Research Article

A comparative study of autonomic function tests (sympathetic and parasympathetic) in three trimesters of pregnancy

Reena Kaur Ruprai, Sandeep H Ghuge

Department of Physiology, Rural Medical College, Loni, Maharashtra, India.
Correspondence to: Reena Kaur Ruprai, E-mail: reenakaur.ruprai@rediffmail.com

Received July 8, 2016. Accepted July 22, 2016

Abstract

Background: Women exhibit large variations in behavior and hormones during different phases of their reproductive life. Emotions, hormones are much under command of autonomic nervous system. During pregnancy a woman's body focuses its primary attention to nurture the new one and the body automatically prioritizes the needs of her unborn. The autonomic nervous system is known to play a major role in cardiovascular regulation in pregnancy, which is associated with lots of changes in hemodynamics, including blood pressure, cardiac output and also in systemic vascular resistance.

Objective: The present study was done to evaluate the autonomic (sympathetic and parasympathetic) nervous system sequentially during the three trimesters of pregnancy.

Materials and Methods: Total 90 healthy pregnant women having no major illness, were considered for the study and grouped as group I 30 subjects of first trimester, group II 30 subjects of second trimester and group III, 30 subjects of third trimester. All subjects were evaluated by CANWIN–Cardiac Autonomic Neuropathy Analyser.

Result: Women in group I show normal parasympathetic function plus mild parasympathetic (PNS) dysfunction; and moderate sympathetic (SNS) dysfunction .Women in group II shows mild PNS dysfunction with moderate SNS dysfunction. Women in group III shows moderate parasympathetic and sympathetic dysfunction.

Conclusion: The autonomic dysfunction starts from the first trimester of pregnancy. The present study thus can be an effective tool to anticipate the pregnancy related cardiovascular complications such as pregnancy induced hypertension, pre-eclampsia thereby decreasing the morbidity, and improving the outcome of pregnancy of healthy mother and healthy baby.

KEY WORDS: Pregnancy, sympathetic activity, parasympathetic activity, cardiovascular

Introduction

A well synchronized interplay between the sympathetic and parasympathetic system is mandatory to deal with cardiovascular adaptations in various pathophysiological condition. One of the most precious situations is pregnancy where substantial alterations in cardiovascular system are observed. The blood volume, cardiac output, stroke volume begin to change after the first trimester to accommodate the growing fetus.[1–7] It might be anticipated that the baroreflex function would be decreased in pregnancy due to physiological hypervolemia. Systemic vascular resistance is also decreased to hemodynamic changes. Arterial blood pressure shows a progressive fall in the first and middle trimester. The cardiovascular sympathetic nervous activity shifted to higher sympathetic modulation in late pregnancy.[8] Aortocaval compression is one of the important factor associated with this. The parasympathetic activity is also different from the pre pregnant state.

The cardiovascular modification are of value not only to maternal adaptation to pregnancy but also in nurturing the

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2017.08072016574	

growing fetus, failure of which may be associated with complication like pregnancy induced hypertension, pre-eclampsia and eclampsia.[5]

So the present study was undertaken to monitor the sequential changes in the autonomic activity in the three trimesters of pregnancy; with an objective to find the relation between pregnancy and cardiovascular functions as well as prediction of cardiovascular risk during pregnancy.

Materials and Methods

After having the institutional ethical committee approval, the study was done on 90 healthy normotensive pregnant females in the age group of 18–28 years attending the Antenatal Clinic of Pravara Rural Hospital, Loni regularly. Pregnancy was confirmed by urinary human chorionic gonadotrophin determination test. Informed written consent was taken from the study participants after having explaining them the study protocol. Subjects having any illness in the present or past, hypertension, diabetes, cardiovascular abnormality, bad obstetric history, history of previous abortion, previous caesarean section were excluded from the study.

Subjects were grouped as follows;

GROUP I: 30 subjects of first TRIMESTER
GROUP II: 30 subjects of second TRIEMSTER
GROUP III: 30 subjects of third TRIMESTER

Following cardiovascular sympathetic and parasympathetic tests were carried out with analyzer CANWIN, it is window based cardiac autonomic neuropathy analyzer with interpretation.

