A Study of the Changes of Cardiovascular Haemodynamics at Different Gestational Periods of Normal Pregnany

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الخلاصة:

اجريت هذه الدراسة على(102)من النساء الحوامل الصحجات اللاتي تتراوح اعمارهن بين (٢٠-٤٠) سنة بهدف دراسة التغيرات على وظائف الاوعية الدموية ووظيفة عضلة القلب اثناء الحمل الطبيعي ومقارنة هذه التغيرات على مختلف مراحل الحمل باستخدام جهاز الالكولقاس كمية ضخ الدم للنبضة الواحدة (SV) وقياس كمية ضخ الدم للدقيقة الواحدة (CO) وقياس الضخ الجزئي للبطين الايسر (EF)وحجم البطين الايسر الذي يشمل حجم البطين الايسر في حالة الانبساط (EDD) وحجم البطين الايسر في حالة الانقباض (ESD). تم استخدام جهاز الضغط الزئبقي لقياس ضغط الدم .هؤلاء النسوة تشمل ثلاثة مجاميع: المجموعة الاولى تشمل النساء الحوامل في نهاية (١٣) اسبوع من الحمل ،المجموعة الثانية تشمل النساء الحوامل في نهاية (٢٦) اسبوع من الحمل ،المجموعة الثالثة تشمل النساء الحوامل في نهاية (٣٩) اسبوع من الحمل،بالاضافة الى النساء غير الحوامل كمجموعة مقارنة .وتبين من نتائج هذه الدراسة ان هناك زيادة معنوية في كمية ضخ الدم للنبضة الواحدة و كمية الدم التي يضخها القلب في الدقيقة الواحدة و ضربات القلب وحجم البطين الايسر في حالة الانبساط مع تقدم فترة الحمل وهناك انخفاض معنوي في المقاومة المحيطية للاوعية الدموية (PVR) مع تقدم مراحل الحمل (تم حسابها باستخدام القانون PVR=MBP/CO) بينما لا يوجد أي تغير معنوي في حجم البطين الايسر في حالة الانقباض ومعدل الضخ الجزئي للبطين الايسر ومتوسط ضغط الدم في كل المجاميع مع تقدم الحمل

Abstract

This study is carried out on 102 normal healthy pregnant women,aged 20- 40 years in order to study the changes in haemodynamic variables and cardiac function during normal pregnancy and make comparison between changes in different gestational age, by using non invasive technique including :

-Echocardiography for estimation of stroke volume [SV], cardiac output[CO] , left ventricular ejection fraction [EF] and left ventricular dimension including end – diastolic dimension [EDD] and end- systolic dimension[ESD].Mercury sphygmomanometer for measuring blood pressure.

Those women are divided into three groups ; 1.The first group includes pregnant women at end of first trimester [at gestational age of 13 weeks]. 2.the second group includes pregnant women at end of second trimester[at gestational age of 26 weeks].3.The third group includes pregnant women at end of third trimester[at gestational age of 39 weeks] .- In addition to non pregnant women as a control group.The results of this study indicates that there is significant increase in SV, CO , HR, EDD with the increase of gestational age of pregnancy and significant decrease in PVR with the increase of gestational age[PVR are calculated from the equation: PVR=MBP/CO]. While there are no significant differences in ESD ,EF, and MBP in all groups.

Aim of the study :Cardiovascular hemodynamic changes that occur during different gestational age of normal pregnancy include: SV ,EDD, ESD, EF, HR .CO, MBP and PVR.

INTRODUCTION :

