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Ultrasound in Prediction of Perinatal Outcomes in Fetuses with Restriction of Intrauterine Growth

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ABSTRACT

Studies of Doppler flow velocimetry have been proceeding as a principal mechanism for identification the compromised small fetus from a small fetus that is improbable to suffer from dangerous perinatal complications. The aim of this study is the Prediction of Perinatal Outcome in Fetuses Suspected to Have Intrauterine Growth Restriction: Doppler US Study of Fetal Cerebral, and Umbilical Arteries. This is a longitudinal prospective study done at department of Obstetrics and Gynecology in Salah Al-Deen General Hospital in Tikrit city between February-July 2020. The study included a convenient sample 100 pregnant women in 3rd trimester suspected of IUGR (n=100). Studies of various fetal vessels were performed using color Doppler ultrasound curvilinear probe with a high pass filter. The following vessels were studied with the mother in a recumbent position during fetal inactivity and apnea. 1st Umbilical Artery (UA), 2nd Middle Cerebral Artery (MCA). Fetal outcome was studied under major and minor adverse outcomes. The current study found that the umbilical artery systolic/diastolic ratio was concordant with major and minor adverse outcome among 55 cases regarding of abnormal finding, and among 25 cases regarding negative findings. The umbilical artery RI was concordant with major and/or minor adverse outcome among 34 cases regarding of abnormal finding, and among 28 cases regarding negative findings. The umbilical artery PI was concordant with major and/or minor adverse outcome among 52 cases regarding of abnormal finding, and among 29 cases regarding negative findings. Serial Doppler examinations of fetal (S/D ratio, UA RI, & UA PI), and (MCA PI, & MCA/UA PI) provide better information than does a single measurement.

Keywords: Doppler Ultrasound Prediction of IUGR Outcomes, IUGR Outcomes by Doppler Ultrasound

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استخدام الموجات فوق الصوتية(دوبلر) في التنبؤ بنتائج الفترة المحيطة بالولادة في الأجنة التي من المتوقع أن يكون لها تقييد للنمو داخل الرحم

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الملخص

تتقدم دراسات قياس سرعة تدفق دوبلر كآلية أساسية لتحديد الجنين الصغير المتضرر من جنين صغير من غير المحتمل أن يعاني من مضاعفات خطيرة في الفترة المحيطة بالولادة. الهدف من هذه الدراسة هو توقع نتائج الفترة المحيطة بالولادة في الأجنة المشتبه في إصابتها بتقييد النمو داخل الرحم: دراسة دوبلر الأمريكية للشرايين الدماغية والكلوية والسرية الجنينية. هذه دراسة استباقية طولية أجريت في قسم التوليد وأمراض النساء في مستشفى صلاح الدين العام في مدينة تكريت بين فبراير ويوليو 2020. وشملت الدراسة عينة ملائمة من 100 امرأة حامل في الثلث الثالث من الحمل يشتبه في إصابة الجنين ببطءالنمو داخل الرحم (عدد = 100). أجريت دراسات على أوعية جنينية مختلفة باستخدام مسبار دوبلر ملون بالموجات فوق الصوتية مع مرشح تمرير عالي. تمت دراسة الأوعية التالية مع الأم في وضعية الاستلقاء أثناء عدم نشاط الجنين وانقطاع النفس. الشريان السري الشريان الدماغي الأوسط الثاني. تمت دراسة النتيجة الجنينية تحت نتائج سلبية رئيسية وثانوية. وجدت الدراسة الحالية أن نسبة الشريان السري الانقباضي / الانبساطي كانت متوافقة مع النتائج السلبية الرئيسية والثانوية بين 55 حالة فيما يتعلق بالنتائج غير الطبيعية ، ومن بين 25 حالة تتعلق بالنتائج السلبية. كان الشريان السري RI متوافقًا مع نتائج عكسية كبيرة و / أو ثانوية بين 34 حالة تتعلق بالنتائج غير الطبيعية ، وبين 28 حالة تتعلق بالنتائج السلبية. كان الشريان السري PI متوافقًا مع نتائج سلبية كبيرة و / أو ثانوية بين 52 حالة تتعلق بالنتائج غير الطبيعية ، وبين 29 حالة تتعلق بالنتائج السلبية. وجدت الدراسة الحالية أن فعالية معاملات دوبلر فيما يتعلق بالشريان السري في التنبؤ بنتائج الفترة المحيطة بالولادة الضائرة الرئيسية و / أو الثانوية تظهر أن الحساسية كانت (85٪) ، (52٪) و (80٪) لنسبة S / D ، UA RI ، و UA PI على التوالي. كانت النوعية (71٪) و (80٪) و (83٪) لنسبة S / D و UA RI و UA PI على التوالي. كانت الدقة (80٪) و (62٪) و (81٪) لنسبة S / D و UA RI و UA PI

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على التوالي. توفر فحوصات دوبلر التسلسلية للجنين (نسبة S / D، UA RI ، و UA PI) و (MCA PI، MCA / & UA PI) معلومات أفضل من القياس الفردي.

