IMPACT OF UMBILICAL ARTERY DOPPLER INDICES ON INTRAPARTUM AND NEONATAL OUTCOME

By

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ABSTRACT

Background: Clinical risk assigned antenatally is currently the method used to identify women who should be monitored intensively during the intrapartum period. However, up to 20% of women assigned to be low risk during pregnancy subsequently develop features in labor which make them high risk for adverse perinatal outcomes.

Objective: To evaluate the diagnostic prediction of intrapartum umbilical artery Doppler velocimetry for adverse perinatal outcomes using systematic quantitative overview of the available literature.

Patients and Methods: Our study was a controlled trial performed in populations using umbilical artery Doppler velocimetry (umbilical Doppler). This clinical trial that was conducted at Al-Azhar University Hospital (Bab El-Shairaia Hospital) and Hurghada General Hospital during the period between January 2020 to June 2020. One hundred primigravidae were admitted for delivery by lower section cesarean section and doppler velocimetry study was then performed on a free-floating loop of the umbilical cord and Doppler indices were calculated.

Results: There was a statistically significant difference between both groups regarding the need for NICU admission and assisted ventilation. In the normal doppler group, 9.1% of fetuses needed NICU admission compared to 73.9% in the abnormal doppler group. Also, only 1.3% of the newborn needed assisted ventilation in the normal doppler group versus 39.1% in the abnormal group.

Conclusion: Umbilical artery doppler indices abnormalities can predict the neonatal outcome. Abnormal umbilical artery doppler was associated with more neonatal complications. Umbilical artery doppler is recommended to be done before delivery.

Keywords: Umbilical Artery Doppler, Intrapartum and Neonatal Outcome, Cardiotocography.

INTRODUCTION

Although women will subsequently be monitored in labor, they lose the benefits of earlier detection and surveillance when initially admitted. Similarly, antenatally undetected small for gestational age infants, a group at significant risk of intrapartum hypoxia, also lose the benefits of monitoring during labor *(Winchester et al., 2018)*.

The labor ward 'admission' cardiotocograph (CTG) is performed in many obstetric units as a screening test for subsequent fetal distress in labor. The functional stress of labor causes changes in the fetal heart rate pattern in those fetuses who are at risk of subsequent

compromise. However, it lacks adequate sensitivity for predicting fetal asphyxia and is also subjected to wide inter-observer variation. Doppler analysis of the umbilical artery has been used for some time in the antenatal period to determine fetal wellbeing. The pathological basis for an abnormal umbilical artery waveform is obliteration of the tertiary stem villi within the placental vasculature, resulting in increased umbilical-placental resistance. The result of meta-analysis of antenatal umbilical artery waveform analysis in high-risk pregnancies found a reduction in perinatal mortality in the group receiving the test. However, in the unselected population or, low risk population, no benefit with antenatal testing has been found. They concluded that antenatal umbilical artery Doppler could not be recommended in those populations *(Byford et al., 2014).*

Umbilical artery Doppler flow velocimetry has been adapted for use as a technique of fetal surveillance, based on the observation that flow velocity wave forms in the umbilical artery of normally growing fetuses differ from those of growth-restricted fetuses. Abnormal flow velocity wave forms have been correlated histopathologically with small-artery obliteration in placental tertiary villi and functionally with fetal hypoxia and acidosis, as well as with perinatal morbidity and mortality. At least, 3 randomized clinical trials (RCTs) have evaluated the utility of umbilical artery Doppler velocimetry, as a technique of antepartum fetal surveillance, in pregnancies complicated by suspected intrauterine growth restriction. Women assigned to antepartum umbilical artery Doppler velocimetry have been shown to require less frequent antenatal monitoring and shorter durations of maternal hospitalization *(Nicolaides and Rizzo, 2015).*

Doppler ultrasound provides information regarding three aspects of blood flow-velocity, resistance to blood flow through a particular vessel and volume of blood flow. While the Doppler pattern of the uterine arteries reflects the efficiency of placentation, the umbilical artery Doppler reflects placental function and indicates degree of placental insufficiency. Cerebral vasodilation also known as "brain sparing effect" is a response of fetus to chronic hypoxemia by vasoconstriction of somatic, renal and hepatic vessels and increased blood supply to vital organs like brain and heart. This preferential blood flow to brain can be detected by MCA (Middle cerebral artery) Doppler *(Roy and Bhosale, 2018).*

The aim of this study was to evaluate the diagnostic prediction of intrapartum umbilical artery Doppler velocimetry for adverse perinatal outcomes using systematic quantitative overview of the available literature.

