Evaluation of Hemodynamic Changes during Pregnancy by Deep Breathing Test and Standing up Test

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Abstract

Deep breathing test and standing up test are used to evaluate the integrity of autonomic nervous system .Cardiovascular reflexes were studied in 25 pregnant women in comparison with 20 non pregnant women. This study showed that pregnancy altered the HR response in deep breathing .In deep breathing test HR variability(mean heart rate range) and E/I ratio decreased in pregnancy . Systolic and diastolic blood pressure increased after standing up in pregnant women, So this study conclude that parasympathetic responsiveness decreased during pregnancy and sympathetic activity increase.

الخلاصة

اختبار النفس العميق واختبار الوقوف بعد وضع الاستلقاء هما من الاختبارات المتبعة لتقييم كفاءة الجهاز العصبي اللاإرادي. تم دراسة انعكاسات القلب و الاوعية الدموية في٢٥ حامل و قورنت مع٢٠امراة غير حامل ووجد ان الحمل يغير معدل نبضات القلب .ففي اختبار التنفس العميق تغيرات معدل النبض و نسبة الاعلى الى الادنى قلت في حالة الحمل وكذلك ضغط الدم الانقباضي والانبساطي ازداد في اختبار الوقوف و هذا يدل على ان استجابة الجهاز اللاإرادي اللاودي تقل اثناء الحمل مع زيادة نشاط الودي.

Introduction

Pregnancy is associated with several profound changes in maternal hemodynamic, from these changes are Maternal blood volume and cardiac out increase. Although the autonomic nervous system plays a central role in the adaptation of the cardiovascular system to varying hemodynamic needs, the role of the autonomic nervous system in the adaptation of the circulation to pregnancy is poorly understood [1]. Noninvasive cardiovascular autonomic reflex tests have been used to assess autonomic nervous function in diabetes mellitus and various other disease[2,3]. These tests remain the cornerstone for these assessment[4]. These tests includes: deep breathing test, orthostatic test, isometric handgrip, cold pressure, hyperventilation and others[5]. Heart rate variability with deep breathing (HRVdb) is highly sensitive measure of cardiovagal or parasympathetic cardiac function [6,7]. In 1847Karl Ludwig noted that HR increased with inspiration and decreased with expiration (respiratory sinus arrhythmia) [8,9]. Blood pressure fluctuations during standing up and handgrip evaluate sympathetic innervation[2].

Materials and Methods

Subjects

This study was performed in antenatal care unit in Hilla city. The subject were the pregnant women who came for follow up, and control from

the medical staff of that healthy center and from healthy visitors.

25 healthy pregnant women with mean age± SD (28±2) years old were included in this study and compared with 20 non pregnant women with mean age(30±1)years old. All were in stable clinical conditions. Full history had been taken from them including any previous history of disease, e.g. (hypertension ,diabetes mellitus),history of smoking and drug ingestion like drug with anticholinergic activity and antispasmodics, these will effect on the heart rate variability during breathing (HRVdb).HRVdb influenced by age ,as the variability decrease with advancing age, so it is essential to use methods with well-defined age stratified normal value[6] (i.e) in autonomic tests it is mandatory to take age in to account[10]

Apparatus

1.automated sphygmomanometer.(Rossmax).

2.electrocardiography:paper moves 1500small division in a minute, so to measure heart rate, the number of small square between two p waves or R-R interval is counted, 1500 divided by this number gives the heart rate[11,12].

