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Middle Cerebral Artery and Umbilical Artery Doppler Indices in Pre-gestational diabetic Versus Normal Pregnancies and Their Values in Predicting Adverse Neonatal Outcome

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ORIGINAL ARTICLE

Middle Cerebral Artery and Umbilical Artery Doppler Indices in Pregestational Diabetic Versus Normal Pregnancies and Their Values in Predicting Adverse Neonatal Outcome

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Abstract

Introduction: **In the US, 6−7% of pregnancies are complicated with diabetes mellitus (DM). It is divided into gestational diabetes (DM) and pregestational diabetes (PGDM) (GDM).**

Aim: **The study's objective was to evaluate how pregestational diabetes mellitus affected foetal middle cerebral and umbilical arteries. Doppler indicators to identify potential negative neonatal outcomes.**

Patients and methods: **The El Galaa Teaching Hospital and Al Hussien Hospital both participated in this comparative cross-sectional study. The current study included 120 patients, divided into two groups, who travelled to Al Hussien Hospital and El Galaa Teaching Hospital between October 2021 and the study's conclusion. Study group and the control group: 60 healthy pregnant women who were part of the control group (Group 1).Group 2 of the study included 60 expectant mothers who have gestational diabetes.**

Results: **The managed group (RI 0.62 and PI 0.92) and the uncontrolled group did not statistically differ in the mean resistance index (RI) and pulsatility index (PI) of the umbilical artery (RI 0.62 and PI 0.92). The managed group's middle cerebral artery mean RI and PI (RI 0.81 and PI 1.77), compared to the uncontrolled group, did not statistically differ from one another.**

Conclusion: **Maternal diabetes mellitus has no connection to abnormal Doppler indices of placental or foetal circulation (regardless the glycemic control).Additionally, the UA and MCA tests' sensitivity in predicting a poor neonatal outcome was only moderate.**

Keywords: Diabetic, Middle cerebral artery, Neonatal, Outcome, Pregestational, Pregnancies, Umbilical artery Doppler

1. Introduction

In the US, 6−7% of pregnancies are complicated with diabetes mellitus (DM). It is divided into gestational diabetes (DM) and pregestational diabetes (PGDM) (GDM). Pregestational diabetes is becoming more common among women who are in reproductive years.[1]

DM is linked to higher rates of perinatal morbidity and mortality. In pregnancies where diabetes is present, complications such macrosomia, hyperbilirubinemia, shoulder dystocia, congenital anomalies, and delivery trauma are more likely to develop.[2]

Pregnancy-related complications including pre-eclampsia and preterm labour are more likely among women who have had long-term diabetes mellitus prior to the current pregnancy. Additionally, uterine arteries may be affected by diabetic vasculopathy, which could lead to aberrant utero-placental circulation development, placental insufficiency, and poor foetal growth.[3]

Doppler velocimetry is one of the most important methods for antenatal foetal surveillance. The

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umbilical and middle cerebral arteries are included in the calculation of blood flow across arteries and veins. However, the results of the Doppler ultrasonography examination in diabetes pregnancies have been inconsistent. Despite their ubiquitous use, very few studies have actually looked at the effectiveness of these techniques in improving perinatal outcomes for women with diabetes.[2]

The study's objective was to evaluate how pregestational diabetes mellitus affected foetal middle cerebral and umbilical arteries. Doppler indicators to identify potential negative neonatal outcomes.

2. Patients and methods

This comparative cross-sectional study was carried out at El Galaa Teaching Hospital and Al Hussien Hospital. One hundred twenty patients who visited Al Hussien Hospital and El Galaa Teaching Hospital between October 2021 and the study's conclusion were included in the current study; they were divided into two groups: Control group and Study group: **Control group (Group 1)**: 60 healthy pregnant women. **Study group (Group 2)**: 60 pregestational diabetic pregnant patients.

2.1. Inclusion criteria

Mother's age must be between 18 and 40 years old, gestational age must be between 34 and 37 weeks, only one pregnancy, and gestational age must be verified by a reliable last menstruation date and a first trimester ultrasound. Patients known to have pregestational diabetes in group 2 (study group), regardless of whether they were on an insulin pump, an oral hypoglycemic medication, or a diet, are included in this group. Group 1 (control group) consists of pregnant women in good health.

