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Comparison of Peak Expiratory Flow Rate in Different Body Positions among Pregnant Women

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Abstract: ***Background: A vast amount of physical and physiological changes occurs during pregnancy in various systems of the body. Dyspnea is a common problem among the pregnant women due to growing size of fetus and alteration in respiratory system. During the course of normal and uncomplicated pregnancy as many as 60% to 70% of women experience sensation of Dyspnea as major discomfort. Dyspnea can be defined as difficulty in breathing or breathlessness. Clinically PEFR can be used to assess the lung function and can be taken as index for lung function. Various studies state that different body position influence PEFR value. hence this study is intended to compare the PEFR in different relaxation position among pregnant women in 2nd trimester. Objectives: To compare PEFR values obtained during the different relaxation position in pregnant women in 2nd trimester and to find optimal position in which maximal expiration is possible in pregnant women in 2nd trimester. Method: 72subjects participated in the study after scrutinizing for inclusion and exclusion criteria, on voluntary basis with gestational age of 14 to 27 weeks. Patients were asked to assume different relaxation position and PEFR was measured and best of 3 values were taken for statistical analysis. One-way ANOVA was used to find the difference in PEFR value between the different relaxation positions. Post hoc analysis (Bonferroni test) used to find multiple comparisons between the position. P value was kept at<0.05 for statistical significant. Results: The mean PEFR values are as follows: high side lying was 312.50+27.87. Relaxed sitting was 340.14+27.03. Relaxed standing was 352.36+26.82. Forward lean sitting was 364.44+25.22. Forward lean standing was 379.44+29.25. when mean difference in scores of PEFR between different body positions forward lean standing has was found to have max PEFR value followed by forward lean sitting, relaxed standing, relaxed sitting and high side lying. Interpretation & Conclusion: Different body positions were found to have influence on PEFR values. Upright postures were better than recumbent position among upright posture, forward lean standing and sitting was found to have higher value when compared to relaxed sitting and standing which was due to fixation of upper extremity. Thus these position can be encouraged more to relieve the discomfort of Dyspnea.***

Keywords: Pregnancy, 2nd trimester, Dyspnea, PEFR, Different body positions

1. Introduction

The state of being pregnant is a period from the conception to the birth when a woman carries a developing fetus in the uterus.[1]

There occurs a vast amount of physical and physiological changes during pregnancy starting from conception of fetus.[2]. The changes occur in almost all systems of the body.[3] Major changes are seen in endocrine system and reproductive system. There is increase in production of estrogen, progesterone; and hormone relaxin.[4]These hormones in turn affect the musculoskeletal system and other system s of the body bringing about various changes such as reduction in smooth muscle tone, increased storage of fat, increased growth of uterus and breast duct, increased retention of water and increased extensibility of connective tissue.[5]

Changes are also seen in cardiovascular and respiratory system.[6] Cardiac output increases in pregnancy and at least 60% of this rise has occurred by 8 to 10 weeks.[7] There is an increase of stroke volume by 10% and pulse rate increase up to 10 to 15%.[8] Increased amount of progesterone sets respiratory center extremely sensitive for Co2 which results in the increased tidal volume. Owing to increased demand and work of breathing the minute volume and tidal volume increases up to 23 to 26% during pregnancy.[9]

The full term of pregnancy can be divided into 3 trimesters; a trimester consisting of 3 months.[10] A fetus reaches maximum size by 3rdtrimester, and this is corresponded by increased adaptation, and various discomforts owing to increased demands.[11]

Dyspnea is common among the pregnant women due to alteration in respiratory system and growing size of the fetus.[12]During the course of normal and uncomplicated pregnancy as many as 60 to 70% women experienced a sensation dyspnea as major discomfort during pregnancy.[13] Dyspnea can be defined as difficulty in breathing or breathlessness.[14]

When a uterus gets enlarged with growing uterus diaphragm is elevated as much as 4 cms,[15] Rib cage is displaced upwards resulting in increased anteroposterior and transverse diameter.[16] As a result the length tension relationship of all the respiratory muscle including diaphragm is altered reducing efficacy of their contraction.[17]. There is also reduction in the expiratory reserve volume and residual volume by 20%.[18]

Clinically the peak expiratory flow rate can be used to assess the lung function and document objectively.[19] Peak expiratory flow rate can be said as the maximum flow achieved during expiration delivered with maximal force starting from the level of maximal lung inflation.[20] In

healthy individual Peak expiratory flow rate is determined by: the volume of the lung (which is the function of the thoracic dimension and hence stature); by the elastic properties of the lung; and by the power and coordination of expiratory muscle.[21]

