Research Article

Journal of Gynecology & Reproductive Medicine

Non Stress Test – An Update

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Submitted: 15 Feb 2017; **Accepted:** 31 July 2017; **Published:** 09 Sep 2017

Abstract

Non stress test is a time tested, convenient and reliable test of antenatal fetal surveillance. It accurately predicts those fetus that do not require acute or premature obstetric intervention and thereby prevents pregnancies from being subjected to unnecessary iatrogenic risks and avoids unnecessary medical, financial and emotional burden. The principle of non stress test is that the heart rate of a fetus with adequate oxygenation and normal neurological response will temporarily accelerate with fetal movement. Loss of reactivity is commonly associated with a fetal sleep cycle but may result from any cause of central nervous system depression, fetal acidosis or maternal drug intake and requires further evaluation for an extended period or evaluation with other techniques like biophysical profile or amniotic fluid testing or umbilical artery Doppler study as per the overall clinical scenario. A correctly performed NST, using standard technique with proper interpretation may be of great value in planning further management.

Introduction

The objective of antenatal care is to prevent adverse maternal and perinatal outcome. Technological advancement and understanding of fetal physiology has enabled us to decrease perinatal mortality to some extent. Antenatal fetal assessment helps in decision regarding timely intervention such as steroid administration and delivery to prevent further harm. Several techniques are used for antepartum fetal surveillance including fetal movement assessment, non stress test [NST], contraction stress test, fetal biophysical profile, modified biophysical profile and umbilical artery Doppler velocimetry.

NST is an important tool in the armamentarium of obstetricians. It involves integrated monitoring of fetal neurologic and cardiovascular system with an aim to predict fetal acidemia and hypoxemia. It is a method of electronic fetal monitoring where fetal heart is measured in response to fetal movement. As the name implies, the fetus is not subjected to any stress or risk. Principle of non stress test is that a well oxygenated fetus has temporary fetal heart rate acceleration in response to movements which is an indicator of normal fetal autonomic function. Physiologic loss of reactivity is associated with fetal sleep cycle. Pathological loss of reactivity may result from any cause of central nervous system depression including fetal acidosis. During adverse circumstances like reduced utero-placental perfusion or maternal compromise, the placenta is not able to exchange adequate oxygen resulting in fetal respiratory acidosis. Excess hydrogen ions accumulate in fetal circulation leading to progressive hypoxia and subsequently metabolic acidosis. The ultimate or preterminal patterns associated with cellular hypoxia and systemic asphyxia result in relatively fixed foetal heart baselines, reduced or absent fetal heart rate variation, absence of foetal heart rate accelerations, and the appearance of spontaneous late decelerations.

Indications of Non Stress Test

The results of antepartum fetal surveillance have not definitively demonstrated improved perinatal outcome. Therefore, all indications for antepartum testing should be considered somewhat relative [1]. Usually, antepartum fetal surveillance is used in pregnancies at a high risk of antepartum fetal death. Some of the conditions in where NST is indicated include the following:

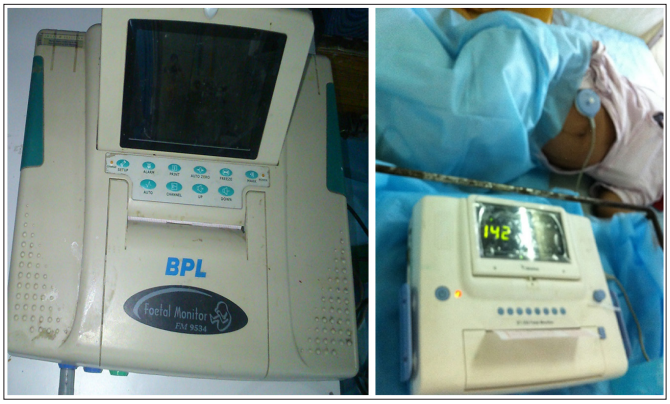
Maternal conditions

Diabetes, hypertensive disorders, chronic renal disease, antiphospholipid syndrome, poorly controlled thyroid disorder, asthma, severe respiratory disease, cholestasis, viral hepatitis, febrile illness, hemoglobinopathies, cyanotic heart disease, systemic lupus erythematosus, and morbid obesity.

