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Borderline Amniotic Fluid Index, Fetal Doppler Indices and Non-Stress Test as Predictors of Poor Perinatal Outcomes

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Abstract

Background: Assessment of amniotic fluid is an essential part of evaluation of fetal health in terms of fetal distress, meconium aspiration, cesarean section and fetal mortality. The assessment of amniotic fluid volume is very crucial for the survival of the fetus and the Amniotic Fluid Index (AFI) is the most common way for the estimation of amniotic fluid volume which is performed by ultrasound method. Studies have revealed that AFI is an accurate criterion for estimating adequate placental function.

Aim of Study: This study was borderline amniotic fluid index, non-stress test and fetal doppler indices as predictors of poor perinatal outcomes.

Patients and Methods: This study was a cross sectional study that was conducted on 250 pregnant women attending the Maternity Outpatient Clinic at Al-Hussein Hospital, Al-Azhar University and the study was carried during the period between January 2019 till January 2020. Women with a singleton pregnancy who were in third trimester (›|32 weeks) were included in this study and outcomes were studied after delivery.

Results: Abnormal continuous cardiotocography (CTG) and abnormal doppler was associated with preterm labor with statistically significant difference between each group and the normal group. On the other hand, there was no statistically significant different between the abnormal CTG group and the abnormal doppler group (p=0.4568). Fetal distress occurred only in 3.77% of the normal group with statistically significant difference when compared to each of the other two groups. In the abnormal CTG group, about 89.80% of cases had fetal distress. While in the abnormal doppler group, in nearly half of cases (48%), fetal distress was noticed. There was a statistically significant difference between the abnormal CTG group and the abnormal doppler group regarding the fetal distress (p<0.001).

Conclusion: Abnormal CTG is an immediate good indicator of fetal distress and can detect fetal distress more accurately than doppler ultrasound or decreased AFI. However, doppler ultrasound should be considered as long-term indicator.

Key Words: *Amniotic fluid index – Fetal doppler indices – Non-stress test – Poor perinatal outcomes.*

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Introduction

ASSESSMENT of amniotic fluid is an essential part of evaluation of fetal health in terms of fetal distress, meconium aspiration, cesarean section and fetal mortality **[1]**. The assessment of amniotic fluid volume is very crucial for the survival of the fetus and the Amniotic Fluid Index (AFI) is the most common way for the estimation of amniotic fluid volume which is performed by ultrasound method **[2]**, study have revealed that AFI is an accurate criterion for estimating adequate placental function **[3]**.

Amniotic fluid volume varies with gestational age, rising to a plateau between 22-39 weeks of gestation and reaching 700 and 800ml, which correspond to an AFI of 14-15cm **[4,5]**. Any decrease or increase in the volume of amniotic fluid may lead to pregnancy complications **[6,7]**.

In most studies oligohydramnios has been defined as an AFI of 5cm or less and its associated maternal and fetal complications are proven **[8]**. However, there are different views about the range of borderline AFI. In a study done by Phelan et al., **[8]** borderline AFI is defined between 5 and 8cm **[6]**. Also, Gumus et al., **[7]** have defined a borderline AFI as an AFI of 5.1-10.

In spite of different views on borderline AFI in different studies, there are, also, different views about its function and influence on maternal and fetal complications and medicalcare for fetal health. In most reported studies, the pregnancies with borderline AFI of 5-8cm have shown bad outcomes such as non-reactive non-stress tests, fetal heart rate (FHR) deceleration, meconium aspiration, immediate cesarean delivery rate, low Apgar score, LBW, NICU admission and SGA in comparison with control subjects with normal amniotic fluid

level (8.1-18cm) [8]. Also, the low amniotic index may increase the operative delivery rate [2].

Several studies indicate that Doppler indices may be powerful predictors of adverse perinatal outcome in complicated pregnancies Combining the Doppler waveform analysis of the middle cerebral artery (MCA) with that of the umbilical artery (UA) by a common cerebroplacental ratio, i.e., the ratio of their pulsatility indices has been suggested as a useful clinical simplification [9].

