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# Assessment of the role of umbilical artery doppler ultrasound in predicting mode of delivery and neonatal outcome in high risk pregnancy

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## ABSTRACT

*Objective*: to assess umbilical artery Doppler indices in relation to fetal outcome in high risk pregnancies. *Methods*: The present prospective study was carried out from the 1st of January 2019 until the 1st of October 2019 in Maternity Teaching Hospital in Erbil, Kurdistan Region-Iraq. The study compared two groups of high risk pregnant women (A and B) each group included 106 women.



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One of the groups underwent Doppler velocimetry, while the other one did not. Required data including age, gravidity, gestational age, and resistant index from Doppler's, mode of delivery, meconium, APGAR1, APGAR5, and neonatal weight were collected for both groups. *Results*: The study population included 28 women with gestational diabetes, 100 women with preeclampsia and 84 women with gestational hypertension. Doppler was done for group A only, The mean age of women of the whole sample was 30.0 ± 6.37 years. The majority of women in group A delivered by cesarean section compared with 11.3% of women of group B. There was a significant relationship between history of hypertension and diabetes mellitus and birth weight ($p<0.05$). *Conclusions*: Umbilical artery Doppler is an effective tool for prenatal monitoring in women with high risk pregnancy.

**Keywords:** High risk pregnancy, Umbilical Artery Doppler Ultrasound, delivery, neonatal outcome

## 1. INTRODUCTION

Pregnant women with gestational diabetes, hypertension, and preeclampsia are considered to be women with high risk pregnancy. Maternal hyperglycemia during pregnancy is called gestational diabetes mellitus (GDM) which is characterized by carbohydrate intolerance of different severity with first recognition during pregnancy (Balaji *et al.*, 2011). Mothers with GDM have been reported to develop other comorbidities like hypertension (HTN) or preeclampsia (Li *et al.*, 2018). Pregnancy in patients with diabetes is often complicated by utero-placental circulation insufficiency and adverse outcomes including hypertension, preeclampsia, and stillbirth (Prakash *et al.*, 2017). Achieving a normal pregnancy requires a good uteroplacental blood flow which can be negatively affected by gestational diabetes mellitus (GDM) and its complications including preeclampsia (i.e. hypertension with protein urea during pregnancy) (Browne *et al.*, 2015; Ridder *et al.*, 2019). Diabetes during pregnancy has also been reported to affect the mode of delivery, increasing the need for operative delivery (i.e. Cesarean) (Berger and Melamed, 2014). In case of pregnant women with preeclampsia, the mode of delivery should preferably vaginal; therefore, clinical and pediatric preparations need to be provided for such women (Guida *et al.*, 2017).

In terms of delivery mode, research has indicated that spontaneous vaginal delivery with 73.9% is the most common type of delivery among high risk pregnant women, followed by lower segment cesarean section with 25.2% (Majella *et al.*, 2019). Research has shown that in comparison with births that start spontaneously, elective caesarean sections which are performed without medical indication can be associated with greater risks for maternal and neonatal wellbeing (Karlström *et al.*, 2013). Remarkable decrease has been reported in uteroplacental circulation in pregnant women hypertension, which can be contributed to a pathologic status of spiral arteries which is thought to be developed during placentation in the first three months of pregnancy. Accordingly, the early assessment of uteroplacental blood flow in pregnancy using Doppler may be applicable in predicting the development of these conditions (Nagar *et al.*, 2015). The evaluation of placental circulation using Doppler can be performed to screen impaired placentation and its adverse effects due to pre-eclampsia, perinatal death, and intrauterine growth restriction. Fetal circulation assessment can help in better understanding of the pathophysiology of a variety of pathological pregnancies as well as their clinical management. Early screening of preeclampsia may allow for proper antenatal monitoring and accurate timing of fetal delivery, avoiding adverse consequences. There are various biochemical and hemodynamic measures with limited accuracy for this condition (Giannakou *et al.*, 2018; Kalafat and Thilaganathan, 2017; Abdulla *et al.*, 2020).