Pregnancy-related conditions

pregnancy-induced hypertension, decreased fetal movement, oligohydramnios, polyhydramnios, intrauterine growth restriction, post-term pregnancy, moderate to severe isoimmunization, previous intrauterine death or bad obstetric history, multiple gestation with significant growth discrepancy, maternal age>35yrs or < 18yrs, pregnancy after assisted reproductive techniques.

NST Machine



Period of Gestation at which NST is to be initiated

The non stress test of neurologically healthy preterm fetus is frequently nonreactive. From 24 to 28 weeks of gestation up to 50% of non stress tests may be non reactive and from 28 to 32 weeks of gestation, 15 % of non stress tests are non reactive [1]. Decision to start antenatal fetal testing by NST should be individualised according to risk factors of pregnancy. The obstetrical history and severity of maternal and fetal disorders in the current pregnancy should be considered. It is conventionally started at 32 weeks in pregnancies with one high risk of still birth and at 28 weeks in pregnancies with multiple risk factors. It is invariably done for women presenting with decreased fetal movements. It should be done between 287 and 294 days in otherwise healthy postdated pregnancies. It should be started two weeks before the time of an adverse event in previous pregnancy in women of bad obstetric history.

Frequency of Test

There is no reliable evidence regarding frequency of performing this test but conventionally it is repeated-

- Once a week in pregnancies with single risk factor.
- Twice a week in pregnancies with multiple risk factors especially in postdated pregnancy and Diabetes mellitus [2].
- May be done more frequently or daily in high risk pregnancy with multiple factors like in severe pre-eclampsia remote from term.

Procedure

Testing should be performed in a quiet and relaxed environment. Medical history, substance abuse and history of drug intake should be carefully reviewed. Patient should avoid cigarette smoking for at least 2 hours before NST. There should not be intake of any CNS depressant drug for at least 8 hours prior to NST. Fluid intake should be adequate to decrease the risk of dehydration with uterine hypo perfusion and fetal hypoxia. Intake of atenolol may result in non reactive NST due to sympathetic depression of fetus. Methadone and Phenobarbitone prolong the time taken by the fetus to be reactive. Position of the woman should be left lateral or semi reclining in a bed to prevent venacaval compression. Alternate position may be in reclining chair [3]. Before starting the procedure vitals of woman, abdominal examination for gestational age, fetal position, uterine activity and position of fetal heart sound is essential. External cardiac transducer is placed over fetal heart sound. Event marker is given in woman's hand to mark perceived fetal movement on graph. A 20 minutes tracing is taken in general. If NST is nonreactive, it is extended to 40 minutes [extended NST]. If it is still non reactive, tracing may be extended to 90 minutes.

Components of NST

For the purposes of classification, the National Institute of Child Health and Human Development definitions are used.

Baseline

The mean fetal heart rate rounded to increments of 5 beats per minute during a 10 minutes segment excluding:

- Acceleration and decelerations.
- Periods of marked variability.
- Baseline segments that differ by more than 25 beats per minute.

The baseline should be for a period of 2 minutes in any 10 min segment.

a) Baseline Tachycardia

Fetal heart rate baseline≥160 bpm persisting for at least 10 minutes. This occurs in cases of maternal fever, infection, hyperthyroidism, anemia, fetal hypoxia, prematurity or due to certain maternal drug intake and needs further evaluation.

b) Baseline Bradycardia

Fetal heart rate baseline ≤110 bpm persisting for at least 10 minutes. This should be differentiated from a prolonged FHR deceleration, defined as a FHR decrease of at least 15 bpm that lasts longer than two minutes but less than ten minutes. Bradycardia in the range of 100 to 120 bpm with normal variability is not associated with fetal acidosis. Bradycardia less than 100 bpm occurs in fetuses with congenital heart abnormalities or myocardial conduction defects while severe prolonged bradycardia of less than 80 bpm that lasts for 3 minutes or longer is an ominous finding indicating severe hypoxia and is often a terminal event.

