International Journal of Advances in Medicine
Lalitha V et al. Int J Adv Med. 2018 Oct;5(5):1158-1162
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933
DOI: http://dx.doi.org/10.18203/2349-3933.ijam20183821

Original Research Article

A study on rate pressure product in south Indian pregnant women with anaemia

Lalitha Venugopal[1], Priyadharsini Rajendran[2]*, Parghavi V.[1]

[1]Department of Physiology, Indira Gandhi Medical College and Research Institute, Puducherry, India
[2]Department of Pharmacology, Jawaharlal Institute of Postgraduate and Medical Education and Research, Puducherry, India

Received: 13 August 2018
Accepted: 18 August 2018

***Correspondence:**
Dr. Priyadharsini Rajendran,
E-mail: shalipriya85@gmail.com

ABSTRACT

Background: Anaemia is a cause of serious concern and contributes to a significantly higher maternal mortality. Rate Pressure Product (RPP) is a major determinant of myocardial oxygen consumption and blood flow. There is an increase in oxygen demand in anemia. Thus, in the present study, we have compared the difference in RPP between a normal pregnant women and pregnant women with anemia.
Methods: A total of 180 pregnant women (normal pregnant woman - 90 and pregnant woman with anaemia - 90) belonging to different trimesters of pregnancy were included in the study. Age, height, and weight were recorded, and their body mass index was calculated. The systolic blood pressure, diastolic blood pressure, heart rate was recorded and RPP was calculated.
Results: There was a significant increase in RPP in pregnant woman with anaemia in all three trimesters of pregnancy, but the significant increase was more in the third trimester.
Conclusions: The present study shows that there is an increase in RPP in pregnant woman with anaemia and they are more prone to hemodynamic stress and cardiovascular risks, especially in their third trimester of pregnancy. This hemodynamic change may be taken into account to prevent the cardiovascular complications associated with anemia in pregnancy. Thus, RPP can be used as a sensitive non-invasive simple marker for early diagnosis of cardiovascular disease in pregnant woman.

Keywords: Cardiovascular risk, Pregnant woman with anaemia, Rate pressure product

INTRODUCTION

Physiological changes occur in all systems of the body during pregnancy. The changes in the cardiovascular system include an increase in the cardiac output, heart rate and stroke volume throughout pregnancy, but the systolic and diastolic blood pressures are found to decrease during the second trimester.[1,2] These changes are essential to meet the metabolic demands of the mother as well as the fetus. Anemia is a major public health problem that needs total elimination and is one of the most commonly encountered medical disorders during pregnancy. In developing country like India, anaemia is a cause of serious concern and contributes to a significantly higher maternal mortality. It accounts for nearly 20-40% of maternal deaths and affects both mother and fetus.[3,4] According to WHO, haemoglobin level less than 11gm/dl in pregnant women constitutes anaemia and haemoglobin level below 7 gm/dl is severe anaemia. Severe anaemia during pregnancy is associated with poor fetal outcomes.[5] Increased incidence of pre-term labour, pre-eclampsia, and sepsis have been

associated with anaemia. Pregnancy is associated with various adaptive cardiovascular changes, especially in the third trimester. Pregnant women with anaemia are prone to increase cardiovascular risks.[4,6] Rate Pressure Product (RPP) is a major determinant of myocardial oxygen consumption and blood flow.[7-9] It is the product of systolic blood pressure and heart rate. Previous studies have reported that an increase in RPP is an important marker of cardiovascular disease.[10,11] Though there are many studies highlighting the importance of RPP in obese individuals, diabetics and prehypertensives and hypertensives.[7,12] the importance of RPP as a cardiovascular marker in pregnant woman with anemia has not been established so far. Since pregnant woman with anemia is more prone for cardiovascular disease, in the present study we have assessed the RPP in pregnant woman with anaemia and compared the same with the normal pregnant woman without anemia.

METHODS

The present comparative cross-sectional study was carried out in the Department of Physiology and Outpatient Department (OPD) of Obstetrics and Gynaecology, IGMC and RI, Puducherry. After obtaining the approval from the Institute Research committee and Ethics Committee, a total of 180 pregnant women belonging to different trimesters of pregnancy who visited the OPD of Obstetrics and Gynaecology of IGMC and RI was recruited in the study. Convenient sampling method was used.