Method

The subjects(pregnant and non-pregnant women)who were involved in this study were reassured to avoid any emotional excitement and tried to simplify the test for them so that they will not be frightened. Evaluation the validity of automated sphygmomanometer was done by comparisons between systolic blood pressure (SBP) and diastolic blood pressure (DBP) obtained by mercury sphygmomanometer and those obtained by automated one (systemic error) [13,14] and comparison between duplicate estimates of BP at supine position (random error) then the paired differences of each two estimates were determined in order to test the reproducibility or repeatability of this device and using 95% tolerance limit by the statistical equation: 2SD/mean*100%[15]. Subject should be in supine position and ECG leads were connected to the subject as o'brien advised performing the deep breathing test in supine position so vagal effect are then most pronounced[16]. Before performing the test, the subject should be in steady state means that the heart rate in consecutive minute change by less than 3 beats/minute[17]. Two tests were performed deep breathing test and standing up test. These tests performed under standardized conditions, in the morning, after period of relaxation, tobacco and medications were not allowed before the tests[3]. In deep breathing test, the subject breathed continuously and with as maximal tidal volume as possible at rate of 6breaths per minute [2]. Expiratory to inspiratory ratio (E:I) assessed by taken the ratio of the longest R-R interval during expiration to the shortest R-R interval during inspiration. E:I ratio may be assessed from single breath or the mean of successive breaths[18,19]. Measuring mean heart rate range(MHRR)is by subtracting the maximum and minimum values during inspiration and expiration of series of successive breath at least 6 breath[20]. In orthostatic test systolic and diastolic blood pressure are measured in supine and standing position .this test should be performed after5-10min supine rest because a very short(1min)resting period as used in Ewing test battery will yield relatively small circulatory responses, the very long resting period used by O'Brien is unnecessary[16].

Statistical analysis: Comparison of E:I and MHRR of pregnant women with control group during deep breathing test were made by student's

independent t- test, while comparison between systolic blood pressure and diastolic blood pressure of pregnant women during standing up test were done by using student paired t-test.

Comparisons between SBP and DBP that measured by mercury sphygmomanometer and automated one were done by independent t-test, evaluating the reproducibility of automated sphygmomanometer was achieved by paired t-test. P value <0.05 considered statistically significant [21].

Results

Evaluation the validity of automated sphygmomanometer by systemic error indicate that there were no significant difference between values of systolic blood pressure (SBP) and diastolic blood pressure(DBP) measured by mercury sphygmomanometer with those values measured by automated one, table (1). Evaluation the reproducibility of automated sphygmomanometer were done by taking duplicate estimate of SBP and DBP (random error), and using 95% tolerance limit by taking: 2SD / mean* 100% showed that there were no significant difference between paired values. Table(2).

Table 1 Evaluation of automated sphygmomanometer by systemic error :P<0.05

Parameter	Automated sphygmomanometer	Mercury sphygmomanometer
SBP(mmHg)	102.58±9.11	105±8.20
DBP(mmHg)	62.33±8.38	60.00±7.81

Table 2 Evaluation of automated sphygmomanometer by random error: P<0.05

parameter	Mean ±SD	Mean of paired differences	Standard deviation	95% Tolerance limit
SBP(mmHg)	102.58±9.11	0.75	3.407	6.6%
DBP(mmHg)	62.33±8.38	0.33	1.66	5.3%

Comparison between expiratory to inspiratory ratio (E:I) ratio and mean heart rate range(MHRR) of pregnant women during deep breathing test with E:I and MHRR of control group showed the E:I ratio and MHRR of control group were significantly higher than those of pregnant women, p < 0.05, table(3), figure(1,2) respectively.

Comparison between (SBP) and (DBP) of pregnant women during standing up test showed that SBP and DBP were significantly higher during standing position than the values during supine position, p<0.05, table (4), figure (3).

Table 3 Comparison between E:I ratio and MHRR during deep breathing test of pregnant women with E:I ratio and MHRR of control group. P<0.05

Parameter	E:I	MHRR
Pregnant group	1.106±0.06	8.08±3.39
Control group	1.312±0.09	23±6.61

Table 4 Comparison between (SBP) and (DBP) of pregnant women during standing up: P<0.05

Parameter	Supine position	Standing position
SBP(mmHg)	102.58±9.11	119±17.56
DBP(mmHg)	62.33±8.38	75.08±8.38

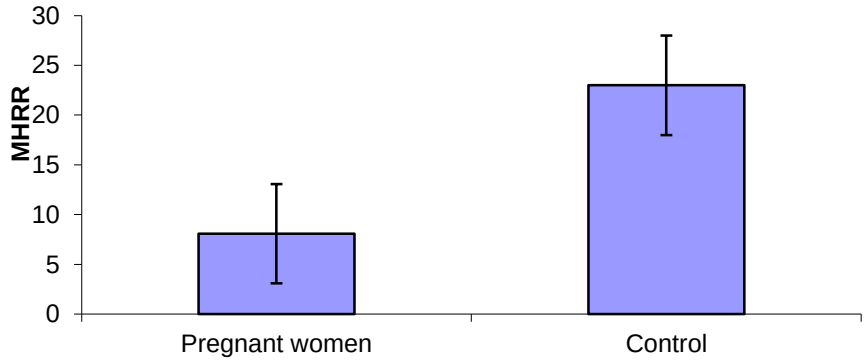

Figure 1 Comparison between MHRR in pregnant women and control group during deep breathing test. P value<0.05.*MHRR: mean heart rate range.