2.2. Exclusion criteria

IUGR (EFW less than the 10th percentile for gestational age), membrane rupture or oligohydramnios (AFI less than the fifth percentile), along with any other enduring maternal conditions, such as renal failure, epilepsy, or CNS injury.

2.3. All the patients were submitted to the following steps

Each patient's informed permission was obtained, along with their full medical history, including their menstrual, obstetric, current, past, and family histories, as well as a thorough physical examination (both general and local): **Routine baseline investigations:** Complete blood count, Rh typing, assessment of the functioning of the liver and kidneys, FBS, PPBS, and HbA1C, as well as routine obstetric ultrasound to determine the foetal weight (EFW), the amniotic fluid index (AFI), and the gestational age, as well as to rule out any foetal abnormalities.

2.4. Doppler ultrasonography assessment

The instrument was used to carry out Doppler investigations (voluson p6 with Doppler unit and convex linear transducer 3.5 MHZ).

2.5. Umbilical artery Doppler

The umbilical artery's resistance index and pulsatility index were assessed using a pulsed wave Doppler on a free loop of cord.

2.6. Middle cerebral artery Doppler

The resistance index and pulsatility index of the middle cerebral artery were calculated. The newborn's birth weight, blood sugar level, apgar score at 1 and 5 min, and whether a transfer to a neonatal critical care unit is necessary are all assessed (NICU).

2.7. Outcomes

The major goal was to compare the resistance and pulsatility indicators of the umbilical artery between the control and study groups. To determine whether the middle cerebral artery Doppler indices and the MCA/UA PI ratio differ between the control and study groups (resistance index and pulsatility index). Another requirement for success To assess how well the middle cerebral artery and umbilical artery Doppler indices predict a poor newborn outcome in pregestational diabetes women (sensitivity and specificity).

2.8. Statistical analysis

The statistical programme SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) and Microsoft Excel 2019 (Microsoft Corporation, NY, USA) were used to analyse the data. Data in quantitative form were expressed using the mean and standard deviation (SD).

Quantitative data were represented using frequency and percentage. The independent-samples *t*-test of significance was used to compare two means. The proportions between two qualitative

Table 1. Umbilical artery, middle cerebral artery Doppler indices (resistance index RI and pulsatility index PI) and cerebroplacental Doppler ratio (MCA/UA PI) in both groups.

Variable	Control group	Study group	*P* value
UA RI (mean ± SD)	0.61 ± 0.06	0.63 ± 0.07	0.057
UA PI (mean ± SD)	0.95 ± 0.13	0.93 ± 0.25	0.659
MCA RI (mean ± SD)	0.83 ± 0.06	0.8 ± 0.1	0.07
MCA PI (mean ± SD)	1.81 ± 0.37	1.73 ± 0.45	0.322
MCA/UA PI (mean ± SD)	1.92 ± 0.29	1.94 ± 0.42	0.754

measures were compared using the Chi-square (X2) test of significance. Data correlation was performed using the Pearson's correlation coefficient (r) test.

3. Results

Table 1.

As indicated by Table 9, there was no measurably massive distinction between the review gathering's mean opposition record (RI) and pulsatility list (PI) of the umbilical vein (RI 0.63 and PI = 0.93) and the benchmark group's (RI 0.61 and PI 0.95 - $P = 0.057$ and 0.659, individually). The mean RI and PI of the center cerebral conduit didn't change measurably fundamentally between the review bunch (RI 0.8 and PI 1.73) and the benchmark group (RI 0.83 and PI 1.81 - $P = 0.07$ and 0.322, individually). Furthermore, there was no measurably tremendous contrast in the mean Cerebroplacental Doppler proportion (MCA/UA PI) between the two gatherings (1.94 in the review bunch versus 1.92 in the benchmark group - $P = 0.754$) [Figure 9].