الكلمات الدالة: الدوبلر في التنبؤ بنتائج الأجنة المصابين بتقييد للنمو داخل الرحم، التنبؤ بنتائج الأجنة المصابين بتقييد للنمو داخل الرحم

1. Introduction

Traditionally, serial sonographic assessment of amniotic fluid volume & fetal biometry has been utilized along with antepartum assessment of Fetal Heart Rate (FHR) measurement to evaluate the situation of a fetus at high risk of growth restriction.[1,2] Doppler ultrasound represent the cheap, available, safe, and a noninvasive technique for diagnosing any restriction in fetal growth correlated with an abnormal fetal and/or uteroplacental circulation.[2-4] [8-10] Because a fetus with growth restricted vulnerable to compromised blood flow is specially at great risk for hypoxia. Studies of Doppler flow velocimetry have been proceeding as an principle mechanism for identification the compromised small fetus from a small fetus that is improbable to suffer from dangerous perinatal complications. The aim of this study is the prediction of Perinatal Outcome in Fetuses Suspected to Have Intrauterine Growth Restriction: Doppler US Study of Fetal Cerebral, and Umbilical Arteries.

2. Patients and Methods

A Longitudinal prospective study carried out in department of Obstetrics and Gynecology in Salah Al-Deen General Hospital in Tikrit city from 1st February- 31st July 2020 and included a convenient sample of 100 pregnant women in third trimester suspected of IUGR (n=100). Studies of various fetal vessels were performed using color Doppler ultrasound curvilinear probe with a high pass filter. The following vessels were studied with the mother in a recumbent position during fetal inactivity and apnea. Umbilical Artery (UA), and Middle Cerebral Artery (MCA). The Umbilical Artery (UA) measurements were made from free loop of cord midway between the placental and abdominal wall insertion. The middle cerebral artery (MCA) was located in a transverse plane at the level of the lesser wing of the sphenoid

bone with sample gate placed on proximal portion of the vessel. Flow velocity wave forms, the resistance index, pulsatility index, systolic/diastolic ratio of umbilical artery, middle cerebral artery were noted. 1st Doppler study is considered abnormal when resistance and pulsability index of umbilical artery (>2 SD), middle cerebral artery (<5th percentile, and uterine artery (>2 SD) for the gestational age according to the standard reference values; the reference value of umbilical artery P.I. and cerebroumbilical ratio, according to Laskowska M et al [5] [11] and MCA PI ratio & Umbilical artery RI reference values were taken according to Prior T et al. [6] [12] 2nd The ratios examined were considered abnormal when PI of MCA/UA <1.12. The patients are followed by serial Doppler assessment every 2 week and non-stress test and the results of the last Doppler examination within 10 days of delivery are considered, in the subsequent correlation with perinatal outcomes.

3. Results

The analysis of 100 cases that enrolled in this study shows that: The mean maternal age 25.9±2.5. Primigravidas represent 64 (64%) of the studied population while 36 (36%) were multiparas.. The maximum gestational age at which the delivery occurred was preterm 59(59%). the mean birth eight was 2100±300. There was 1 stile birth, therefore the analysis of 99 patient show that the admission to neonatal intensive care unit was done for 65(65.7%), while 34 (34.3%) not admitted and was reported, as shown in table 1.

