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EFFECTIVENESS OF UMBILICAL ARTERY DOPPLER EXAMINATION, CARDIOTOCOGRAPHY AND AMNIOTIC FLUID INDEX APPLIED IN EARLY INTRAPARTUM PERIOD IN DIAGNOSIS OF FETAL DISTRESS

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ABSTRACT

The present study aims to find an alternative solution to continuous monitoring with Cardiotocography (CTG) during intrapartum management process of pregnant women with no previous antenatal follow-up, and to diagnose low-risk pregnancies and avoid the financial burden and discomfort to the pregnant woman resulting from continuous monitoring. Randomly selected 114 term pregnant women with expected vaginal delivery, singleton pregnancies and no major fetal abnormalities were included in the study. Routine obstetric ultrasonography (USG) and uterine artery (UA) doppler measurements were administered. The pregnant women included in the study had an average gestation period of 38.3 ± 1.3, average age of 26.1 ± 5.3, average parity of 2.1 ± 1.5 and average infant birth weight of 3280 ± 442 g. 13 pregnant women were considered to have fetal distress following continuous monitoring with cardiotocography. Furthermore, decreased amniotic fluid index was detected in 9 of them. 10 cases were assessed to be pathological as a result of Uterine Artery Doppler examination. In two cases deemed pathological, fetal distress developed and found to be statistically insignificant. No statistically significant difference was found between decreased amniotic fluid index cases and non-decreased amniotic fluid index cases in terms of C-section application due to fetal distress. In our study, Cardiotocography + Amniotic Fluid Index measurement was determined to be the most valuable combination as the delivery room admission test.

Key words*: Fetal distress, intrapartum period, amniotic fluid index, Cardiotocography, Umblical Artery Doppler Examination*

1. Introduction

At present, the primary goal of obstetric applications is to minimize perinatal mortality. To this end, it is essential to focus on measures to decrease fetal mortality. Perinatal death rate in our country is, unfortunately, far higher than that in developed countries [1]. It is understood from the mortality statistics of Turkish Institute of Statistics (2016) that out of yearly 1,309,771 pregnancies, 18.7% of them result in miscarriages, approximately 4.7% of which are intentional, and 0.9% of them are stillbirths [2]. According to the data of National Center for Health Statistics (2001), perinatal mortality rate is 0.65% in the United States [3].

The primary cause of high perinatal morbidity and mortality rates is insufficient antenatal follow-up. It is demonstrated that maternal Doppler examination is quite useful in the determination of vascular disorders induced by pregnancy, hypertension and IUGR (Intrauterine Growth Retardation) in particular. However, studies also show that there is no sufficient correlation between fetal prognosis and Uterine Artery (UA) Doppler values measured at the beginning of dilatation phase in a no-contraction time frame [4].

Cartiotocography (CTG) is commonly used as the delivery room admission test in many clinics. Many recent publications suggest that CTG is not superior to intermittent auscultation in low-risk pregnancies . American College of Obstetricians and Gynecologists (ACOG) has stated that intermittent auscultation or CTG can be used for intrapartum monitoring in both low-risk and high-risk pregnancies [5].

Our study aims to find an alternative solution to continuous monitoring with CTG in intrapartum management problem of pregnant women with no previous antepartum follow-up, and to diagnose low-risk pregnancies and avoid the financial burden and discomfort to the pregnant woman resulting from continuous monitoring, and to provide an additional contribution to CTG assessments.

2. Method

Randomly selected 114 term pregnant women admitted to Perinatology Clinic of Taksim Training and Research Hospital with expected vaginal delivery, singleton pregnancies and no major fetal abnormalities were included in our study within the dates of December 2005 and May 2006. Requirements were regular contractions in cardiotocography (CTG), and cervical dilatation of less than 5 cm and absence of membrane rupture in vaginal examination.

Pregnant women taken to the delivery room were firstly subjected to bimanual examination, and then vaginal inspection with a speculum to determine the risk of membrane rupture. Afterwards, routine obstetric Ultrasonography (USG) and Uterine Artery (UA) Doppler measurements were performed.

Following obstetric and Doppler USG, the pregnant women were monitored with GE Medical System Corometrics 120 Series external fetal monitor. They were placed in the system in a comfortable reclining position on left side. During the interpretation of CTG data obtained on admission, such cases as presence of tachycardia (160 beats/min), late deceleration in more than 50% of contractions for 30 minutes, detection of decreased variability (beat to beat) longer than 30 minutes (<5 beats/min.), severe persistent variable decelerations (minimum 60 seconds and <60 beats/min.) or detection of persistent atypical variable decelerations, presence of bradycardia (for minimum 2 minutes <100 beats/min.), normal variability and acceleration, basal rate of 100-120 beats/min. without decelerations were assessed to be pathological.

