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Do different positions during a non-stress test affect the maternofetal physiological parameters and comfort in pregnant women?

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Abstract:

BACKGROUND: A non-stress test (NST) is an essential diagnostic test performed during pregnancy to assess fetal well-being. It is a recording of fetal movements besides fetal heart rate, indicating fetal biophysiological well-being. As maternal physiology is altered in various positions, apt positioning during the NST is essential for accurate results while ensuring maternal comfort. This study aims to evaluate the effect of different maternal positions, left lateral and semi-fowler's, on NST reactivity, maternal blood pressure, heart rate, and comfort in pregnant women while performing the NST.

MATERIALS AND METHODS: This crossover study evaluated 50 healthy pregnant women between 32 and 40 weeks of gestation with no obstetric complications for the effect of maternal positions on maternofetal physiological parameters and comfort. The NST was performed for 20 min in each position with a washout period of 10 min. The maternofetal physiological parameters were recorded by a calibrated sphygmomanometer and the electrocardiograph interpretations. The maternal comfort was assessed using a maternal comfort rating scale (MCRS) for each position after the NST. Relevant descriptive and inferential statistics are applied to compute the results.

RESULTS: Statistically, there was a significant difference in the mean maternal blood pressure and heart rate between the left lateral and semi-fowler's positions at 0 and 20 min ($P = 0.001$), whereas within the groups, in the same position at 0 and 20 min, no significant difference was found. There was no significant difference in NST reactivity ($P = 0.79$) in different positions. There was no significant difference between the MCR scores of women in either of the positions ($Z = -1.64$, df = 49, $P = 0.100$).

CONCLUSION: Semi-fowler's position demonstrated favorable maternal blood pressure and heart rate during the NST in the third trimester of pregnancy, though it was clinically not significant. There was no significant difference in the comfort of women in both positions. Hence, either of the positions can be implemented in practice as an alternative position while performing the NST, based on the women's preference.

Keywords:

Blood Pressure, fetal activity, fetal heart rate, noninvasive prenatal testing, third trimester

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Introduction

Quality antenatal care (ANC) is crucial for ensuring normal pregnancy and delivery of a healthy baby.[1] According to the United Nations Children's Fund, at least four ANC visits are recommended for all pregnant women. The prevailing rate of ANC visits in India is 51% compared to the global rate of 65%.[2] The main objective of modern obstetrics is to decrease perinatal morbidity and mortality to a minimum by regular screening during ANC.[3-5] A non-stress test (NST) evaluates fetal health in pregnant women by recording the fetal

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movements and fetal heart rate. NST is a noninvasive, easily interpretable diagnostic test that can detect the fetus at risk for neonatal complications or intrauterine fetal death, or suspected fetal hypoxia in an early stage which could be intervened.[5] The NST recognizes the cardiovascular reflex responses to fetal neurological status.[6] It is one of the factors that tend to disappear earliest during the progressive fetal compromise. It is well-practiced by obstetricians, nurses, and midwives and allows them to make rational decisions, engage in early management, and reduce perinatal mortality. The rise of 15 bpm from the baseline fetal heart rate (BFHR) lasting for 15 s or more in 20 min with a fetal activity is necessary for a 20-min period to label it as a reactive NST.[6-8] Since the NST is performed for 20 min, the maternal position is crucial for enhancing comfort. The obstetrician's or midwife's role is to ensure appropriate positioning of the expectant mother that renders comfort to her and does not affect physiological parameters that may show variations in NST outcomes.[8,9]

In clinical settings, the researchers observed that women are placed supine while performing NST, leading to aortocaval compression and decreasing the pregnant women's cardiac output. Some women manifest with "supine hypotension syndrome" and possibly fetal discomfort resulting in a nonreactive NST, while a change in positioning shows a reactive NST.[7,8,10,11] Hence, the maternal position is one of the significant aspects to be considered while recording the NST, reducing errors and thereby false interpretations. Maternal position throughout the NST influences the hemodynamics of the maternal and fetoplacental circulation.[11] Midwives assist pregnant women undergoing the NST in providing various positions like lateral, sitting, or semi-fowler to decrease discomfort, evaluate the fetus at risk, and minimize the need for prolonged monitoring.

