

EFFECT OF ORTHOSTATIC STRESS ON SYSTOLIC TIME INTERVALS IN RABBITS

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Abstract : Systolic time intervals (STI) are sensitive indices of myocardial function. The present study was conducted to evaluate the effect of orthostatic stress on STI before and after 70° head up tilt (HUT) in rabbits. Electrocardiogram (ECG), phonocardiogram and carotid arterial pulse were recorded simultaneously on four channel polyrite (INCO). Within 1 second of tilt there was a significant rise ($P < 0.001$) in electromechanical systole (QS_2), left ventricular ejection time (LVET), pre-ejection period (PEP), and ratio of PEP/LVET ($P < 0.01$), however, there was no change in heart rate and mean arterial blood pressure insignificantly. QT/ QS_2 ratio and ejection fraction (EF) were also elevated ($P < 0.05$) on tilt. After 20 seconds of HUT, QS_2 showed reduction ($P < 0.001$), LVET elevation ($P < 0.001$), PEP and ratio of PEP/LVET reduction ($P < 0.001$) from control level. QT/ QS_2 and EF declined gradually towards basal values. These changes in STI (raised LVET, reduced PEP and PEP/LVET ratio) and increased QT/ QS_2 ratio and EF pointed towards rise in contractility of heart.

Key words : systolic time intervals ejection fraction QT/ QS_2

INTRODUCTION

Measurement of systolic time intervals (STI) is a sensitive and noninvasive method for assessment of inotropic state of myocardium (1). Passive tilting is an easily gradable, rapidly reversible and sensitive method for producing postural stress and is used to assess the integrity of autonomic cardiovascular regulatory mechanism (2). The human body has an in built baroreceptor reflex system to buffer changes produced by gravitational stress (3). Quadrupeds differ from human beings in that they rarely assume an upright posture. It was, therefore, decided to study the time

course of STI changes after 70° Head up Tilt (HUT) in anesthetized rabbits.

METHODS

The study was carried out in rabbits (n=15) weighing one to two kilogram (mean = 1.96 ± 0.6). Animal was anesthetized with urethane (0.5 gm/kg body weight). Tracheal intubation was done. Animal limbs were tied over the small table specially designed for tilting. Lead II electrocardiogram (ECG), carotid arterial pulse (CAP) and phonocardiogram (PCG) were recorded simultaneously on four channel polyrite (INCO). From these

following STI were calculated as described by Singh and Sood (4).

Electromechanical systole (QS_2) was measured from onset of QRS deflection of ECG to first high frequency vibration of aortic component of second heart sound. Left ventricular ejection time (LVET) was measured from point of onset of sudden upstroke of CAP tracing to the trough of the incisura. Pre-ejection period (PEP) was obtained by subtracting LVET from QS_2 . Ratio of PEP/LVET was also calculated. Recordings were taken at a paper speed of 50 mm/sec. Only clearly defined tracings were analysed. Measurements were made on 10 cycles and the averages calculated. The results were expressed in milliseconds. Heart rate (HR) was calculated from RR interval of ECG. Ejection fraction (EF) was found out by using equation $EF = 1.125 - (1.25 \times PEP/LVET)$ devised by Garrad and coworkers (5). QT interval/

electromechanical systolic ratio (QT/QS_2), as it reflects sympathetic activity, was derived according to Udupa and coworkers (6). Right femoral artery was cannulated, and connected to pressure transducer (Strain gauge type) which was in turn connected to two channel polyrite to record the mean arterial blood pressure (MAP). Recordings were taken first in supine position, and then during sudden 70° HUT (within 1–2 sec) and kept for 120 seconds.

The data were subjected to statistical analysis using student 't' test. P values of less than 0.05 were taken as statistically significant.

RESULTS

There was immediate (within 1 second) and significant rise in QS_2 , LVET, PEP and ratio of the PEP/LVET after 70° HUT. HR

TABLE I: Effect of 70° head-up tilt on systolic time intervals.

