Original Article

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Non-stress Test and Vibroacoustic Stimulation Test in High-risk Pregnancies and its Relation to Perinatal Outcome

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Abstract

Introduction: Non-stress test (NST) is commonly performed fetal surveillance test, but shows low sensitivity and positive predictive value. Vibroacoustic stimulation test (VAST) improves the sensitivity and specificity in high-risk pregnancies.

Objective: (1) To evaluate the efficacy of VAST in antenatal fetal assessment in high-risk pregnancy, (2) to correlate the VAST results with the perinatal outcome, and (3) to compare efficacy of VAST over NST.

Materials and Methods: This study was conducted on 100 women with high-risk pregnancies fulfilling inclusion criteria. NST was performed and results were obtained. Patients with nonreactive NST underwent VAST. The perinatal outcome was noted as any one of: (a) Caesarean section (CS) for fetal distress, (b) 5 min APGAR score <7, (c) admission to the neonatal intensive care unit (NICU) for more than 24 h, and (d) neonatal mortality.

Results: About 48 patients with reactive NST were in Group I and 52 with nonreactive NST in Group II. In Group II after subjecting to VAST, 27 patients became reactive. 11.12% of VAST reactive (VAST-R) and 88% of VAST nonreactive (VAST-NR) underwent emergency CS, 11.12% VAST-R, and 76% of VAST-NR had a 5 min APGAR <7 (both $P < 0.001$); 7.4% VAST-R, 44% VAST-NR required NICU admission ($P = 0.009$); there were two neonatal mortalities. 88.89% of VAST-R group had a favorable outcome, 92% of VAST-NR group had an unfavorable outcome ($P < 0.001$). 52% of NST-R had a favorable outcome, 50% of NST-NR had an unfavorable outcome (P - not significant). The sensitivity, specificity, positive and negative predictive value of NST was 50.98%, 51.02%, 50% and 52.1% and of VAST was 88.46%, 92.3%, 92% and 88.89%, respectively.

Conclusion: VAST is easy to perform adjunct to NST, in the antenatal fetal assessment of high-risk pregnancy with higher specificity, sensitivity, positive and negative predictive value in predicting perinatal outcome.

Key words: Antenatal fetal surveillance, Fetal acoustic stimulation test, High-risk pregnancy, Non-stress test, Vibroacoustic stimulation test

INTRODUCTION

High-risk pregnancies require sophisticated maternal and fetal surveillance and on many occasions, difficult management decisions to optimize the outcome. Fetal morbidity and mortality are greater in high-risk women, such as those with prolonged pregnancy, intrauterine growth restriction (IUGR), hypertension, or other risk factors.[1] The test commonly used for antepartum fetal assessment is the non-stress test (NST) which looks for the presence of spontaneous temporary accelerations in the fetal heart rate (FHR) associated with fetal movements perceived by the mother or observed by the obstetrician. Fetal heart accelerations associated with fetal movement is a reflex that is affected by pathological and physiological influences on the fetal brain. The most common physiological condition being the fetal sleep states and most common pathological condition being

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fetal asphyxia. Due to which, NST has been shown to have a low sensitivity.

The vibroacoustic stimulation test (VAST) aims to assess the functional state of the fetal central nervous system and its reflex cardiovascular response. The test is based on the observations that (1) the fetal cochlear apparatus gets mature enough to appreciate acoustic stimulation from 28 weeks, (2) auditory sensation is one of the first to get affected by hypoxia.[2] Due to the affection of the auditory system in a hypoxic fetus, a compromised fetus does not show a reflex cardiovascular response of fetal heart acceleration in response to acoustic stimulation.