As displayed in Table 2, Neonatal birth weight was altogether higher in the review bunch than those of the benchmark group (3315.17 vs. 3116.83 g separately - $P = 0.003$) and the mean of neonatal glucose was fundamentally lower in the review bunch (68.27 mg/dl versus 79.92 mg/dl in the benchmark group, $P = 0.002$). Infants of diabetic ladies experienced critical hypoglycemia all the more habitually contrasted with those of the benchmark group (23.3% versus 3.3% separately - $P = 0.001$). One-min and 5-min Apgar score under 7 was fundamentally recognized all the more oftentimes in the review bunch (30 versus 10% for 1 min and 20 versus 6.7% for 5 min, $P = 0.006$ and 0.032, separately). Out of 60 diabetic ladies in the review bunch, 7 babies were confessed to NICU versus 3 in the benchmark group with no factual importance between them ($P = 0.186$).

As shown in Table 3, the was no statistically significant difference between both groups regarding the mean **gestational age** (36.2 in group 2a versus 36.37 weeks in group2b − $P = 0.471$), the frequency of **macrosomia** (23.3% in group 2a versus 26.7% in group 2b−$P = 0.766$) and the frequency of **polyhydramnios** (20% in group 2a versus 26.7% in group 2b -$P = 0.542$) (Figure 11, Table 4).

The mean obstruction file (RI) and pulsatility record (PI) of the umbilical vein didn't vary measurably fundamentally between the oversaw bunch and the uncontrolled gathering (RI 0.64 and PI 0.94 - $P = 0.5$ and 0.764, individually). The mean center cerebral corridor RI and PI for the oversaw bunch and the uncontrolled gathering (RI 0.81 and PI 1.77 - $P = 0.52$ and 0.488, separately) didn't contrast in a genuinely huge way. Additionally, there was no measurably tremendous distinction in the mean Cerebroplacental Doppler proportion (MCA/UA PI) between the two gatherings (1.98 in the controlled diabetic gathering versus 1.9 in the uncontrolled diabetic gathering - $P = 0.46$).

As shown in Table 5, there was no statistically significant difference between both groups as regard; **neonatal birth weight** (3230 in group 2a versus 3400 g in group 2b, respectively - $P = 0.150$) and **neonatal blood sugar** (68 in group 2a versus 68.53 g/dl in group 2b, respectively - $P = 0.926$). Furthermore, there was no statistically significant difference in the number of newborns that experienced **hypoglycemia** (6 in group 2a versus 8 in group 2b−$P = 0.542$), **1-min Apgar score less than 7** (8 in group 2a versus 10 in group 2b−$P = 0.573$) and **Five-min Apgar score less than 7** (5 in group 2a versus 7 in group 2b−$P = 0.519$). Also, there was no statistically significant difference between both groups in the number of neonatal **admissions to NICU** (3 in group 2a versus 4 in group 2b−$P = 1$).

As shown in Table 6, the sensitivity, Specificity, positive and negative predictive values and accuracy of umbilical artery Doppler in the prediction of

Table 2. Neonatal birth weight (NBW), blood sugar (BS) and adverse neonatal outcome in the study and the control groups.

Variable	Control group	Study group	*P* value
NBW (gram − mean ± SD)	3116.83 ± 214.99	3315.17 ± 455.41	0.003
Neonatal BS (mg/dl) (mean ± SD)	79.92 ± 18.83	68.27 ± 22.07	0.002
Adverse Neonatal Outcome			
Hypoglycemia (<50 mg/dl - No., %)	2 (3.3%)	14 (23.3%)	0.001
1 min Apgar score <7 (No., %)	6 (10%)	18 (30%)	0.006
5 min Apgar score <7 (No., %)	4 (6.7%)	12 (20%)	0.032
NICU admission (No., %)	3 (5%)	7 (11.7%)	0.186

Table 3. Gestational age, macrosomia and polyhydramnios in group 2a versus group 2b

Variable	Group 2a (Controlled DM)	Group 2b (Uncontrolled DM)	*P* value
GA (Weeks – mean ± SD)	36.2 (±1.06)	36.37 (±0.67)	0.471
Macrosomia (No., %)	7 (23.3%)	8 (26.7%)	0.766
Polyhydramnios (Number, %)	6 (20%)	8 (26.7%)	0.542

Table 4. Umbilical artery, middle cerebral artery Doppler indices (resistance index RI and pulsatility index PI) and cerebroplacental Doppler ratio (MCA/UA PI) in group 2a and group 2b

