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Ultrasound Technique Based on Liposome Nanovesicles in the Evaluation of Abnormal Pregnancy Outcomes in Diabetic Women

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ABSTRACT

Gestational diabetes mellitus (GDM) refers to the first occurrence or detection of glucose tolerance abnormalities during pregnancy, including cases that may have existed before pregnancy but have not been detected. It is one of the common complications during pregnancy. In recent years, the incidence of GDM has been on the rise. The most common complication of GDM is macrosomia, which often causes dystocia, neonatal asphyxia, birth injury and postpartum bleached blood. Early diagnosis, appropriate treatment and maintenance of reasonable and stable blood glucose concentration can significantly reduce the incidence of complications. The purpose of this study was to investigate the application of ultrasound techniques based on liposome nano-vesicles in the assessment of abnormal pregnancy outcomes in diabetic pregnant women. Objective: To investigate the value of ultrasound in the examination of fetal growth in pregnant women with gestational diabetes mellitus. For this purpose, a total of 100 pregnant women with gestational diabetes admitted to the hospital were selected as the research objects, and the clinical data of ultrasound examination were retrospectively analyzed. According to the newborn weight, they were divided into the control group (normal fetus group) and the observation group (giant fetus group). The growth of fetuses in the two groups was compared, and the predictive value of each measurement index to the weight of a giant fetus was analyzed. Multiple regression analysis showed that LL, AC and FL played a decisive role in fetal weight, with statistically significant differences (P<0.05). In conclusion, ultrasonography is of great value in predicting fetal growth in pregnant women with gestational diabetes mellitus and can be widely used.

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Introduction

Gestation diabetes mellitus (GDM) is the first occurrence or occurrence of diabetes mellitus and is a common complication of pregnancy. Statistics show that the incidence of GDM in China is 4.5-5.5%, and GDM patients account for more than 80% of pregnant women with diabetes. The giant fetus is the most common complication of PREGNANT women with GDM, which can lead to perinatal brachial plexus nerve injury and clavicle fracture. Ultrasound is a non-invasive examination method of clinical application pervasive, through ultrasound can timely grasp the GDM pregnant women fetal growth, and on the basis of the quantitative necessary intervention measures, to ensure the safety of mother to child, therefore this study discusses the fetal ultrasound growth of pregnant women in gestational diabetes check application value, so as to provide a reference for clinical application (1).

Common biological indicators measured by ultrasound include double acrosome diameter, head circumference, abdominal circumference, liver length and femur length, among which double acrosome diameter and head circumference are often used to estimate the gestational week after pregnancy and body weight (2). However, it is difficult to obtain the standard double-parietal diameter section when the fetal head is connected or inserted into the pelvis in late pregnancy. In addition, due to the compression and deformation of the fetal head due to the pelvis, the measurement of double-parietal diameter is not accurate. Moreover, the femoral length section is relatively easy to obtain and the measurement error is relatively small. The measurement of liver length has

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little influence on the objective receptor position (3). Glucose increase in GDM in pregnant women enters the fetal blood circulation through the placental barrier to promote the secretion of insulin by the fetal pancreas and increase the storage of fetal glycogen. The liver is the main place of fetal material metabolism. The liver converts surplus nutrients into dust and stores them in liver cells to make liver cells increase in size and volume. Ultrasound measurement of fetal liver length can estimate the fetal weight (2,3).

Pietryga et al. studied the uterine artery and umbilical artery of 146 pregnant women with GDM and found that only 16% had abnormal uterine artery blood flow and only 5% had abnormal umbilical artery blood flow (4). Uterine and umbilical artery resistance was associated only with fetal birth weight and placental weight but not with maternal hemoglobin a1C. Greef et al. compared the doppler measurement results of fetal umbilical blood tube and venous catheter and found that the two were insignificant in differentiating GDM from normal pregnant women. Total umbilical flow (TU-VF) of a fetus greater than gestational age is higher than that of the normal fetus, while the average TUVF of the normal fetus is higher than that of a fetus less than gestational age, which is not associated with diabetes mellitus (5).