Physiological changes in pregnancy :Physiological and anatomical alterations develop in many organ systems during the course of pregnancy and delivery .Physiological changes during pregnancy facilitate the adaptation of the cardiovascular system to the increased metabolic needs of the mother, thus enabling adequate delivery of oxygenated blood to peripheral tissues and the fetus. Changes occur in circulating blood volume (affecting preload), peripheral vascular compliance and resistance (affecting afterload), myocardial function and contractility, heart rate, and sometimes heart rhythm and the neurohormonal system .Women without heart disease adapt well and adverse cardiac events are rare. In some women, heart disease may first be detected during pregnancy when inadequate adaptation exposes previously unrecognized limitations of cardiac reserve. In the presence of important maternal structural heart disease, increased cardiovascular demands of pregnancy can result in cardiac decompensation, arrhythmias, and, rarely, maternal death(1). Early changes are due ,in part , to the metabolic demands brought on by the fetus , placenta and uterus and , in part, to the increasing levels of pregnancy hormones, particularly those of progesterone and oestrogen. Later changes , starting in mid pregnancy ,are anatomical in nature and are caused by mechanical pressure from the expanding uterus (2). During pregnancy ,the heart undergos remodeling similar to that observed in athletes , with increases in chamber dimensions, left ventricular wall thickness , and mass that is consistent with a process of eccentric hypertrophy(3 ,4,5).

MATERIALS AND METHODS

The study sample are the pregnant women who come to obstetric private clinic and referred to Al- Sadar hospital [Echo department] from November 2007 through May 2008 , those with different gestational age . One hundred two [102] looking healthy subjects are included in this study , no any signs or symptoms of any disease. Full history has been taken from them including any previous history of cardiac disease , hypertention , diabetes mellitus , or history of smoking .The women are classified into three groups [at end of first trimester, at end of second trimester and at end of third trimester] according to their gestational age ; -Group [1][at end of first trimester] ;includes 27 pregnant women with 13 weeks of gestation, with mean age[25.03±12.59years],-Group[2][at end of second trimester]; includes 25 pregnant women with 26 weeks of gestation.-Group [3][at end of third trimester]; includes 24 pregnant women with 39 weeks of gestation with mean age [26.66 ± 5.75 years].

In addition to those pregnant women , 26 healthy femals with no pregnancy are also included in this study as a control with mean age [25.53 ± 5.75 years],We excluded other four pregnant women from this study because of mitral valve prolapse [those are asymptomatic patients diagnosed by echocardiography].

The details of anthropometric data are presented in table 1 :

Table [1]:

Anthropometric data of control [non pregnant women] and pregnant women at end of first , at end of second , and at end of third trimesters			
Groups	age [Years] Mean ±SD	Weight [Kg] Mean ± SD	height [Cm] Mean ± SD
Control group [n =26]	25.53 ± 5.75	61.76 ± 11.66	155.65 ± 4.05
First trimester group [n= 27]	25.03 ± 12.59	71.44 ± 3.60	156.76 ± 8.5
second trimester group[n=25]	24.96 ± 5.67	76.05 ± 9.53	159.84 ± 4.81
third trimester group[n= 24]	26.66 ± 5.75	80.91 ± 9.12	159.45 ± 4.03

n ; number of subjects .

Apparatus; 1.Mercury sphygmomanometer ;and stethoscope for measuring of blood pressure .Mean BP is calculated according to this equation ; [Rushmer, 1976](6) .That's mean MBP = Diastolic blood pressure plus one third of pulse pressure [difference between systolic BP and diastolic BP] .

2. Echocardiography ;To estimate SV indifferent groups [control ,first trimester ,second trimester and third trimester groups] Cardiac out put is calculated from this equation:CO =SV X HR Echocardiography is also used for measuring left ventricular dimension[LVD] [includingLV dimension and LV systolic dimension], left ventricular ejection fraction[EF] and fraction shortening .

3.Ultrasound :Obstetric ultrasound examination is performed to obtain accurate fetal gestation , to exclude fetal abnormalities , and to confirm a singleton pregnancy (twin pregnancy are excluded from this study.

Statistical Analysis :All values are expressed as a mean ± SD .These comparisons by using analysis of variance [ANOVA] are to determine the difference in changes between control group, first group , second group and third group] .A p-value < 0.05 is considered statistically significant .