During intrapartum follow-up, CTGs were classified based on the functional classification of Cabaniss [6]. Patients with atypical characteristics and basal rate changes, tachiarrhythmia, bradiarrhythmia, reduced variability, variable decelerations with atypical accelerations, late decelerations with absent variability, severe variable decelerations with atypical characteristics and with tachycardia and decreased basal variability, late variable decelerations (s-sign) with loss of basal variability, prolonged decelerations not entirely turning into basal, repeated prolonged decelerations, marked sinusoidal pattern, parameters in the form of agonal patterns were assessed to have Fetal Distress (FD).

Doppler examination was performed with GE Logic 3 digital color Doppler device. All of Doppler analyses were done by one physician. Doppler results were not reported to the delivery room team and any detected risk factor/factors were not reported to the physician doing the Doppler measurements. UA Doppler analysis was performed as two measurements, one from contracted and one from non-contracted uterus, during a time when the fetus was resting and not breathing when the pregnant woman was in supine position. After monitoring five identical waves, the image was frozen and Uterine Artery Pulsatility Index (UA PI) value was measured by using the automatic measurement method. All measurements were made from the free part of umbilical cord close to the bladder as much as possible to ensure standardization. Absence of end-diastolic flow and presence of backflow, and also PI value being above the 90th percentile according to a nomogram arranged based on gestational weeks [7] were interpreted as abnormal doppler results. USG was performed by the physician performing the doppler examination in the same session with the same device. Fetal biometry with USG, fetal presentation, amniotic fluid quantity and major fetal abnormality assessments were conducted. No fetal abnormality was detected in any of the cases and all fetuses were observed to be in cephalic presentation.

For Amniotic Fluid Index (AFI) assessment, four vertical measurements were taken by color Doppler from an area not containing umbilical cord when the pregnant woman was in supine position, and the women whose total of four measurements was below 50 mm were assessed to have oligohydramnios.

2.1. Statistical Method

As the most objective criterium for the diagnosis of FD by UA Doppler, CTG and AFI, abnormal intrapartum CTG patterns were used. Fisher's exact t-test was used in statistical analysis. Predictive power for detecting intrapartum FD, sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) of CTG, AFI and UA Doppler analyses were calculated and determined initially for each of them and later for three of them together.

3. Findings

According to CTG findings obtained from continuous monitoring of the pregnant women admitted to the study, 11.4% of women (n=13) were deemed to have FD. C-Section (CS) was applied to 6 of them who failed to respond to intrauterine resuscitation attempts and vacuum extraction was applied to one of them. Only one patient was taken to Neonatal Intensive Care Unit in the second postpartum hour due to meconium aspiration syndrome and was discharged from the hospital after 24

hours. The 5-minute Apgar score was found above 7 in all babies. No perinatal death was observed in any of the women included in our study.

Normal and abnormal results of the pregnant women for the three parameters analyzed are given Table 1 below.

Table 1. Distribution of Parameters by Normal and Abnormal Results

Parameters	Normal Results n (%)*	Abnormal Results n (%)
Doppler	104 (91.2%)	10 (8.8%)
CTG	90 (79%)	24 (21%)
AFI	105 (92%)	9 (8%)

CTG: Cardiotocography AFI: Amniotic fluid index

*Multiple analyses were conducted on pregnant women.

Eight women developing FD were observed to have abnormal CTG results on admission to the study. This result was found significant compared to the group with normal CTG. In CS applications due to FD, a statistically significant difference was observed between patients with non-reactive CTG and those with reactive CTG. The relationship between CTG and perinatal course of the cases is given in Table 2.

Table 2. Distribution of Cases with Normal and Abnormal Cardiotocography Results in Perinatal Period

Cases	Normal CTG (n=90)	Abnormal CTG (n=24)
Fetal Distress	5 (5.5%)	8 (33.3%)*
CS due to FD	1 (1.1%)	5 (20.8%)*
Need for NICU	1 (1.1%)	---
Vacuum due to FD	1 (1.1%)	---

*P<0.001FD:Fetal Distress, CS: C-Section NICU: Neonatal Intensive Care Unit

Decreased AFI was observed in 9 of the pregnant women. Statistically extremely significant FD was detected in 4 of them. No statistically significant difference was found between decreased AFI cases and non-decreased AFI cases in terms of application of C-section due to FD.

