UMBILICAL ARTERY DOPPLER VERSUS NON-STRESS TEST IN HIGH RISK PREGNANCIES

By

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ABSTRACT

Background: Maternal monitoring of fetal movement is a mean of screening fetal status. The rationale is based on the assumption that early recognition of decreased fetal movement (DFM) makes it possible for the clinician to intervene at a stage when the fetus is still compensated, and thus prevent progression to fetal or neonatal injury or death.

Objective: To evaluate the role of non-stress test and umbilical artery Doppler measurements as an antenatal screening test for assessment of fetal well-being in high risk pregnancies affected by decreased fetal movements.

Patients and methods: The current study enrolled 200 patients complaining of decreased fetal movements came for ante natal care in ante natal care clinic of Al Azhar Assiut University Hospital. Enrolled women were randomly allocated in two equal groups, the study continued for 1 year (from January 2019 – December 2019).

Results: This study shows that the use of umbilical artery Doppler ultrasound assessment as an antenatal screening test was 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.

Conclusion: Umbilical artery Doppler ultrasound assessment of the fetus in conjunction with a policy of directed intervention resulted in a decrease in the rate of cesarean delivery for fetal distress in a high-risk pregnancy, when compared with the NST.

Keywords: DFM, Umbilical Artery Doppler, Non-Stress Test, High Risk Pregnancies.

INTRODUCTION

Perception of fetal movement typically begins in the second trimester, and occurs earlier in parous women than nulliparous women the mother's first perception of fetal movement is termed "quickening." Awareness of fetal movement is a means for the mother to monitor her fetus without the need for a clinician or equipment. Maternal perception of fetal movement is reassuring to pregnant women, whereas decreased fetal movement (DFM) is a common reason for concern *(Gillieson et al., 2010).*

Decreased fetal movement (DFM): is defined as the qualitative maternal perception of reduction of fetal movement. Several techniques for antepartum fetal surveillance are used to

recognize fetal well-being and compromised fetuses with different sensitivity and specificity levels, those techniques include non-stress test and umbilical artery Doppler velocimetry *(Smith et al., 2010).*

Heart rate reactivity is believed to be a good indicator of normal fetal autonomic function. Loss of reactivity is commonly associated with a fetal sleep cycle but may result from any cause of central nervous system depression, including fetal acidosis *(Alfirevic et al., 2012).*

Results of non-stress tests are classified as reactive or non-reactive. Various definitions of reactivity have been used. Most commonly, the non-stress test is considered reactive, or normal, if there are two or more fetal heart rate accelerations within a 20-minute period, with or without fetal movement percepted by the woman, according to *(American College of Obstetricians and Gynecologists, 2011).* The non-reactive non stress test lacks sufficient fetal heart rate accelerations over a 40-minute period. The non-stress test of the neurologically healthy preterm fetus is frequently non-reactive from 24 to 28 weeks of gestation, up to 50 percent of non-stress tests may not be reactive, and from 28 to 32 weeks of gestation, 15 percent of non-stress tests are not reactive *(Grant et al., 2008).*

Doppler ultrasonography is used to assess the hemodynamic components of vascular impedance. Umbilical artery Doppler flow velocimetry has been adapted as a fetal surveillance technique because it is believed that flow velocity waveforms in the umbilical artery of fetuses with normal growth differ from those of fetuses with growth restriction. The umbilical flow velocity waveform of a normally growing fetus has high-velocity diastolic flow, while in cases of intrauterine growth restriction; the umbilical artery diastolic flow is diminished. With extreme intrauterine growth restriction, the flow may be absent or even reversed. There is a high perinatal mortality rate among such pregnancies *(Gill, 2011).*

The aim of this study was to evaluate the role of non-stress test and umbilical artery Doppler measurements as an antenatal screening test for assessment of fetal well-being in high risk pregnancies affected by decreased fetal movements.

PATIENTS AND METHODS

The current study enrolled 200 patients complaining of decreased fetal movements came for ante natal care in ante natal care clinic of Al Azhar Assiut University Hospital. Enrolled women were randomly allocated in two equal groups, the study continued for 1 year (from January 2019 – December 2019)

Group (I): Non-stress test group of high risk pregnant women.

Group (II): Umbilical artery Doppler group of high risk pregnant women.

Ethical considerations:

The study was approved by the Scientific Ethical Committee of Faculty of Medicine, Al-Azhar University. An informed written consent was taken from every participant in the study.