To perform VAST, at the end of 10 min of plain cardiotocography (CTG), a vibroacoustic stimulation is given by placing an acoustic stimulator near baby's vertex, for a period of a maximum of 3 s. In a healthy fetus, cardiac acceleration occurs almost instantaneously on giving the stimulus. If it fails to occur with one stimulus, the stimulus may be repeated at 1 min intervals for a maximum of 3 times.[2]

Hence, it may help obstetricians to discover unsuspected cases of chronic fetal distress. It has been shown to reduce the number of nonreactive tests and testing time.[3] The addition of VAST as a component of the biophysical profile for the fetal assessment in high-risk pregnancies has also been proved to be of reliable diagnostic approach due to higher accuracy, ease of administration, and shorter testing time.[4] Hence, the present study has been undertaken to study the efficacy of VAST as a test of antenatal fetal surveillance in various high-risk pregnancy conditions, and its advantages over NST.

Objectives

(1) To evaluate the efficacy of VAST in antenatal fetal assessment in high-risk pregnancy, (2) to correlate the VAST results with the perinatal outcome, and (3) to compare efficacy of VAST over NST.

MATERIALS AND METHODS

This was a prospective study carried out on 100 high-risk pregnancies admitted from September 2011 to September 2013 in a tertiary hospital. Women with high-risk factors fulfilling the inclusion criteria admitted in the antenatal wards were randomly selected. The procedure was explained and informed consents were obtained from the patients. After examining the patients, necessary investigations were performed, including Doppler studies in patients of IUGR and pregnancy induced hypertension (PIH). Electronic Fetal Monitor of Bionet Company, Twin view FC 14000, model MW 160KA1803F52 was used. Vibroacoustic Stimulator belonging to Maestro Mediline Company, giving a stimulation of 75 db intensity at 1 meter at 75 hz was used to perform CTG. Inclusion criteria: (1) Post datism, (2) prolonged pregnancy, (3) prelabour rupture of membranes, (4) gestational diabetes, (5) bad obstetric history, (6) IUGR with at least 2-3 weeks head circumference/abdominal circumference lag, (7) PIH, and (8) oligohydramnios, not in labor, with singleton pregnancy of gestational age more than 34 weeks, with cephalic presentation. Exclusion criteria: (1) Patients in labor, (2) preterm labor, (3) multiple gestations, (4) malpresentations, (5) cases requiring immediate emergency caesarean section (CS) for placenta praevia or placental abruption and cord prolapse, (6) eclampsia, and (7) thick meconium stained liquor.

NST was observed for: (a) Basal heart rate, (b) variability, (c) presence of at least 2 accelerations and absence of decelerations. Patients with reactive NST were allotted Group I, and those with nonreactive or equivocal results in Group II. Group II was followed by a vibroacoustic stimulus for 3 s. In the absence of response, anotherstimulus was given at an interval of 1 min for maximum three stimuli over a 10 min trace. The presence of FHR acceleration in response to stimulus was considered reactive or VAST negative. The absence of FHR acceleration at the end of three stimuli was considered VAST nonreactive (VAST-NR) or VAST positive. With a reactive VAST, no attempts at termination of pregnancy were made. The tests were performed twice a week until patient landed up in spontaneous or induced labor. Perinatal outcome was noted in all three groups.

Table 1: Distribution of high-risk factors

High-risk factors	NST-R Group I *n*=48	NST-NR Group II *n*=52		Total
		VAST R Group II A *n*=27	VAST NR Group II B *n*=25	
PIH	16	5	12	33
IUGR	17	11	10	38
Oligohydramnios	16	9	4	29
PROM	9	3	3	15
Postdatism	15	6	7	28
GDM	2	1	1	4
BOH	1	4	0	5
Others	5	7	7	19

PIH: Pregnancy induced hypertension, IUGR: Intrauterine growth restriction, PROM: Prelabour rupture of membranes, GDM: Gestational diabetes mellitus, BOH: Bad obstetric history, NR: Non-reactive, R: Reactive, NST: Non-stress test, VAST: Vibroacoustic stimulation test