PATIENTS AND METHODS

This was a controlled trial performed in populations using umbilical artery Doppler velocimetry (umbilical Doppler). This clinical trial was conducted at Al-Azhar university hospital (Bab El-Shairaia hospital) and Hurghada General Hospital. It included 100 Patients undergoing delivery lower section cesarean section.

Primary outcome was to determine if the use of intrapartum umbilical artery Doppler velocimetry is a good predictor of perinatal and neonatal adverse outcome.

Secondary outcome was to determine the effect screening test in reduction of overall fetal compromise and neonatal morbidity.

Recruitment of data started once the protocol was approved by Research and Ethical Committee of the Department of Obstetrics and Gynecology during the period between January 2020 to June 2020.

Primigravidae were recruited, and Doppler velocimetry study was then performed on a free-floating loop of the umbilical cord, and Doppler indices were calculated. They were followed up during labor: intrapartum events, mode of delivery, and neonatal outcome was recorded.

MedCalc® version 12.3.0.0 program "Ostend, Belgium" was used for calculations of sample size, statistical calculator based on 95% confidence interval and power of the study 80% with α error 5%.

Every patient was subjected to history taking, General examination, Abdominal examination, Obstetric ultrasound, and laboratory investigations (CBC, LFT, KFT, PT, PTT, INR, and Rh group).

Inclusion criteria:

1. Primigravida

2. Women undergoing delivery by lower segment caesarean section.

3. Age ranging from (20-35).

4. Gestational age $\geq$ 37 Weeks.

5. Informed written consent from the patient.

6. Singleton pregnancy.

Exclusion criteria:

1. History of venous thrombosis (DVT and/or Pulmonary embolism) OR arterial thrombosis (angina pectoris, myocardial infarction, stroke).

2. History of epilepsy or seizure.

3. Any known cardiovascular, renal or liver disease.

4. Autoimmune Diseases.

5. Sickle Cell Disease.

6. Severe hemorrhagic Disease.

7. Placenta Previa.

8. Morbidly adherent Placenta.

9. Abruptio placenta.

10. Eclampsia, HELLP syndrome.

11. Administration of Low Molecular Weight Heparin or Anti platelets the week before delivery.

12. Multiple pregnancy.

Each patient in the study was tested for:

1. The need for blood transfusion.

2. Perinatal and post-delivery of fetal wellbeing (peripartum changes).

3. Neonatal morbidity or mortality occurred (assisted ventilation, neonatal ICU admission required, etc.).

Informed consent was taken from every participant before recruitment in the study after explanation of the purpose and procedures of the study.

Statistical analysis:

The collected data were tabulated, and statistically analyzed using SPSS program (Statistical Package for the Social Sciences) software version 20.0.

Descriptive statistics were done for numerical parametric data as mean ± SD (standard deviation) and minimum and maximum of the range and for numerical non parametric data, while they were done for categorical data as number and percentage.

Inferential analyses were done for quantitative variables using independent t-test in cases of two independent groups with parametric data and Mann-Whitney U test in cases of two independent groups with non-parametric data.

Inferential analyses were done for qualitative data using Chi square test for independent groups. P value <0.050 was considered significant.

RESULTS

The studied population was divided according to the umbilical artery doppler into two groups: group with normal umbilical artery doppler included 77 cases, while 23 had abnormal umbilical artery doppler.

The age and gestational age were recorded and show no significant difference between the two groups regarding the age and the gestational age, there was a significant difference between the two groups as regarding the estimated fetal weight. The estimated fetal weight was lower in the abnormal doppler group than the normal doppler group (3363.49 ± 449.08 and 2599.00 ± 186.17 respectively) **(Table 1)**.