Sympathetic tests

1. Blood pressure response to standing /Orthostatic postural hypotension
2. Blood pressure response to sustained handgrip

Parasympathetic tests

1. Resting heart rate /minute
2. Heart rate response to deep breathing (Expiratory/ Inspiratory ratio)
3. Heart rate response to Valsalva maneuver
4. Heart rate response to standing (30:15 ratio)

Precautions during measurements

1. Test were carried out only after the subjects were relaxed
2. Subjects were advised to have light breakfast and empty their bladder before commencing the tests
3. All tests were performed in 60 minute in under resting conditions between 9–12 noon as described by Voss et al.[15] to avoid the effects of circadian rhythms on heart rate

Result

A total of 90 pregnant women were included in the present study, the results are depicted below in the form of tables. Table 1 shows the group wise distribution of mean and standard deviation of age, height, weight, BMI reflecting that the groups were statistically comparable at the start of the study. Table 2 shows the group wise distribution of mean and standard deviation for parasympathetic tests in the three groups. As evident from the table, women in group II and III has mild to moderate parasympathetic dysfunction. Table 3 shows the group wise distribution of mean and standard deviation of sympathetic tests in the three groups. As can be seen, women in the three groups showed moderate sympathetic dysfunction. Table 4 shows group wise distribution of ANS tests interpretation. Thus, it shows that women in group I had normal parasympathetic function plus mild to moderate parasympathetic dysfunction and moderate sympathetic dysfunction. Women in group II showed mild parasympathetic

Table 1: Demographic characteristics of the groups

Parameters	Group I (*n* = 33)	Group II (*n* = 33)	Group III (*n* = 34)
	Mean ± SD	Mean ± SD	Mean ± SD
Age (Years)	22.06 ± 2.78	21 ± 1.66	21.94 ± 2.39
Height (Cm)	155 ± 4.99	155.79 ± 5.38	154.73 ± 4.81
Weight (Kg)	48.14 ± 0.074	47.68 ± 7.14	50.45 ± 8.03
BMI	20.01 ± 2.47	19.62 ± 2.18	21.08 ± 3.18

Table 2: Parasympathetic tests in the three groups

Para-sympathetic tests	Group I (*n* = 33)	Group II (*n* = 33)	Group III (*n* = 34)
	Mean ± SD	Mean ± SD	Mean ± SD
RHR /min	80.48 ± 10.22	89.82 ± 12.94	94.18 ± 16.74
E : I Ratio	1.26 ± 0.142	1.19 ± 0.107	1.17 ± 0.12
30 : 15 Ratio	1.12 ± 0.160	1.10 ± 0.15	1.08 ± 0.133
Valsalva Ratio	1.56 ± 0.258	1.51 ± 0.25	1.39 ± 0.35

Table 3: Sympathetic tests in the three groups

Sympathetic tests	Group I (*n* = 33)	Group II (*n* = 33)	Group III (*n* = 34)
	Mean ± SD	Mean ± SD	Mean ± SD
OHT	2.91 ± 2.92	4.09 ± 3.38	5.38 ± 3.47
HGT	7.91 ± 7.14	4.54 ± 5.3	10.97 ± 4.2

Table 4: Group wise distribution of ANS interpretation

	Group I (*n* = 33)	Group II (*n* = 33)	Group III (*n* = 34)
Parasympathetic tests	Normal/Mild	Mild	Mild/Moderate
Sympathetic tests	Moderate	Moderate	*Moderate*
ANS dysfunction	Mild + Moderate	Moderate	Moderate

dysfunction and moderate sympathetic dysfunction. Women in group III showed moderate parasympathetic and sympathetic dysfunction. So, in group II, both the sympathetic and parasympathetic functions are more affected as seen by statistically significant results in resting heart rate and expiratory to inspiratory ratio.

Discussion

Summarizing the autonomic changes separately in different trimesters of pregnancy, it was observed that, women in group-I, had mild autonomic nervous system dysfunction. Women in group-II showed moderate autonomic nervous system dysfunction, wheras women in group-III demonstrated moderate autonomic nervous system dysfunction with mild parasympathetic dysfunction plus moderate sympathetic dysfunction.

