Cardiovascular reflexes in response to head down tilting in normal subjects

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انعكاسات القلب و ألاوعيه الدموية استجابة لميلان جسم الإنسان إلى عند الأشخاص الطبيعيين

الخلاصة:

الهدف من هذه البحث هو دراسة انعكاسات القلب والاوعيه الدموية استجابة لميلان جسم الإنسان إلى الأسفل بدرجة ٢٠°.

أجريت هذه الدراسة على٦٠شخص من الأصحاء (٤٠ ذكر و٢٠انثى) لغرض دراسة تأثير ميلان جسم الإنسان إلى الأسفل بدرجة ٢٠° بواسطة استخدام الطرق غير المباشرة لقياس متغيرات داينيميكية القلب والاوعيه الدموية حيث استعمل جهاز الضغط الزئبقي لقياس ضغط الدم وجهاز اوكسي ميتر لقياس النبض (HR) وجهاز الايكو الدوبلر لقياس كمية الدم التي يضخها القلب في النبضة الواحدة (SV)، كمية الدم التي يضخها القلب في الدقيقة الواحدة (CO)، سرعة الوقت المتكاملة (VTI).

تم تقسيم الأشخاص إلى فئتين عمريتين: الفئة العمرية الأولى (٢٠-٤٠ سنه) مكونه من ٣٢ ذكر و٨ إناث والفئة العمرية الثانية (٤١- ٦٠سنه) مكونه من ٨ ذكور و١٢ أنثى.

وكانت نتائج البحث تشير إلى أن التغيرات في الفئة العمرية الأولى تمثلت بزيادة معنوية في مقدار ما يضخه القلب في النبضة الواحدة (SV) وما يضخه في الدقيقة الواحدة (CO) وسرعة الوقت المتكاملة (VTI) بينما ان هناك انخفاض معنوي في عدد نبضات القلب (HR) و المقاومة المحيطية الكلية للاوعيه الدموية (TPVR) وكل هذه التغيرات حدثت بسبب ميلان الرأس بدرجة٢٠° إلى الأسفل. بينما أشارت النتائج إلى عدم وجود اي تغيير معنوي في ضغط الدم الانقباضي (SBP) و ضغط الدم الانبساطي (DBP) ومعدل ضغط الدم (MBP).

في الفئة العمرية الثانية أشارت التغيرات إلى وجود زيادة معنوية في مقدار ما يضخه القلب في النبضة الواحدة (SV) وما يضخه في الدقيقة الواحدة (CO) وسرعة الوقت المتكاملة (VTI) وضغط الدم الانقباضي (SBP) وضغط الدم الانبساطي (DBP) ومعدل ضغط الدم (MBP) استجابة إلى ميلان الرأس بدرجة ٢٠° إلى الأسفل بينما لم تحصل أي تغييرات معنوية في عدد نبضات القلب (HR) و المقاومة المحيطية الكلية للاوعيه الدموية (TPVR).

Abstract

Objectives: The aim of this study is to investigate the changes in hemodynamic variables in response to head down tilting.

Methods: This study was carried out on 60 normal healthy subjects, 40 males and 20 females in order to study the cardiovascular reflexes in response to 20° head down tilting by using non-invasive techniques including mercury sphygmomanometer for measurement of blood pressure , pulse oximeter for measurement of heart rate, Doppler echocardiography for estimation of velocity time integral (VTI) ,stroke volume (SV) and cardiac output (CO).The subjects were divided into two groups: the first group includes subjects with age between 20-40 years and this group consist of 32 males and 8 females.The second group includes the subjects with age between 41-60 years and this group consist of 8 males and 12 females.

Results: In the first group there is significant increase in velocity time integral (VTI) , stroke volume (SV) and cardiac output (CO) and significant decrease in heart rate (HR) and total peripheral vascular resistance (TPVR) in response to 20°head down tilting. While there are no significant differences in systolic, diastolic and mean blood pressure.

In the second group there is significant increase in velocity time integral (VTI), stroke volume (SV), cardiac output (CO), systolic, diastolic and mean blood pressure in response to 20° head down tilting. While there are no significant differences in heart rate (HR) and total peripheral vascular resistance (TPVR).
Keywords: head down tilt, cardiac output.

Introduction

There have been many researches concerning the assessment of cardiovascular reflexes in normal subjects to test the integrity of the cardiovascular performance such as head up tilting at different angles of tilt (1,2,3), lower body negative pressure (LBNP) which simulate head up tilting but subject remain in supine position(4,5), neck suction to stimulate carotid baroreceptors(6), valsalva maneuver(7), supine and upright exercise(8) or immersion in water (9) in which there is shifting of blood from the lower part of the body to the thoracic cavity so that it will cause loading of cardiopulmonary low pressure and arterial high pressure receptors(10) but there were a very little researches concerning head down tilt for the assessment of cardiovascular reflexes. Head down tilt (HDT) has been widely accepted as an effective simulated weightlessness model in humans by inducing a fluid shift from the lower body towards the thoracic compartment and result in a loading of cardiopulmonary pressure and arterial high pressure receptors. So the aim of this study is to investigate the changes in hemodynamic variables in response to head down tilting.

