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Effect of Uterine Contraction and Amniotomy on Fetal Cardiotocograph

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Abstract: Both uterine contractions and artificial rupture of fetal membranes (amniotomy) are important events during delivery phase, this study was planned to determine possible effects of both events on fetal heart rate using nonstress test method. Sixty term pregnant women admitted for termination of pregnancy were selected. Primary nonstress test was performed, then nonstress test was done after active uterine contractions. After the amniotomy the last test was done. All results were statistically analyzed. Out of 60 term pregnant women, 51 (85%) patients reported acceleration for primary nonstress test. After uterine contractions, acceleration was seen in 46 (76.7%) patients, this happened in 40 (66.7%) cases after amniotomy. There was no deceleration after primary nonstress test. However, deceleration reported after uterine contractions and amniotomy in five (8.3%) and two (3.3%) cases, respectively. The 56 (93.3%) patients showed variability in primary nonstress test; variability following the uterine contractions and amniotomy was seen in 58 (96.7%) and 56 (93.3%) of subjects, respectively. None of them were statistically significant (p>0.05). Mean fetal heart rate baseline in primary Nonstrees test was (141.00±9.35), this was (140.50±10.51) following uterine contractions and (143.08±11.97) after amniotomy. Baseline fetal heart rate reduction, statistically significant, was seen following uterine contractions (r = +0.28, p = 0.02). This means reductions in lower baseline fetal heart rates will be more outstanding. Uterine contractions and amniotomy had no correlation with presence or absence of variability, acceleration and deceleration.

Key words: Fetal heart rate, artificial rupture of fetal membranes (amniotomy), uterine contractions, nonstress test

INTRODUCTION

The nonstress test (NST) is a noninvasive method used to evaluate fetal well-being. This test, a part of cardiotocograph (CTG) used within at least 20 min after admission of patients, is the only screening test for evaluation of fetal well-being during delivery. Important components of NST are baseline Fetal Heart Rate (FHR), baseline variability, acceleration and deceleration (Gearhart *et al.*, 2008).

NSTs are described as either reactive or nonreactive. An NST is considered reactive if at least two accelerations are present in a 20 min follow up period (at least 15 bmp above the baseline and lasts for at least 15 sec). An NST is considered nonreactive if sufficient accelerations are absent within a 40 min period (Gearhart *et al.*, 2008).

NST has been approved as a screening method for evaluation of fetal well-being in high-risk pregnant population. However, its application has been associated with an increased incidence of cesarean delivery for fetal distress compared to Umbilical artery Doppler as a screening test for fetal well-being (Williams *et al.*, 2003).

Effect of pregnant woman's position has been studied; NST duration did not vary greatly in the reclining position, but in the sitting position or during walking, the time taken to record the three large accelerations required to define the trace as reactive, decreased significantly with the progression of pregnancy (Cito *et al.*, 2005). Sitting up, semi-fowler and left lateral positions and also the preferences of the pregnant women have been recommended to be used during the non-stress test, supporting the Cito *et al.* (2005) study (Aluş *et al.*, 2007).

In a research, both NST and polysomnography were applied for evaluation of obstructive sleep apnea in pregnancy and its possible effect on fetal outcome (Sahin *et al.*, 2008).

Some researchers have proposed modifications for NST to shorten the analysis time needed for NST without decreasing efficacy in compromised fetuses (Park *et al.*, 2009).

Role of the time in which, NST is performed has been studied and based on this study; evening NSTs would save time and decrease maternal anxiety (Babazadeh *et al.*, 2005).

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It has been shown that some medical problems such as oligohydramnios, fatal embryonic anomalies, growth and placental diseases interfere with interpretation of NST and reduce its sensitivity up to 50%. Nonreactive test has a weak specificity in detecting fetal death. False reliability of reactive test is six in 1000 and as a retrospective test is not reliable (Creasy *et al.*, 2009).