The relationship between the abnormalities in umbilical artery Doppler velocimetry and the adverse pregnancy results has been widely investigated. There are many studies reported a significant association between the increase of fetoplacental resistance (which is estimated by systolic-diastolic ratio (S/D) or resistance index) and the later incidence of either fetal growth retardation (FGR) or preeclampsia (Salavati *et al.*, 2018; Ibrahim *et al.*, 2019). In spite of these statistically significant relationships, the clinical application of studies on umbilical artery Doppler remains questionable due to its low predictive values for both of FGR and preeclampsia as well as its adverse effects in low-risk populations (Lai *et al.*, 2016). Given the significance and effects of pregnancy diabetes and preeclampsia on both the delivery mode and neonatal outcomes, and the efficacy of Umbilical Artery Doppler Ultrasound in predicting mode of delivery, insufficient placental, uterine and fetal circulations, the present study aimed to investigate the predictive role of Doppler imaging in detecting high-risk pregnancies and their consequences for the women.

## 2. PATIENTS AND METHODS

### Study design and setting

The present prospective comparative study was carried out in high risk ward, outpatient department, and ultrasound department of Maternity Teaching Hospital in Erbil, Kurdistan Region -Iraq. The study was conducted from the 1st of January 2019 until the 1st of October 2019.



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### Study sample

The study sample consisted of 212 high risk pregnant women who were divided into two groups: Group A that consisted of 106 high risk pregnant women after history, examination and investigation subjected to Doppler velocimetry by using Evolution 6 ultra-sonogram machine and 3.5-5 MHZ abdominal convex probes, verbal informed consent was obtained from all women after the procedure was explained to them, while group B hadn't Doppler because they came to labour room in labour state, without attending antenatal clinic. The sample size was determined using EpiInfo computer program, leading to a sample size of 106 individuals in each group by taking the significance level of 5%, study power of 90%, and estimated prevalence of the APGAR score <7 at the first minute of 20% in Group A and 41% in Group B (Berkley *et al.*, 2012).

### Inclusion criteria

In order to select the women for Groups A and B, some inclusion criteria were utilized, including: any age group, gestational age between 28 and 41 weeks, singleton pregnancy, any parity, and being risky for fetal compromise or high risk pregnancy which include; pregnancy induced hypertension, women with gestational diabetes and preeclampsia, other type of high risk were not presented in the selected sample.

### Exclusion criteria

The exclusion criteria that were taken into account while choosing the study sample included women with twin pregnancies, fetal malpresentation, history of previous caesarian section, pregnancy without comorbidities, and congenital malformed fetus.

### Data collection

Required data including age, gravidity, parity, miscarriage history, gestational age, and resistant index, mode of delivery, meconium, fetal distress, NICU admission, APGAR1, APGAR5, and neonatal weight were collected for both groups.

### Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 22). Chi square test of association was used to compare proportions. Fisher's exact test was used when the expected count of more than 20% of the cells of the table was less than 5. Kappa statistics was calculated to show the agreement between the resistant index test results and the outcome. McNemar test was used when the same sample was compared in two occasions (resistant index test results compared with the pregnancy outcome).

### Ethical considerations

Ethical considerations were taken into account by obtaining required approval from Ministry of Higher Education and Scientific Research on January, 2019. In addition, required permission was retrieved from the authorities of Maternity Teaching Hospital. Moreover, written informed consent was obtained from each woman.

## 3. RESULTS & DISCUSSION

**Table 1** Basic characteristics of the study sample

| | Doppler[A] | | No Doppler[B] | | P-value |
|---|---|---|---|---|---|
| Gravida | | | | | |
| Primiparous | 24 | (22.6) | 21 | (19.8) | |
| Multiparous | 45 | (42.5) | 39 | (36.8) | |
| Grand multiparous | 37 | (34.9) | 46 | (43.4) | 0.448 |
| Parity | | | | | |
| Nulliparous | 28 | (26.4) | 25 | (23.6) | |
| Multiparous | 78 | (73.6) | 81 | (76.4) | 0.634 |
| Miscarriage | | | | | |
| No abortion | 60 | (56.6) | 63 | (59.4) | |
| History of abortion (1-2) | 40 | (37.7) | 37 | (34.9) | |
| Recurrent abortion | 6 | (5.7) | 6 | (5.7) | 0.909 |



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| | | | | | |
|---|---|---|---|---|---|
| (≥ 3) | | | | | |
| Gestational age | | | | | |
| 28-32 | 20 | (18.9) | 2 | (1.9) | |
| 33-36 | 30 | (28.3) | 4 | (3.8) | |
| 37-41 | 56 | (52.8) | 96 | (90.6) | |
| ≥ 42 | 0 | (0.0) | 4 | (3.8) | < 0.001* |