Results :

Table [2]:Differences in hemodynamic variables at end of first trimester; at end of second trimester ; at end of third trimester and in control group [non pregnant women]:

parameter	Control group	First group	Second group	Third group
SV*	67.15 ± 10.85	76.07±10.28	79.12 ±13.10	81.50 ±9.90
EDD*	45.38 ± 4.18	46.66 ±3.58	48.28 ±3.45	51.91 ±3.37
ESD	31.84 ± 5.06	32.40 ±5.16	33.33 ±4.68	35.92 ±7.82
EF	63.76± 8.43	63.28 ±11.28	62.85 ±8.30	57.83 ±7.69
MBP	90.87 ±5.11	93.00 ±6.04	91.06 ±5.67	92.05 ±7.93
HR*	78.80 ± 4.14	79.22 ±4.21	86.48 ±9.28	90.58 ±5.24
CO*	5.20 ± 0.85	5.63 ±0.95	6.72 ±1.14	7.08 ±1.05
PVR*	17.85 ± 2.82	16.89 ±3.06	13.89 ±2.35	13.28 ±2.32

The results indicate the following changes :By ANOVA test , in general there are significant differences in SV , EDD , HR , CO and PVR in all groups , while there are no significant differences in ESD, EF and in MBP in all groups .By

multiple comparisons among these groups ,the results indicated the following differences :1.Stroke Volume [SV] is significantly increased in first , second and third group than in control group with no significant changes in SV between first and second ,first and third , second and third groups as shown in figure [5 :

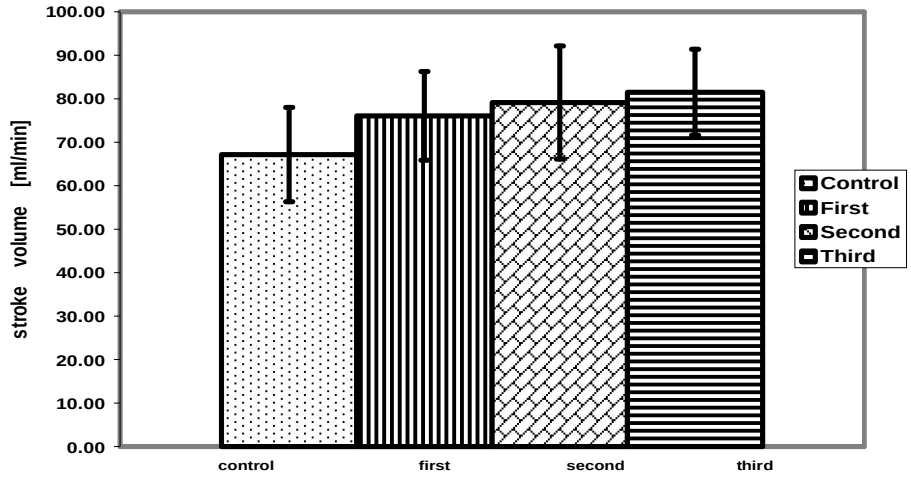

Figure [5] :differences in stroke volume among control, first ,second and third groups .

2.End diastolic dimension [EDD]: is significantly higher at end of third trimester than other groups . Also significant changes are occurred between control group and third group , between control and second , between first and third ,and between second and third group as shown in figure [6]:

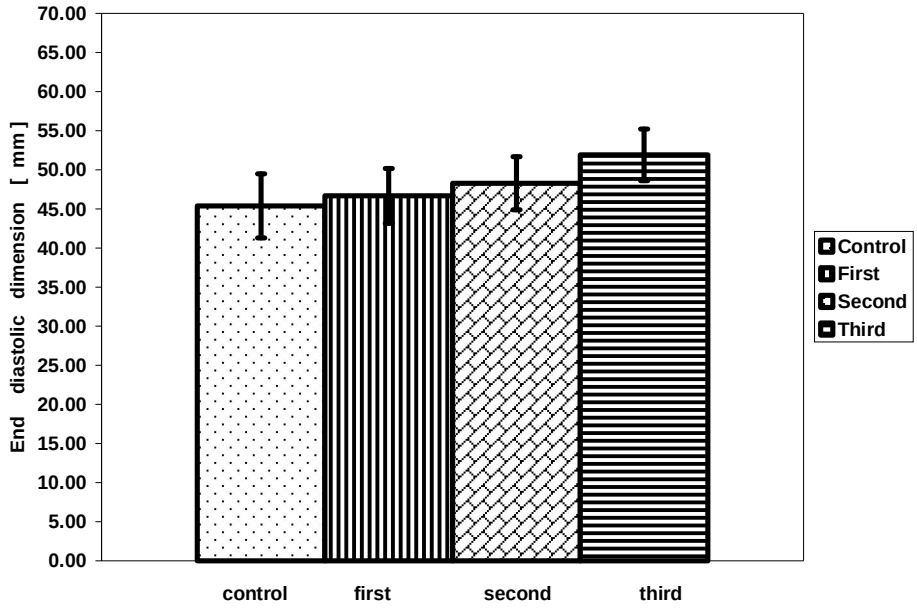

Figure [6]: differences in end diastolic dimension of left ventricle among control , first , second and third groups .

3.End systolic dimension[ESD]: is significantly higher at end of third trimester than control group and first group while no significant changes occur between

first and second groups , first and control groups , second and third groups , and , second and control groups as shown in [figure [7]:

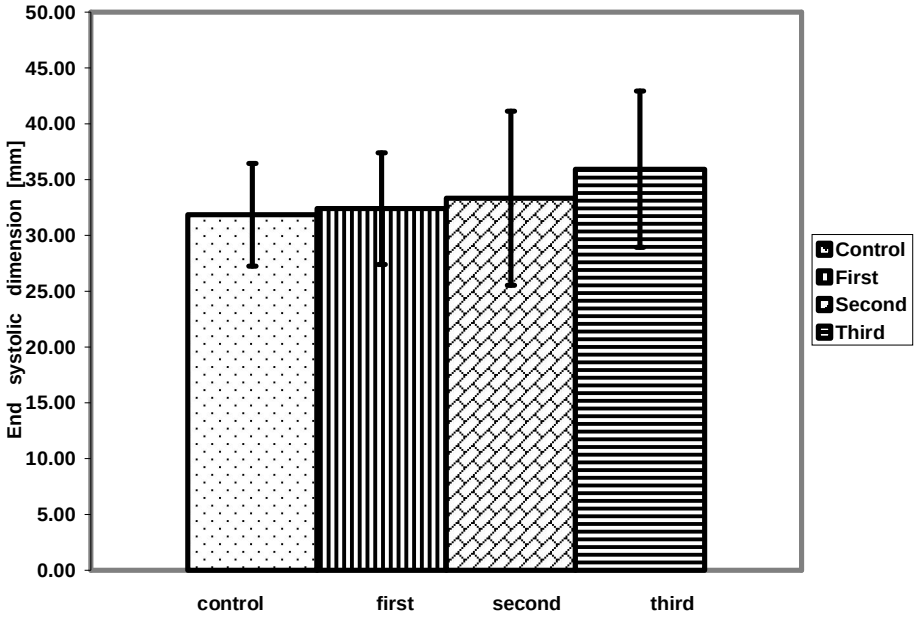

Figure [7]: differences in end systolic dimension of left ventricle among control , first , second and third groups .

4.Ejection Fraction[EF]: is significantly lower in third trimester as compared with control and first groups , while no significant changes occur between first and second , first and control , second and control , and , second and third as shown in figure [8]