Doppler velocimetric study is a valuable tool for evaluation of high-risk pregnancies. It is recommended that umbilical artery Doppler should be the standard of practice in managing high-risk pregnancies complicated with fetal growth restriction and preeclampsia [10].

Doppler is found to detect changes in fetoplacental and uteroplacental circulation which correlate strongly with the fetal growth and therefore associated with pregnancy outcome. Doppler velocimetry is helpful in predicting high risk pregnancies with intrauterine growth restriction [11].

The aim of the study was to study borderline amniotic fluid index, non-stress test and fetal doppler indices as predictors of poor perinatal outcomes.

Patients and Methods

This was a cross sectional study that was conducted on 250 Pregnant women attending the Maternity Outpatient Clinic at Al-Hussein Hospital, Al-Azhar University. Women with a singleton pregnancy who were in third trimester (≥32 weeks) were included in this study and outcomes were studied after delivery.

Normal amniotic fluid volume was defined as 8<AFI<20 and borderline amniotic fluid was defined as AFI5-8 Cm [6].

Adequate information was obtained by the data within the patients' medical record and factors such as gestational age, number of births, number of pregnancies, pregnancy with preeclampsia, mode of delivery, pregnancy and perinatal outcomes (Intrapartum fetal distress in the form of passage of meconium, preterm birth or birth under 37 weeks, induction of labor, birth weight, NICU admission and fetal growth restriction) were analyzed and recorded.

Assessment of fetal doppler indices represented in middle cerebral artery doppler and umbilical artery doppler and the ratio of both.

The poor perinatal outcome of cases with impaired doppler, the poor perinatal outcome of cases with borderline AFI and poor perinatal outcome of cases with normal doppler and AFI are compared to know whether these indices can predict poor perinatal outcomes or not and what index is more predictable.

Also stating if cases with borderline AFI or impaired doppler are allowed to reach maturity or deliver normally.

Inclusion criteria: Third trimester from 32 week, have a single fetus pregnancy, and AFI from 8-5cm.

Exclusion criteria: Preterm rupture of membranes, uterine anomalies, vaginal bleeding and maternal disease.

All pregnant women will be submitted to:

1- Complete history taking: Personal history, obstetric history, gynecological history, past history and surgical history.

2- General and abdominal examination: Blood pressure, thyroid gland, lower limbs and fundal level of the uterus.

3- Routine investigations: (a) Abdominal ultrasound to assess: Fetal presentation, serial fetal growth assessment, placental location and grading and AFI and fetal doppler indices (umbilical artery and middle cerebral artery doppler). (b) Non-stress test: Through performing antenatal fetal cardiotocography.

4- Follow-up of perinatal outcomes:

   a- During pregnancy: Screening for pre–eclampsia, and follow-up of fetal growth, AFI, and fetal doppler indices and CTG.

   b- During labor: Mode of delivery (normal vaginal, instrumental delivery or cesarean section), recording of any maternal or fetal distress, duration of labor, and meconium staining.

   c- After birth: Neonatal birth weight, presence of congenital anomalies or need for neonatal intensive care unit.

Statistical analysis:

Data were analyzed using computer programs Microsoft Excel 2016 version 1812 (Microsoft Corporation, NY, USA) and SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) statistical program. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent-samples *t*-test of signifi-

cance was used when comparing between two means. Chi-square (X^2) test of significance was used in order to compare proportions between two qualitative parameters. Pearson's correlation coefficient (r) test was used for correlating data. p-value <0.05 was considered significant.

Results

The demographic data of the studied population and the studied groups were then divided into 3 groups (Normal group, Abnormal CTG group and Abnormal Doppler group) (Table 1).

There was no significant difference between the studied groups regarding the age of the patient, gravidity and parity. However, the gestational age was higher in the normal group (36.40 ±2.29 weeks) than the abnormal CTG group and the abnormal doppler group (34.98 ±2.24 and 35.47±2.29 weeks respectively) with a statistically significant difference between the normal group and the abnormal groups. Meanwhile, there was no statistically significant difference between the abnormal CTG group and the abnormal doppler group (p=0.2447) (Table 2).