On comparison among the three groups, in group II the parasympathetic dysfunction is more in comparison to group I as evident by statistically highly significant ($p < 0.01$) and significant ($p < 0.05$) results in resting heart rate and expiratory to inspiratory ratio, respectively. In group II the sympathetic dysfunction was also more as compared to group I with statistically significant result in - sustained hand grip test ($p < 0.05$). On comparison of parasympathetic tests and sympathetic tests in group II and III it was found that, in group III the parasympathetic dysfunction is more in comparison to group II when compared with the mean values, however statistically non significant results were found in the parasympathetic tests among group II and group III. The sympathetic dysfunction was found to be more in group II when compared to group III and statistically highly significant ($p < 0.01$) results in-sustained hand grip test were obtained.

Thus these results indicate that

- ANS dysfunctions start from the first trimesters of pregnancy.
- These autonomic dysfunctions goes on increasing in severity as the pregnancy advances i.e. autonomic dysfunction is directly proportional to number of weeks of pregnancy.
- The autonomic dysfunction is by both parasympathetic and sympathetic autonomic dysfunction but mainly because of the parasympathetic dysfunction.

The results indicates that sympathetic activity was decreased more in second trimester, less in first trimester and least in last trimester of pregnancy i.e. towards prepregnant level. In the early pregnancy an overall decrease in vascular tone leads to systemic vasodilatation and rise in arterial compliance, there is a possible role of release of vasopressin,[14] which causes hemodilution and with a reduction in viscosity, which potentiates fall in vascular resistance and contributing to fall in afterload.

Also, There is evidence that increased nitric oxide (NO) activity plays a major role for the pregnancy-associated drop in systemic resistance, as depicted in study done by Morris et al.[10] Another important contribution is by circulating estrogens[6,9] progressively during pregnancy which may stimulate vascular function directly or indirectly via increased NO availability.

Other factors contributing are increased concentrations of circulating prostaglandins[6,11] increased heat production by the developing fetus and development of a low-resistance circulation in the pregnant uterus.

With further increase in the gestational age, aortocaval compression caused by the enlarging gravid uterus further compromises venous return and cardiac output leading to a shift in sympathetic nervous activity towards an even higher sympathetic and lower vagal modulationin the third trimester of pregnancy.[2,3,10]

These findings emphasize that the most important maternal adaptation to pregnancy take place by change in cardiovascular sympathetic activity for the better perinatal outcome.[12–14]

The changes in the parasympathetic nervous system may be due to the following:

- The increase in heart rate in third trimester is consistent with the finding that vagal baroreflex was significantly decreased in healthy women in third trimester. Heart rate variability and baroreflex sensitivity are reduced in pregnancy in comparison with nonpregnant state.[15]
- Explaining the parasympathetic responses, the increase in the heart rate could be attributed to the reduced vagal baroreflex in third trimester. Study performed by Ekholm et al.,[4] also reflected a decrease in heart rate variability and baroreflex sensitivity during pregnancy and returned to normal level after pregnancy.
- Valdes et al.[14] also found a decrease in baroreflex sensitivity in late pregnancy.

Thus winding up, the parasympathetic dysfunction goes on increasing as pregnancy advances.

However, Ashwini et al.,[1] did not find much significant difference in parasympathetic activity on comparison among pregnant and non pregnant females, whereas the sympathetic was found higher in the first trimester of pregnancy in comparison to non pregnant women.

In the study done by Vikhe et al.,[17], altered cardiovascular indices were observed in pregnancy, thereby supporting the present work.

In the work done by Silver et al.,[13] shows similarity with the present study concluded that there is inhibition of resting parasympathetic activity with an increment of the sympathetic modulation during third trimester of pregnancy in comparison to first and non pregnant level. Thus, there is symapthovagal imbalance in later stages of pregnancy.

The author Ekholm et al.[4] demonstrated decreased parasympathetic responsiveness during pregnancy which returns to normal after delivery.

Thus this kind of study with use of non invasive methods is an area of keen interest, with least risk to maternal as well as fetal well being.