Measurement of Peak expiratory flow rate is of value in identifying air flow limitation,[22] various types of instruments are used to measure PEFR, including pneumotachometer, spirometers, turbines, and anemometers.[23] The most suitable and commonly used instruments in clinical practice are flow meters which measures PEFR only and hence may be referred to as peak flow meter. Peak expiratory flow rate measurement was pioneered by B. M. Wright. They are relatively inexpensive; further they are portable and do not require electric power for operation.[24]

A longitudinal study was done among asthmatics using PEFR as outcome measure indicated that PEFR is a reliable measure which can be used as index to lung function.[25]

A study done to evaluate the respiratory tract function in healthy women in the last month of uncomplicated pregnancy revealed that a symptom of dyspnea depends upon the mechanics of ventilation and not on the status of the bronchi. It also states that dyspneic system found in pregnant women is correlated with changes in vital capacity components.[26]

A study was done to know the effect of body position on Pao2 and Paco2 during pregnancy. 21 healthy pregnant women were recruited for study in end of first, secondand third trimester. Arterial blood gas analysis and PEFR was used as outcome measure. The study concluded that upright positions are better than recumbent positions.[27]

A longitudinal study to know the effect of gestational age and position on PEFR concluded that PEFR measurements are affected by maternal position and advanced gestational age especially in the supine position.[28]

Breathing in rhythm and prolonging the expiration after adapting relaxation posture helps to reduce dyspnea.[29] The patients position is important in order to achieve relaxation, concentration and freedom of thoracic and abdominal movements.[30] The positions commonly used for this are side lying, high side lying, relaxed sitting, relaxed standing, forward lean sitting and forward lean standing.

A randomized control trail was done to evaluate the influence of various relaxation positions on Dyspnea among COPD patients. The study concluded that relaxation position has positive influence; and Dyspnea gets reduced with alteration in position.[31]

Breath control and effective breathing is of vital importance during labour.[32] Effective breathing prevents fetal and maternal distress and helps the mother to cope up with the pain. Although association was established between Dyspnea and position, studies on effect of position on Dyspnea among pregnant women are limited.[33]Hence this study is intended to compare the peak expiratory flow rate in different relaxation position among pregnant women in 2nd trimester.

2. Methodology

The Observational study was approved by the institutional research committee. A total of 72 willing to participate in the study after screening for inclusion and exclusion criteria. Purposeful sampling technique was done to perform the study, and data collection was done between the age group of 25 to 35 years in the 2nd trimester of gestational.

We included Healthy pregnant women in the age group of 25 to 35 years in their 2nd trimester and Both primi and mutiparious subjects. Subject excluded were subjects with cardio-pulmonary problems, Pre eclamptic toxemia (PET), Diabetes Mellitus, Smokers and alcoholics, Complicated pregnancy, Hypertension.

3. Procedure

Each subject was allowed to participate in the study after satisfying the inclusion criteria and a written consent was obtained. The subjects were instructed that the effort from them should be maximal and without hesitation at the start of the blow.

Recording Procedure:
Three consecutive measurements were taken for each position. The best reading of 3 measurements was used in the analysis for each relaxation position. The measurement in different positions was performed within 5 minutes of rest between each position. If the largest two of 3 acceptable blows were not reproducible within 40 $L.min^{-1}$, up to two additional blows were performed totry and obtain better agreement. The data used in the statistical analysis were the highest values obtained across the trials for each test in each position. The highest value was used because all tests were maximal efforts. PEFR was taken in each of 5 different relaxation positions: High side lying, Relaxed sitting, Relaxed standing, Forward lean standing and Forward lean sitting.

High side lying:
The patient was kept with 3-5 pillows to raise the shoulder while lying on her side. One pillow was placed between the waist and axilla to keep the straight. Before blowing the air nose was clipped. Maintaining the same position, subjects were instructed to take a deep breath, filling lungs completely and blow the air as fast as possible in a single blow into the peak flow meter with lips tightly placed around the opening.

Relaxed sitting:
The patient was made to sit on a chair, the back was kept straight with the subject's forearm resting on her thighs and wrist relaxed. Before blowing the air nose was clipped. Maintaining the same position, subjects were instructed to take a deep breath, filling lungs completely and blow the air as fast as possible in a single blow into the peak flow meter with lips tightly placed around the opening.

Relaxed standing:
The patient was asked to lean back against the wall with the feet placed slightly apart and approximately 30cm away from the wall. Her shoulders and arm was relaxed. Before blowing the air nose was clipped. Maintaining the same position, subjects were instructed to take a deep breath, filling lungs completely and blow the air as fast as possible in a single blow into the peak flow meter with lips tightly placed around the opening.