Table (1): Age and gestational age (GA) between the two groups, Estimated Fetal Weight in the studied groups

Groups / Parameters	Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
Age (Mean ± SD)	28.06 ± 4.65	29.09 ± 4.19	0.3473
GA (Mean ± SD)	39.13 ± 1.47	39.09 ± 1.56	0.9040
Groups / Parameter	Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
EFW (g)	3363.49 ± 449.08	2599.00 ± 186.17	<0.0001

The laboratory results in the studied groups. However, there was no significant difference between the two groups **(Table 2)**.

Table (2): Laboratory results in the studied groups

Groups \ Parameters	Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
Hb (g/dl)#	11.3442 ± 1.5396	11.2478 ± 1.6822	0.7971
PLT▲	203.1948 ± 66.3408	202.2609 ± 63.1673	0.7429
WBCs▲	8.7143 ± 2.6013	8.8957 ± 1.9272	0.6137
ALT▲	24.0909 ± 8.9460	24.2609 ± 9.6964	0.8907
AST▲	24.4675 ± 10.3867	24.6957 ± 8.7253	0.6468
CR#	0.8833 ± 0.1619	0.8734 ± 0.1622	0.7980
Urea▲	24.7922 ± 9.4093	24.6522 ± 9.3983	0.7031

#Independent Sample t-test; ▲ Mann-Whitney test

The umbilical doppler indices were studied in both groups and there was no significant difference between the two groups regarding the umbilical artery pulsatility index. Meanwhile, there was a significant difference between both groups when the umbilical artery resistive index and S/D ratio were compared **(Table 3)**.

Table (3): Umbilical artery doppler indices in the studied groups

Groups \ Parameters	Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
UAPI	1.19 ± 0.26	1.27 ± 0.22	0.1740
UARI	0.66 ± 0.07	0.83 ± 0.04	<0.0001
S/DRatio	2.10 ± 0.10	2.19 ± 0.21	0.0064

There was a statistically significant difference between both groups regarding the need for NICU admission and assisted ventilation. In the normal doppler group 9.1% of fetuses needed NICU admission compared to 73.9% in the abnormal doppler group. Also, only 1.3% of the newborn needed assisted ventilation in the normal doppler group versus 39.1% in the abnormal group. The neonatal mortality rate was higher in the abnormal doppler group (17.4%) compared to (5.2%) in the normal doppler group but there was no statistically significant difference between both groups (Table 4).

Table (4): NICU admission, fetal assisted ventilation and neonatal mortality in both groups

Groups \ Parameters		Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
NICU Admission	Yes	7 (9.1%)	17 (73.9%)	< 0.0001
	No	70 (90.9%)	6 (26.1%)	
Assisted Ventilation	Yes	1 (1.3%)	9 (39.1%)	< 0.0001
	No	76 (98.7%)	14 (60.9%)	
Neonatal Mortality	Yes	4 (5.2%)	4 (17.4%)	0.0598
	No	73 (94.6%)	19 (82.6%)	

When studying the fetal outcome in both groups there was a statistically significant difference between the two groups regarding hyperbilirubinemia, hypoglycemia and RDS. We found that incidence of hyperbilirubinemia was 39.1% in the cases with abnormal umbilical artery doppler which was higher than the normal doppler cases (16.9%) as shown in with statistically significant difference between both groups. The incidence of hypoglycemia was also higher in the abnormal doppler group than the normal doppler group (30.4% vs. 10.4% respectively) and there was a statistically significant difference between them. RDS was compared in both group and again it was higher in the abnormal doppler group (43.5%) than in normal doppler group (13%) and there was a statistically significant difference between both groups (**Table 5**).