One of important indications for FHR continuous surveillance, known as admission labor test and done within 20-30 min after admission, is in labor phase (Cunningham *et al.*, 2010).

Studies have shown effects of fetal sleep and movement, gestational age, sedative drugs and mother's nutrition on NST. However, present study concentrates on the evaluation of possible effects of uterine contractions and amniotomy during labor phase on NST, which has not been studied before.

MATERIALS AND METHODS

We studied 60 term pregnant women, gestational age between 38-42 weeks, admitted in Tabriz Alzahra Obstetrics and Gynecology Hospital from October 2008 to December 2008 for termination of pregnancy. Inclusion criteria were no uterine contraction and amniotic fluid leakage, normal amniotic fluid index test done in the first day of admission. Exclusion criteria were as follow: narcotic and analgesic drug consumption, receiving magnesium sulphate, Intra Uterine Growth Retardation (IUGR), oligohydramnios and mother's medical problems such as diabetes mellitus, hypertension and cardiovascular diseases. A primary NST was done, for all of 60 subjects, at least for 20 min up to 40 min. Fetal growth retardation was ruled out by evaluation of early pregnancy sonographies (Aloka SSD-3500 Plus Prosound, Tokyo, Japan).

Abdominal palpation, vaginal examination and tococardiograph test results were used to rule out patients who had uterine contractions.

In order to FHR monitoring, external CTG transducer is placed on mother's abdomen in a way that the best fetal cardiac activity monitoring is possible. Before placement of transducer by a fitted belt on mother's abdomen, lubricant is used. Mother and fetus movements may interfere with NST registration. Vertical line in NST registering papers shows FHR in the form of beat per minute (30-240 bpm) and horizontal line shows speed of registration (3 cm min^{-1}).

Second NST was done after active uterine contractions. Active uterine contractions are defined as at least three contractions within 10 min lasting for 35-45 sec with the pressure of 180-200 Monte video units.

Contraction were either spontaneous (contraction stress test) or oxytocin induced (oxytocin challenge test), registered in the speed of 0.5 to 6 milli unit per minute. Using oxytocin challenge test had medical indication and based on Bremme and Bygdeman (1980) study, only oxytocin was injected for induction of uterine contractions. Uterine contractions were registered through using tocometer transducer placed on the uterine fundus without application of any lubricant (Tritsch *et al.*, 1976).

Interpretation of FHR diagrams, due to lack of any consensus on definitions, may be a great challenge for obstetricians. We have used NICHHD (National Institute of Child Health and Human Development) standard definitions in our study. Normal fetal heart rate ranges from 110 to 160 bpm, baseline fetal heart rate less than 110 bpm is defined as bradycardia; baseline fetal heart rate greater than 160 bpm is tachycardia (Creasy *et al.*, 2009).

Fetal heart rate baseline variability (BLV) is the degree to which the baseline varies within a particular bandwidth, excluding acceleration and decelerations. It is determined over a time period of 5 or 10 min and expressed in beats min^{-1} bpm, variations less than 6 bpm or more than 25 (bpm) may be of great importance.

An acceleration is defined as a transient increase, after 32 weeks of pregnancy, in heart rate of 15 bpm or more and lasting 15 sec or more. Accelerations lasting more than 2 min and less than 10 min are called prolonged. Accelerations more than ten minutes are considered baseline.

A deceleration is a transient episode of slowing the fetal heart rate below the baseline of more than 15 bpm and lasting 15 sec or more. A deceleration immediately following acceleration and recovering within 30 sec or less is considerable normal.

Variable deceleration is a sudden decrease in fetal heart rate below the baseline. In variable deceleration heart rate reduction will be more than 15 bpm, last more than 15 sec but less than 2 min; they are called variable because they vary in shape, size and sometimes in timing with respect to uterine contractions.

Based on Rodeck and Whittle (2009) definition, 15 bpm reductions in fetal heart rate, lasting more than 2 min and less than 10 min, are named prolonged deceleration. Decelerations longer than 10 min are considered baseline change.