In the 1st antenatal care visit all participants were subjected to:

A. Careful history taking.

B. General examination.

C. Investigations:

Complete blood picture, blood grouping and Rh typing.

• Renal function tests.

• Blood glucose level.

• Liver function tests.

• Ultrasonongraphic evaluation: for assessment of viability, gestational age, gross fetal malformation, amniotic fluid for oligohydramnios or polyhydramios and placenta.

Cardiographay was used to perform non-stress test results were classified into reactive or non-reactive. According to American college of Obstetricians and Gynecologists (ACOG) the non-stress test was considered reactive, or normal, if there were two or more fetal heart rate accelerations within a 15- 20-minutes period, with or without fetal movement. The non- reactive non stress test lacks sufficient fetal heart rate accelerations over a 20-minutes period and repeated for another 20 minute *(American College of Obstetricians and Gynecologists, 2011).*

A computed sonography system (Logic GE -Korea) range-gated pulsed wave Doppler ultrasound with real time ultrasonography (Duplex system) and color flow mapping. A curved array transducer with 3.5 MHz frequency was used for abdominal examination. The apparatus has 128 grey levels with 2-D imaging mode, spectral Doppler mode, color Doppler imaging mode and fetal M-mode, Umbilical artery Doppler ultrasound indices (included resistant index (RI), pulsatility index (PI) and systolic/diastolic ratio(S/D ratio) were done for all participants using trans abdominal ultrasound. The patients were put in semi-recumbent position; the end of the transducer was applied to the upper abdomen slightly above umbilicus but variation may be present sometimes.

The peak systolic and end diastolic frequency shifts were recorded; systolic, diastolic ratio, resistance index and pulsatility index were calculated according to the following formulas:

• RI = S-D/S

• PI = S-D/Mean

• S/D = systole/diastole

Where: S = peak systolic velocity. D = End-diastolic flow.

Mean = requires digitized waveform analysis for calculation.

The cut-off levels were considered if:

• RI > 0.70 was considered abnormal.

• PI >0.99 was considered abnormal.

• S/D ratio value >4 was considered abnormal.

Follow up visits concluded:

• Careful history for any evidence suggesting abnormal fetal wellbeing.

• Clinical examination for abnormal gain of weight, any elevation of blood pressure, pathological edema of both lower limbs, obstetric examination.

• Investigations:

- Routine investigations.

- Non stress test for Group (I).

- Umbilical artery Doppler for Group (II).

Protocol of managements:

For non-stress test group (Group I):

- Patients with normal non-stress test were discharged and followed up every one week until the expected date of delivery.

- Patients with non-reactive non stress test the test were repeated after 3 days.

According to the results of 2nd testing the following was done:

- Patients with normal non-stress test: were discharged and followed up every one week until the expected date of delivery.

- Patients with abnormal non-stress test: induction of labor was offered after induction of lung maturity by Dexamethason.

For umbilical artery Doppler group (Group II):

- Patients with normal umbilical artery Doppler: were discharged and followed up every one week until the expected date of delivery.

- Patients with abnormal umbilical artery Doppler findings: induction of labor was offered after induction of lung maturity by Dexamethason.

All patients were followed up until delivery to determine fetal outcomes.

Statistical analysis:

The data in this study were analyzed using the statistical package for the social science (SPSS 10 for windows, version II). The analysis was performed using the following procedures. Student's test (t-test): was used to check the significance between continuous data (quantitative items between two different groups). Chi-square test (X2): Was used to check the significance between categorical data (qualitative items between two different groups). The probability of significance (P value): The probability (P value < 0.05) was taken as the limit of statistical significance.

RESULTS

Mean age of NST group was 29.15 ± 2.22 years with range between 25 and 34 years while mean age Doppler group was 28.99 ± 3.98 years with range between 24 and 35. It was noticed that there were insignificant differences between both groups as regarding baseline sociodemographic data **(Table 1)**.