Studies that have been conducted in different positions lacked methodological rigor, and the findings were inconclusive regarding the best position for NST, indicating a gap in theory and practice. This study explores the effect of different maternal positions during the NST on its reactivity, difference in heart rate, blood pressure (BP), and maternal comfort and attempts to identify a suitable position that can be suggested while performing the NST.

Materials and Methods

A crossover design adopted for the study evaluated NST reactivity, maternal physiological parameters, and comfort at two different points after introducing each position. A total of 50 women between 32 and 40 weeks of gestation attending the antenatal clinic for regular checkups or admitted for safe confinement in the obstetrics ward of a tertiary care teaching and research center in eastern India were recruited for the study. Antenatal women in labor pain, with a twin pregnancy, with a bad obstetric history, and with substance abuse were excluded from the study. The maternal parameters were recorded during a 20-min NST, at baseline and 20 min in each position with a washout period of 10 min.

Tools

Demographic and obstetric data

The tool consisting of 13 items was constructed to assess the sociodemographic and obstetric data of the participants. It had items on age, education, religion, occupation, monthly family income, residential area, body mass index, gravida, gestation age in weeks, presentation, hemoglobin, previous history of back pain, and placenta position. Instructions were given to the respondents, and the researchers collected data from reports and interview techniques. A tick mark was placed on the most appropriate response by the participants.

Maternal and fetal parameters

The researchers constructed the tool to monitor the maternal physiological parameters (heart rate and BP) and fetal physiological parameters (NST outcomes).

The maternal parameter chart was prepared to assess the physiological parameters (maternal heart rate, systolic and diastolic BP) at 0 and 20 min in different positions. The BP apparat us used in the study was calibrated. The NST outcomes include NST reactivity, BFHR, beat to beat variability, the total number of accelerations, time taken for the first acceleration (in minutes), time taken for the first fetal movement (in minutes), number of fetal movements, decelerations, time consumed for reactive NST (in minutes), NST onset, and termination time (in minutes). The NST findings were recorded in the chart by interpreting the graph.

Maternal comfort rating scale

The maternal comfort rating scale (MCRS), an 11-point rating scale ranging from 0 to 10, was developed by the researchers to evaluate the women's comfort in different positions. It was modified based on expert opinion. It is a self-report scale used to rate comfort, using parameters like back pain, dyspnea, fainting, drowsiness, headache, nausea, and vomiting. A score of 0 indicated no discomfort, whereas a score of 10 indicated severe discomfort. The comfort levels were categorized based on scores as follows: 0 = comfortable, 1–3 = mild discomfort, 4–7 = moderate discomfort, and 8–10 indicated severe discomfort.

All the tools were translated to Odia by a language expert and back translated to English by another language expert and were found to have the same meaning. The content validity of the tools was checked, and there was

92% agreement, suggesting excellent content validity of the tool with a content validity index of 0.92. The inter-rater reliabilities of systolic BP (r = 0.95), diastolic BP (r = 0.94), pulse oximeter (r = 0.94) and MCRS (r = 0.97) were computed and were found to be reliable.

Sample size analysis

The sample size was calculated using the equation $n = (\sigma 1 + \sigma 2)\ 2\ (Z\alpha + Z\beta)\ 2/d2$; with α as 0.05 (5%) and β as 0.20 (20%), the power $(1 - \beta)$ was 80% and the sample size was estimated to be 50 participants.[10] By referring to literature and conducting pilot research, the researchers determined that the 10-min washout period effectively removed the effect of position on maternal and fetal parameters.