One hour later, after reaching acceptable dilatation (4-5 cm) and finishing amniotomy, third NST was performed. All patients were under close supervision during performing NSTs. Objects' data and the effects of uterine contractions and amniotomy on four components

of NST, were recorded in the blank forms provided previously. Ethical approval of our research was given by the ethics committee of the Tabriz University of Medical Sciences (TUMS). Type of this study was descriptive cross-sectional. Data analyzing was performed using SPSS 14 for windows (SPSS Inc. IL, USA). Comparisons between NST results after uterine contraction and amniotomy, in all steps, were done using general linear model repeated measures. Pearson's correlation coefficient and linear regression analysis were used to assessment of relations between variables. The p-values less than 0.05 considered statistically significant.

RESULTS

The mean age of patients was 24.25±4.70 years (range 16-37) (Table 1).

Mean gravidity numbers for our patients were 1.82±0.10 (range 1-6). Mean number of parity and live children delivery both were 0.6±0.01 (range 0-3). Mean number of abortions was 0.2±0.08 (range 0-2). Gestational age of studied women are shown in Table 2. Mean gestational age was 39.80±0.97 weeks (range 38-42). Mean amount of amniotic fluid index was 11.78±2.99 cc (range 8-20).

Based on admission day sonography, women without amniotic fluid leakage and uterine contractions were selected for studying. A normal amount for amniotic fluid index was in this range: 8-24cc (Cunningham *et al.*, 2010). We had only one case with amniotic fluid index equal to 8cc, others' mean amniotic fluid index was 11.78±2.99 cc.

Although, reduction in baseline FHR was seen after uterine contraction (from 140.50 to 141.17), the results were not statistically meaningful (p>0.05).

Baseline rate: In the primary NST mean number of FHR was 141.00±9.35 bpm (range120-165). In the NST performed following the uterine contractions mean baseline rate was 140.50±10.51 bpm (range110-170) and baseline rate following amniotomy was 143.08±11.97 bpm (range118-162). Prolonged baseline variability after uterine contractions and amniotomy was not found in this research.

Pearson test showed a direct linear correlation between baseline fetal heart rate in primary NST and NST

following uterine contractions which was statistically significant (r = +0.28, p = 0.02). This means uterine contractions reduce baseline fetal heart rate, more reductions may be observed in lower baseline FHRs. We did not find any statistically significant correlation between amniotomy and baseline FHR changes (CI = 95%, p>0.05).

Variability of baseline rate: In primary NST, baseline variability was observed in 56 (93.3%) cases; there was not any baseline variability just in four (6.7%) cases. In NST performed following uterine contractions, variability was found in 58 (96.7%) cases; there was not any changes just in two (3.3%) cases. 56 (93.3%) of studied objects had baseline variability after amniotomy, four (6.7%) cases had no variability. In comparison of NST variability following uterine contractions and amniotomy, NST variability was not significantly changed (p>0.05). There was not significant correlation between primary NST variability and uterine contractions and also between primary NST variability and amniotomy (CI = 95%, p>0.05).

Acceleration: In primary NST, we found acceleration in 51(85%) cases and no change was observed in nine (15%) cases. NST following uterine contractions induced acceleration in 46 (76.7%) objects; no change was seen in 14 (23.3%) objects. The 47 (78.3%) of studied women had acceleration after amniotomy, 13 (21.7%) cases had no acceleration. In comparison of NST acceleration following uterine contractions and amniotomy, NST acceleration was not significantly changed (p>0.05). There was not significant correlation between primary NST acceleration and uterine contractions and also between primary NST acceleration and amniotomy (CI = 95%, p>0.05).