**Table 2** Accuracy of resistant index in diagnosing the outcomes

| | Outcomes | | | | |
|---|---|---|---|---|---|
| Resistant index | Abnormal | Normal | Total | p (McNemar) | Kappa |
| | Mode of delivery (CS/NVD) | | | | |
| Abnormal | 58 | 0 | 58 | | |
| Normal | 23 | 25 | 48 | < 0.001 | 0.543 |
| Total | 81 | 25 | 106 | | |
| | Meconium | | | | |
| Abnormal | 2 | 56 | 58 | | |
| Normal | 2 | 46 | 48 | < 0.001 | -0.007 |
| Total | 4 | 102 | 106 | | |
| | Fetal distress | | | | |
| Abnormal | 43 | 15 | 58 | | |
| Normal | 10 | 38 | 48 | 0.424 | 0.528 |
| Total | 53 | 53 | 106 | | |
| | NICU admission | | | | |
| Abnormal | 43 | 15 | 58 | | |
| Normal | 10 | 38 | 48 | 0.424 | 0.528 |
| Total | 53 | 53 | 106 | | |
| | APGAR1 | | | | |
| Abnormal | 34 | 24 | 58 | | |
| Normal | 6 | 42 | 48 | 0.001 | 0.447 |
| Total | 40 | 66 | 106 | | |
| | APGAR5 | | | | |
| Abnormal | 6 | 52 | 58 | | |
| Normal | 2 | 46 | 48 | < 0.001 | 0.057 |
| Total | 8 | 98 | 106 | | |
| | Neonatal weight | | | | |
| Abnormal | 32 | 26 | 58 | | |
| Normal | 2 | 46 | 48 | < 0.001 | 0.489 |
| Total | 34 | 72 | 106 | | |

**Table 3** Measures of accuracy of resistant index in diagnosing the outcomes

| | Sensitivity | Specificity | PV+ | PV- | Agreement |
|---|---|---|---|---|---|
| Mode of delivery | 71.6% | 100.0% | 100.0% | 52.1% | 78.3% |
| Meconium | 50.0% | 45.1% | 3.4% | 95.8% | 45.28% |
| Fetal distress | 81.1% | 71.7% | 74.1% | 79.2% | 76.40% |
| NICU admission | 81.1% | 71.7% | 74.1% | 79.2% | 76.40% |
| APGAR 1st min. | 85.0% | 63.6% | 58.6% | 87.5% | 71.70% |
| APGAR 5th min. | 75.0% | 46.9% | 10.3% | 95.8% | 49.00% |
| Neonatal weight | 94.1% | 63.9% | 55.2% | 95.8% | 73.50% |



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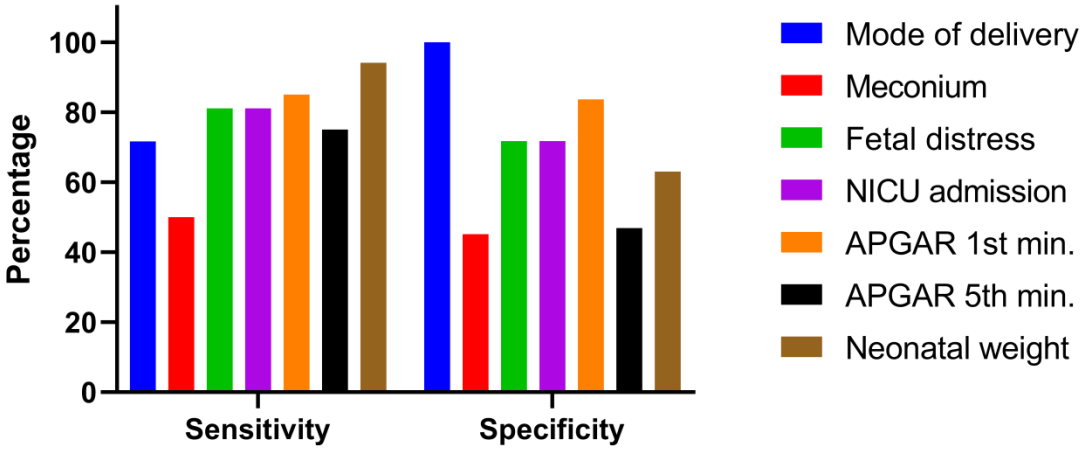