Ethical consideration

Ethical permission was obtained from the institutional ethical committee vide reference number IEC/XXXX/2018-19/19. Written informed consent was obtained from each participant before enrolling them in the study. Participants were ensured that their privacy will be protected and confidentiality maintained at each stage of the research.

Data collection method

Pregnant women in a non-fasting state with a singleton pregnancy with no obstetric/medical complications were included in the study. Women in labor and those with twin pregnancy or bad obstetric history or substance abuse were excluded. After obtaining ethical approval from the institute, all pregnant women meeting the inclusion criteria were enrolled in the study by consecutive sampling. The investigator obtained their written consent. The statistician created a computer-generated randomized position sequence and sealed it in an opaque envelope. The participants were blinded to the sequence of left lateral and semi-fowler.

All women ate three biscuits and emptied the bladder before the NST procedure in each position. After positioning the woman in the first assigned position, the physiological parameters (BP and pulse) were recorded at 0 min of connecting to the NST machine. The NST was performed for 20 min, and the maternal physiological parameters were rechecked 20 min later. The findings were recorded in the maternofetal physiological parameter monitoring chart. The MCRS was administered to the women at the end of each position.

Change in position for the next NST was done after the washout period of 10 min, and the exact steps were followed for a subsequent position, as carried out for the first position [Figure 1].

Data analysis

The data collected was checked for completeness, coded, and analyzed by Statistical Package for the Social Sciences (SPSS) 16. The data were checked for normality by the Kolmogorov–Smirnov test and were found to be normally distributed. Paired *t*-test was used for comparing the means of both the position groups, the Wilcoxon signed rank-sum test for comparing medians, and the Chi-square and McNemar's test for comparing proportions.

Results

The mean age of pregnant women was 26.86 + 3.86 years. Most women were primigravidas (66%) at 38–40 weeks

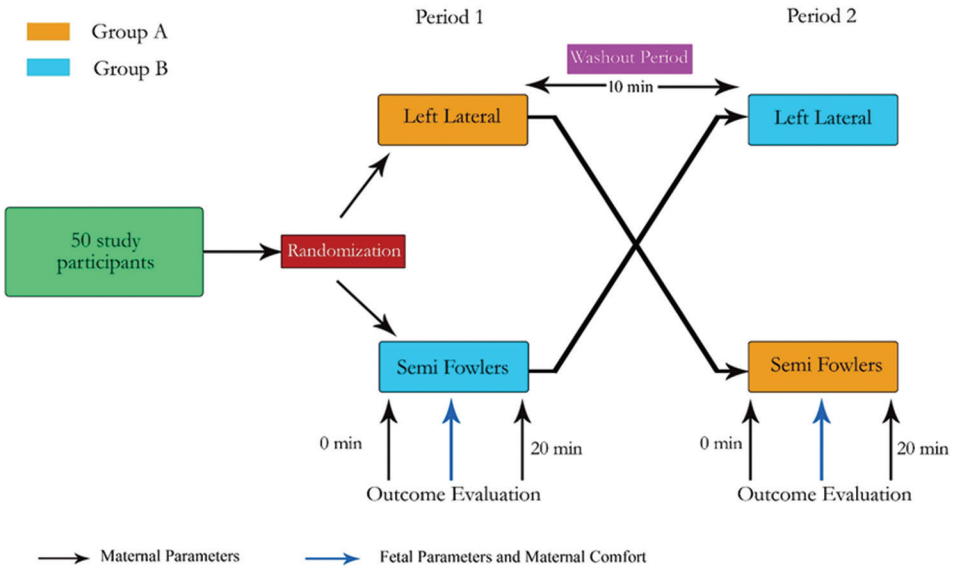

Figure 1: Crossover design used for assessing maternal and fetal parameters in left lateral and semi-fowler's positions

of gestation (48%). More than half (58%) of the subjects had a body mass index (BMI) greater than 25, with no history of back pain (88%) [Table 1].