The liposome is a kind of ultramicro particle with a diameter of several nanometers to several microns arranged by the phospholipid bilayer in the aqueous phase. Liposomes contain a non-polar end (hydrophobicity) and a polar head (hydrophilicity), so they have amphiphilic properties: hydrophilicity and hydrophobicity (6-7). When phospholipids are dissolved in an aqueous solution, they usually form multi-lamellar vesicles (MLV) with different particle sizes. After ultrasonic treatment of MLV suspension, MLV becomes a small lamellar vesicle containing only a single bimolecular layer (SUV). In recent years, a single lamellar vesicle (LUV) with a large diameter has been developed. Small single-lamellar vesicles have been widely used in the laboratory (8-9). The other method is the extrusion method, which is suitable for various lipids, easy to operate, and has good repeatability. The size of small single-lamellar vesicles is uniform and can be controlled by different filter membranes according to needs. There is no ultrasonic damage and no organic impurities are introduced (10). In recent years, a lot of liposomes have been used for gene delivery system, such as quaternary ammonium salt, cholesterol and two acylglycerol cation derivatives and polyamine lipid derivatives, liposome as a little interference RNA and DNA, anti-cancer drug (including the hydrophobic and hydrophilic drugs) molecules such as carrier has been applied in medical field development. DNA can be condensed between the layered or inverted hexagon phase structures of cationic liposomes (11). For use in cell transfection, liposomes are usually mixed with so-called helper lipids, DOPE, and cholesterol. The auxiliary phospholipid has the ability to improve the transformation of cationic liposomes from sheet-like lipids to hexagonal phase structure, which is beneficial to the improvement of transfection efficiency. However, it is worth noting that the ratio of liposomes to auxiliary phospholipids is an important factor affecting transfection efficiency and toxicity.

Biological applications of nanomaterials, including biosensors, bioimaging, photothermal therapy and gene-drug delivery, have potential applications (12-13). Furthermore, gold nanoparticles are small in size and can easily enter cells through diffusion and endocytosis, which provides conditions for gene or drug delivery (14).

A gold nanometer with a diameter of 2 nm can be conjugated to approximately 100 molecules, and in principle, a monolayer can be connected to 108 ligands. Payloads can be large biomolecules like DNA, RNA, and small proteins. In addition, it is important to effectively release the loaded molecules, which can be controlled by drug/gene release depending on pH and laser (15).

Their clinical applications. Although some studies have shown that gold nanomaterials are safe for biological use, they are transmitted to the mitochondria and nucleus of cells, causing oxidative stress and genotoxicity. The advantages of a nanocarrier are shown in Figure 1(14-15).

Hyperglycemia in GDM pregnant women can directly lead to abnormal or damaged embryonic development, which is one of the main causes of congenital malformations of embryos. It can lead to abnormalities of the central nervous system, cardiovascular system and digestive system, among which abnormalities of the cardiovascular and central nervous system account for about 2/3, and the incidence of neural tube defects is 14-21 times higher than normal pregnancy (16). Genitourinary, gastrointestinal and skeletal abnormalities are also common. The guidelines for GDM examination and diagnosis indicate that the main cause of most fetal malformations is that maternal diabetes is not controlled in the pre-pregnancy period (17). To sum up, in view of the pathogenesis of GDM, the effect of GDM on fetal growth and development can be timely grasped through ultrasonic monitoring, which is of great value in guiding the treatment and treatment (18).

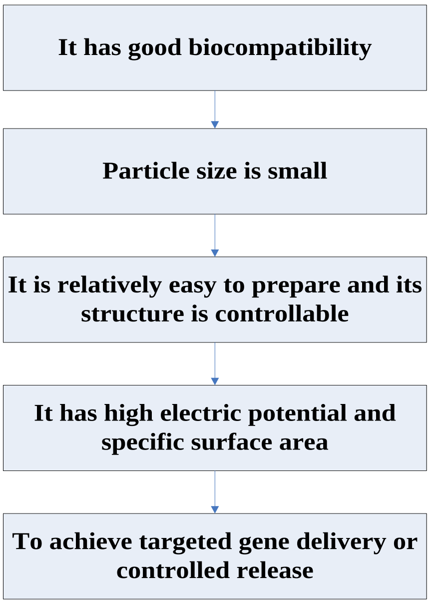

Figure 1. Advantages of nanocarriers

The liver is the main place for fetal material metabolism. When fetal nutrition is excessive, the liver converts nutrients into glycogen and stores it in liver cells, making liver cells enlarge and liver volume increase accordingly. According to relevant studies, "Ultrasound examination of 130 pregnant women at 21-24 weeks of pregnancy found that the fetal liver of GDM pregnant women was thicker than that of normal glucose pregnant women (19). In this study, FLL, abdominal subcutaneous fat, ventricular septum and umbilical cord Huatong glue thickness of fetuses in GDM pregnant women were compared, and FLL was more sensitive than the other three thicknesses values (20-21).