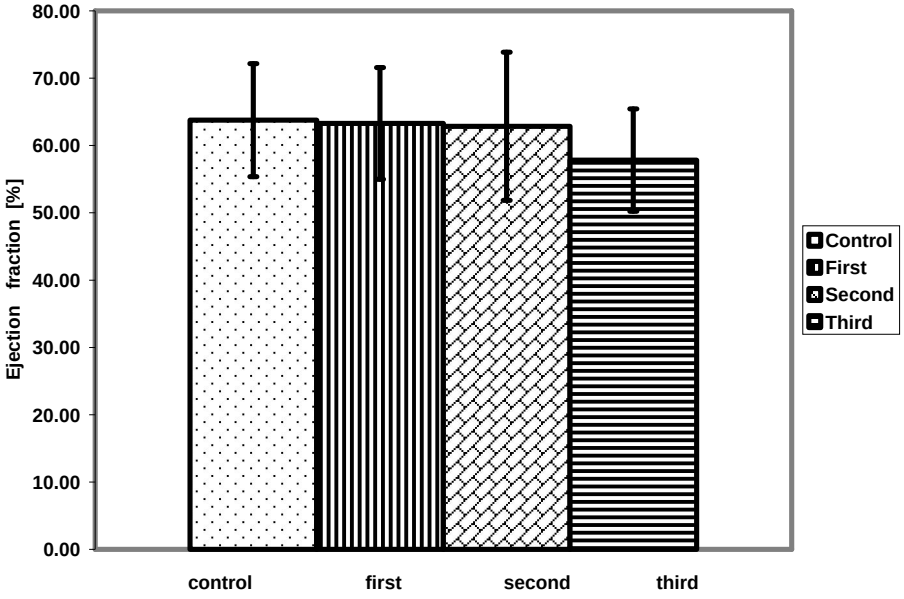

Figure [8] : differences in ejection fraction of left ventricle among control , first , second and third groups .

5.Mean blood pressure[MBP]: there are no significant changes among all groups in mean blood pressure as shown in figure[9]:

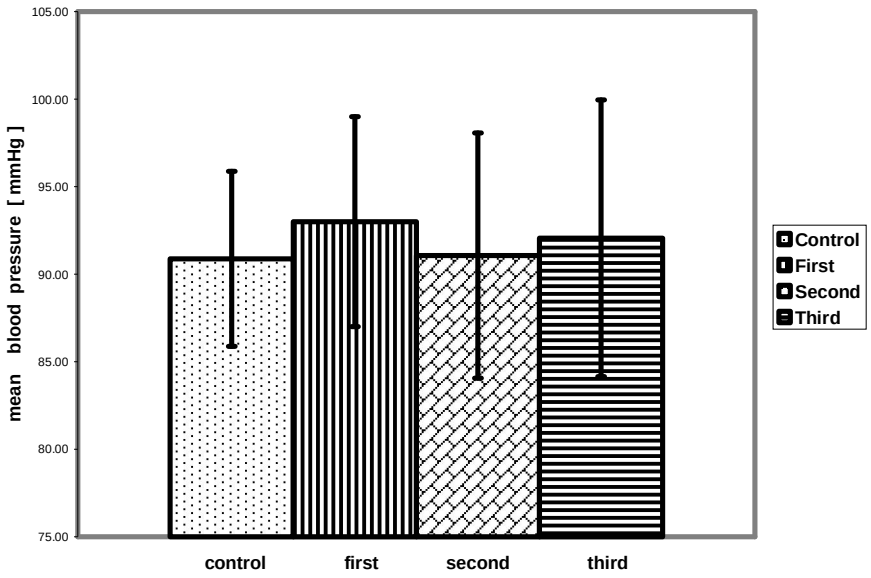

Figure [9] : differences in mean blood pressure among control , first , second and third groups .

6.Heart Rate[HR]: is significantly increased in first , second and third trimesters . Also significant changes occur between first and second , first and third , second and control , and, third and control , and between second and third groups as shown in figure [10] :

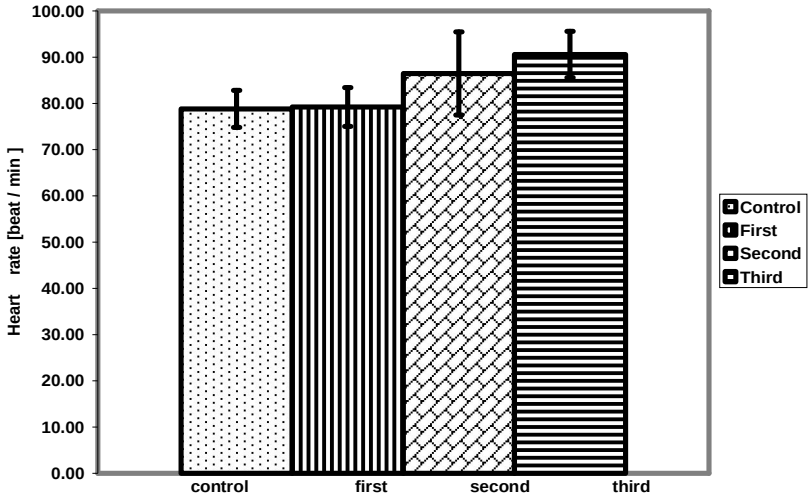

Figure [10]: differences in heart rates among control , first , second and third groups .