Following UA Doppler examination, 10 cases were assessed to be pathologic. In two of the pathologic cases, FD developed and was found to be statistically insignificant. According to pathologic and normal Doppler results, no statistically significant difference was detected in terms of the application of CS due to FD. Perinatal distribution of the cases according to UA Doppler results are presented in Table 3.

Table 3. Relationship Between Umbilical Artery Doppler and Perinatal Period

	Abnormal UA Doppler n (%)	Normal UA Doppler n (%)
Fetal Distress	2 (20%)	11 (10%)
CS due to Fetal Distress	1 (10%)	5 (4%)
Need for NICU	---	1 (1%)
Vacuum due to FD	---	1 (1%)
Total	10 (8.7%)	104 (91.3%)

FD: Fetal Distress CS: C-Section NICU: Neonatal Intensive Care Unit

Sensitivity, specificity, NPV and PPV resulting from the use of Uterine Artery Doppler Analysis and Amniotic Fluid Index assessments in dual and triple combinations were calculated. Results of this calculation along with previous calculations for CTG, AFI and UA Doppler are given in Table 4 below.

Table 4. Sensitivity, Specificity, Negative and Positive Predictive Values of Single, Dual and Triple Combinations of Cardiotocography (CTG), Uterine Artery (UA), Doppler Analysis and Amniotic Fluid Index (AFI) in Diagnosis of Fetal Distress (FD)

	Sensitivity	**Specificity**	**NPV**	**PPV**
CTG	61	84	94	33
AFI	30	85	81	44
UA DOPPLER	15	**92**	89	20
CTG+AFI	76	86	96	42
CTG + DOPPLER	61	78	94	26
AFI+DOPPLER	38	89	92	**45**
CTG+AFI+DOPPLER	**84**	82	**97**	37

CTG: Cardiotocography, UA: Uterine Artery, AFI: Amniotic Fluid Index, FD: Fetal Distress, NPV: Negative Predictive Value, PPV: Positive Predictive Value

4. Discussion

It is known that predetermination of fetal health in pregnant women applying to obstetric clinics reduces perinatal mortality rate [8]. Obstetricians traditionally tend to classify the pregnancies as “low” and “high” risk. Although there are many well-organized approaches for high-risk group, effective methods that will help the at-risk fetus in low-risk pregnancies are also needed [9]. CTG is still used in many clinics as the gold standard in intrapartum assessment and birth management. We also use CTG as the delivery room admission test and intrapartum monitoring method along with AFI measurement. Despite all of its negative features, CTG is still the most commonly used practical method to diagnose intrapartum FD and decide on obstetric intervention.

Many comprehensive studies investigating the effect of CTG on perinatal outcome suggest that CTG fails to improve the perinatal outcome [10-13]. Pursuant to these studies, CTG's sensitivity in determination of perinatal mortality is 60% while its specificity is less than 50%. Sarno et al. found the

sensitivity, specificity, positive and negative predictive values of CTG performed on admission to the delivery room as 83%, 84%, 23% and 98% respectively, in terms of its ability to diagnose Fetal Distress requiring C-section [17]. Visser et al. found the sensitivity, specificity, positive and negative predictive values of CTG as 79%, 85%, 68%, 91% respectively, in terms of its ability to diagnose FD, by referring to post-partum normal and abnormal UA gas values of reactive CTG patterns. In this study, although positive and negative predictive values in the presence of deceleration were 81% and 89%, these values were found as 88% and 76% in the case of variability loss [18]. CTG findings of our study are in parallel with the findings of Visser's study. As a result, it is of common belief that CTG can improve perinatal outcomes despite the contradictory studies. While some studies recommend intermittent auscultation for low-risk group on admission to the delivery room [18], others strongly recommend CTG during the whole delivery [17].

Amniotic fluid volume is an important indicator of fetal status and a chronic indicator of fetal well-being. Decreased AFI must be regarded as a serious obstetric condition, because fetal distress and birth asphyxia ratios increase considerably in these patients. This is closely related with the underlying causes (IUGR, placental insufficiency, post-maturity, pre-maturity etc.) The relationship between oligohydramnios and adverse perinatal outcomes have been demonstrated by many researchers [18, 19]. Moreover, fetal heart rate changes may occur in association with the squeezing of cord between the baby and uterus wall during labor in fetal heart trace. In our study, similar with other studies in the literature, a significant difference was found between normal AFI cases and low AFI cases. However, in our study, no statistically significant difference was found between decreased AFI cases and non-decreased AFI cases in terms of C-section application due to fetal distress. This can be explained by both inadequate number of total cases and inadequate number of oligohydramnios cases. In a study by Baron C. et al investigating the effect of oligohydromnios during labor, variable decelerations and C-section due to FD were observed more in oligohydramnios cases. No difference was found between the groups with respect to Apgar score or neonatal complications [22]. In this study, sensitivity, specificity, positive predictive value and negative predictive value of oligohydramnios as a predictor of C-section delivery due to FD was found as 78%, 74%, 33% and 95% respectively.