Material and Method:

1. Subjects

This study was carried out on 60 normal subjects 40 men and 20 women. They are apparently normal healthy subjects. They are examined by consultant physician and they have no symptoms of any diseases with normal cardiovascular status which evaluated by physical examination, also chest X-ray, electrocardiogram and echocardiography, was consistently within normal range. They divided into two age groups the first age group (20-40 years) and it consist of 32 males and 8 females while the second group age group (41-60 years) and it consist of 8 males and 12 females.

2. Materials: The study is performed by using Transthoracic 2-D and Doppler echocardiography techniques G.E Vivid S5:10.3.0 build 114 (General Electric) with a probe frequency 1.7-3.4 MHz , Mercury sphygmomanometer, pulse oximeter and electrically motorized tilt table.

3. Method: Study protocol consists of two phases:

Phase -1 (supine control state): The subject first placed in supine position for 5-15 minutes for a steady state. The steady state mean that heart rate changing by less than 2-3 beats in consecutive minutes (1,11). Then measurements of blood pressure by sphygmomanometer and heart rate by pulse oximeter were made.

Cardiac output was measured by echocardiography. Left ventricular outlet tract (LVOT) diameter was measured at the level of the aortic annulus from the parasternal long-axis view (12) in systole (13) using 2-D echocardiography. The diameter of the aortic orifice was measured at the attachment of the valve cusps and it was determined only at baseline, and this value was assumed to be constant and used during second phase of CO calculations. LVOT area was calculated as π (LVOT diameter/2)2. The pulsed Doppler sample volume was positioned in the middle of the left ventricular outflow immediately proximal to the aortic valve leaflets from the apical 5-chamber view (14). The outline contour of the velocity curve was traced and the velocity time integral was derived automatically. Doppler-determined CO was calculated as the product of heart rate × the Doppler time velocity integral × cross-sectional area of the aortic annulus,

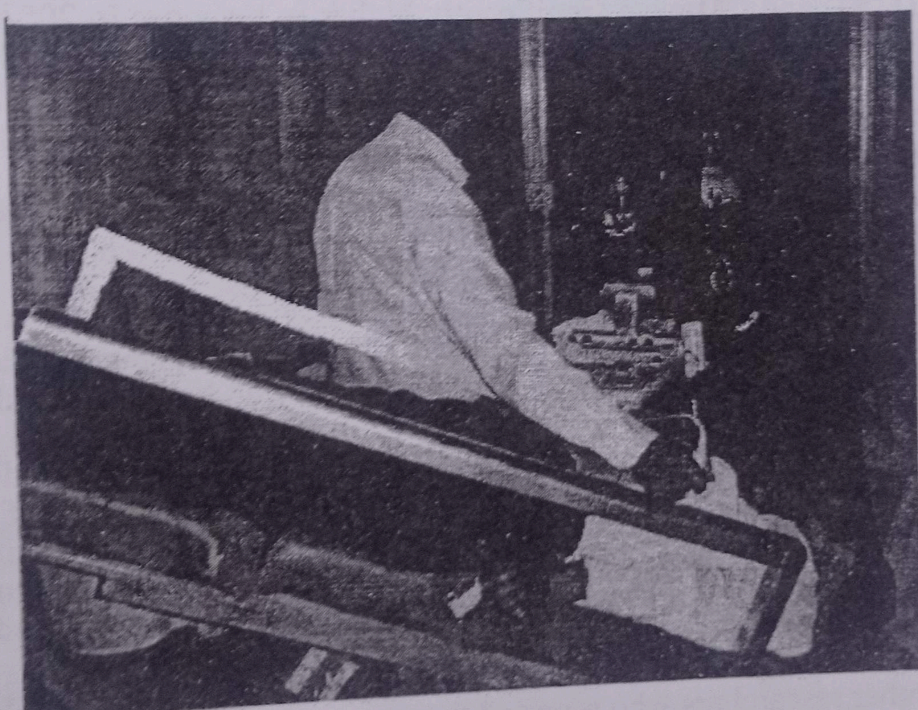
which was considered as a circle. So we use the following equations:

SV = 0.785 X D2 XVTI (15,16)

CO = SV X HR

Total Peripheral vascular resistance (TPVR) is calculated from the equation: TPVR =MBP /CO

Phase -2 :The subject was tilted by 20° head down tilting and after a steady state the measurement of all hemodynamic variables was repeated.



Tilt table (20° head down tilting).

4. Statistical Analysis:
Paired t-test was used to determine the differences in hemodynamic variables during supine position and 20 °head down tilting.

Results:
Data collected and represented in table (1).