7.Cardiac output[CO]: is significantly increased in first , second and third trimesters. There is significant increase between first and second , between first and third , between second and control , and , between third and control groups ,while no significant changes between first and control and between second

and third groups as shown in figure[11]: :

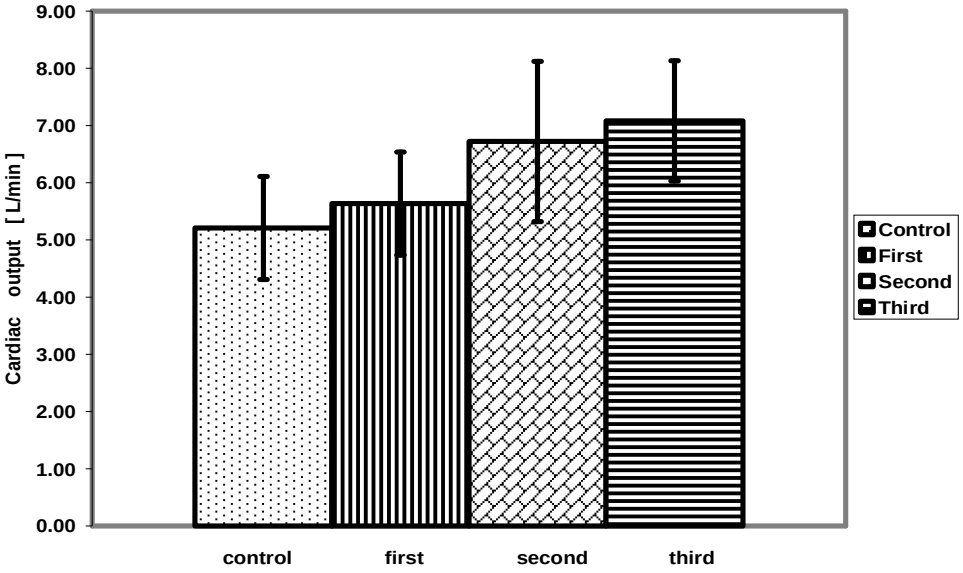

Figure [11]: differences in cardiac output among control , first, second and third groups .

8.Peripheral Vascular Resistance[PVR] : There is a significant decrease between first and second groups , between first and third groups ,control and second ,and, between control and third groups , while no significant changes between first and control groups and between second and third groups as shown in figure [12]:

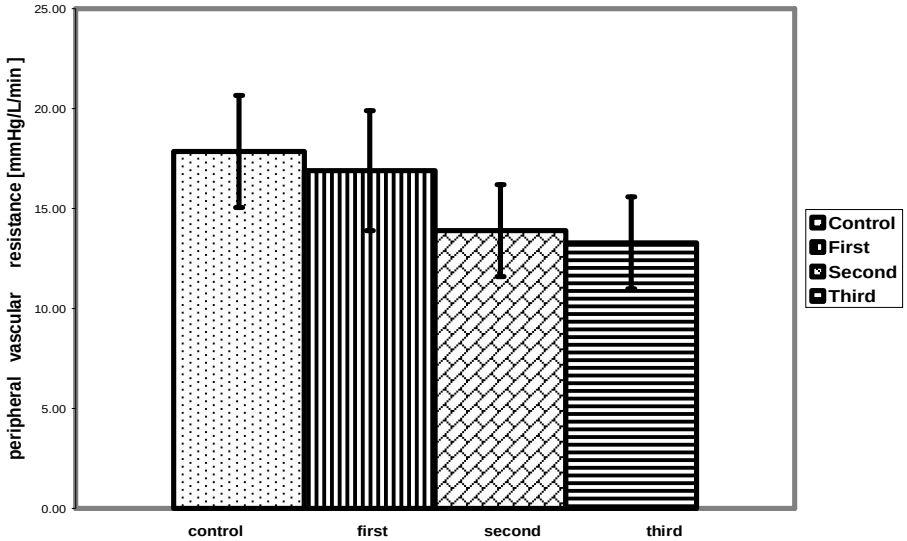

Figure [12] : differences in peripheral vascular resistance among control , first , second and third groups .