No significant relationship was observed between FD development and UA Doppler examination performed during early intrapartum period. Furthermore, according to pathologic and normal Doppler results, no statistically significant difference was detected in terms of the application of CS due to FD. Studies in literature suggest that Doppler examination does not provide statistically significant benefits in low-risk groups in intrapartum period [7, 20-22]. On the other hand, there is an all-around agreement about the use of Doppler in high-risk groups [4,23, 24]. Farell et al. reviewed the literature for the use of intrapartum Doppler velocimetry and examined the Doppler results of 2700 cases from low- and high-risk groups selected not based on any criteria. They concluded that this technique is a poor indicator of

adverse perinatal outcomes in low-risk group. It was stated that Doppler velocimetry has a minor role in the follow-up of fetal well-being during labor [24].

As is known, modified biophysical profile only uses non-stress test and amniotic fluid test, and this test was found to be more reliable than all biophysical profiles [18]. Evaluation of CTG and AFI together showed that sensitivity and positive predictive value increased significantly compared to the use of only CTG - 61% versus 76% sensitivity and 33% versus 42% positive predictive value. No significant difference was found in specificity and negative predictive value. The use of CTG + AFI displayed the highest sensitivity except for when all three of them were used together.

The highest sensitivity (84%) was obtained from simultaneous use of the three tests in our study. However, simultaneous use of them was shown to have no superiority over the use of CTG + AFI. In all tests and combinations, positive predictive value was found to be low. Taking all the criteria into consideration, CTG + AFI measurement was assessed to be the most valuable combination to use in admissions to the delivery room. In a study by Chauhan et al. in which CTG and UA Doppler were compared as delivery room admission tests, CTG was applied to 155 pregnant women in intrapartum period for 30 minutes and UA A/B ratio was simultaneously measured. Results were assessed in terms of intrapartum CTG abnormalities and CS due to FD, umbilical artery PH, Apgar score and NICU requirement. In this study, UA A/B ratio was monitored in correlation with SGA, however sensitivity and specificity were found to be low. Both tests showed poor results in predicting fetal outcomes. Nevertheless, CTG had no advantages over Doppler as a delivery room admission test in this study [19]. Özden et al. compared UA Doppler analysis and CTG in terms of its predictive power of perinatal outcomes. They included 99 term pregnant women with singleton pregnancies. All patients were assessed with both methods in intrapartum period and were compared as to their umbilical vein blood pH and 1st and 5th minute Apgar scores. Comparison of CTG findings with UA Doppler analysis showed that CTG is much more effective in predicting adverse perinatal outcomes. Sensitivity of the methods were found as 72% versus 36% [20]. In the event of simultaneous use of both tests for detecting adverse perinatal outcomes, sensitivity and NPV decreased but specificity and PPV slightly increased. Researchers recommend the use of UA Doppler analysis in selected high-risk pregnant groups, and point out that neonatal deaths result from not only FD but also from death trauma and low birth weight.

Although the findings of our study are similar with those of the studies in literature, UA Doppler applied in early intrapartum period was not detected to be superior to CTG and AFI. Moreover, the addition of UA Doppler examination to the other tests applied during admission to the delivery room resulted in no improvements in perinatal outcomes.

5. Results

In the present study conducted to assess the comparative effectiveness of UA Doppler examination, CTG and AFI in diagnosis of FD in early intrapartum period, all three methods were

applied to the pregnant women on admission to the delivery room, then continuous monitoring with CTG was performed for intrapartum monitoring. Results showed that the effectiveness of UA Doppler examination for diagnosis of FD in early intrapartum period was very low. Furthermore, the addition of UA Doppler analysis to the other tests created no statistical significance in terms of diagnosis of FD. Low positive predictive values resulting from the use of only CTG has increased, although insufficiently, with the addition of AFI to this test. In conclusion, it can be said that CTG + AFI measurement is the most valuable combination as the delivery room admission test in our study.

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