They were divided into two groups: Control group and Study group. Control group consists of normal pregnant woman (n= 90 i.e. 30 in each trimester) and Study group included newly diagnosed pregnant woman with anaemia based on WHO criteria for anaemia in pregnant women, irrespective of their gestational age and severity of (n= 90 i.e. 30 in each trimester).[13] Pregnant women with hypertension, Gestational Diabetes Mellitus (GDM) or any other chronic medical illness, multiple pregnancies and pregnant women on iron therapy were excluded from the study.

Subjects were asked to report to the research laboratory of the Physiology department of IGMC and RI between 8:30 to 9:30 am. Prior to the initiation of the study, the entire procedure was explained to the subjects and a written informed consent was obtained from all the subjects.

Age, height and weight of the subjects were recorded and their body mass index (BMI) was calculated. Basal systolic BP (SBP), diastolic BP (DBP), and basal heart rate (BHR) were recorded using Omron (SEM 1 Model) automatic BP monitor (Omron Healthcare Co. Ltd, Kyoto, Japan). RPP was calculated using the formula RPP = SBP X BHR X 10-2.[6,7]

Statistical analysis

Data were expressed as mean ± Standard deviation (SD). Analysis of data was done by two-tailed unpaired Student t test using Graph pad InStat (Version 3, USA) software. The probability of chance (p value) less than 0.05 was considered statistically significant.

RESULTS

At the end of the study period, a total of 90 healthy pregnant women and 90 pregnant women with anemia participated in the study.

They were divided equally into three groups based on the gestational week with 30 pregnant women in each trimester of pregnancy both in the control and study group.

Table 1 represents the comparison of parameters between the control group (normal pregnant woman n=30) and study group (pregnant woman with anemia n=30) in the first trimester of pregnancy.

Basal heart rate, RPP, and haemoglobin levels were significantly high ($p<0.001$) in the study group when compared with that of the control group.

Table 1: Comparison of parameters between control group and study group in the first trimester of pregnancy.

Parameters	Control group (n=30)	Study group (n=30)	P value
Age (years)	23.83±3.43	24±4.55	0.8708
Height (cm)	154.67±5.46	153.25±5.25	0.3088
Weight (Kg)	52.67±15.38	49.75±9.03	0.3736
BMI (Kg/m^2)	21.62±10.78	20.22±3.94	0.5067
SBP (mmHg)	105.25±7.53	108.33±6.08	0.0866
DBP (mmHg)	71.5±10.33	73.33±10.76	0.5043
BHR (beats/min)	72±3.88	86.33±6.48	<0.0001*
RPP (mm/Hg/min)	76.53±7.62	93.55±14.22	<0.0001*
Hemoglobin (g/dl)	11.68±0.82	9.65±1.27	<0.0001*

Data are expressed as mean±SD. Analysis of data was done by unpaired Student's 't' test. BMI: Body mass index; SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, RPP: Rate Pressure Product

Table 2: Comparison of parameters between Control group and Study group in the second trimester of pregnancy.

Parameters	Control group (n=30)	Study group (n=30)	P value
Age (years)	26.77±7.71	24±8.07	0.1793
Height (cm)	154.77±5.63	156.36±5.23	0.2617
Weight (Kg)	59.08±11.68	55.71±10.75	0.2497
BMI (Kg/m^2)	23.74±4.30	22.78±4.13	0.3815
SBP (mmHg)	93.84±26.94	102.21±12.44	0.1278
DBP (mmHg)	65.38±5.19	66.36±9.35	0.6176
BHR (beats/min)	80.54±6.69	89.93±6.28	<0.0001*
RPP (mm/Hg/min)	81.92±4.15	91.91±2.99	<0.0001*
Hemoglobin (g/dl)	12.03±1.16	9.13±1.20	<0.0001*

Data are expressed as mean±SD. Analysis of data was done by unpaired Student's 't' test. P <0.05 was considered significant, BMI: Body mass index; SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, RPP: Rate Pressure Product.

Table 3: Comparison of parameters between control group and study group in the third trimester of pregnancy.

Parameters	Control group (n=30)	Study group (n=30)	P value
Age (years)	25.04±4.04	25.89±3.98	0.4150
Height (cm)	157.48±5.52	156.63±4.72	0.5240
Weight (kg)	70.74±12.13	65.63±10.07	0.0811
BMI (kg/m^2)	28.42±4.46	26.71±4.41	0.1408
SBP (mmHg)	102.85±11.84	109.85±9.86	0.0157*
DBP (mmHg)	71.44±8.19	75.81±8.50	0.0472*
BHR (beats/min)	80.78±8.64	88.70±8.49	0.0007*
RPP (mm/Hg/min)	84.63±4.31	95.99±5.38	<0.0001*
Hemoglobin (g/dl)	11.69±0.86	9.73±0.95	<0.0001*

Data are expressed as mean ± SD. Analysis of data was done by unpaired Student's 't' test. P <0.05 was considered significant. BMI: Body mass index; SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, RPP: Rate Pressure Product

Table 2 displays the comparison of parameters between control group and study group in the second trimester of pregnancy. There was a significant increase in basal heart rate, RPP (p<0.001) and haemoglobin levels in the study group when compared with that of the control group.