Variable	Group 2a (Controlled DM)	Group 2b (Uncontrolled DM)	*P* value
UA RI (mean ± SD)	0.62 ± 0.06	0.64 ± 0.08	0.5
UA PI (mean ± SD)	0.92 ± 0.23	0.94 ± 0.26	0.764
MCA RI (mean ± SD)	0.81 ± 0.09	0.79 ± 0.1	0.52
MCA PI (mean ± SD)	1.77 ± 0.45	1.69 ± 0.45	0.488
MCA/UA PI (mean ± SD)	1.98 ± 0.37	1.9 ± 0.47	0.46

adverse neonatal outcomes among diabetic patients were 25%, 88.89%, 60%, 64% and 63.33%, respectively.

As displayed in Table 7, When used to anticipate unfortunate infant results in diabetes patients, center cerebral supply route Doppler's responsiveness, particularity, positive and negative prescient qualities, and precision were each 20.83%, 91.67%, 62.50%, 63.46%, and 63.33%, separately.

4. Discussion

The considerable advances made in the clinical and obstetrical management of pregnancies complicated by pregestational diabetes during the past few years have resulted in appreciable improvements in mother and perinatal outcomes. The main causes of this improvement are strict periconceptional glucose control and improvements in foetal surveillance.[4]

Our outcomes showed that pregnancies in pregestational diabetic ladies are related with an expanded gamble of fetal and neonatal dangers contrasted with pregnancies in sound ladies; in any case, there were no undeniable contrasts in umbilical conduit (UA), center cerebral supply route (MCA), and cerebroplacental proportion Doppler records. Moreover, the probability of a poor neonatal result was higher in the uncontrolled diabetic gathering contrasted with the controlled diabetic gathering; be that as it may, the distinction didn't arrive at factual importance. Besides, there were no measurably huge contrasts in the umbilical corridor, center cerebral conduit Doppler files, or cerebroplacental proportion between the controlled and uncontrolled pregestational diabetic pregnant ladies, and the responsiveness of both UA and MCA evaluations was low concerning the expectation of a poor neonatal result. (25% and 20.83%, separately), while the explicitness was 89% and 92%, respectively. In certain exploration, the impact of umbilical course and center cerebral supply route Doppler ultrasound assessment on poor perinatal result and maternal glycemic status

Table 6. Umbilical artery Doppler's sensitivity, specificity, positive and negative predictive values, and accuracy in predicting unfavourable neonatal outcomes in diabetic individuals.

Statistic	Value	95% CI
Sensitivity	25%	9.77%–46.71%
Specificity	88.89%	73.94%–96.89%
Positive Predictive Value	60%	32.09%–82.64%
Negative Predictive Value	64%	57.86%–69.71%
Accuracy	63.33%	49.90%–75.41%

Table 7. The awareness, Particularity, positive and negative prescient qualities and exactness of center cerebral conduit Doppler in the expectation of unfavorable neonatal results among diabetic patients.

Statistic	Value	95% CI
Sensitivity	20.83%	7.13%–42.15%
Specificity	91.67%	77.53%–98.25%
Positive Predictive Value	62.50%	30.49%–86.36%
Negative Predictive Value	63.46%	58.04%–68.56%
Accuracy	63.33%	49.90%–75.41%

Table 5. Neonatal birth weight (NBW), blood sugar (BS) and adverse neonatal outcome in the controlled and the uncontrolled diabetic groups.

Variable	Group 2a (Controlled DM)	Group 2b (Uncontrolled DM)	*P* value
NBW (gram – mean ± SD)	3230.83 ± 322.86	3400.33 ± 550.18	0.150
Neonatal BS (mg/dl) (mean ± SD)	68 ± 22.03	68.53 ± 22.47	0.926
Adverse Neonatal Outcome			
Hypoglycemia (<50 mg/dl - No., %)	6 (20%)	8 (26.7%)	0.542
1 min Apgar score <7 (No., %)	8 (26.7%)	10 (33.3%)	0.573
5 min Apgar score<7 (No., %)	5 (16.7%)	7 (23.3%)	0.519
NICU admission (No., %)	3 (10%)	4 (13.3%)	1

was assessed. Maternal DM was not connected to deviant Doppler lists in the flow investigation. This revelation concurred with the discoveries of an examination by Salvesen *et al*.[5]

