The Role of Ultrasound During the Second and Third Trimesters in the Management of Diabetic Pregnancies

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Abstract

Introduction: Ultrasound is a key diagnostic method throughout pregnancy, particularly valuable in high-risk conditions such as gestational diabetes. Technological advances, including 3D/4D imaging and color Doppler, have improved the early detection of abnormalities and reduced pregnancy-related complications. This makes ultrasound an essential tool—second only to blood glucose monitoring—in the follow-up of diabetic pregnancies from early gestation to delivery. Methodology: This study analyzed data from pregnant women by evaluating their gestational age, glycemic levels, and ultrasound findings. Data were processed using cross-tabulated statistical tables and presented through diagrams to support interpretation. Results: Among 1,402 pregnant women undergoing ultrasound evaluation, 36 showed fetal abnormalities in the second trimester, and 165 in the third. Women with gestational diabetes or prediabetes were identified and followed throughout pregnancy. Documented complications included polyhydramnios, macrosomia, and fetal growth restriction. Conclusion: Diabetic and prediabetic pregnancies are strongly associated with increased obesity and fetal anomalies. Proper monitoring through standardized ultrasound protocols significantly improves maternal and fetal outcomes. Raising awareness and adherence to these protocols is crucial for improving perinatal care.

***Keywords:** gestational diabetes, prediabetes, ultrasound, macrosomia, fetal growth restriction, polyhydramnios, pregnancy complications*

1. Introduction

Ultrasound is the primary imaging modality for monitoring embryonic and fetal development throughout pregnancy. Regular sonographic evaluations are essential for early detection of structural or growth abnormalities, especially in high-risk pregnancies such as those complicated by gestational diabetes.

Numerous intrauterine changes during pregnancy are only diagnosable through ultrasound. The documentation of each ultrasound session is critical in tracking the evolution of the pregnancy and managing potential complications. Its importance in the first trimester of high-risk pregnancies is well established. However, it becomes particularly vital in the second and third trimesters, especially from the 24th week onward.

Ultrasound during this period provides critical information, such as:

- **Placental maturity** (Verma et al., 2022),

- **Fetal position and weight** (Pavithra et al., 2022),
- **Amniotic fluid volume** (Phelan et al., 1987).

A strong correlation has been observed between **polyhydramnios** and gestational diabetes, as well as between **macrosomia** (fetal weight >4000 grams) and maternal hyperglycemia. Additionally, ultrasound is the only non-invasive method capable of evaluating placental calcifications and the maternal-fetal blood flow.

According to Sinno et al. (2019), in diabetic pregnancies, **at least two ultrasound assessments spaced 3–4 weeks apart** are recommended, particularly using **abdominal circumference (AC)** measurements to screen for large-for-gestational-age (LGA) fetuses—typically those above the 90th percentile (McMurrugh et al., 2024).

Strengths of Ultrasound in Late Diabetic Pregnancy

1. **Early Detection of Fetal Anomalies (16–22 weeks):**
   - **Spina bifida:** early detection via vertebral alignment (Neave, 1984),
   - **Anencephaly:** detected by irregular cranial bone formation (Martinez, 1994),
   - **Cardiac malformations:** evaluated by fetal heart orientation and structure (Shankar et al., 2019).
2. **Monitoring Fetal Growth in Third Trimester:**
   - Measurements of **biparietal diameter (BPD)**, **abdominal circumference (AC)**, and estimated **fetal weight** help detect macrosomia or fetal hypotrophy (Wu et al., 2015; Smith GC, 1997).
   - Infants of diabetic mothers are more likely to be **LGA** and require neonatal resuscitation due to complications such as **hypoglycemia**, **metabolic imbalances**, or **hyaline membrane syndrome** (Scifre et al., 2015).