Table 3 shows the comparison of parameters between control group (normal pregnant woman) (n=30) and study group (pregnant woman with anemia (n=30) in the third trimester of pregnancy. Systolic blood pressure (p<0.05), diastolic blood pressure (p<0.05), basal heart rate, RPP and haemoglobin levels (p<0.001) were significantly high in the study group when compared with that of the control group. Rest of the parameters like age, height, weight and body mass index did not show any significant change between the two groups.

DISCUSSION

Anemia affects more than 56 million women globally and two-thirds of the women population are from Asia. Moreover, pregnant woman with anaemia is more prone to cardiovascular diseases. Thus, anemia in pregnancy is associated with increased maternal and perinatal morbidity and mortality.[5,14] Though there are many studies highlighting the autonomic dysfunctions in pregnant woman, the importance of RPP, a marker of cardiovascular disease in normal and anemic pregnant women has not been addressed so far.

RPP is a product of heart rate and systolic blood pressure. It is a major determinant of myocardial oxygen consumption. Though in the clinical setting, the measurement of myocardial oxygen consumption is by indirect invasive method and quite difficult to measure, the RPP acts as an indirect and easy method of measuring the myocardial oxygen consumption.[15,16] Increase in RPP in pregnant woman with anaemia shows that there is increased demand for myocardial oxygen supply. Therefore, there is an increase work load on the heart in these individuals and they are at high risk of developing cardiovascular disease anytime during their pregnancy.

As a normal pregnant woman in the third-trimester undergoes various adaptive cardiovascular changes, the risk of developing cardiovascular diseases is more in the third trimester anemic pregnant woman. These results are almost similar to the study done by Singh et al, in which, it was found that the physiological adaptations during pregnancy are usually well tolerated by healthy women but there is a threat to those who are with compromised cardiac function.[17]

A study conducted by Teli et al, showed that there was a statistically significant increase in double product in

pregnancy in all trimesters and the rise was more noticed in the third trimester.[18] These findings shows that there is an enhanced stroke volume and heart rate during pregnancy which may lead to increased myocardial oxygen demand. Thus, an increase in RPP is an important marker and a risk predictor of cardiovascular disease. Further studies conducted in diabetes, obesity, and anemia shows that RPP was increased in study group compared to the control group.[7,12,17,19,20]

Therefore, in the present study, authors have attempted to compare the difference in RPP among normal pregnant woman and pregnant woman with anaemia in different trimesters of pregnancy. The results of the present study have shown that RPP was significantly higher in pregnant woman with anaemia in all the three trimesters of pregnancy, but this significant increase was more in the third trimester of pregnancy.

Present study attempted to explore the possibility of assessing the importance of RPP as a cardiovascular marker in pregnant woman with anemia, who are more prone for cardiovascular disease at different gestational age and compared the same with normal pregnant woman without anemia. However, authors have not assessed the pregnancy outcome of the subjects as well as the differences in RPP in different grades of anemia i.e. (mild, moderate, severe) in pregnant anemic women in different trimesters, which could have given a better understanding of the effects of the changes in the RPP in anemic mother as well as in the fetus. Secondly, the sample size was also small which may be considered as one of the limitations of the study. In addition to this, authors did not consider the confounding factors such as the age, socioeconomic status, culture etc. which may have a substantial effect on the study because of logistic feasibility. Hence further studies in a larger population are required.

CONCLUSION

The present study shows that there is an increase in RPP in pregnant woman with anaemia and they are more prone for hemodynamic stress and cardiovascular risks, especially in their third trimester of pregnancy. This hemodynamic change may be taken into account to prevent the cardiovascular complications associated with anemia in pregnancy. Thus, RPP can be used as a sensitive non-invasive simple marker for early diagnosis of cardiovascular disease in pregnant woman.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Lalitha V, Priyadharsini R, Parghavi V. A study on rate pressure product in south Indian pregnant women with anaemia. Int J Adv Med 2018;5:1158-62.