Table (1): Sociodemographic characteristics of the studied groups

Patients group / Characteristics	NST Group (n= 100)		Doppler Group (n= 100)		P-value
	No.	%	No.	%	
Age (years)					
< 30 years	60	60%	62	62%	>0.05
≥ 30 years	40	30%	38	38%	
Mean ± SD	29.15 ± 2.22		28.99 ± 3.98		>0.05
Range	(25 – 34)		(24 – 35)		
Social class					
Low	19	19%	14	14%	0.05
Middle	49	49%	51	51%	
High	32	32%	35	52%	
Residence					
Rural	56	56%	60	60%	0.05
Urban	44	44%	40	40%	
Educational level					
Illiterate	30	30%	28	28%	>0.05
Basic education	15	15%	22	22%	
Secondary	25	25%	22	22%	
High education	30	30%	28	28%	
Gestational age at recruitment (weeks)					
< 38 weeks	53	53%	50	50%	>0.05
≥ 38 weeks	47	47%	50	50%	
Mean ± SD	36.56 ± 0.97		36.10 ± 1.1		>0.05
Range	(33 – 40)		(33 – 40)		
Fetal sex					
Male	60	60%	56	56%	>0.05
Female	40	40%	44	44%	
Number of antenatal care visits					
One	10	10%	13	13%	>0.05
Two	25	25%	22	22%	
More than two	65	65%	65	65%	

NST: non-stress test

The most frequent risk factors in NST group were diabetes mellitus (DM) (22%), preterm labor (PTL) (18%) and premature rupture of membrane (PROM) (14%) while the most frequent risk factors in Doppler group were DM (23%), preeclampsia (14%) and previous intrauterine growth restriction (IUGR) (14%). It was noticed that both groups had insignificant differences as regarding risk factors **(Table 2)**.

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Table (2): Classification of participants of both groups according to the risk factors

Risk factor	NST Group (n= 100)		Doppler Group (n= 100)		P-value
	No.	%	No.	%	
Diabetes mellitus	22	22%	23	23%	>0.05
Gestational hypertension	11	11%	12	12%	>0.05
Placenta previa	5	5%	6	6%	>0.05
Polyhydramnios	4	4%	6	6%	>0.05
Preeclampsia	13	13%	14	14%	>0.05
Previous IUGR	12	12%	14	14%	>0.05
PROM	14	14%	12	12%	>0.05
PTL	18	18%	11	11%	>0.05
Anemia	7	7%	5	5%	>0.05
History of CFMF	4	4%	5	5%	>0.05

Data expressed as frequency (percentage). IUGR: intrauterine growth restriction; PROM: premature rupture of membrane; PTL: preterm labor; CFMF: congenital fetal malformations; NST: non-stress test.

There were statistically significant difference between 1st visit and 2nd visit as regarding result of NST & UAD (**Table 3**).

Table (3): Results of NST in the 1st and 2nd antenatal care visits in group I

NST Visits	1st ANC visit (n=100)	2nd ANC visit (n=60)	P1. Value
Reactive	40 (40%)	40 (66.7%)	< 0.001
Non-reactive	60 (60%)	20 (33.3%)	
P2. Value	< 0.005	< 0.001	
UAD	1st antenatal care visits (n=100)	2nd antenatal care visits (n=30)	P1. value
Normal	70 (70%)	10 (33.3%)	**< 0.001**
Abnormal	30 (30%)	20 (66.7%)	
P2. Value	< 0.01	< 0.001	

There was a statistically significant difference between both tests as regard to abnormal results; the abnormal test results were significantly higher in NST group in 1st visit and higher in UAD group in 2nd visit (**Table 4**).

Table (4): Abnormal results of both groups in the 1st and 2nd antenatal visits

Visit	NST group (n=100)	UAD group (n=100)	P value
1st visit	60/100 (60%)	30/100 (30%)	**< 0.001**
2nd visit	20/60 (33.3%)	20/ 30 (66.7%)	**< 0.001**

UAD: umbilical artery Doppler; NST: non stress test

There were statistically significance between NST and UAD where successful induction was higher in UAD group (65 vs. 25%; p. value < 0.001) (**Table 5**).

Table (5): Induction of labor for abnormal test results for both groups

Groups / Results of induction	NST Group (n= 20)		Doppler Group (n= 20)		P-value
	No.	%	No.	%	
Succeed	5	25	13	65	< 0.001
Failed	15	75	7	35	

NST: non-stress test

It was found that the rate of vaginal delivery was statistically higher in UAD group (70% vs. 60% p < 0.05), while CS rate was statistically higher in NST group (40% vs. 30%) **(Fig. 1)**.