Effect of positions on maternal physiological parameters

The effect of different positions on maternal BP and heart rate was determined by comparing the means of maternal systolic and diastolic BP and heart rate using paired *t*-test [Table 2]. Statistically, there was a significant difference in systolic and diastolic pressure and heart rate between the left lateral and semi-fowler at 0 and 20 min. There was a reduced BP and heart rate in the left lateral compared to semi-fowler's position at both 0 and 20 min. However, clinically, the range was within normal limits [Table 2].

Table 1: Frequency and percentage distribution of maternal variables

Variables	Frequency	Percentage (*n*=50)
Age (in years)		
21-25	19	38
26-30	31	62
BMI		
Normal	21	42
Overweight	18	36
Obese	11	22
Gravida		
Primigravida	33	66
Multigravida	17	34
Gestational age (in weeks)		
32-33	5	10
34-35	1	2
36-37	20	40
38-40	24	48
Previous history of back pain		
Yes	6	12
No	44	88

BMI=Body mass index

Effect of positions on maternal comfort

The maternal comfort score was compared between the left lateral and semi-fowler's positions using the Wilcoxon signed rank-sum test. There was no significant difference between the MCR scores of women in either of the positions ($Z = -1.64$, df = 49, $P = 0.100$). However, descriptive analysis revealed that more than half of the subjects (58%) were more comfortable in the left lateral position than in the semi-fowler's position [Figure 2].

Effect of positions on fetal parameters in the NST

The McNemar's test on NST reactivity scores revealed no significant difference in the NST reactivity between the left lateral and semi-fowler's position ($P = 0.79$). In the NST outcomes, only the fetal heart rate (FHR) was significantly different between the two positions ($P = 0.037$), while other parameters were not significantly different [Table 3].

Discussion

The NST is the most common and significant test performed for the assessment of fetal well-being. It is a simple and noninvasive method of assessing fetal well-being by observing the FHR and its acceleration in response to fetal movement. The present study was undertaken to determine the effects of maternal

Table 2: Maternal parameters in the left lateral and semi-fowler's positions

Treatment sequence/effect	Maternal parameters	Treatment period (0 min)		WID (A-B)	Treatment period (20 min)		WID (A-B) *n*=50
		1	2	0 min	1	2	20 min
Systolic pressure							
A then B	Mean (SD)	96.80 (7.73)	107.23 (9.19)	11.65 (6.59)	98.23 (9.40)	107.53 (8.26)	10.07 (5.46)
B then A	Mean (SD)	98.7 (11.34)	111.25 (10.31)	12.50 (5.75)	97.75 (11.24)	110.95 (9.59)	13.20 (5.54)
Treatment effect	Mean (SD)			11.42 (7.29)			11.18 (6.43)
	CI			9.34-13.49			9.35-13.00
	t#			11.06**			12.27**
Diastolic pressure							
A then B	Mean (SD)	59.76 (7.88)	71.53 (8.49)	11.76 (6.84)	60.84 (7.80)	74.38 (7.37)	13.69 (8.09)
B then A	Mean (SD)	60.83 (9.45)	72.83 (7.82)	12.50 (6.95)	60.66 (9.72)	73.00 (8.34)	14.16 (5.69)
Treatment effect	Mean (SD)			11.88 (7.25)			12.96 (8.64)
	CI			9.81-13.94			10.50-15.41
	t#			11.57**			10.60**
Heart rate							
A then B	Mean (SD)	81.76 (12.26)	84.84 (12.62)	4.61 (4.37)	81.38 (10.14)	84.00 (10.40	5.69 (3.51)
B then A	Mean (SD)	81.91 (11.80)	85.16 (12.52)	4.41 (5.71)	82.58 (10.29)	85.91 (11.80)	5.33 (4.11)
Treatment effect	Mean (SD)			3.16 (5.98)			2.96 (6.03)
	CI			1.46-4.85			1.24-4.67
	t#			3.73*			3.46*