**Figure 1** Assessment of sensitivity and specificity of resistant index in diagnosing the outcomes

**Table 4** Pregnancy outcomes of the two study groups

| | Doppler[A] | | No Doppler[B] | | Total | | |
|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | p-value |
| Mode of delivery | | | | | | | |
| Normal | 25 | (23.6) | 94 | (88.7) | 119 | (56.1) | |
| CS | 81 | (76.4) | 12 | (11.3) | 93 | (43.9) | < 0.001 |
| Meconium | | | | | | | |
| Yes | 4 | (3.8) | 20 | (18.9) | 24 | (11.3) | |
| No | 102 | (96.2) | 86 | (81.1) | 188 | (88.7) | 0.001 |
| Fetal distress | | | | | | | |
| Yes | 53 | (50.0) | 34 | (32.1) | 87 | (41.0) | |
| No | 53 | (50.0) | 72 | (67.9) | 125 | (59.0) | 0.008 |
| NICU admission | | | | | | | |
| Yes | 53 | (50.0) | 34 | (32.1) | 87 | (41.0) | |
| No | 53 | (50.0) | 72 | (67.9) | 125 | (59.0) | 0.008 |
| APGAR 1$^{st}$ minute | | | | | | | |
| Low | 40 | (37.7) | 20 | (18.9) | 60 | (28.3) | |
| Normal | 66 | (62.3) | 86 | (81.1) | 152 | (71.7) | 0.002 |
| APGAR 5$^{th}$ minute | | | | | | | |
| Low | 8 | (7.5) | 4 | (3.8) | 12 | (5.7) | |
| Normal | 98 | (92.5) | 102 | (96.2) | 200 | (94.3) | 0.235 |
| Weight | | | | | | | |
| IUGR (< 2.5 Kg) | 34 | (32.1) | 2 | (1.9) | 36 | (17.0) | |
| Normal (≥ 2.5 Kg) | 72 | (67.9) | 104 | (98.1) | 176 | (83.0) | < 0.001 |

**Table 5** Outcomes of hypertensive and diabetic women

| | Hypertension | | Diabetes | | Total | | |
|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | p |
| APGAR 1 | | | | | | | |
| Low (< 7) | 50 | (27.2) | 10 | (35.7) | 60 | (28.3) | |
| Normal (≥ 7) | 134 | (72.8) | 18 | (64.3) | 152 | (71.7) | 0.350 |
| APGAR 5 | | | | | | | |
| Low (< 7) | 10 | (5.4) | 2 | (7.1) | 12 | (5.7) | |



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Normal (≥ 7) | 174 | (94.6) | 26 | (92.9) | 200 | (94.3) | 0.662* |
| Weight (Kg) | | | | | | | |
| IUGR (< 2.5 Kg) | 36 | (19.6) | 0 | (0.0) | 36 | (17.0) | |
| Normal (≥ 2.5) | 148 | (80.4) | 28 | (100.0) | 176 | (83.0) | 0.006* |
| Total | 184 | (100.0) | 28 | (100.0) | 212 | (100.0) | |

Owing to the strict association between the pathogenesis of intrauterine growth retardation and the poor supply of the feto-maternal unit, color Doppler flowmetry is a suitable tool for monitoring the blood supply from the mother to the fetus (Salavati *et al.*, 2018). Development of color Doppler technology has made it possible to monitor repetitive non-invasive hemodynamic in pregnancy. It is assumed that a poor blood supply to the fetus may negatively affect its growth. It has been demonstrated that Doppler is more sensitive in early detection of the fetal compromise than other methods of fetal monitoring, and helps in decision-making about the accurate timing of delivery (Lai *et al.*, 2016).

In this study umbilical artery Doppler studies were performed in group A pregnancies, while group B hadn't had Doppler because they came to labour room in labour state, this helped us to predict fetal morbidity and mortality in the abnormal umbilical artery Doppler group. It has been proved that perinatal morbidity and mortality were significantly greater in small for gestational age babies with abnormal umbilical artery Doppler studies than in those with normal studies (Messawa *et al.*, 2012). In accordance with the results of the present study about four-fifths of women who presented at this study had borne more than one child which could be considered as a fact that the rate of giving birth among all participants is high in both groups. On the other hand, for more than 80% of women, the gestational age is at the range of 33-41 years. These basic characteristics of the study sample could be effectively applied for achieving more information about all women who participated at the present study.