Deceleration: There was no deceleration in primary NST. Deceleration following uterine contractions was in five (8.3%) cases and no change was seen in 55 (91.7%) cases. In NST after amniotomy, deceleration was registered in just two (3.3%) cases; no change was observed in 58 (96.7%) cases. In comparison of NST deceleration following uterine contractions and amniotomy, NST deceleration was not significantly changed (p>0.05). There was not significant correlation between primary NST deceleration and uterine contractions and also between primary NST deceleration and amniotomy (CI = 95%, p>0.05). The FHR in cases that had deceleration was between 100-110 bpm and lasted less than two minutes. Prolonged deceleration was not seen in present research. Summary of all results are shown in Table 3.

Table 1: Studied subjects' age decades

Patients' age (Years)	<20	20-25	25-30	30<
N (%)	13 (21.7%)	27 (45%)	12 (20%)	8 (13.3%)

Table 2: Gestational age classification in the studied pregnant women in percentage

Weeks of gestation	38	39	40	41	42
Percent	10	26.7	28.3	23.3	1.7

Table 3: Fetal heart rate changes in the studied pregnant women during primary NST, NST following uterine contraction and amniotomy

Results	Primary NST	NST following uterine contraction	NST following amniotomy
Baseline rate	141.00±9.35	140.50±10.51	143.08±11.97
Variability			
Positive	56 (93.3%)	58 (96.7%)	56 (93.3%)
Negative	4 (6.7%)	2 (3.3%)	4 (6.7%)
Acceleration			
Positive	51 (85%)	46 (76.7%)	40 (66.7%)
Negative	9 (15%)	14 (23.3%)	20 (33.3%)
Deceleration			
Positive	0 (0%)	5 (8.3%)	2 (3.3%)
Negative	60 (100%)	55 (91.7%)	58 (96.7%)

DISCUSSION

FHR monitoring, due to legal and ethical reasons, is a widely used technique for evaluation of fetal health (Creasy *et al.*, 2009). Regarding Rodeck and Whittle (2009) findings; different factors classified in subgroups of technical, maternal and fetal have the potential capability of interfering in FHR monitoring, recording and its interpretation. We aimed to omit or reduce effects of such these factors on the NST.

Gestational age (range 38-42 weeks) was another important factor used to choose patients. Patients with gestational age out of this range would have missed or reduced variability in baseline fetal heart rate, reduced acceleration or increased deceleration. Most of objects (27.3%) in present study had gestational age equal to 40 weeks. Patients received sedative drugs and magnesium sulphate infusion had been ruled out before.

Cardiotocographic signal tracts corresponding to 127 uterine contractions relating to 30 healthy fetuses were analyzed; their results mainly showed a general, statistically significant power increase of the FHR variability following uterine contractions (Romano *et al.*, 2006). Based on the Bremme and Bygdeman (1980) findings; such modifications of the FHR variation that follow a contraction can be a sign of autonomic nervous system reaction.

We studied more subjects compared to another similar research (Romano *et al.*, 2006) and so present study may have more statistical power. Variability following uterine contraction in just two (3.3%) cases was observed; not statistically significant. Lack of acceleration after uterine contraction was found in 14 (23.3%) cases; statistically meaningless. Although, deceleration following uterine contraction was observed in five (8.3%) cases, the results were not statistically meaningful. More reductions following uterine contraction were found in lower baseline fetal heart rates expressing the less probability of baseline fetal heart rate reduction in higher fetal heart rates.

Present findings indicate that any changes on the NST components other than reduction in baseline FHR may incite us to search for any other possible factors having effect on the NST components.

Elective amniotomy appears to increase the likelihood of umbilical cord compression in the active phase of labor and results in more mild and moderate variable decelerations, but it does not result in more severe abnormal fetal heart rate patterns or more operative intervention (Garite *et al.*, 1993). Ware and Devoe (1994) had noted that the majority of the alterations observed after amniotomy were not indicative of fetal distress as a direct result of artificial membrane rupture.