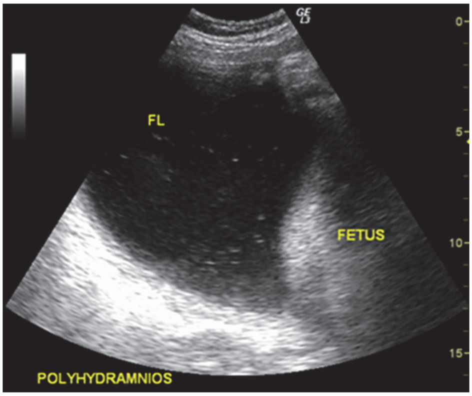

Figure 1. Posterior amniotic pocket in a 28–29-week pregnancy exceeding 6 cm, without the presence of fetal parts.

Interpretation: The image illustrates polyhydramnios, a common complication of diabetic pregnancies, identified by excessive amniotic fluid in the absence of small parts like limbs or umbilical cord.

1.1 Assessment of Amniotic Fluid in Diabetic Pregnancy

Amniotic fluid volume is a sensitive indicator of fetal well-being. In diabetic pregnancies, abnormalities in fluid volume—**either polyhydramnios or oligohydramnios**—are common and may indicate underlying pathology such as fetal malformations or poor glycemic control.

The **amniotic fluid index (AFI)** is the sum of the deepest vertical pockets in all four uterine quadrants. Normal AFI ranges between **8.1–18 cm**.

- **AFI <5 cm** is considered **severe oligohydramnios**
- **AFI 5–8 cm** indicates **borderline low fluid**
- **AFI >18 cm** is **polyhydramnios** (Magann et al., 2011)

Figure 2. Presentation of reduced amniotic fluid (oligohydramnios) in a 20-week pregnancy.
Interpretation: This ultrasound shows decreased posterior amniotic pocket (<4 cm) with visible fetal parts, suggesting **oligohydramnios**, which may require further Doppler assessment to exclude fetal distress or intrauterine fetal demise.

1.2 Doppler Flowmetry in the Third Trimester

In the last trimester, **Doppler ultrasound** plays a vital role in assessing:

- **Umbilical artery flow resistance** (for placental function),
- **Middle cerebral artery (MCA) flow** (for cerebral oxygenation),
- **Cerebroplacental ratio (CPR)** (for fetal compromise).

These parameters help detect **placental insufficiency, fetal growth restriction, or macrosomia**. Abnormal MCA or elevated umbilical artery resistance indices are indicative of **intrauterine hypoxia** (Bilardo et al., 1990; Hecher et al., 1995).

1.3 Placental Maturity and Calcification

Placental aging can be assessed via ultrasound by identifying **calcification islands**:

- A **heavily calcified placenta** with reduced perfusion may lead to compromised fetal circulation and increased risk of fetal distress.
- Diabetic pregnancies often exhibit **accelerated placental maturation**, **basal thickening**, and **increased vascularization** due to hormonal dysregulation and leptin imbalance (Desoye, 2007; Abdella et al., 2014).

1.4 Key Pathological Findings in Diabetic Pregnancies

- **Polyhydramnios** detected before the third trimester should prompt re-evaluation of **fasting blood glucose** and detailed fetal anomaly screening (Dashe et al., 2000).
- **Macrosomia and hypotrophy** can coexist, reflecting either overgrowth due to hyperglycemia or growth restriction due to vascular insufficiency (Tieu et al., 2014).

1.5 Study's aim

- To investigate fetal outcomes during the second and third trimesters in pregnancies affected by gestational diabetes, using ultrasound.
- To improve awareness and implementation of standardized imaging protocols in the management of diabetic pregnancies.

2. Methodology

This observational study was conducted over a two-year period at Durrës Hospital. Pregnant women who underwent routine or diagnostic ultrasounds were included. Data were collected on:

- Maternal glycemia levels (normoglycemic, prediabetic, gestational diabetic),
- Gestational age at diagnosis,
- Type of fetal anomaly,
- Placental and amniotic changes observed via ultrasound.

Patients were categorized by **maternal age**, **glucose status**, and **fetal findings**. Statistical analyses were performed using cross-tabulations, and findings were visualized with tables and graphs.