Table (1): comparison between hemodynamic variables in age group 1 and 2 in supine position :systolic blood pressure(SBP), diastolic blood pressure(DBP) mean blood pressure (MBP), heart rate (HR) , velocity time integral (VTI) stroke volume (SV), cardiac output (CO) and total peripheral vascular resistance(TPVR).

hemodynamic variables	Group 1		Group 2	
	Supine position	20° head down tilt	Supine position	20° head down tilt
SBP(mm.Hg)	117.3 ± 8.18	118.1 ± 7.79	125 ± 9.92	132.5 ± 11
DBP(mm.Hg)	74.1 ± 6.91	74.6± 7.44	78.8 ± 5.97	84.75 ± 6.86
MBP(mm.Hg)	88.5 ± 5.91	89 ± 6.27	94.2 ± 6.49	100.7± 7.25
HR(bpm)	75.9 ± 5.99	72.4± 6.39	73.1 ± 6.6	72.35± 6.72
VTI(cm)	22 ± 2.11	26.8 ± 2.48	20.2 ± 3.98	23 ± 4.29
SV(ml)	71.2 ± 10.1	86.7± 12.63	65 ± 8.31	75.3 ± 10.34
CO(L/m)	5.4 ± 0.86	6.3 ± 1.03	4.7 ± 0.48	5.3 ± 0.5
TPVR	16.8± 2.94	14.6 ± 2.64	20.2 ± 2.53	19.1± 2.51

1. Cardiovascular reflexes in response to 20° head down tilting in group1 (20 - 40 years) indicated that VTI, SV and CO were significantly higher in response to 20° head down tilting than that of supine position . Whereas the HR, TPVR were significantly lower in 20° head down tilting and there were no significant changes in SBP,DBP and MBP.
2.Cardiovascular reflexes in response to 20° head down tilting in group2 (41- 60 years): indicated that the SV, CO, VTI, SBP, DBP and MAP were significantly higher in response to 20° head down tilting than that of supine position, where as there are no significant differences in HR and TPVR.

Discussion:

1. Cardiovascular reflexes in response to 20° head down tilting in group1 indicated that VTI, SV and CO were significantly higher in response to 20° head down tilting than that of supine position which is mostly because in head down tilting blood and fluid are redistributed from the caudal to the cephalic portions of the body, leading to an increased venous return. This increase in venous return induces distension of the heart and adjacent vessels. There is an intrinsic ability of the heart to adapt to increasing volumes of inflowing blood called the Frank-Starling mechanism of the heart so the greater the heart muscle is stretched the greater the quantity of blood pumped into the aorta.(17)

The HR and TPVR were significantly decreased in response to head down tilting. This result agree with other researchers who reported that the cardiopulmonary blood volume and the filling pressure of the heart play a key role in the regulation of the cardiovascular function and the body fluid volume homeostasis. Experimental studies have shown that changes in cardiac filling originate reflexes through the activation of receptors in the heart. The mechanisms probably involve a combined stimulation of cardiopulmonary low-pressure and arterial high-pressure receptors. In humans relative contribution of each type of receptors, low vs. high cannot be ascertained (18,19, 20). When activated, these receptors induce powerful depressor reflexes with bradycardia and sympathetic inhibition. In this study there was no change in SBP, DBP and MBP which is in agreement with other researchers who reported that the increase in stroke volume lead to an increase in arterial blood pressure which returned to approximately the same level for an individual within 18 sec. the initial increase in blood pressure is due to primary hydrostatic shift and blood pressure returned to approximately the same level for an individual by the secondary response (depressor reflexes)

2. Cardiovascular reflexes in response to 20° head down tilting in group 2 indicated that VTI, SV and CO were significantly higher in response to 20° head down tilting than that of supine position which is mostly due to increase venous return to the heart similar to that at group 1.The HR and TPVR were not significantly changed while SBP, DBP

and MBP were significantly higher in response to 20° head down tilting than that of supine position. Normally increase in age is associated with gradual dysfunction of regulatory function (21,22). However, the mechanism of this important phenomenon is unknown. It has been suggested that age-related dysfunction of regulatory mechanism might result from:

A. Altered autonomic reflex function:
The structure and function of autonomic neurons appear to be altered with aging. These structural changes are associated with dysfunction of body cardiovascular maintenance, blood pressure, water and electrolyte distribution, and energy metabolism. Several studies indicate that basal sympathetic activity increases in some elderly individuals, and the increase may be associated with dysregulation of the ability of the sympathetic nervous system to respond to a variety of challenges. (23)

B. Reduce vascular response.
Due to the cholesterol deposits of atherosclerosis and endothelial dysfunction Overall changes in vasomotility with aging are characterized by (i) decreased relaxation (ii) increased constriction, and the resulting imbalance of vascular tone leading to increased vasoconstriction Simultaneously , the vasoconstrictor action of adrenergic stimulation may be increased (24).

C. The reduction either in the afferent or central integrating parts of the baroreflex pathway (25).

Conclusion:
The cardiovascular regulatory mechanism facilitate the adaptation of cardiovascular system to any volume or pressure overload on the cardiovascular system. Head down tilting results in loading of the arterial high pressure and cardiopulmonary low pressure receptors leading to a depressor reflex (via the vasomotor center) in a manner opposite to that of head up tilting. There is age related dysfunction of regulatory function of the cardiovascular system.

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