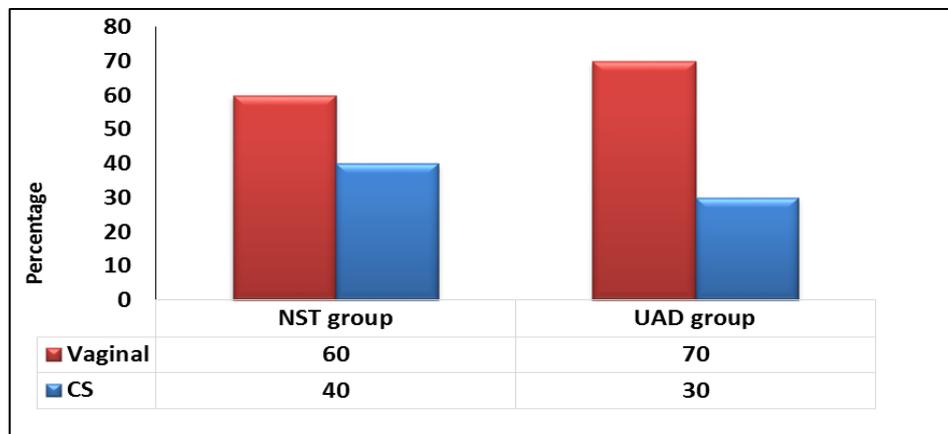|	NST group	UAD group
■ Vaginal	60	70
■ CS	40	30

Figure (1): Mode of delivery and fetal outcomes in NST group and UAD groups

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 **(Table 6)**.

Table (6): Fetal outcomes of the studied groups

	NST group (n=100)		UAD group (n=100)		P-value
APGAR score					
1-min APGAR score < 4	20	20	4	4	< 0.001
5-min APGAR score >7	80	80	96	96	
State of admission to NICU					
NO	87	87	97	97	< 0.001
YES	13	13	3	3	
Cause of admission to NICU					
Diabetes mellitus	5	5	1	1	0.789
Hypertension	3	3	1	1	
Preeclampsia	4	4	1	1	
Previous IUGR	1	1	--	--	
Gestational age at time of admission to NICU					
<37 weeks	5	5	1	1	0.379
≥37 weeks	8	8	2	2	

Data expressed as frequency (percentage). NST: non-stress test; UAD: umbilical artery Doppler; NICU: neonatal intensive care unit; IUGR: intrauterine growth restriction

DISCUSSION

In the present study there were no statistically significant differences between both groups as regards to other sociodemograhic characteristics.

It was found that the percentage of non-reactive NST in the 1st ANC visit was 60%. When NST was repeated after one weak 40 out of the 60 patients with non-reactive test became reactive while only 20 patients remained non-reactive so the percentage of non-reactive NST among high risk patients with decreased fetal movements had dropped from 60% in the 1st ANC visit to 20 % in the 2nd ANC visit and the difference was statistically very highly significant.

The difference in results between the two consecutive test results could be attributed to the presence of false positive results for NST. This finding is in agreements with *(Neilson, 2010)* who estimated false positive results of NST in different risk factors to vary from 35-65% and they concluded that NST should be performed at least twice to decrease this false positive result.

It was found that the percentage of abnormal UAD in the 1st ANC visit was 30%. When the test was repeated after one weak 10 out of the 30 patients with abnormal test became normal while only 20 patients remained abnormal so the percentage of abnormal test among high risk patients with decreased fetal movements had dropped from 30% in the 1st ANC visit to 20% in the 2nd ANC visit and the difference was statistically highly significant. The difference in results between the two consecutive test results could be also attributed to the presence of false positive results for UAD.

In the 1st ANC visit: The incidence of abnormal test results was (60% vs. 30%) for NST and UAD groups respectively and the difference was statistically significant.

In the 2nd ANC visit: The incidence of abnormal test results was 20% vs. 20% for NST and UAD groups respectively and the difference was statistically significant ($p<0.05$).

These differences between abnormal test results in NST and UAD groups in both 1st and 2nd antenatal care visits could be attributed to higher false positive results of NST compared to UAD.

The results of our study was found to be similar to *(Morrissette et al., 2012)* who reported in their study a higher false-positive rate for non-stress test than umbilical artery Doppler (39% vs. 22%), they concluded that repetition of non-stress test is recommended to decrease the higher false positive results. Also, *Morris et al. (2011)* stated that in high-risk populations, fetal umbilical artery Doppler is a moderately useful test to predict mortality and risk of fetal compromise.

As a result of the presence of false positive results for the antenatal screening tests for fetal wellbeing, investigators recommend either repetition of NST *(Morrissette et al., 2012)* or the test is to be applied to multiple fetal vessels in case

of Doppler studies *(Khanduri et al., 2017)* to increase the sensitivity of these tests.

In the current study the rate of successful induction of labor was significantly higher in UAD group (65% vs.25% for UAD and NST groups respectively). This result is in accordance with *(Roger et al., 2017)* who found that more patients in the Doppler group required an induction of labor than in NST group.