C) Baseline variability

Baseline FHR variability is a term that is used to describe fluctuations in baseline fetal heart rate. It is a product of integrated activity between the sympathetic and parasympathetic branches of the autonomic nervous system and therefore, reflects the status of the central nervous system

It is quantified as the amplitude of peak to trough in bpm

- **Absent**-Amplitude range undetectable.
- **Minimal**- amplitude variability is ≤5bpm
- **Moderate**-amplitude variability is 6-25 bpm
- **Marked**-amplitude variability is ≥25 bpm

Acceleration

This is seen as abrupt increase in fetal heart rate -

- At a period of gestation ≥32 weeks- at least 15 bpm acceleration lasting for at least 15 sec but less than 2 min.
- At a period of gestation ≤32 weeks-at least 10 bpm acceleration lasting for at least 10 sec but less than 2 min.
- Prolonged acceleration-lasting for more than 2 min but less than 10 min.

Deceleration

a) Variable deceleration

Abrupt decrease in fetal heart rate ≥15 bpm lasting for ≥15 sec but less than 2 min with preservation of beat to beat variability. Variable decelerations are caused due to compression of the umbilical cord which initially occludes the umbilical vein, resulting in an acceleration (pre deceleration shoulder) and indicates a

healthy response. This is followed by occlusion of the umbilical artery, which results in the sharp down slope. Finally, the recovery phase is due to the relief of the compression and the sharp return to the baseline, which may be followed by another healthy brief acceleration or post deceleration shoulder.The actual clinical use of these decelerations is questionable. However, non-reassuring, variable deceleration need to be monitored. Non reassuring variable decelerations classically have no anterior or posterior shoulder and tend to "slide" into a deceleration in a somewhat sluggish manner with loss of beat to beat variability indicating fetal hypoxia.

b) Prolonged deceleration

Deceleration in fetal heart rate ≥15 bpm lasting more than 2 min but less than 10 minutes.

c) Early deceleration

A gradual decrease and return of FHR with uterine contraction. Nadir of deceleration occurs at same time as peak of contraction due to compression of the fetal head during contractions which stimulates reflex vagal response, resulting in a slowing of the FHR. Early decelerations are mostly accompanied by normal baseline variability and do not need any intervention except a careful watch.

d) Late deceleration

A gradual decrease and return of FHR with uterine contraction. Nadir of deceleration occurs after the peak of contraction. Late decelerations are associated with severe hypoxia and acidosis. These are frequently are accompanied by decreased baseline FHR variability and require close supervision. Position of the mother may be changed, oxygen administration, intravenous fluids may be given and delivery may be expedited.

Sinusoidal wave pattern

A sinusoidal fetal heart rate pattern is defined as a pattern of fixed, uniform fluctuations of the fetal heart rate that creates a pattern resembling successive geometric sine waves. It is frequently described as undulating and smooth and is characterized by the absence of variability. It is a smooth undulating sine wave pattern with amplitude: 10 to 15 bpm , frequency: 3-5 cycles per minute and duration >2 minute. It requires immediate evaluation as it may represent the terminal rhythm. It is also present in cases of severe fetal anemia and in maternal use of illicit drugs. Pseudo sinusoidal pattern is a benign finding and resembles sinusoidal pattern with short term variability.

Table 1: Antepartum classification: Non-Stress Test [11]

Parameter	Normal NST (Previously "Reactive")	Atypical NST (Previously "Non-Reactive")	Abnormal NST (Previously "Non-Reactive")
Baseline	110-160 bpm	100-110 bpm >160 bpm <30 min. Rising baseline	Bradycardia-100 bpm Tachycardia-160 for-30 min. Erratic baseline
Variability	6-25 bpm (moderate) ≤ 5 (absent or minimal) for < 40 min	≤ 5 (absent or minimal) for 40-80 min.	≤5 for ≥80 min. ≥25 bpm ≥10 min. Sinusoidal
Decelerations	None or occasional variable <30 sec	Variable decelerations 30-60 sec. duration	Variable decelerations >60 sec. duration Late deceleration(s)
Accelerations Term Fetus	>2 accelerations with acme of ≥15 bpm, lasting 15 sec. in 40 min. of testing	< 2 accelerations with acme of ≥15 bpm, lasting 15 sec. in 40-80 min.	≤2 accelerations with acme of ≥15 bpm, lasing 15 sec. in > 80 min.
Preterm Fetus (<32 weeks)	>2 accelerations with acme of ≥10 bpm, lasting 10 sec. <40 min. of testing	< 2 accelerations of ≥ 10 bpm, lasting 10 sec. in 40-80 min.	≤2 accelerations of ≥10 bpm, lasting 10 sec. in >80 min.
ACTION	**FURTHER ASSESSMENT OPTIONAL**	**FURTHER ASSESSMENT REQUIRED**	**URGENT ACTION REQUIRED**

Management after NST

In case of reactive NST further antenatal testing can be continued according to previous plan depending upon the risk factors of the pregnancy. The overall clinical situation and fetal status need to be assessed .In case of abnormal NST, further testing may be required in the form of ultrasound and biophysical profile. Decisions of intrauterine resuscitation, in utero transport to better neonatal facility or immediate delivery may be taken.