Table 2: Distribution of perinatal outcome

Outcome	NST-R Group I *n*=48 (%)	NST-NR Group II *n*=52		Total	Chi-square Df=2	*P* value
		VAST-R Group II A *n*=27 (%)	VAST-NR Group II B *n*=25 (%)			
Intrapartum fetal distress fetal distress/MSL/tachycardia	21 (43.75)	3 (11.1)	23 (92)	47	34.5	<0.001**
CS-for fetal distress	20 (41.66)	3 (11.12)	22 (88)	45	31.4	<0.001**
APGAR at 5 min<7	11 (22.91)	3 (11.12)	19 (76)	33	28.9	<0.001**
NICU Admission>24 h	12 (25)	2 (7.40)	11 (44)	25	9.27	0.009#
Neonatal Mortality	1	0	1	2		

CS: Caesarean section, **Highly significant, #Significant, R: Reactive, NR: Non-reactive

OBSERVATIONS AND RESULTS

Out of 100, 48 patients had a reactive NST throughout pregnancy and were allotted Group I. Of the 52 patients with nonreactive NST in Group II, 27 became VAST reactive (VAST-R) when subjected to vibroacoustic stimulus and allotted Group IIA while 25 remained VAST nonreactive and were allotted Group IIB. Observations were noted and Chi-square test was applied. $P < 0.05$ was considered significant. The age group and parity in each group were comparable. High-risk factors in each group were as follows: (Table 1).

Although the study included patients beyond 34 weeks of gestation, many high-risk pregnancies were identified near term. In Group I, a total of 35 (72%) and in Group II, a total of 22 (42.3%) patients required induction of labor. The perinatal outcome was as follows: (Table 2).

Two patients with reactive NSTs had an instrumental vaginal delivery due to second stage fetal distress which though an adverse outcome, was not included in the present study. A total of 25 neonatal intensive care unit (NICU) admissions were observed in the study. Although NST was reactive in 48 patients, there were 12 NICU admissions. 52.08% of NST-R had a favorable outcome and 50% of NST-NR had an unfavorable outcome (*P* value - not significant, Table 3). 88.89% of VAST-R group had a favorable outcome while 92% of VAST-NR group had an unfavorable outcome ($P < 0.001$, Table 4).

The sensitivity, specificity, positive predictive value and negative predictive value of NST were 50.98%, 51.02%, 50% and 52.1%, respectively. The sensitivity, specificity, positive predictive value and negative predictive value VAST was, 88.46%, 92.3%, 92% and 88.89%, respectively (Table 5).

Table 3: Non stress test outcome

NST results	Unfavorable outcome (%)	Favorable outcome (%)	Total	Chi-square Df=1	*P* value
NST-NR	26 (50)	26 (50)	52	0	1.0**
NST-R	23 (47.91)	25 (52.08)	48		
Total	51	49	100		

**Not significant, R: Reactive, NR: Non-reactive, NST: Non-stress test

Table 4: Vibroacoustic stimulation test outcome

VAST results	Unfavorable outcome (%)	Favorable outcome (%)	Total	Chi-square Df=1	*P* value
VAST-non reactive	23 (92)	2 (8)	25	30.8	<0.001*
VAST-reactive	3 (11.12)	24 (88.89)	27		
Total	26	26	52		

*Highly significant, R: Reactive, NR: Non-reactive. VAST: Vibroacoustic stimulation test

DISCUSSION

In the study, it was found, out of the 52 patients which had a nonreactive NST, 27 became reactive after VAST. During the period of antenatal surveillance, in 9 patients when VAST became reactive, the pregnancy was continued, and biweekly tests were continued. Out of these patients only 1 had an unfavorable perinatal outcome.

In 1986, Smith *et al.*,[3] performed a retrospective analysis of the adjunctive use of acoustic stimulation in the study group and found a 50% reduction in the number of nonreactive test. Consequently, a prospective study was conducted to compare the standard NST with VAST, in which it was found that the incidence of the nonreactive test in the control group of NST was 14% while in the study group was 9%. Chen,[5] (1991) studied 103 pregnant females and found a reduction in the number of falsely nonreactive test from 26 with non stress test, to zero with vibroacoustic stimulation test (Table 5).