Nonetheless, the concentrate just included all around controlled diabetic pregnancies (65 cases), and they detailed that maternal DM isn't related with irregularities in that frame of mind of placental or fetal flow. All things being equal, They examined placental and foetal dissemination in pregnancies complicated by gestational diabetes mellitus, observing any changes in foetal blood pH, Po2, and hematocrit.[5]

Comparable exploration was led by Ben-Ami et al.[6] on 92 diabetic pregnant ladies between the ages of 28 and 40 weeks of growth to evaluate the umbilical course's systolic to diastolic proportion (S/D proportion) as an indicator of the perinatal result in such pregnancies. In their examination, the S/D proportion in hatchlings with unfortunate results was not connected to maternal diabetes, and the Doppler studies had a responsiveness and explicitness of 39% and 92%, separately, as markers of poor perinatal result. They in this way presumed that the umbilical course's S/D proportion enjoys no upper hands over other much of the time used tests in the administration of diabetic pregnancy. The unfavourable perinatal outcomes in 50 pregnant women with GDM were then examined by Niromanesh *et al*.[7] using the non-stress test (NST) and umbilical supply route (UA) Doppler assessments. Individually, 12% of the females and 22% of them collectively displayed odd UA Dopplers and non-receptive NSTs. Unfavorable findings were obtained for 13 ladies. The most generally acknowledged unfavourable outcomes were hypoglycemia ($n = 9$), Apgar 1-min 7 ($n = 8$), newborn admitted to NICU ($n = 6$), and respiratory pain condition ($n = 6$).

Ladies with non-receptive NST (P 0.001) and unusual UA Doppler ($P = 0.033$) had a higher probability of having an unfortunate result. The NST has a responsiveness of 76.9% and a particularity of 97.3% for foreseeing different adverse results. The UA Doppler was 30.8% responsive and 94.6% specific, respectively, in predicting various bad outcomes. Taking this into account, they came to the conclusion that NST is a more accurate indicator of subpar perinatal outcomes in GDM patients. Additionally, Yalti et al.[8] state that umbilical velocimetry is a test of placental functionality and may not always accurately reflect foetal condition. They discovered that the responsiveness and favourable prophetic characteristics of umbilical corridor Doppler records were 30% and 50%, respectively, each. Leung et al.[9] in their study from January to December 2002, was conducted on 169 singleton GDM pregnancies, concluded that Doppler results for the UA and MCA should be cautiously interpreted because GDM pregnancies can result in fictitious adverse outcomes. However, they found no correlation between the UA PI and MCA PI and unusual results in GDM pregnancies. However, they found no correlation between the UA PI and MCA PI and unusual results in GDM pregnancies.

Shabani et al.[10] then examined how GDM impacted the foetal MCA and umbilical course (UA) Doppler borders to separate them from healthy pregnancies. The remaining 66 expectant women who took part in the review were not pregnant, although 33 of them had gestational diabetes mellitus. For each pregnant woman who was selected, Doppler ultrasound was utilised to capture the greatest systolic and diastolic rates, pulsatility file (PI), obstruction record (RI), and systolic diastolic percentage (SD) in the umbilical artery as well as in both the right and left foetal MCAs. We accept that this is the primary review to think about pregestational diabetes and solid pregnancies regarding the Doppler records of the center cerebral and umbilical veins in the creating embryo. Most prior examinations in ladies with gestational DM zeroed in to a greater degree toward the umbilical course and fetal supply routes' blood stream (GDM). We additionally assess the effect of glycemic the board on the Doppler files. We further wiped out patients with other clinical ailments to forestall any potential predisposition in the Doppler files that could emerge in such circumstances.

4.1. Conclusion

Fetal and neonatal problems are more likely to be present in pregnancies where DM is present. In high-risk pregnancies, Through non-invasive Doppler measurements of placental and foetal circulations, foetal health can be evaluated (e.g., pre-eclampsia and intrauterine growth retardation). However, abnormal placental or foetal circulation Doppler indices are not connected to gestational diabetes mellitus in women (regardless the glycemic control). Additionally, the UA and MCA tests' sensitivity in predicting a poor neonatal outcome was only moderate.

Authorship

All authors have a substantial contribution to the article.

Disclosure

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Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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