Negative predictive value of NST for fetal and neonatal death is considered more than 90% within one week of testing [4]. False positive rate of NST is 60% so it is better in ruling out than in predicting fetal compromise [5]. Several studies where NST was used as primary screening tool show that up to 40% of the fetus may not meet acceleration criteria within 40 minutes and up to 50% show variable decelerations. Only variable decelerations lasting more than one minute should be given significance [1].

Till now evidence supporting NST to reduce perinatal morbidity and mortality is poor. There are conflicting results from various randomized control trials performed regarding this subject. Four blinded randomized trials done on total 1636 high risk pregnancies included in Cochrane review demonstrated no benefits in terms of perinatal morbidity and mortality in patients monitored with NST [6]. A study by Brown and Patrik demonstrated that the time period of lack of acceleration on NST is strongly correlated with fetal compromise [7]. They concluded that lack of acceleration for more than 80 minutes is associated with continuation of lack of acceleration and fetal compromise. Their observation is substantiated by another study by Leveno et al [8].Consensus is of performing bio-physical profile, continuous tocography, amniotic fluid index or umbilical artery Doppler assessment in cases of non reactive NST depending on the clinical parameters of the mother and fetus. Administration of glucose and performance of manual stimulation is not recommended as a technique to encourage acceleration. Both these techniques

failed to decrease the number of non reactive NST's in clinical trials evaluated in Cochrane review [9, 10]. Use of vibrio-acoustic stimulation decreases the testing time and increases the number of reactive antenatal NST's but its use is not recommended due to lack of evidence on its safety and reliability.

Conclusion

Non-stress test is already a part of primary ante-natal fetal testing but its use and interpretation should be according to guidelines. After seeing the NST readings, evaluation should be done to confirm if the recording is continuous and adequate for interpretation, type of equipment used, identify the baseline fetal heart rate and presence of short and long term variability, presence of accelerations or decelerations from the baseline with relation to movement and then conclude whether the FHR recording is reassuring, non-reassuring or ominous. Finally a plan should be developed in the context of the clinical scenario and according to interpretation of the FHR. Society of obstetricians and gynecologists of Canada recommends that antepartum non-stress testing may be considered when risk factors for adverse perinatal outcome are present (III-B). In the presence of a normal non-stress test, usual fetal movement patterns, and absence of suspected oligohydramnios, it is not necessary to conduct a biophysical profile or contraction stress test (III-B). Understanding the physiology and varying patterns of fetal heart rate tracings promotes improved obstetric care and reduces unnecessary interventions.

Key Points

- The non stress test has become a useful tool in antenatal surveillance because of its wide applicability, ease of performance and relatively low cost.
- The fetal non stress test is performed in high risk pregnancies after 32 to 34weeks gestation and poses no known risks or side effects to mother or baby.
- A normal or reactive non-stress result indicates that the fetus is getting adequate oxygen supply and may be repeated weekly, two times per week or even daily depending on the clinical condition and risk involved.
- Non-reactive or atypical non stress test requires additional testing to determine whether the result is truly due to poor oxygenation, or whether there are other reasons for fetal non reactivity like sleep patterns, certain maternal prescription or nonprescription drugs. This should be followed by testing for extended time period or evaluation by bio-physical profile, amniotic fluid index or umbilical artery Doppler assessment on the basis of clinical profile.
- Negative predictive value of NST for fetal and neonatal death is considered more than 90% within one week of testing while false positive rate of NST is 60%. Therefore, it is a better test in ruling out than in predicting fetal compromise.
- Non stress test should be performed using standard equipment and interpretation should be carefully done according to the recommendations. However, any decision should be based on critical evaluation of the mother and fetus along with the reports of the test.

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