Table (5): Fetal outcome in the studied groups

Parameters	Groups	Normal Doppler (N=77)	Abnormal Doppler (N=23)	P-value
Hyperbilirubinemia	**Yes**	13 (16.9%)	9 (39.1%)	0.0245
	No	64 (83.1%)	14 (60.9%)	
Hypoglycemia	**Yes**	8 (10.4%)	7 (30.4%)	0.0187
	No	69 (89.6%)	16 (69.6%)	
RDS	**Yes**	10 (13%)	10 (43.5%)	0.0014
	No	67 (87%)	13 (56.5%)	

DISCUSSION

This study evaluated the diagnostic prediction of intrapartum umbilical artery Doppler velocimetry for adverse perinatal outcomes using systematic quantitative overview of the available literature. Clinical risk assigned antenatally is currently the method used to identify women who should be monitored intensively during the intrapartum period. However, up to 20% of women assigned to be low risk during pregnancy subsequently develop features in labor which make them high risk for adverse perinatal outcomes *(Winchester et al., 2018)*.

Umbilical artery Doppler flow velocimetry has been adapted for use as a technique of fetal surveillance, based on the observation that flow velocity wave forms in the umbilical artery of normally growing fetuses differ from those of growth-restricted fetuses *(Byford et al., 2014)*.

One hundred primigravidae were admitted for delivery by lower section cesarean section and doppler velocimetry study was then performed on a free-floating loop of the umbilical cord and Doppler indices were calculated. There was no significant change in the maternal age and the gestational age between the two groups. This was similar to the results obtained by the study performed by *Tagliaferri et al. (2020)*, who identify the efficiency of cCTG parameter or parameter set in the discrimination among fetuses. *AbdElhai et al. (2020)* determined the value of fetal Doppler indices umbilical artery (UA)-PI and their correlation with the perinatal outcome found no difference between study group and control group regarding difference in

maternal age and gestational age. *Kandil et al. (2021)* showed no statistical significance for comparison between the RDS status regarding the maternal age.

The umbilical doppler indices were studied in both groups, and there was no significant difference between the two groups regarding the umbilical artery pulsatility index. This was different from the finding of the study *AbdElhai et al. (2020)* that adverse outcome group had higher UA-PI than the normal group. *Stumpfe et al. (2019)* found that regression analysis of UA pH $\leq$ 7.10 showed a significant association with UA PI.

The umbilical doppler indices were studied in both groups and there was significant difference between the two groups regarding the umbilical artery resistance index. The study done by *Orchinik et al. (2011)* showed the patterns of growth in the normal and abnormal RI groups. Even after correction for gestational age at birth, neonatal sex, an abnormal RI was associated with a lower birthweight across all weight percentiles. These patterns are significantly different between the 2 groups. This indicates the abnormal RI group had more growth restricted babies across all growth centiles.

Regarding Doppler indices, *Kandil et al. (2021)* showed increased resistive index of umbilical artery > 0.69 correlated with neonatal, RDS while fetuses with UtA RI values were between 0.43 and 0.66 noticed in RDS vs 0.42-0.57 in the non-RDS, with statistically significant Doppler values between the two groups. Regarding the UA RI, a mean value > 0.69 was found to correlate with delayed lung maturity and neonatal RDS. The UA

PI values were found to be significantly higher in RDS 0.92–1.32 vs 0.86–1.12 in non-RDS.

There was a significant difference between the two groups as regarding the estimated fetal weight. The estimated fetal weight was lower in the abnormal doppler group than the normal doppler group. This was similar to the results obtained by the study performed by *Tagliaferri et al. (2020)*. Significant difference was found regarding estimated fetal weight. *AbdElhai et al. (2020)* showed that there was statistically significant difference between the control group and the study group as regards the neonatal birth weight between both groups.

There was a significant difference in uterine artery Doppler between the two groups as regarding adverse neonatal outcome as respiratory distress syndrome (RDS), neonatal intensive care unit (NICU), and assisted ventilation. RDS was compared in both group and again it was higher in the abnormal doppler group (43.5%) than in normal doppler group (13%) and there was a statistically significant difference between both groups.

In the normal doppler group, 9.1% of fetuses needed NICU admission compared to 73.9% in the abnormal doppler group. Also, only 1.3% of the newborn needed assisted ventilation in the normal doppler group versus 39.1% in the abnormal group.