1 or 2=A/B depending on sequence, A=left lateral position, B=semi-fowler's position, CI=confidence interval, SD=standard deviation, WID=within individual difference (A−B). *P<0.001, **P<0.0001; #*t*-test used is paired *t*-test. df=49

Table 3: Comparison of fetal parameters between left lateral and semi-fowler's positions (*n*=50)

Treatment sequence/effect	Fetal parameters	Treatment periods		WID (A−B)
		1	2	
Fetal heart rate				
A then B	Mean (SD)	135.96 (7.61)	138.65 (6.71)	2.69 (7.37)
B then A	Mean (SD)	140. 91 (7.92)	139. 37 (8.63)	1.54 (7.34)
Treatment effect	Mean (SD)			5.66 (5.04)
	CI			0.06-4.21
	$t^{\#}$			2.06
	P			0.04*
Total number of accelerations				
A then B	Mean (SD)	5.73 (3.94)	5.96 (3.76)	0.23 (4.75)
B then A	Mean (SD)	4.25 (3.73)	6.66 (3.86)	2.41 (3.03)
Treatment effect	Mean (SD)			3.56 (2.40)
	CI			0.15-2.23
	$t^{\#}$			1.75
	P			0.08
Time taken for the first acceleration				
A then B	Mean (SD)	3.90 (5.30)	3.00 (2.64)	0.90 (5.77)
B then A	Mean (SD)	5.48 (5.55)	2.19 (2.69)	3.29 (6.56)
Treatment effect	Mean (SD)			4.61 (4.60)
	CI			0.72-2.94
	$t^{\#}$			1.21
	P			0.23
Time taken for the first fetal movement				
A then B	Mean (SD)	4.40 (4.81)	4.24 (3.88)	0.16 (6.36)
B then A	Mean (SD)	5.82 (6.53)	3.45 (3.75)	2.36 (7.17)
Treatment effect	Mean (SD)			5.09 (4.59)
	CI			0.88-2.98
	$t^{\#}$			1.08
	P			0.28
Number of fetal movements				
A then B	Mean (SD)	8.96 (6.55)	13.15 (8.64)	4.19 (9.4)
B then A	Mean (SD)	9.75 (8.52)	13.33 (14.28)	3.58 (16.87)
Treatment effect	Mean (SD)			9.74 (9.91)
	CI			3.50-4.42
	$t^{\#}$			0.23
	P			0.81
Number of decelerations				
A then B	Mean (SD)	0.15 (0.46)	0.23 (0.58)	0.07 (0.56)
B then A	Mean (SD)	9.75 (8.52)	0.62 (1.68)	0.29 (1.96)
Treatment effect	Mean (SD)			0.58 (1.29)
	CI			0.30-0.50
	$t^{\#}$			0.49
	P			0.62
Time consumption for reactive NST (in minutes)				
A then B	Mean (SD)	5.95 (5.22)	4.94 (3.76)	1.00 (5.46)
B then A	Mean (SD)	7.57 (6.14)	4.12 (3.02)	3.45 (7.64)
Treatment effect	Mean (SD)			5.21 (4.61)
	CI			0.83-3.09
	$t^{\#}$			1.16
	P			0.25

1 or 2=A/B depending on sequence, A=left lateral position, B=semi-fowler's position, CI=confidence interval, NST=non-stress test, SD=standard deviation, WID=within individual difference (A−B). **P*<0.05. #*t*-test used is paired *t*-test

positioning on fetal reactivity, maternal physiological parameters, and comfort among low-risk pregnant women. We excluded women with high-risk pregnancies to serve as a control for the variable. A reliable reactive NST result, which is generally yielded in a 20-min application, is accepted as sufficient.[8,11] However, due to