3. Results

During the second trimester, the fetal complications of diabetic pregnancy are represented by abnormalities in the development of the fetus, which, as mentioned above, are significant. The high risk of these pregnancies for abnormalities seems to be related to the fact of a poor glycidic control during the first trimester where organogenesis occurs.

Nearly two-thirds of abnormalities involving these systems are in patients with impaired glucose tolerance or known diabetes. Neural tube defects occur 13 to 20 times more often in diabetic pregnancies. From Mills et al. (2010) we have published the results of a study on birth anomalies among women with gestational diabetes and without gestational diabetes table. (Prifti M. 2024) The difference between them is almost three times the values obtained.

Second trimester ultrasound revealed structural anomalies in **36 women with diabetic pregnancies**. Most abnormalities were related to **neural tube** and **cardiac malformations**, consistent with poor glycemic control during organogenesis.

Studies such as Mills et al. (2010) have shown a 13–20x higher risk for neural tube defects in diabetic pregnancies. Our findings support this trend.

Tabela 1: Distribution of Fetal Anomalies Diagnosed by Ultrasound in the Second Trimester (n = 36)

Type of Anomaly	Total Cases	Diagnosed by Ultrasound	% Diagnosed by Ultrasound	Percentage of Total (%)
Cardiac anomalies	13	10	77%	36.1%
Spina bifida	14	6	42%	38.9%
Other anomalies	9	8	89%	25.0%
Total	**36**	**36**	**70%**	**100%**

Interpretation. In 36 cases with fetal anomalies identified in the second trimester were diagnosed via ultrasound 70% of them. This confirms the **diagnostic contribution of ultrasound** in detecting major fetal structural anomalies in this study population, reinforcing its critical role in diabetic pregnancy monitoring.

Prediabetic patients in the second trimester have a 1.6-fold increased risk of a fetus with cardiac anomalies, while diabetic patients have a 1.3-fold increased risk of developing spina bifida compared with prediabetic patients. There are differences between diabetic and prediabetic women, but these differences are not statistically significant (P 0.460).

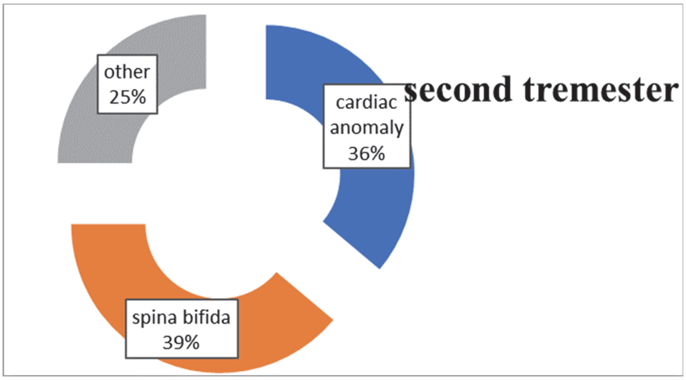

Figure 3. Distribution of anomalies by affected fetal systems.
Interpretation: Cardiac and neural tube defects were most prevalent, aligning with existing literature on malformation risk in diabetic pregnancies.

In the third trimester, fetal complications in pregnancies affected by prediabetes or gestational diabetes primarily included:

- **Polyhydramnios**
- **Macrosomia** (fetal weight > 4 kg)
- **Fetal hypotrophy** (fetal weight < 2.5 kg)

Of the total pregnancies monitored, **11%** of diabetic or prediabetic cases presented these complications. Additionally, **placental or fluid abnormalities were detected in 50% of high-risk pregnancies after the 32nd week**.