The Amniotic fluid index was measured in the studied population and it ranged between 5-8 in the three groups (borderline AFI) with no statistically significant difference between the three groups.

Estimated birth weight was recorded after delivery and it was 3164.28±508.44 in the normal group which is higher than the other two groups (2241.31±512.59 in the abnormal CTG group and 2364.15±469.64 in the abnormal doppler group). There was a statistically significant difference between the normal group and each of the other two groups. Meanwhile, there was no statistically significant difference between the abnormal CTG group and the abnormal doppler group (Table 3).

We found that abnormal CTG and Abnormal doppler was associated with preterm labor with statistically significant difference between each group and the normal group. On the other hand, there was no statistically significant different between the abnormal CTG group and the abnormal doppler group (p= 0.4568).

Labor was induced in the normal group (44.65%) more than the abnormal CTG and the abnormal doppler groups (8.16% and 4% respectively) with statistically significant difference. Yet, there was no statistically significant difference between the later groups (p=0.3280).

Vaginal delivery was higher in the normal group (89.31%). While, in the abnormal groups the rate of cesarean sections was higher (79.59% in abnormal CTG group and 70.67% in abnormal doppler group). There was a statistically significant difference between the normal group and the two abnormal groups (p<0.001). On the other hand, there was no statistically significant difference between the abnormal CTG group and the abnormal doppler group (p=0.2688) regarding the mode of delivery (Table 4).

Fetal distress occurred only in 3.77% of the normal group with statistically significant difference when compared to each of the other two groups. In the abnormal CTG group, about 89.80% of cases had fetal distress. While in the abnormal doppler group, in nearly half of cases (48%), fetal distress was noticed. There was a statistically significant difference between the abnormal CTG group and the abnormal doppler group regarding the fetal distress (p<0.001).

In the normal group, 8.18% of neonates were admitted to the NICU compared to 67.35% and 58.67% in the abnormal CTG group and the abnormal doppler group respectively with statistically significant difference between the normal group and each of the other two groups. However, despite of higher incidence of NICU admission in the abnormal CTG group (67.35%) than the abnormal doppler group (58.67%), there was no statistically significant difference between both groups.

Only 2 cases in the normal group had IUGR (1.26%) with statistically significant difference when compared to the abnormal CTG group (46.94%) and to the abnormal doppler group (34.67%). But there was no statistically significant difference when comparing the two abnormal groups (Table 5).

Table (1): Demographic data of the studied population and study groups.

Parameter	Mean ±SD		Range
Age of the patient	30.11±5.936		20-40
Gravidity	2.38±0.946		1-4
Parity	1.14±0.904		0-3
Gestational Age (GA)	36.03±2.349		32-40
Amniotic Fluid Index (AFI)	6.52±0.966		5-8
Estimated Birth Weight (EB W)	2893.28±617.823		1564-3990
Study groups:	Normal Group	Abnormal CTG	Abnormal Doppler
Number	159	49	75
Percentage	63.6%	19.6%	30%

Table (2): Basic characteristics of the groups.

Parameter	Normal group (N=159)		Abnormal CTG (N=49)		Abnormal Doppler (N=75)		*p*-value		
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	p_1	p_2	p_2
Age	30.31±5.85	20-40	30.98±5.64	21-40	29.61±6.21	20-40	0.4796	0.4066	0.2167
Gravidity	2.35±0.95	1-4	2.51±0.98	1-4	2.40±0.94	1-4	0.3133	0.7191	0.5328
Parity	1.10±0.91	1-3	1.31±0.96	0-3	1.17±0.89	0-3	0.1736	0.5660	0.4333
GA	36.40±2.29	32-40	34.98±2.24	32-39	35.47±2.29	32-40	<0.001	0.0041	0.2447

N : Number. *p* 1: Normal group vs abnormal CTG. *p*>0.05 : Non-significant.
SD: Standard deviation. *p*2: Normal group vs abnormal doppler. *p*<0.05 : Significant.
GA: Gestational age. *p*3: Abnormal CTG vs abnormal doppler. *p*<0.001: Highly significant.