One of the main objectives of the present study was to evaluate the mode of delivery by applying umbilical artery Doppler ultrasound. The outcomes of the present study are in line with the study by (Salavati *et al.*, 2018) which confirmed the benefit of umbilical artery Doppler assessment for the prediction of adverse perinatal outcomes in high-risk pregnancy. Based on the information mentioned at the Table 3 in 81 women who went under Doppler test the mode of delivery was abnormal which in 58 of them the resistant index was abnormal too. Anyway, it could be seen that the predictive effect of the Doppler test is high. However, one of the main objectives of fetal surveillance is to recognize any possible risks that threaten the fetuses for reducing the adverse outcomes, minimize perinatal mortality and fetal morbidity (O'Neill and Thorp, 2012).

Gestational age can be effectively detected by measuring the woman's age of pregnancy which is taken from the onset of last menstrual period (LMP), or via measuring the gestation age using more accurate methods (Mahendru *et al.*, 2016). Based on the data mentioned at the Table 1 overall information on the participated women in this study could be seen which would be used for being informed about their age range, their gravidity and parity situations, miscarriage and also their gestational age. As instance, in the present study, the gestational age of participant women by considering both studied groups at the range of bigger than 42 weeks is lower than 2%. This could be accepted as proof to the outcomes of the study by (Berkley *et al.*, 2012). The process of pregnancy loss which also known as spontaneous mainly called miscarriage, which at the present study was seen in more than 40% of women among women who underwent the Doppler test. As demonstrated by (Iqbal *et al.*, 2018) the Doppler ultrasound could be effectively applied for confirming the presence of significant retained products of conception in the cavity of uterine.

According to the data of Table 2 – 5 and figure 1, it could be seen that the use of abnormal umbilical Doppler can lead to a reduced Apgar score, lower birth weight, and increased neonatal morbidity. Moreover, the sensitivity for identifying abnormalities in neonatal weight was 94.1%, having a specificity of 100% for detecting the cesarean section as a delivery mode. These results are in line with the results of (L. and Bhattacharjee, 2018). One other pregnancy outcome of applying the Doppler test which was significant in comparison with the other group was that the presence of meconium was denied powerfully in more than 95% of cases. This could be considered as one of the main and most important aspects of applying the Doppler test for more accurate detective purposes. These achievements are mainly in line with the Rajarajeswari et al study outcomes which cited that babies having low birth weight are vulnerable to fetal demise, meconium aspiration, birth asphyxia, hypothermia, hypoglycemia, respiratory distress syndrome, intraventricular hemorrhage, and necrotizing enterocolitis. Consequently, having information about the weight of babies at the time of their birth could be one of the main factors for controlling health symptoms and conditions of them (Abdelazim *et al.*, 2019).

## 4. CONCLUSION

The present study was an attempt to evaluate the role of umbilical Artery Doppler Ultrasound in predicting mode of delivery and neonatal outcome in high risk pregnancy. It was concluded that umbilical Artery Doppler Ultrasound had a high sensitivity value of



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94.1% for detecting the abnormal neonatal weight, and the highest specificity of 100% for detecting the Cesarean section as a mode of delivery. Moreover, Umbilical artery Doppler is an efficient device for prenatal monitoring in women with high risk pregnancy and IUGR fetuses. In addition, birth weight can be highly affected by the pregnant women's history of hypertension and diabetes mellitus.

**Author contribution**

Alan A. Abdul kader: Conception and design of the work, the acquisition, analysis, and interpretation of data for the work, and Drafting the work.

Ghada S. Al sakkal: Conception and design of the work, interpretation of data for the work, and revising it critically for important intellectual content

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**Conflict of Interest**

The authors declare that they have no conflict of interest.

**Informed consent**

Written informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

**Ethical approval for human**

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (Code: 2019/A043).

**Data and materials availability**

All data associated with this study are present in the paper.

**Peer-review**

External peer-review was done through double-blind method.

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