Discussion :

1.Stroke volume :Stroke volume is significantly increased in first , second and third trimester than in control group.The most likely cause of stroke volume increases in pregnancy are in part , due to plasma volume expand following the activation of mechanisms of fluid retention by the kidneys , and in other part, due to hormonal effect which also may contribute to fluid retention such as oestrogen, aldosterone, prolactine ,placental lactogen, prostaglandins and growth

hormone(7).This study agree with Carbrillon et al. that stroke volume continue to increase till term (8).

2.End diastolic dimension :End diastolic dimension is significantly higher at end of third trimester than other groups . These possibly due to the increased time required for ventricular remodeling(9,10 ,11).

3.Ejection Fraction:This study demonstrate that LV fractional shortening and ejection fraction during pregnancy are showing a transient fall in LV fractional shortening and ejection fraction during the third trimester, this in agreement with other investigators (12,13) .The most likely cause of this transient fallness, is that a reduced preload in the latter part of the third trimester contributes to a reversible fall in LV systolic function[because physiologically, an increase in preload and reduction after load are often accompanied by an increase in left ventricular function](7).

4.Mean Blood Pressure :Mean blood pressure does not change during pregnancy . The main cause is that reduced vascular resistance is an important adaptive response that maintains mean blood pressure within normal range at the time of greatly increased cardiac output [because MBP= CO XPVR].(14,15,16)

5.Heart Rate:Heart rate is increased during pregnancy especially in third trimester ,this is due to increased physiological demands on cardiovascular (17,18,19) .

6.Cardiac output: This study shows the expected increase in cardiac output in normal pregnancy . This study show a significantly higher cardiac output in the third trimester compared with the first and control group , and this increment continue until term,this in agreement with other investigators (20, 21) . The most likely reason of increase of cardiac output in the early and mid first trimester is either mediated by an endocrine stimulus or by an increase in heart rate in early pregnancy(22).

Cardiac output increases predominantly in the latter half of pregnancy and continues to increase and peak at term , this maximal cardiac output occurrence is due to a15% increase in heart rate and a 24% increase in stroke volume (23, 7) and as cardiac output measured by equation [CO =HR X SV].

7. Peripheral vascular resistance :Total vascular resistance decreases with pregnancy , with the decrement leveling off beyond the second trimester , this agree with other investigators (24).

The most likely cause of this decrement is due to increase vascular distensibility in pregnancy ,and this distensibility changes are due to reduced smooth muscle tone and vascular wall remodeling (25).The other cause of decrease total vascular resistance may be due to direct hormonal effects of oestrogen because oestrgen receptors have been found in both the vascular smooth muscle and endothelium.[oestrogen cause vasodilation by potentiating endothelium- dependent[related to acetylcholine] and endothelium- independent[nipride- responsive] pathways(26,27,28) .

The other cause of decrease vascular resistance in normal pregnancy is probably due to increased aortic blood velocities noted early in pregnancy could enhance the shear stress- induced release of endothelial relaxing factors[eg, nitric oxide and prostaglandin 2](29)

Conclusions :

1. There are significant increases in cardiac output , stroke volume , heart rate , end diastolic dimension of left ventricle , and a significant decrease in peripheral vascular resistance among all groups.

2.There are no significant differences in end systolic dimension of left ventricle, mean blood pressure and ejection fraction among all groups .

Recommendations:

1.Follow up the women by echocardiography after delivery till 12 weeks post partum.

2.Future studies will be designed to evaluate abnormal gestations, such as those complicated by chronic hypertension or preeclampsia in relation to these normative data .

4.To study a possible effect of parity on cardiac output changes in pregnancy , and to find if there is a significant difference in CO between primiparous and multiparous women .

5.To study a significant correlation between CO and maternal stature and its surrogate marker of birth weight.

6.To study the changes in cardiovascular hemodynamic variables in twin pregnancy .

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