Forward lean sitting:
Patient was made to sit at the table leaning from the hips, head and upper chest was supported with several pillows. The back was kept straight so that the diaphragmatic movement will not get inhibited. Before blowing the air nose was clipped. Maintaining the same position, subjects were instructed to take a deep breath, filling lungs completely and blow the air as fast as possible in a single blow into the peak flow meter with lips tightly placed around the opening.

Forward lean standing:
The patient was asked to lean forward with her forearm resting on a couch of suitable height adjusted with pillows. Before blowing the air nose was clipped. Maintaining the same position, subjects were instructed to take a deep breath, filling lungs completely and blow the air as fast as possible in a single blow into the peak flow meter with lips tightly placed around the opening.

4. Result and Data Analysis

Analysis of variance (ANOVA) was performed to compare PEFR scores in different relaxation positions. P value was kept < 0.05 for statistical significance. Multiple comparison of PEFR scores in different relaxation positions were performed using Bonferroni test (post hoc analysis) Statistical software: SPSS 11.0 was used for analysis of the data and Microsoft word and excel have been used to generate graphics and tables.

Shows age distribution patients taken for the study. 24 patients were taken between the group of 25 to 28 which accounted for 33.3%. Between the age group of 29 to 31 the number of patients were 24 which again came for 33.33%. in the age group of 32 to 35, 24 patients participated in the study which is again 33.3%. the mean age was 29.80 with standard deviation of 2.780.

Table 1: Age Distribution

Age	No. of subjects	Percent	Mean age	Std. Deviation
25 – 28	24	33.3	29.80	2.780
29 – 31	24	33.3		
32 - 35	24	33.3		
Total	72	100.0		

Shows gestational age of patients participated in the study. There were 25 patients between the gestational age of 14 to 18 weeks which accounted for 34.7%. 26 patients between the gestational age of 19 to 23 weeks which can for 36.1%. between the gestational age group of 24to 27 weeks, 21 patients participated which was 29.2%. The mean gestational age was 22.73 with standard deviation of 2.455.

Table 2: Gestational age

Gestational age	No. of subjects	Percent	Mean	Std.Devation
14 – 18	25	34.7	22.73	2.455
19 – 23	26	36.1		
24- 27	21	29.2		
Total	72	100.0		

Compares the mean PEFR values in different body positions. High side lying was found to have min and max PEFR of 250 and 380 respectively, with mean and standardization of 312.50+27.870. The minimum value of PEFR was 280 for relaxed sitting and max was 400 with mean and standard deviation as 340.14+27.036. The min PEFR value of relaxed standing was 290 and maximum was 420 with mean 352.36 and standard deviation 26.827.

Forward lean sitting was found to have min and max PEFR of 300 and 430 respectively, with mean and std. deviation of 364.44+25.225. The mean value for forward lean standing was 320 and max was 480with mean value of 379.44 std. deviation 29. 258.The above value were at p <0.0001 which was highly significant. The ANOVA F value was found to be 234.913.

Table 3: Comparison of PEFR mean value in different body positions:

Positions	N	Minimum	Maximum	Mean	Std. Deviation	ANOVA F value	p value
HSL	72	250	380	312.50	27.870	234.913	p<0.0001 HS
R SIT	72	280	400	340.14	27.036		
R STAN	72	290	420	352.36	26.827		
FL SIT	72	300	430	364.44	25.225		
FL STAN	72	320	480	379.44	29.258		

Compares the mean difference in the scores of PEFR between different relaxation position. High side lying was found to have min PEFR score when compared to other positions. The mean difference of high side lying with other position are as follows, relaxed sitting 27.639; relaxed standing 39.861; forward lean sitting 51.944; forward lean standing 66.944.

Relaxed sitting was found to have second least value of PEFR. The mean difference in PEFR value of relaxed sitting from other position are as follows relaxed standing 12.222; forward lean sitting 24.306; forward lean standing 39.306.

The mean PEFR value for relaxed standing was 352.46, the mean difference in PEFR value from other positions is: forward lean sitting 24.306 and forward lean standing 39.306.