Parameters	Before tilt	After tilt					
		Immediate	10 sec	20 sec	40 sec	60 sec	120 sec
Heart rate (Beats/min)	273.33±4.84	255.55±6.91	274.88±5.76	273.3±5.87	273.3±4.84	273.3±4.84	273.3±4.84
QS_2 (msec)	160.00±17.12	172.22±21.66***	163.33±20.61***	142.42±25.87***	162.50±35.96	162.50±35.96	161.23±28.16
LVET (msec)	87.00±21.38	94.44±12.36***	88.75±21.00***	91.25±22.95***	93.75±17.27***	91.42±17.26***	91.42±17.26
PEP (msec)	71.11±23.68	78.88±16.91***	76.25±36.22	48.75±30.90***	73.75±31.19	72.25±30.28	73.15±30.13
PEP/LVET ratio	0.89±.44	0.95±.33**	0.63±.16**	0.65±.63***	0.75±.50	0.83±.43	0.85±.50
Mean arterial pressure (mmHg)	87.42±1.15	86.53±3.83	94.38±2.96	97.8±11.87	95.97±2.63	91.16±2.70	88.86±1.70
QT/QS_2 ratio	0.71±0.08	0.73±0.11*	0.90±0.15**	0.90±0.13***	0.87±0.03	0.82±0.05	0.76±0.07
EF	0.11±0.02	0.24±0.06*	0.33±0.05**	0.30±0.01***	0.22±0.03	0.20±0.03	0.16±0.01**

Values are mean±SD.

P values: *<0.05, **<0.01, ***<0.001 = Significant

and MAP showed reduction immediately on tilt which was not found to be significant. After 10 sec of tilt QS_2 , LVET, PEP showed reduction from the immediate level of tilt, still the QS_2 ($P < 0.001$) and LVET ($P < 0.001$) were at statistically higher levels than the basal levels. But ratio of PEP/LVET showed reduction ($P < 0.01$) from the basal value. The rise in HR and MAP was not found to be significantly changed as compared to control value. After 20 sec of HUT QS_2 showed reduction, LVET elevation and PEP and ratio of PEP/LVET showed reduction from control values. After 40 sec all parameters reached almost to the basal levels. QT/ QS_2 ratio and EF showed trends towards increment on tilt, values were maximum on 20 sec, then they gradually declined (Table I).

DISCUSSION

STI correlated well with noninvasively determined measures of myocardial performance (1). It has been claimed that cardiovascular responses to gravitational stress are better developed in the human than in quadrupeds (7, 8). In the present study, passive tilting produced an increase in STI and decrease in heart rate and blood pressure. Passive tilt produces central hypovolemia due to venous pooling in dependent parts (hind limbs). This may result in decrease in heart rate and

prolongation of cardiac cycle and thus increases in STI immediately on tilt.

Frey and Kenny (9) and Vijaylakshmi (10) have reported prolongation of PEP after head up tilt (HUT) in normal human subjects. Similarly increase in PEP/LVET ratio is described by Stafford and coworkers (11) on assumption of upright posture and during peripheral pooling of blood in human beings. Prolongation of LVET indicates increase in stroke volume (12). Fall in blood pressure on passive tilt deactivates the baroreceptors resulting in sympathetic out flow. It is advocated that decrease in left ventricular performance results in increase in PEP/LVET ratio (13). Increased sympathetic stimulation is reflected by elevation of LVET, reduction in PEP and ratio of PEP/LVET, and rise in QT/ QS_2 ratio (14) as occurred in present study within 20 sec of tilt.

EF shows significant correlation with PEP, LVET and PEP/LVET ratio (5). Ahmed and coworkers (13) reported that EF is depressed in patients with right or left ventricular overload. In the present study EF was found to be elevated in rabbits showing increase contractility of heart.

Therefore, it is concluded that immediately on tilt the STI increases and returns to basal level within 20 sec in rabbits.

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