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Table 1. The general characteristics of the patient

Characteristics	No.	Percent
Age	25.9±2.5.	
Parity		
Primigravidas	64	64%
Multiparas	36	36%
Mode of delivery		
Vaginal	58	58%
Cesarean section	42	42%
age at birth		
Preterm	59	59%
Full term	41	41%
Birth weight	2100±300	
admission to neonatal intensive care unit		
Yes	65	65.7%
No	34	34.3%

The normal vaginal delivery was 58(58%) versus 42(42%) delivered by SC.. The admission to neonatal care unit was 65(65.7%), as shown in table 2. About 46 (70.7%) of those admitted were born by vaginal delivery while 19 (29.3%) were born by cesarean section. About 46 (46.5%) of the live birth babies their birth weight was 1.5-2 kg, followed by (2-2.5kg) 34(34.3), then those weight < 1 kg 19(34.34%). The APGAR at 5 minutes was abnormal (<7) among 51(51.52%), and normal (≥ 7) among 48(48.48%), as shown in figure 11. Further analysis of the 51 patient with abnormal APGAR score show that 38 (74.5%) were delivered by normal vaginal delivery, while 13(25.5%) were delivered by C/S. Fetal outcome was studied under major and minor adverse outcomes. Major adverse outcomes include: stillbirth, neonatal death and septicemia. While minor outcomes include-cesarean delivery for fetal distress, APGAR score below 7 at 5 minutes, admission to NICU for treatment. Major adverse outcome found among 24(24%) of the newborns, stillbirth was 1(1%), neonatal

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death7 (7%), and septicemia was 18(18%). The minor adverse outcome was among 65 newborn: LSCS 42(42%), Apgar at 5 minutes <7 51(51%), and NCU admission 65(65%), as shown in table 2.

Table 2. The summary of maternal and fetal outcome.

	No.	Percent
Major	24	24%
Stillbirth	1	1%
neonatal death	7	7%
Septicemia	18	18%
Minor	65	
LSCS	42	42%
Apgar at 5 minutes <7	51	51%
NCU admission	65	65%

The umbilical artery systolic /diastolic ratio was concordant with major and minor adverse outcome among 55 case regarding of abnormal finding, and among 25 case regarding negative findings. The umbilical artery RI was concordant with major and/or minor adverse outcome among 34 case regarding of abnormal finding, and among 28 case regarding negative findings. The umbilical artery PI was concordant with major and/or minor adverse outcome among 52 case regarding of abnormal finding, and among 29 case regarding negative findings. As shown in table 3.

Table 3. Umbilical artery Doppler according to major and minor adverse outcome.

Test	Adverse outcome (major and minor)		Total
	Present	Absent	
UA S/D			
Abnormal	55	10	65
Normal	10	25	35
U A RI			
Abnormal	34	7	41
Normal	31	28	59
U A PI			
Abnormal	52	6	58
Normal	13	29	42
Total	65	35	100

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The Efficacy of Doppler parameters regarding umbilical artery in predicting of major and minor adverse perinatal outcome show that sensitivity was (85%),(52%) and (80%) for S/D ratio, UA RI, and UA PI respectively. The specificity was (71%), (80%) and (83%) for S/D ratio, UA RI, and UA PI respectively. The accuracy was (80%), (62%) and (81%) for S/D ratio, UA RI, and UA PI respectively.as shown in table 4.

Table 4. The Efficacy of Doppler parameters regarding umbilical artery in predicting major and minor adverse perinatal outcome.

Doppler finding	Sensitivity	Specificity	False Positive	False negative	Accuracy	PPV	NPV
UA S/D	85	71	29	15	80	85	71.4
U A RI	52	80	20	48	62	83	47.5
U A PI	80	83	17	20	81	90	69

The MCA PI was concordant with major and minor adverse outcome among 51 cases regarding of abnormal finding, and among 23 case regarding negative findings. The MCA/UA PI was concordant with major and minor adverse outcome among 53 cases regarding of abnormal finding, and among 27 case regarding negative findings. As shown in table 5.

Table 11. MCA artery Doppler according to major and minor adverse outcome.

Test	Adverse outcome (major and or minor)		Total
	Present	Absent	
MCA PI			
Abnormal	51	12	63
Normal	14	23	37
MCA/UA PI			
Abnormal	53	8	61
Normal	12	27	39
Total	65	35	100

The Efficacy of Doppler parameters regarding Middle cerebral artery in predicting major and/or minor adverse perinatal outcome show that sensitivity was (78%), and (82%) for MCA PI, and MCA/UA PI respectively. The specificity was (66%), and (77%) for MCA PI, and MCA/UA PI respectively. The accuracy was (74%), and (80%) for MCA PI, and MCA/UA PI respectively, as shown in table 6.

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Table 6. The Efficacy of Doppler parameters regarding Middle cerebral artery in predicting major and minor adverse perinatal outcome.