Table (3): Amniotic fluid index [AFI] and estimated birth weight in the studied groups.

	Normal group (N=159)		Abnormal CTG (N=49)		Abnormal Doppler (N=75)		*p*-value		
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	p_1	p_2	p_2
Amniotic Fluid Index (AFI)	6.58±0.96	5-8	6.37±1.05	5-8	6.40±0.96	5-8	0.1888	0.1843	0.8589
Estimated Birth Weight (EB W)	3164.28 ±508.44	2032-3990	2241.31 ±512.59	1564-3711	2364.15± 469.64	1564-3345	<0.001	<0.001	0.1722

N : Number. *p* 1: Normal group vs abnormal CTG. *p*>0.05 : Non-significant.
SD: Standard deviation. *p*2: Normal group vs abnormal doppler. *p*<0.05 : Significant.
*p*3: Abnormal CTG vs abnormal doppler. *p*<0.001: Highly significant.

Table (4): Preterm labor, induction of labor and mode of delivery among the studied groups.

	Normal group (N=159)	Abnormal CTG (N=49)	Abnormal Doppler (N=75)	*p*-value		
				p_1	p_2	p_2
Preterm Labor:						
Yes	81 (50.94%)	37 (75.51%)	52 (69.33%)	0.0025	0.0082	0.4568
No	78 (49.06%)	12 (24.49%)	23 (30.67%)			
Induction of Labor:						
Yes	71 (44.65%)	4 (8.16%)	3 (4%)	<0.001	<0.001	0.3280
No	88 (55.35%)	45 (91.84%)	72 (96%)			
Mode of Delivery:						
VD	142 (89.31%)	10 (20.41%)	22 (29.33%)	<0.001	<0.001	0.2688
CS	17 (10.69%)	39 (79.59%)	53 (70.67%)			

N : Number. *p* 1: Normal group vs abnormal CTG. *p*>0.05 : Non-significant.
SD: Standard deviation. *p*2: Normal group vs abnormal doppler. *p*<0.05 : Significant.
*p*3: Abnormal CTG vs abnormal doppler. *p*<0.001: Highly significant.

Table (5): Neonatal outcome among the studied groups.

Neonatal Outcomes	Normal group (N=159)	Abnormal CTG (N=49)	Abnormal Doppler (N=75)	*p*-value		
				p_1	p_2	p_2
Fetal Distress (Meconium-stained AF):						
Yes	6 (3.77%)	44 (89.80%)	36 (48%)	<0.001	<0.001	<0.001
No	153 (96.23%)	5 (10.20%)	39 (52%)			
NICU Admission:						
Yes	13 (8.18%)	33 (67.35%)	44 (58.67%)	<0.001	<0.001	00.3320
No	146 (91.82%)	16 (32.65%)	31 (41.33%)			
IUGR:						
Yes	2 (1.26%)	23 (46.94%)	26 (34.67%)	<0.001	<0.001	00.1735
No	157 (98.74%)	26 (53.06%)	49 (65.33%)			

N : Number. NICU: Neonatal Intensive Care Unit. *p* 1: Normal group vs abnormal CTG. *p*>0.05 : Non-significant.
SD: Standard deviation. IUGR: Intrauterine growth retardation. *p*2: Normal group vs abnormal doppler. *p*<0.05 : Significant.
AF: Amniotic Fluid. *p*3: Abnormal CTG vs abnormal doppler. *p*<0.001: Highly significant.

Discussion

Fetal distress is not an uncommon occurrence in labor. It occurs as a consequence of labor even in those categorized as low-risk based on various risk classifications in the antenatal period. A better way to screen patients admitted in labor would be to assess the ability of the fetus to withstand the functional stress of uterine contractions in early labor. The obstetricians are more concerned with the early recognition of fetal distress during labor and such an adverse outcome should be detected at the earliest point of time by an effective surveillance method **[12]**.