The forward lean sitting was found to be second best position and it mean difference from forward lean standing was 15.000

Multiple Comparisons of mean difference in scores of PEFR between different relaxation positions (post hoc Analysis - Bonferroni test)

Table 4

(I) position	(J) position	Mean Difference (I-J)	Std. Error	Percentage change	p value	
HSL	R SIT	27.639	2.162	-8.84	p<0.0001	HS
	R STAN	39.861	2.808	-12.76	p<0.0001	HS
	FL SIT	51.944	2.173	-16.62	p<0.0001	HS
	FL STAN	66.944	2.864	-21.42	p<0.0001	HS
R SIT	R STAN	12.222	2.309	-3.59	p<0.0001	HS
	FL SIT	24.306	1.530	-7.15	p<0.0001	HS
	FL STAN	39.306	2.384	-11.56	p<0.0001	HS
R STAN	FL SIT	12.083	2.263	-3.43	p<0.0001	HS
	FL STAN	27.083	2.876	-7.69	p<0.0001	HS
FL SIT	FL STAN	15.000	1.667	-4.12	p<0.0001	HS

5. Discussion

Changes in body position significantly affect peak expiratory flow rate results in pregnant individuals. The result showed that there is significant difference in PEFR values among the different body positions. The F value is 234.913 ($p< 0.05$, SS). In multiple comparison of PEFR scores between different body positions (high side lying, relaxed sitting, relaxed standing, forward lean sitting and forward lean standing). The result obtained were statistically significant ($p< 0.05$, SS)

Based on mean PEFR scores obtained, the five different relaxation positions, and are listed in the descending order as follows: 1. Forward lean standing (379.44) 2. Forward lean sitting (364.44), 3. Relaxed standing (352.36) 4. Relaxed sitting (340.14) 5. High side lying (312 .05)

The position high side lying was found to have min PEFR value. This may be explained by the following fact: due to increasing size of the fetus the diaphragm is pushed cephalically in2nd trimester of pregnancy, which stretches the diaphragm more than 20% from the resting muscle length which reduces the efficacy of contraction; it also proved that lung volumes are reduced in recumbent position.

During high side lying the upper extremity are not fixed and they are compressed hence contribution from the accessory muscle of respiration are minimal with reduction in lung compliances resulting in reduced PEFR.

The position relaxed sitting was found to have the second least value of PEFR, this might be due to increase in ventilation perfusion ratio with upright posture. And with upright posture the moment arm of scalenus anterior, medius and posterior along with serratus posterior, superior increases and thus pulls the rib cage increasing the lung volume and thus helping in the generation of PEFR.

The position relaxed standing was found to be effective than relaxed sitting, this may be due to increase in lung volume in standing position due to increase in thoracic cavity volume. First gravity pulls the abdominal contents caudally within the abdominal cavity, increasing in the vertical diameter of the thorax. Further the inspiratory muscles are able to expand unrestricted thorax in all directions a contraction of diaphragm is more effective when compared to high side lying and relaxed sitting.

Forward lean sitting was found to have more PEFR value than relaxed standing, this may be due to effective contraction of scalenus anterior, pectoral, latissimus dorsi muscle are increased during forward lean sitting as upper extremity are relatively fixed than in above mentioned positions. Hence these muscles act with reverse origin and insertion bringing about movement of chest wall and increasing the thoracic cavity volume and thus increasing the lung volume and generation of PEFR.

Forward lean standing was found to have maximum PEFR value and can be said as best of all positions. This may be due to following reasons; upright posture causing increase in ventilation perfusion ratio; the gravity pulling the abdominal contents caudally and increasing the thoracic cavity volume and thus increasing the lung volume; the fixation of upper extremity increases the efficacy of accessory muscles thus bringing about effective breathing and higher PEFR.

When PEFR values are compared between sitting and standing, standing position had higher values of PEFR, which was similar to previous studies. It has been hypothesized that this may be due to subjects taking slightly lesser inspiration in sitting position than in standing position because the abdominal contents are higher in the abdominal cavity interfering with diaphragmatic motion.

To summarize, different body positions influence the PEFR value and there was negative correlation between gestational age and PEFR values, that is, with increasing gestational age there was reduction in the PEFR. This may be due to increase in the size of fetus causing additional demands on mother; further due to increase in size of fetus the abdominal muscles are more stretched due to which synergistic action of abdominal during respiration is lost.

Further PEFR value increase more when upper extremity was fixed along with upright posture as in forward lean standing. The positions forward lean sitting and standing can be encouraged more to be assumed in order to relive the discomfort of Dyspnea among pregnant women during 2nd and 3rdtrimester.

6. Conclusion

Different body positions were found to have influence on PEFR values. Upright postures were better than recumbent position among upright posture, forward lean standing and sitting was found to have higher value when compared to relaxed sitting and standing which was due to fixation of upper extremity. Thus these position can be encouraged more to relieve the discomfort of Dyspnea.

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