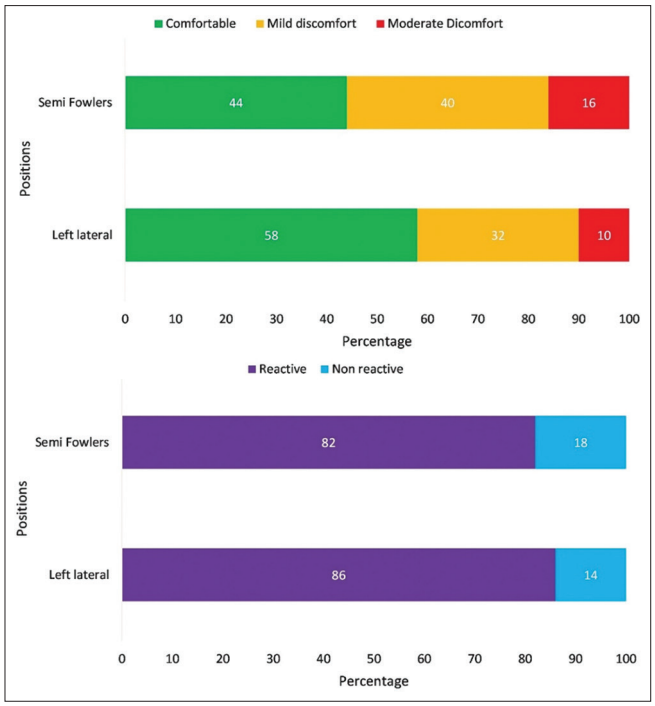

Figure 2: Maternal comfort and NST reactivity in the left lateral and semi-fowler's positions

the increased number of patients and relatively limited number of electro-topographs in a resource-poor setting of ours, 20-min application for NST in each position was perceived, with a washout period of 10 min, as a long waiting period by the pregnant women, due to which many women refused to participate in the study. There is a paucity in the literature suggesting the best positions for NST reactivity, considering maternal physiological parameters and comfort. In our study, clinically, the highest percentage of subjects had reactive NST in the left lateral (86%) compared to semi-fowler's (82%) position; however, it was not statistically significant. A similar study finding by Moffatt and Van den Hof (1997) is in agreement with the present study results. The similarity of findings could be because of the selection of expected pregnancies. Studies conducted elsewhere contradict the current results, which have reported more fetal reactivity in the lateral position than in the supine position.[12-15] This could be because of the larger sample size in the above studies. A previous study conducted in Turkey reported significant (P = 0.013) differences among four groups, in which the semi-fowler's position yielded the highest fetal reactivity (85.3%) than the supine position (69%).[11] Similar findings were reported with significant differences in studied conducted in USA[16] and Turkey.[17] The discrepancy between the current study result and the above-mentioned studies may be due to the differences in the research design. Besides, one study examined the effects of supine position on fetal reactivity, and it is known that aortocaval compression may influence fetal reactivity.[18]

On the contrary, a study conducted in Iran by El Sayed and Mohamady[13] reported better reactive NST in the left lateral position (87.5%) compared to the semi-fowler's position (66.7%). While in a study conducted in Italy, the sitting position had a shorter NST reactive time when compared to the walking or a reclined position.[14] In another study, the NST was reactive in a semi-sitting position in high-risk pregnant women with hypertension; however, our study excluded high-risk subjects.

In Moffat and Van den Hof's study, the mean time to reactivity was 14.51 ± 6.36 min,[12] which was longer than our findings because the study included high-risk pregnant women while our study controlled this variable. Our findings, in tandem with the findings of Moffat and Van den Hof,[12] contradict the findings of Nathan *et al*.,[16] who compared semi-fowler's position with supine position and found that the semi-fowler's position applications significantly minimized the test time and yielded more accurate results.