Doppler finding	Sensitivity	Specificity	False Positive	False negative	Accuracy	PPV	NPV
MCA PI	78	66	34	22	74	81	62.2
MCA/UA PI	82	77	23	18	80	87	69.2

The umbilical artery systolic /diastolic ratio was concordant with major adverse outcome among 21 cases regarding of abnormal finding, and among 56 case regarding negative findings. The umbilical artery RI was concordant with major adverse outcome among 13 cases regarding of abnormal finding, and among 62 case regarding negative findings. The umbilical artery PI was concordant with major adverse outcome among 20 cases regarding of abnormal finding, and among 60 case regarding negative findings. As shown in table 6.

Table 7. Umbilical artery Doppler according to major adverse outcome.

Test	Adverse outcome (major)		Total
	Present	Absent	
UA S/D			
abnormal	21	20	41
Normal	3	56	59
U A RI			
abnormal	13	14	27
Normal	11	62	73
U A PI			
abnormal	20	16	36
Normal	4	60	64
Total	24	76	100

The Efficacy of Doppler parameters regarding umbilical artery in predicting major adverse perinatal outcome show that sensitivity was (88%), (54%) and (83%) for S/D ratio, UA RI, and UA PI respectively. The specificity was (74%), (82%) and (79%) for S/D ratio, UA RI, and UA PI respectively. The accuracy was (77%), (75%) and (80%) for S/D ratio, UA RI, and UA PI respectively.as shown in table 8.

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Table 8. The Efficacy of Doppler parameters regarding umbilical artery in predicting major adverse perinatal outcome

Doppler finding	Sensitivity	Specifity	False Positive	False negative	accuracy	PPV	NPV
UA S/D	88	74	26	13	77	51	94.9
U A RI	54	82	18	46	75	48	84.9
U A PI	83	79	21	17	80	56	93.8

The MCA PI was concordant with major adverse outcome among 20 case regarding of abnormal finding, and among 60 case regarding negative findings (20 of those with major adverse outcome had abnormal MCA PI, and 60 patient of those without major defect had normal MCA PI). The MCA/UA PI was concordant with major and/or minor adverse outcome among 21 case regarding of abnormal finding, and among 62 case regarding negative findings. As shown in table 9.

Table 9. MCA artery Doppler according to major adverse outcome.

Test	Adverse outcome (major)		Total
	Present	Absent	
MCA PI			
Abnormal	20	16	36
Normal	4	60	64
MCA/UA PI			
Abnormal	21	14	35
Normal	3	62	65
Total	24	76	100

The Efficacy of Doppler parameters regarding Middle cerebral artery in predicting major perinatal outcome show that sensitivity was (83%), and (88%) for MCA PI, and MCA/UA PI respectively. The specificity was (79%), and (82%) for MCA PI, and MCA/UA PI respectively. The accuracy was (80%), and (83%) for MCA PI, and MCA/UA PI respectively, as shown in table 10.

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Table 10. The Efficacy of Doppler parameters regarding Middle cerebral artery in predicting major adverse outcomes.

Doppler finding	Sensitivity	Specificity	False Positive	False negative	accuracy	PPV	NPV
MCA PI	83	79	21	17	80	56	93.8
MCA/UA PI	88	82	18	13	83	60	95.4

4. Discussion:

Our study found that the mean maternal age was (25.9±2.5) and this agrees with BN Lakhkar who found that the Mean maternal age was 27.3 years. The current study found that the maximum gestational age at which the delivery occurred was preterm (59%) and this agrees with BN Lakhkar who found that the preterm (51.7%) of the sample. The current study revealed that (66%) of neonates had admission to neonatal intensive care unit, and this agrees with Mahale N *et al* [7] found it 27.24 years. BN Lakhkar who found that 35 babies were admitted into neonatal intensive care unit for treatment. [8] Novac, M.V., *et al* [9] found that mean maternal age was 28±6.316.

The current study revealed that the major adverse outcome found among (24%) of the newborns, stillbirth was (1%), neonatal death (7%), and septicemia was (18%). The minor adverse outcome was among 65 newborn: LSCS (42%), Apgar at 5 minutes <7 (51%), and NCU admission (65%). Comparable results found by BN Lakhkar as the followings 6 babies died. [8] Of the remaining, 15 required admission for more than 10 days for various complications. Two babies could not be admitted to NICU because of poor parental resources. Of that one baby died. But BN Lakhkar didn't report significant neonatal complications like intraventricular hemorrhage, necrotizing enterocolitis. But BN Lakhkar found that there were a total of 12 perinatal deaths in our study group. Of these seven were neonatal deaths (NND) and five were stillbirths. One patient had normal Doppler parameters but still there was neonatal death. [8] Mahale N et al [7] found that adverse effect was LSCS (44%), admission to the neonatal care unit (76%), APGAR score <7 (47%).