Perez-Delboy *et al.*,[6] studied 113 pregnant patients, and randomized them into VAST group and NST group. He found that 5 (9.6%) patients subjected to NST alone had persistent nonreactive NST while no patients in the Group subjected to vibroacoustic stimulus had persistent

Table 5: Comparison of VAST over NST

Study	Test	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Present study (2013) *n*=100	VAST	88.46	92.3	92	88.89
	NST	50.98	51.02	50	52.1
Nyman *et al.*,[9] *n*=517	VAST	81	89%	12	99.69
Saraçoglu *et al.*,[11] *n*=400	VAST	85.7	94	54.5	98
	NST	87.5	88	38.8	98
Tannirandorn and Kittipibul[12] *n*=604	FAST	66.7	99.8	85.7	99.5
Batcha and Goonewardene[13] *n*=423	VAST	93	79	67	96
	NST	100	45	50	100

VAST: Vibroacoustic stimulation test, NST: Non-stress test

nonreactive test ($P = 0.0002$). Tongsong and Piyamongkol[7] studied the incidence of nonreactive tests, which was 6.8% in the Acoustic stimulation test group and 13.8% in the NST group ($P < 0.001$). Due to fetal sleep-activity cycles, the testing time for NST is also longer. With the application of VAST, there is a reduction of the testing time due to modification of the behavioral cycle.[5,6] In the present study, the time to reactivity was not studied. However, by reducing the number of nonreactive tests, the need for performing extended NSTs and repeat NSTs was avoided. Furthermore, the need for further evaluation in the form of biophysical profile or Doppler and the related costs were avoided.

Out of patients with nonreactive VAST, maximum patients developed intrapartum fetal distress out of which 22 underwent emergency CS. Furthermore, with reactive NST up to 43.75% patients developed intrapartum fetal distress.

Serafini *et al.*,[8] studied the FHR acceleration response to an acoustic stimulation, which was compared to the traditional NST in regard to pregnancy outcome, as reflected by the incidence of intrapartum fetal distress, meconium staining of the amniotic fluid, 1 and 5 min APGAR scores, and perinatal mortality. They found that fetuses with spontaneous or sound-generated reactivity had comparably good outcomes with respect to all outcome measures investigated. Fetuses which lacked spontaneous or sound-stimulated reactivity had an increased risk for intrapartum fetal distress.

Nyman *et al.*,[9] studied 517 patients of high-risk pregnancies. In five cases, where the FHR tracings were pathological, stimulation nonetheless, produced fetal movements, and the fetal outcome was good. 30 cases had pathological fetal heart tracing with no fetal movement on vibroacoustic stimulus, out of which 7 had 5 min APGAR <7. This shows that fetal movement in response to vibroacoustic stimulus inspite of pathological fetal tracing has a good perinatal outcome. They also observed that there was no habituation to the vibroacoustic stimulus.

Salamalekis *et al.*,[10] studied a series of 180 cases of high-risk pregnancies in order to assess if a NST taken 24 h before delivery is of any prognostic significance. They concluded that the nonreactive test could identify a population at risk but it was not helpful as a "stand-alone" modality in decision making because of the low sensitivity and positive predictive value rates (40.9% and 28.1), respectively. Various studies have compared. Tannirandorn et al12, have studied reactive response to short Fetal acoustic stimulation test (FAST) , in 604 high risk pregnancies after 28 weeks of gestation. Fetal heart rates were recorded 3 minutes before and 5 minutes after fetal acoustic stimulation. The results of the tests performed within a week of delivery were compared with perinatal outcomes (Table 5).

CONCLUSION

VAST is an easy to perform, bedside test and cost-effective adjuvant to NST, in the antenatal fetal assessment of high-risk pregnancy with higher specificity, sensitivity, positive and negative predictive value in predicting perinatal outcome.

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