As in routine normal pregnancy these tests are not carried out, an improvisation can be done in antenatal care where in the present era most of the pregnancies are in women who are working, multitasking with more demanding life.

It may also be helpful if diagnose is early, apart from endanger to the mother and new born, it will lessen the economic burden on health care delivery system.

However, further studies should definitely be carried out for correlation of autonomic nervous functions with hormonal imbalance. More effort has to be done for confirmation of such existence. One important limitation is availability of the equipments in the government set up, so that ubiquitously such noninvasive tests can be made accessible.

Conclusion

Thus, the present study has a shown the ample amount of physiological changes the body has to adapt for nurturing the baby in fetus. Such studies are therefore important in early diagnosis of any cardiovascular monitoring in pregnancy, detecting abnormalities at early stage and thereby improving the outcome of pregnancy.

References

1. Ashwini N Nilekar, Purushottam A Giri, Sameer A Kulkarni, Mangala S Valve. Comparative study of cardiovascular autonomic function tests amongst pregnant women of first trimester and non pregnant women. Int J Health Sci Res 2012;2(7): 1–6.
2. Capeless EL, Clapp JF. Cardiovascular changes in early phase of pregnancy. Am J Obset Gynecol 1989;161:1449–53.
3. Clapp JF, Seaward BL, Sleamaker RH, HIser J. Maternal physiologic adaptation to early human pregnancy. Am J Obset Gynecol 1988;159:1456–60.
4. Ekholm EM, Piha SJ, Antilla KJ, Erkkola RU. Cardiovascular autonomic reflexes in midpregnancy. Br J Obstet Gynaecol 1993;100:177–82.
5. Farat MY, Lavigne MC, Ramwell PW. The vascular protective effects of estrogen. FASEB J.1996;10:615–24.
6. Gerber JG, Payne NA, Murphy RC, Nies AS. Prostacyclin produced by the pregnant uterus in the dog may act as a circulating vasopressor substance. J Clin Invest 1981;67:632–6.
7. Hart MV, Hosenpud JD, Hohimer AR, Morton MJ. Hemodynamics during pregnancy and sex steroid administration in guinea pigs. Am J Physiol Regulatory Integrative Comp Physiol 1985;249:R179–85.
8. King TM, Whitehorn WV, Reeves B, Kubota R. Effects of estrogen on composition and function of cardiac muscle. Am J Physiol 1959;196:1282–5.
9. Kuo CD, Chen GY, Yang MJ, Lo HM, Tsai YS. Biphasic changes in autonomic nervous activity during pregnancy. Br J Anaesth 2008 ;84:323–9.
10. Morris NH, Eaton BM, Dekker G. Nittricoxide, the endothelium ,pregnancy and pre-eclampsia. Br J Obstet Gynaecol 1996;103:4–15.
11. Oakley CM. Cardiovascular disease in pregnancy. Can J Cardiol 1990; 6 (Suppl. B):33B.
12. Schier RW, Briner VA. Peripheral arterial vasodialtion hypothesis of sodium and water retention in pregnancy;implications pathogenesis of pre-eclampsia –eclampsia. Obstet Gynecol 1991;77:632–9.
13. Silver HM, Tahvanainen KUO, Kuusel TA, Eckberg DL. Comparison of vagal baroreflex function in nonpregnant women and in women with normal pregnancy, preeclampsia, or gestational hypertension. Am J Obste tGynecol 2001;184:1189–95.
14. Valdes G, Salas SP, Foradiri AC, Gormaz G and Croxatto HR. The neurogenic response to 55 degrees head up tilt in normal pregnant women. Hypertension 1986 ; 8(1): 161–4.
15. Voss A et al. Baroreflex sensitivity, heart rate and blood pressure variability in normal pregnancy. Am J Hypertens 2000;13:1218–25.

How to cite this article: Ruprai RK, Ghuge SH. A comparative study of autonomic function tests (sympathetic and parasympathetic) in three trimesters of pregnancy. Int J Med Sci Public Health 2017;6:139-142

Source of Support: Nil, **Conflict of Interest:** None declared.