The current study found that the UA systolic/diastolic ratio was concordant with major and minor adverse outcome among 55 cases regarding of abnormal finding, and among 25 case

regarding negative findings. This goes in accordance with BN Lakhkar who found that statistical analysis showed that UA S/D ratio is the most sensitive (66.6%) in predicting perinatal morbidity. [8] But the specificity of this index was the least among different parameters (45.4%). The accuracy of the UA S/D ratio was also less. [8] Mahale N *et al* [7] found that efficacy of Umbilical artery RI in prediction of major and minor outcome Sensitivity: 60.15% Specificity: 76.66%, Diagnostic accuracy: 74%. Abnormal umbilical artery RI in prediction of major and minor outcome Sensitivity: 80% Specificity, 86.66% Positive predictive value, 86.6% Diagnostic accuracy 84%.

O'Dwyer V *et al*[10] showed that the strongest and most substantial association with adverse perinatal outcomes in growth-restricted fetuses was found when an abnormal umbilical artery Doppler velocimetry was present, defined as a pulsatility index (PI) greater than the 95th percentile or as absent or reversed end-diastolic flow. Conversely, adverse perinatal outcomes are uncommon in growth-restricted fetuses with normal results at umbilical artery Doppler velocimetry. [10] The current study found that the efficacy of Doppler parameters regarding MCA in predicting major and/or minor adverse perinatal outcome show that sensitivity was (78%), and (82%) for MCA PI, and MCA/UA PI respectively. The specificity was (66%), and (77%) for MCA PI, and MCA/UA PI respectively. The accuracy was (74%), and (80%) for MCA PI, and MCA/UA PI respectively,

This goes with Naveen D. and K. Karthikeyan [11] , found that the MCA Pulsatality index was the most sensitive (79%), Negative Predictive Value (60%). Umbilical artery had the highest specificity of 79% and was significantly more specific than MCA PI or that of MCA/UA PI Ratio. The umbilical artery also had the highest Postive Predictive Value (82%).

This also goes in accordance with BN Lakhkar [8] who found that highest specificity and positive predictive value of predicting neonatal morbidity was for MCA pulsatility index- 90.9% and 88.2% respectively. The different ratios examined show a uniformly high sensitivity for the prediction of the perinatal outcome compared to individual vessels. The current study found that the MCA PI was concordant with major and minor adverse outcome among 51 cases regarding of abnormal finding, and among 23 case regarding negative findings. This goes in accordance with BN Lakhkar who found that the positive predictive

value of a test shows its accuracy and this in our study was higher for MCA Pl, which was 47%. [8]

Mahale N *et al* [7] found that efficacy of these values also near from what found by MCA PI in prediction of major and minor perinatal outcome Sensitivity: 90% Specificity: 93.3% Positive predictive value: 90% Negative predictive value: 93.3% Diagnostic accuracy 92%. Novac, M.V., *et al* [9] found that Doppler abnormalities of middle cerebral arteries were observed in SGA pregnancies, in a higher percentage (57.14%) in early-onset of fetal restriction than in late restriction (19.38%).

The current study found that the Efficacy of Doppler parameters regarding MCA predicting major perinatal outcome show that sensitivity was (83%), and (88%) for MCA PI, and MCA/UA PI respectively. The specificity was (79%), and (82%) for MCA PI, and MCA/UA PI respectively. The accuracy was (80%), and (83%) for MCA PI, and MCA/UA PI respectively. This goes in accordance with BN Lakhkar [8] who found that the sensitivity of the combined Doppler parameters was highest at 91.6% in predicting perinatal outcome when compared with the ratio of the vessels studied which was ratios of the S/D MCA/UA. Pl of MCA/UA and Pl of MCA/DAA which had 83%, 66.6% and 66.6% of sensitivity respectively.

Mahale N *et al* [7] found that MCA/UA PI in prediction of major outcome Sensitivity, 86.6% Specificity, 91.4% Positive predictive value, 81.2% Negative predictive value, 94.1% and Diagnostic accuracy, 90%

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