Amniotic fluid serves several roles during pregnancy. It creates a physical space for fetal movement, which is necessary for normal musculoskeletal development. It permits fetal swallowing-essential for gastrointestinal tract development and fetal breathing necessary for lung development. Amniotic fluid guards against umbilical cord compression and protects the fetus from trauma. It even has bacteriostatic properties **[13]**.

Doppler assessment of the placental circulation plays an important role in screening for impaired placentation and its complications of pre-eclampsia, intrauterine growth restriction and perinatal death. Assessment of the fetal circulation is essential in the better understanding of the pathophysiology of a wide range of pathological pregnancies and their clinical management. This book provides a comprehensive account of Doppler ultrasound in Obstetrics and will be of value to those involved in antenatal care and fetal medicine **[14]**.

Cardiotocography (CTG) is the most popular prenatal diagnostic test for establishing fetal health and consists in simultaneous recording of fetal heart rate and maternal uterine contraction traces. Typically, fetal heart rate and uterine contractions traces are visually analyzed and interpreted by clinicians. Recently, software applications like CTG Analyzer have been developed to support visual CTG interpretation by making it more objective and independent from clinician's experience **[15]**.

Thus, the current study was held to assess the borderline amniotic fluid index, non-stress test and fetal doppler indices as predictors of poor perinatal outcomes in patients.

Our cross-sectional study was conducted on 250 pregnant women attending the Maternity Outpatient Clinic at Al-Hussein Hospital in Cairo City to assess the study parameters.

In our study, there was no significant difference as regard patient characteristics (age, weight, BMI and parity) between the studied groups. However, the gestational age was higher in the normal group (36.40±2.29 weeks) than the abnormal CTG group and the abnormal doppler group (34.98±2.24 and 35.47±2.29 weeks respectively) with a statistically significant difference between the normal group and the abnormal groups.

In the study by Wolf et al., **[16]** found in conclusion that CTG in combination with fetal Doppler, with a strict protocol for the frequency of recordings, is likely to be more effective than visual assessment of CTG for preventing fetal death in early preterm FGR.

This was similar to what we found, that abnormal CTG and abnormal doppler were associated with preterm labor (75.51% and 69.33% respectively) with statistically significant difference between each group and the normal group (50.94%).

Fetal distress occurred only in 3.77% of the normal group with statistically significant difference when compared to each of the other two groups. In the abnormal CTG group, about 89.80% of cases had fetal distress. While in the abnormal doppler group, in nearly half of cases (48%), fetal distress was noticed. There was a statistically significant difference between the abnormal CTG group and the abnormal doppler group regarding the fetal distress ($p<0.001$).

In the normal group, 8.18% of neonates were admitted to the NICU compared to 67.35% and 58.67% in the abnormal CTG group and the abnormal doppler group respectively with statistically significant difference between the normal group and each of the other two groups. However, despite of higher incidence of NICU admission in the abnormal CTG group (67.35%) than the abnormal doppler group (58.67%), there was no statistically significant difference between both groups.

One study showed that the use of umbilical artery doppler ultrasound assessment as an antenatal screening test is associated with a reduction in the incidence of cesarean delivery for fetal distress, more successful induction of labor, less admissions to NICU and better APGAR score in high-risk pregnant population complaining of decreased fetal movement compared to non-stress test **[17]**.

This was similar to our study in regards to admissions to NICU and overall birth weight.

As regards mode of delivery, 77.5% of cases delivered vaginally. Indication for CS included fetal distress (20%), failed induction (6.7%) and failure of progress (30%) **[18]**, which is similar to the results found in our group, vaginal delivery was higher in the normal group (89.31%). While, in the abnormal groups the rate of cesarean sections was higher (79.59%) in abnormal CTG group and 70.67% in abnormal doppler group). There was a statistically significant difference between the normal group and the two abnormal groups (p<0.001). On the other hand, there was no statistically significant difference between the abnormal CTG group and the abnormal doppler group (p=0.2688) regarding the mode of delivery.