A subset of patients (45%) with gestational diabetes also showed **placental vascular abnormalities**, associated with **early placental calcification** and dysfunction and the presence of polyhydramnios in 7 % of cases**.**

Table 2. Correlation Between Glycemia Levels and Fetal Weight (n = 168)

Glycemia Level	>4 kg (Macrosomia)	2.5–4 kg (Normal weight)	<2.5 kg (Hypotrophy)	Total
Prediabetes	26	17	6	49
Gestational Diabetes	5	6	3	14
Normoglycemic	14	86	5	105
Total	**45**	**111**	**14**	**168**

Key Findings from Table 2:

- The majority of **macrosomic fetuses (26 out of 45, or 57.8%)** were from **prediabetic mothers**.
- Only **14 macrosomic fetuses (31%)** belonged to normoglycemic pregnancies.
- Prediabetic and diabetic women had a **statistically significant** association with fetal overgrowth ($P < 0.05$).
- The **Odds Ratio (OR)** of 57.31 [CI 95%: 1.15–62.75] indicates a strong link between **high maternal glucose levels and fetal macrosomia**.

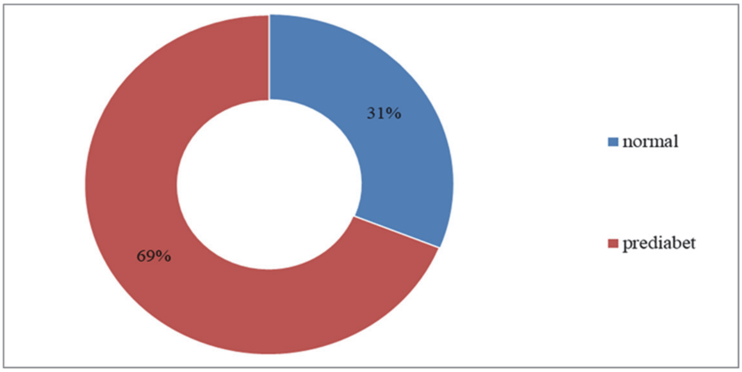

Figure 4. Proportion of Macrosomia Cases in Prediabetic vs Normoglycemic Pregnancies
Interpretation: The uploaded image or chart should visually show that prediabetic women represent the majority of macrosomic cases, exceeding the normoglycemic group.) This figure illustrates the disproportionate rate of macrosomia in prediabetic pregnancies, highlighting the importance of glucose control even in borderline hyperglycemia.

4. Conclusion

Diabetic and prediabetic pregnancies are strongly associated with an increased incidence of **fetal anomalies**, **macrosomia**, **polyhydramnios**, and **placental abnormalities**. Ultrasound proves to be an **indispensable tool** in identifying and monitoring these complications from mid-gestation through to delivery.

This study showed that:

- **100% of fetal anomalies in the second trimester were diagnosed via ultrasound**, reinforcing its diagnostic value.
- **Macrosomia occurred in over 50% of prediabetic pregnancies**, a statistically significant finding.
- **Placental vascular changes and polyhydramnios** were prevalent in over 45% of women with gestational diabetes during the third trimester.

Despite these clear risks, a large portion of patients **did not undergo timely or protocol-based ultrasound evaluations**, leading to missed opportunities for early intervention.

5. Recommendations

1. **Implement Protocol-Based Ultrasound Monitoring**
   All women with elevated blood glucose—whether prediabetic or diagnosed with gestational diabetes—should follow a structured ultrasound schedule, including:
   - Second trimester anomaly scan (18–22 weeks),
   - Serial growth scans in the third trimester (every 3–4 weeks),
   - Doppler studies for fetal circulation.
2. **Educate Patients on Timing and Importance of Imaging**
   Lack of awareness regarding the **timing and purpose of ultrasound** was noted among patients with complications. Targeted education on fetal imaging should be part of routine prenatal counseling in high-risk pregnancies.
3. **Monitor Placental and Amniotic Parameters**
   Sonographic evaluation of **AFI**, **placental calcification**, and **vascularization** must be included in third-trimester assessments, particularly after 32 weeks.
4. **Strengthen Use of 2D/3D and Doppler Imaging**
   The integration of **3D and Doppler technologies** allows for more detailed assessments of uteroplacental structure and function, improving perinatal outcomes.

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