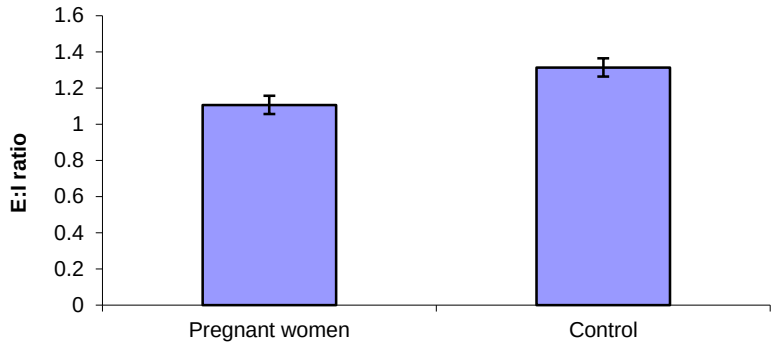

Figure 2 Comparison between E:I ratio in pregnant women and control group during deep breathing test. P value<0.05.*E:I expiratory to inspiratory ratio.

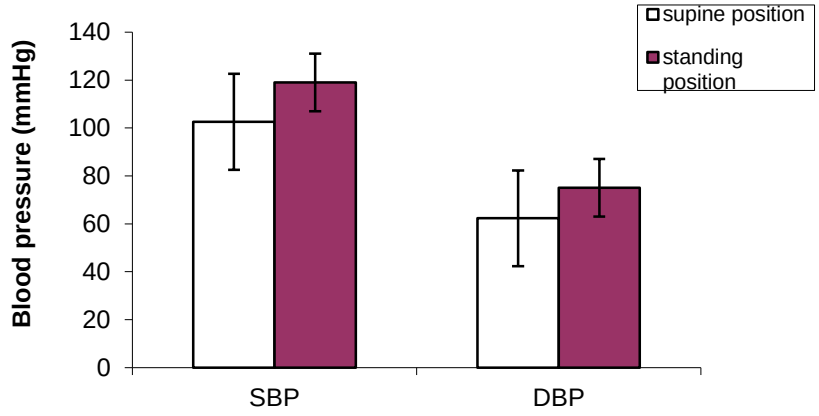

Figure 3 Changes in systolic blood pressure (SBP) anddiastolic bloodpressure(DBP) during standing up test in pregnant women. P value < 0.05.

Discussion

In humans, normal pregnancy is associated with dramatic changes in hemodynamics, which begin early (i.e., following conception, 4 to 5 weeks of gestation) and are accompanied by changing levels of various pressor hormones and vasoactive metabolites. These changes are detectable by 4 weeks[22,23] and are nearly completed in the first half of pregnancy[24,25]. It has been proposed that hemodynamic changes during pregnancy occur through autonomic control mechanisms[26] but the actual role of the autonomic nervous system in pregnancy is poorly understood. Earlier human studies on vasomotor sympathetic activity during pregnancy have focused only on plasma norepinephrine concentrations[27,28]. plasma norepinephrine is an insensitive measure of vasomotor sympathetic activity, since it can be affected by many factors, such as efferent nerve discharges, synaptic transmitter release, reuptake mechanisms, clearance, regional blood flow, or plasma volume[28]. So in this study standard cardiovascular reflex tests were used to evaluate the autonomic regulation in pregnant women and it found that pregnancy altered heart rate response, in deep breathing test MHRR and E:I ratio were decreased in comparison with control group, these results show that parasympathetic activity decreased during pregnancy and these findings are in agreement with Eva *et. al* .[1] studies, whereas systolic blood pressure and diastolic blood pressure increased after standing up in pregnant women and this conclude that sympathetic activity increased during pregnancy and these findings go with Greenwood *et. al*.[30,31] who found that vasomotor sympathetic activity increased in women with normal pregnancy and was even greater in hypertensive pregnant women. These reduction in parasympathetic activity with increment of sympathetic activity could be explained to meet the increased demand due to the placental and fetal circulation.

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