In the study by Omar et al., **[17]** there was a significant difference in APGAR scores <4 at 1 minute (20% vs.4%) and APGAR score 5 minutes >7 (80% vs. 96%) between NST and UAD groups respectively (p<0.001). Also, the admission to neonatal intensive care unit (NICU) was higher for neonates.

Conclusion:

Abnormal CTG is an immediate good indicator of fetal distress and can detect fetal distress more accurately than doppler ultrasound or decreased AFI. However, doppler ultrasound should be considered as long-term indicator.

CTG and doppler ultrasonography are good predictors of poor neonatal outcome especially in cases with borderline oligohydramnios. CTG is-simple, cost effective and can be utilized in heavy work load hospital/setups with limited resources. With the use of CTG in high-risk cases timely intervention can be implied to reduce the perinatal mortality and morbidity.

NST and doppler ultrasound should be a cornerstone in assessment of fetal wellbeing.

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مؤشر السائل الامنيوسى على حافة التدنى ومتابعة قلب الجنين الألكترونية ومؤشرات دوبلر الجنين كمنبئات على النتائج السيئة فى الفترة المحيطة بالولادة

خلفية البحث: تقييم السائل السلوى هو جزء أساسى من تقييم صحة الجنين من حيث ضائقة الحنين، وتطلعات الميكونيوم، والقسم القيصرى ووفيات الجنين. تقييم حجم السائل السلوى أمر بالغ الأهمية لبقاء الجنين ومؤشر السائل السلوى (AFI) هو الطريقة الأكثر شيوعاً لتقدير حجم السائل السلوى الذى يتم عن طريق طريقة الموجات فوق الصوتية. وقد كشفت الدراسات أن AFI هو معيار دقيق لتقدير وظيفة المشيمة كافية

الهدف من البحث: دراسة مؤشر السائل السلوى الحدى واختبار عدم الإجهاد ومؤشرات دوبلر الجنين كمنبئات لنتائج الفترة المحيطة بالولادة السيئة.

المرضى وطريقة البحث: كانت هذه دراسة مقطعية شاملة أجريت على ٢٥٠ امرأة حامل يترددون على عيادة الولادة الخارجية فى مستشفى الحسين بجامعة الأزهر. تم تضمين النساء ذوات الحمل المفرد اللواتى كن فى الثلث الثالث (≤٣٢ أسبو عاً) فى هذه الدراسة ودرست النتائج بعد الولادة. وقد أجريت هذه الدراسة فى مستشفيات جامعة الازهر (الحسين، باب الشعرية) فى الفترة ما بين يناير ٢٠١٩ حتى يناير ٢٠٢٠.

نتائج البحث: ارتبط تصوير القلب المستمر غير الطبيعى (CTG) وال دوبلر غير الطبيعى بالمخاض المبتسر مع فرق مهم إحصائياً بين كل مجموعة والمجموعة العادية. من ناحية أخرى، لم يكن هناك اختلاف مهم إحصائياً بين مجموعة CTG غير الطبيعية ومجموعة دوبلر غير الطبيعية (p=0.4568). لم تحدث ضائقة الجنين إلا ٣.٧٧٪ من المجموعة العادية مع اختلاف مهم إحصائياً بالمقارنة مع كل من المجموعتين الأخريين. فى مجموعة CTG غير الطبيعية، كان حوالى ٨٩.٨٠٪ من الحالات تعانى من ضائقة جنينية. بينما فى مجموعة دوبلر غير طبيعية، فى ما يقرب من نصف الحالات (٤٨٪)، لوحظ الضيق الجنينى. كان هناك فرق يعتد به إحصائياً بين مجموعة CTG غير الطبيعية ومجموعة دوبلر غير الطبيعية فيما يتعلق بضائقة الجنين (p=0.001).

الإستنتاج: CTG غير طبيعى هو مؤشر جيد فورى للضائقة الجنينية ويمكن الكشف عن ضائقة الجنين بشكل أكثر دقة من الموجات فوق الصوتية دوبلر أو انخفاض AFI. ومع ذلك، ينبغى اعتبار دوبلر الموجات فوق الصوتية كمؤشر على المدى الطويل.