In present research, after amniotomy, mean baseline FHR range reached from 141.17±9.35 to 143.08±11.97; not statistically significant. Following amniotomy no change in baseline variability was found. Twenty percent reduction in acceleration, not statistically significant, was seen. Deceleration was found in just two (3.3%) cases. However, this result was statistically meaningless.

In a research, effect of uterine activity on fetal heart rate indexes during the active phase of labor with a computerized fetal heart rate monitoring system was studied. Findings revealed that in active labor, fetal heart rate variability is significantly affected by the intensity and duration of contractions (Zimmer *et al.*, 1998).

Although, studies have shown that fetal movements can increase FHR; acceleration may be observed independently without fetal movement. Fetal movements were not recorded in present study and uterine contractions showed no statistically meaningful effect on the deceleration, variability and acceleration.

In a research program, the relationship between fetal movements, FHR and uterine contractions was studied with a computerized system in 18 parturients during the active phase of labor. Eighty percent of FHR accelerations and 39% of uterine contractions were associated with fetal trunk movements. Ninty eight percent of accelerations with amplitude of 25-30 bpm and 96.4% of accelerations with duration of 40-50 sec were associated with fetal trunk movements (Zimmer *et al.*, 1987).

A study performed in order to investigate the fetal electrocardiogram (FECG) during uterine contractions associated with normal labor. Twenty five patients with low risk pregnancy between 38-41 weeks of gestation were studied during the active stage of labor. Both FECG and intra-uterine pressure are obtained in a conventional manner and are continually sampled into the computer. A significant increase was observed in the T/QRS amplitude ratio during the first half of the uterine contraction. No significant changes were observed in the other components of the FECG. In conclusion, by implementing

a computer based system it is possible to analyze the FECG during labor (Thaler *et al.*, 1988). Based on this research; it may well prove to be a sensitive indicator of fetal condition.

In present research more cases studied compared to another previous research (Thaler *et al.*, 1988). Although, we detected up to 10% increase in FHR variability following uterine contraction. It was statistically meaningless.

A study was established to evaluate different causes of FHR acceleration. Fetal sleep, gestational age less than 33 weeks and more than 42 weeks and women receiving magnesium sulphate infusion, were found to incite reduction in FHR acceleration (Gearhart *et al.*, 2008).

They concluded that other studies are needed to evaluate effects of active labor (uterine contraction) and amniotomy on FHR acceleration. During present study, we planned to delete all factors causing reduction in FHR acceleration mentioned in Gearhart *et al.* (2008) study.

Based on Capogna (2001) study induction of analgesia may transiently alter the balance between factors encouraging and inhibiting uterine contractions with subsequent changes of FHR patterns. Regardless the etiology, these changes are transient and do not produce maternal or fetal morbidity. However, patients using sedative and analgesic drugs were left out the study to delete any possible negative effect of analgesic drugs on FHR.

Labor, in Bremme and Bygdeman (1980) study, was induced for medical reasons at or near term in altogether 200 patients. The women were randomly assigned to low amniotomy and either oral PGE_2 or intravenous infusion of oxytocin. Labor was established slightly earlier in the oxytocin group than in the prostaglandin group of patients. When in labor, frequency and amplitude of contractions as well as uterine contractility were the same in both treatment groups. The frequency of atypical contractility patterns was higher in labor induced with PGE_2 than with oxytocin. Both mild and more severe variations in FHR occurred but were equally common on both treatment groups. Regarding to the results of this study, we just used oxytocin infusion for induction of labor.

CONCLUSION

Uterine contractions reduce baseline FHR. This means reductions in lower baseline FHRs will be more outstanding. In addition, uterine contraction and amniotomy had no correlation with reduction or increase of variability, acceleration and deceleration. Based upon the importance of amniotomy and uterine contractions in the labor phase and validity of FHR monitoring in the

screening of fetal nervous system defects and asphyxia, further studies may be needed. New studies will help tracking possible unknown factors, other than uterine contraction and amniotomy, causing some changes in the NST components during labor phase.

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