately (within 5 sec) followed

by a significant rise in MAP (7.06 mmHg., $P < 0.001$) as compared to the resting values. The initial rise in MAP was followed by a marked decrease (35.88

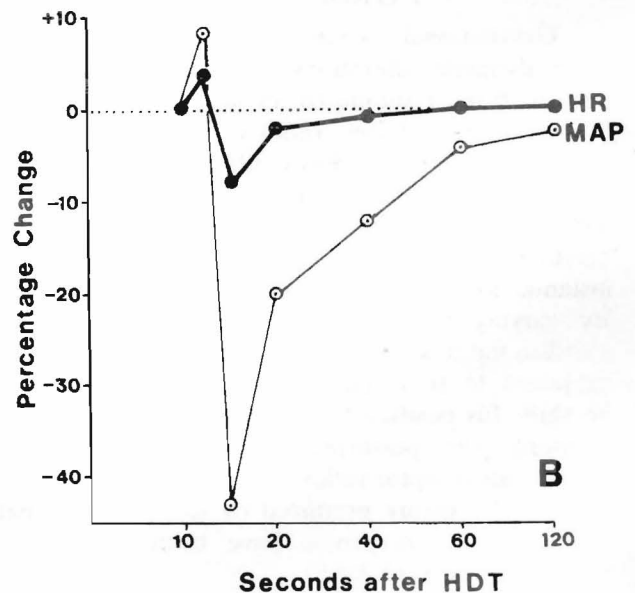
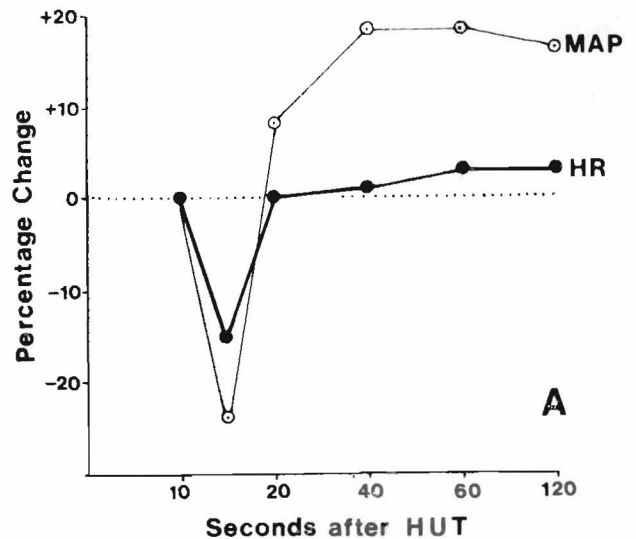


Fig. 1: Variations in mean arterial pressure (MAP) and heart rate (HR) (expressed as percentages of basal values) in response to passive head up tilt (A), and passive head down tilt (B) in rabbits. Each point represents mean of 20 observations.

TABLE I : Changes in mean arterial pressure (mmHg) and heart rate (beats/min) after head up tilt. Values are mean±SE.

	Before tilt	Seconds after head up tilt				
		10	20	40	60	120
MAP (mmHg)	87.04 ±2.97	65.60 ±4.35	94.76 ±4.85	103.21 ±3.77	103.21 ±3.82	101.06 ±4.00
P value		<0.001	NS	<0.001	<0.001	<0.001
HR (beats/min)	296.13 ±5.23	240.26 ±7.78	296.66 ±8.30	301.60 ±8.60	304.80 ±6.67	304.80 ±6.21
P value		<0.001	NS	NS	NS	<0.02

TABLE II : Changes in mean arterial pressure (mmHg) and heart rate (beats/min) after head down tilt. Values are mean±SE.

	Before tilt	Seconds after head down tilt					
		5	10	20	40	60	120
MAP (mmHg)	82.52 ±2.61	89.58 ±2.97	46.64 ±4.75	65.95 ±4.18	72.24 ±3.59	78.64 ±4.03	79.94 ±4.09
P value		<0.001	<0.001	<0.001	<0.001	NS	NS
HR (beats/min)	296.13 ±5.23	307.90 ±4.97	271.80 ±5.85	289.40 ±6.96	291.86 ±6.31	294.86 ±7.38	294.86 ±7.26
P value		<0.001	<0.001	NS	NS	NS	NS

mmHg, $P<0.001$) and reached almost to the resting level at 2 min.

Changes in heart rate : With HDT, there was an immediate (within 5 sec) increase in HR (11.77 beats/min, $P<0.001$) which corresponded with the initial rise in MAP. This was followed by a marked decrease in HR (24.33 beats/min, $P<0.001$). HR normalized at 2 min.

DISCUSSION

It has been claimed that cardiovascular responses to gravitational stress are better developed in humans than in quadrupeds (6,7). The results of the present study have shown a significant increase in MAP (18.5%, $P<0.001$) and in HR (2.92%, $P<0.02$) following HUT; and a marked decrease in MAP (43.48%, $P<0.001$) and in HR (8.21%, $P<0.001$) following HDT. These findings indicate that the baroreceptors are quite sensitive

to changes in central blood volume in anaesthetized rabbits. Similar effects were observed (8) in conscious rabbits by producing acute changes in blood volume. Changes have also been demonstrated (9) in inferior venacaval flow, stroke volume and HR in response to gravitational stress in anaesthetized dogs. In another study in mice changes in HR alone were studied; and tachycardia following HUT was found to be more marked than bradycardia following HDT (7).

In human subjects, HUT has been reported to produce a greater effect on HR than on MAP (3,5). In an earlier study (10) the present workers have also made the same observation. Following HUT there was an increase of 50.47% in HR, and only of 9.26% in MAP. Because of these observations reflex tachycardia has been considered a more sensitive index of postural stress than blood pressure (3).

The findings of the present study in rabbits contrast with human studies mentioned above. We find that when changes in MAP and HR are expressed as percentages of basal values, the changes in MAP are more marked than those in HR (Fig. 1). The relatively mild changes in HR observed in the present study could be attributed to the high baseline heart rate in rabbits (11).

A comparison of the magnitude of effects produced by HUT and HDT, in the present study shows that depressor responses (with HDT) were more powerful than the pressor responses (with HUT). In contrast, in human subjects the pressor responses to HUT and to hypovolemia have been

found to be more marked than those of hypovolemia (6,12).

An interesting observation of the present study is that following HUT there is sudden decrease in HR (within 5-10 sec); and that following HDT there is corresponding increase in HR. These changes in HR possibly suggest immediate response of the volume receptors in the cardiopulmonary circuit to sudden changes in central venous pressure and venous return (5,13,14).

It is concluded that rabbits have a sensitive baroreflex system, and that there are qualitative differences in responses as compared to those in man.

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