BFHR is considered an important index of fetal well-being, especially during the third trimester of pregnancy. The mean BFHR and the number of fetal movements were more among semi-fowlers than those in left lateral position in our study, which contradicts the study finding by Nathan *et al*., where the left lateral position yielded better fetal parameters.[15] However, studies by Kiratli *et al*.[3] and Cito e*t al*. contradict our study findings, where the mean BFHR did not significantly change with maternal position.[15]

The present study found statistically significant differences between the maternal positions and systolic BP, diastolic BP, and heart rate, though they were clinically not significant. Our findings are in agreement with the studies conducted in Saudi Arabia[15] and Turkey,[3,14] though the studies compared the supine position as well. Positioning a pregnant woman in left lateral or semi-fowler's position during the NST can alleviate the symptoms of aortocaval compression and hemodynamic alteration in brachial BP and heart rate.[19,20] The similarity in the study findings may be due to the degree of inclination in the semi-sitting position, time of recording of maternal parameters, sample characteristics, and the study design. The present study showed no significant differences in systolic BP, diastolic BP, and heart rate across the time points, at 0 min and 20 min in the same position, implying that the time duration does not alter the maternal parameter over time, irrespective of the position.

Patient preferences are imperative for individualized patient care. Patients' preferences for the position must be determined before the test, and adjustments are made during the NST. Further, maternal comfort

during the NST may affect the results. The present study showed more perceived comfort in the left lateral than in the semi-fowler's position; however, there was no significant difference, implying that both positions were comfortable. A study by Mucuk *et al*.[20] is in agreement with our study, reporting a higher comfort in the left lateral (92.2%) than in the semi-fowler's position (87.2%). Women favored the left lateral position over other positions in other studies as well.[3,15] Despite the similarity in the results, in the above studies, there were differences in gestational age and in the visual analog scale used to measure maternal comfort. In clinical practice, women's preference for the position should be sought for the NST because, generally, women know in which position their babies are most reactive in terms of their sleep pattern.

Limitations and recommendations

The present study is not without limitations. The expectant mother's comfort assessment was self-reported; hence, there is a chance of subjectivity and reporting bias. The washout period for the study was 10 min, which is short for a crossover design. However, the time could not be increased because of the patient's discomfort and lack of cooperation. Another limitation of this study is the small sample size, as some variables such as the number of accelerations did not reach statistical significance but were very close to the statistical significance level. The data were collected from a tertiary care teaching hospital, limiting the generalizability of the results to other settings. We could not control the women's need for toilet breaks during the NST. Walking to the washroom might have affected the results, which we could not estimate. The presence of the researcher could have resulted in the Hawthorne effect. However, the study's strength is its crossover design, in which subjects serve as their control. Random allocation of position sequences was done to minimize the potential selection bias.

Large multicentric studies should be carried out to explore the best position for the NST in terms of least reactivity time, maternal parameters, and comfort. Further studies need to be conducted on other positions like semi-sitting, walking, and standing in women subjected to the NST. New studies could be carried out on the skill and competency of midwives, nurses, and practitioners in the interpretation of the NST in various positions during pregnancy and the latent phase of labor. Future research should focus on innovative technologies for fetal heart monitoring and interpretations utilizing fetal electrocardiogram, ST-segment analysis, fetal magnetocardiogram, and cardiac valve timing from Doppler. With the advancement in artificial intelligence, automated decision support systems for the updated clinical knowledge from these new techniques will enable a richer and more consistent perinatal analysis to improve fetal and maternal outcomes. Ultimately, it would be necessary to determine the high-risk fetus for early management to prevent fetal jeopardy.

Conclusion

The present study concludes that the maternal BP and heart rate were within normal levels in semi-fowler's and left lateral positions. Both positions had satisfactory NST reactivity. The mean BFHR and the number of fetal movements were more in semi-fowler's than in left lateral position, though they were not statistically significant. The left lateral position needed less time to achieve reactivity. Women reported more comfort in the left lateral position than in semi-fowler's position, though the difference was statistically not significant. It was identified as the superior position for performing the NST in a short time. However, more studies with larger sample size in various settings have to be undertaken to conclude whether the semi-fowler's position demonstrates favorable maternal BP and heart rate during the NST in the third trimester of pregnancy.

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Conflicts of interest

There are no conflicts of interest.

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