Finding of the current study could be attributed to the fact that Doppler assessment identified a higher proportion of patients with early placental compromise than the NST assessment that allows successful induction of labor before the occurrence of placental decompensating. Concomitantly this increased rate of induction did not result in an increase in the overall rate of cesarean delivery. In addition, there was no increase in the rate of cesarean delivery for failure to progress in the Doppler group.

In the present study there were 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. also the admission to neonatal intensive care unit (NICU) was higher for neonates of NST group than UAD group (13% vs. 3% respectively p<0.001). these results was found to be similar to *(Morris et al , 2014)*, *(Roger et al.,2017)* and *(Morrissette et al.,2012)*.

The use of non-stress test for antenatal testing in several large studies show no improvement in perinatal outcome, with a sensitivity to predict perinatal morbidity of 60% and a specificity of <50%.In the

Cochrane meta-analysis of four trials in which electronic fetal monitoring was the primary means of surveillance, there was no significant improvement in the rate of admissions to the neonatal intensive care unit, cesarean delivery rates, the incidence of low APGAR scores at birth, or abnormal neonatal neurologic signs. Doppler ultrasound scanning was introduced to investigate the umbilical artery blood flow pattern in high-risk pregnancies that were at risk for fetal compromise *(Michael et al., 2010)*.

This 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.

CONCLUSION

1. Umbilical artery Doppler ultrasound assessment of the fetus in conjunction with a policy of directed intervention results in a decrease in the rate of cesarean delivery for fetal distress in a high-risk pregnancy, when compared with the NST.

2. The introduction Doppler ultrasound assessment as a primary screening test must be balanced against a higher rate of secondary testing by amniotic fluid index, training of personnel to perform these tests.

3. umbilical artery Doppler velocimetry has more significant than non-stress test due to it is reduce incidence of cesarean section in case of non-reactive

non stress test without increase in perinatal morbidity and mortality rate.

RECOMMENDATIONS

1. Use of umbilical artery Doppler velocimetry as screening tools in high risk pregnancy is very important to decreased perinatal morbidity and mortality rate.

2. Larger prospective randomized, controlled trials are necessary to determine the significance of these tests in specific subgroups for the reduction in other aspects of perinatal morbidity and death.

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دوبلر الشريان السري مقابل اختبار عدم الإجهاد فى حالات الحمل المصحوب بمخاطر

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خلفيـــة البحـــث: مراقبـة الأم لحركـة الجنـين هـي وسـيلة لفحـص حالـة الجنـين. يعتمـد الأسـاس المنطقـي علـى افتـراض أن التعـرف المبكـر علـى انخفـاض حركـة الجنـين يمكّـن الطبيـب مـن التـدخل فـي مرحلـة لا يـزال فيهـا الجنـين معوضًـا، وبالتـالي يمنـع تطور إصابة الجنين أو حديثي الولادة أو الوفاة.

الهـدف مـن البحـث: تقيـيم اسـتخدام إختبـار عـدم الاجهـاد للجنـين و دوبلـر الشـريان السري في حالات الحمل الخطر المصاحب بنقص حركة الجنين.

المريضـات وطـرق البحـث: تـم إجـراء هـذه الدراسـة علـى مـائتين مـن السـيدات اللاتـي يعـانين مـن نقـص حركـة الجنـين فـي مستشـفى طـب الازهـر الجـامعي. و مستشـفى النسـاء و التوليـد و الأطفـال بأسـيوط. وقـد تـم إختبـار السـيدات المشـاركات فـي هـذه الدراسـه عشـوائياً وتـم تقسـيمهم فـي مجمـوعتين متسـاويتين فـى الفتـره مـن ينـاير 2019 الى ديسمبر 2019.

نتـــائج البحـــث: تبـين هـذه الدراسـة أن اختبـار دوبلـر الشـريان السـرى للجنـين بـالتزامن مـع سياسـة التـدخل الموجـه يـؤدي إلـى انخفـاض فـي معـدل الـولادة القيصـرية فـي الحمل الخطر المصحوب باعياء الجنين مقارنه باختبار عدم الاجهاد.

الخلاصـة: قيـاس سـرعة دوبلـر الشـريان السـري أكثـر أهميـة مـن اختبـار عـدم الإجهـاد لأنـه يقلـل مـن حـالات الـولادة القيصـرية فـي حالـة عـدم اختبـار الإجهـاد غيـر التفـاعلي دون زيادة في معدل المرض والوفيات في الفترة المحيطة بالولادة.