The total number of patients who had adverse perinatal outcome was higher among the abnormal group compared to the normal group with statistically significant differences between both groups *(AbdElhai et al., 2020)*.

The incidence of hypoglycemia was also higher in the abnormal doppler group than the normal doppler group and there was a statistically significant difference between them. Neonates with abnormal umbilical artery doppler have significantly higher incidence of hypoglycemia (42.1%) when compared to those with normal umbilical artery Doppler (15.5%) and there was a statistically significant difference between the two groups *(Padma and Nayar, 2021)*. This was similar to the finding in our study.

The neonatal mortality rate was higher in the abnormal doppler group (17.4%) compared to (5.2%) in the normal doppler group but there was no statistically significant difference between both groups. Absent or reversed end diastolic flows indicated marked placental resistance, and has been associated with fetal deterioration, and increased risk of perinatal mortality *(AbdElhai et al., 2020)*. These results agreed with those reported by our study, but without significant difference.

CONCLUSION

Umbilical artery doppler indices abnormalities can predict the neonatal outcome. Abnormal umbilical artery doppler was associated with more neonatal complications. Umbilical artery doppler recommended to be done before delivery.

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تأثير مؤشرات دوبلر الشريان السّري على النتائج داخل الولادة والمواليد الجدد

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خلفيــة البحــث: المخــاطر الإكلينيكيــة قبــل الــولادة هــي حاليًــا الطريقــة المستخدمة لتحديــد النســاء اللــواتي يجــب متــابعتهن بشــكل مكثــف خــلال فتــرة الــولادة. ومــع ذلــك، فــإن 20٪ مــن النســاء المصــنفات علــى أنهــن منخفضــات الخطــورة أثنــاء الحمــل يظهــر علــيهن لاحقًــا بعــض العلامــات أثنــاء المخــاض تجعلهــن معرضــات بشــكل كبيــر لنتــائج سـلبية في الفترة المحيطة بالولادة.

الهــدف مــن البحــث: تقيــيم التنبــؤ التشخيصــي لقيــاس ســرعة الشــريان الســري أثنــاء الــولادة مــن أجــل التنبــؤ بالنتــائج الســلبية فــي الفتــرة المحيطة بالولادة.

المريضــات وطــرق البحــث: أجريــت دراســة مضــبوطة علــى الحــالات باســتخدام مقيــاس دوبلــر للشــريان الســري (دوبلــر الســري). وقــد أجريــت هــذه التجربــة الســريرية فــي مستشــفى جامعــة الأزهــر (مستشــفى بــاب الشــعرية) ومستشــفى الغردقــة العــام فــي الفتــرة مــا بــين ينــاير 2020 إلــى يونيــو 2020. شــملت هــذه الدراســة 100 مريضــة خضعن للولادة القيصرية السفلية.

نتــائج البحــث: تمــت دراســة مؤشــرات دوبلــر الســري فــي كلتــا المجمــوعتين، ولــم يكــن هنــاك فــرق ذو دلالــة إحصــائية بــين

المجموعتين فيما يتعلق بمؤشر نبض الشريان السري. وفي الوقت نفسه، كان هناك فرق ذو دلالة إحصائية بين المجموعتين عند مقارنة معامل مقاومة الشريان السري. في مجموعة دوبلر العادية (احتاج 9.1٪ من الأجنة إلى دخول وحدة العناية المركزة لحديثي الولادة) مقارنة بـ 73.9٪ في مجموعة دوبلر غير الطبيعية. أيضًا، احتاج 1.3٪ فقط من الأطفال حديثي الولادة إلى التهوية المساعدة في مجموعة الدوبلر العادية مقابل 39.1٪ في المجموعة غير الطبيعية.

الاستنتاج: يمكن أن تتنبأ مؤشرات دوبلر الشريان السري بالمضاعفات التي تحدث لحديثى الولادة. يرتبط دوبلر الشريان السري غير الطبيعي بمضاعفات أكثر عند الأطفال حديثي الولادة، يوصى بإجراء دوبلر الشريان السري قبل الولادة.

الكلمات الدالة: دوبلر، الشريان السّري، المواليد الجدد.