Fetal subcutaneous tissue includes muscle and fat, which can store energy and have a greater impact on fetal growth. Since the blood sugar of GDM in pregnant women is transported through the placenta, but the insulin cannot pass through the placenta, which will keep the fetus in a long-term hyperglycemia state, stimulate the fetus to produce a large amount of insulin, activate the amino acid system, promote fat synthesis and excessively increase the storage capacity (22-23). Studies have shown that fetuses with GDM are thicker than those with normal blood sugar. Ultrasound can directly measure the subcutaneous fat, clearly observe the growth and decline of fetal subcutaneous fat, and comprehensively evaluate fetal nutrition. The sensitivity and specificity of prediction of macrosomia were 88% and 75%, respectively, at the thickness of subcutaneous soft tissue of humerus of 13 mm (24-25).

Materials and methods

Preparation of Phospholipid

In this study, the preparation of phospholipids was synthesized by ultrasonic method, and the general steps were as follows: the cationic liposomes DODAB and Chol were weighed in a clean weighing bottle according to the molar ratios of 1:1 and 1:3. A certain volume of chloroform was added to dissolve the lipids in chloroform. After the lipids were dissolved in chloroform, the solvent was thoroughly volatilized by nitrogen or a rotary evaporator. A uniform lipid film could be observed on the wall of the measuring bottle. It is then placed in a vacuum drying oven for several hours. Add the required water phase to the weighing bottle to keep the lipid concentration within millimoles. The aqueous solution of lipids was ultrasonic to transparent by numerical control ultrasonic cleaner, and finally, the uniform size of single-molecule vesicle mixed lipids was obtained by filtration or separation.

Experimental Site

A total of 100 pregnant women with gestational diabetes admitted to hospitals in the study area from May 2019 to May 2020 were selected. Inclusion criteria: All pregnant women in this group received a glucose stimulation test. Glucose tolerance test was performed when the glucose level at 1 h after oral administration of 55 grams of glucose was ≥7.6mmol/L. Glucose tolerance test was performed after oral administration of 70 grams of glucose, such as fasting glucose >5.3mmol/L, glucose level at 1 h after oral administration of 80 grams of glucose was ≥10.2mmol/L, and glucose level at 2 h >8.6mmol/L. Women in the second trimester, 4 to 7 months pregnant; Single fetus with definite gestational age; No previous history of diabetes; Age 20-38, in good health. Pregnant women born prematurely were excluded. According to newborn weight, the patients were divided into the control group (normal fetus group, newborn weight <4000 g) and observation group (giant fetus group, newborn weight ≥4200 g), among which 89 patients were in the control group, age 20-35 years old, average (25.98±1.41) years old. Gestational week (22.36±0.45) weeks; The heart rate was (74.6±6.2) times. Body mass index (BMI) was (26.82±2.57)kg/ m^2. In the observation group, 11 patients were aged 22-38 years, with an average age of (26.24±1.28) years. Gestational week (21.75±0.87) weeks; The heart rate was (76.4±4.9) times. Body mass index (BMI) was (26.73±3.24)kg/ m^2.

Inspection Methods

BPD(double top diameter), FL(femur length), HC(head circumference) and AC(abdominal circumference) were measured by ultrasound in the second trimester (24-28 weeks) and before delivery (12-60h).

Results and discussion

The Role of Ultrasound in Prenatal Examination of Pregnant Women with Gestational Diabetes

All 57 patients passed the surgical period safely, and the wounds all reached grade A healing. During hospitalization, 2 patients developed lower limb deep vein thrombosis, 1 urinary tract infection and 3 lower respiratory tract infections. All patients were cured after treatment, and the length of hospitalization was (12.7±3.6) d. All 57 patients were followed up for at least 12 months. At 12 months after surgery, 35 patients with Harris score of myeloid joint function were excellent, 18 were good, 4 were medium, and 1 was poor, with an excellent and good rate of 93.0%(53/57). The comparison of fetal growth in the second trimester between the two groups is shown in Figure 2 and Table 1.

In this study, fetal growth indicators and fetal appendages in the two groups were analyzed and combined with the height and weight of newborns, the effect of ultrasound in predicting gestational diabetes in pregnant women with fetal macrosomia was evaluated. The experimental results showed that the incidence of macrosomia in pregnant women with gestational diabetes increased, and ultrasound could predict macrosomia according to fetal biological measurements. The experimental conclusion: Ultrasound plays an important role in the prenatal examination of pregnant women with gestational diabetes. In the study group,15 newborns were macrosomia, and 40 newborns in the control group were macrosomia. The incidence of macrosomia in newborns in the study group (26%,15/57) was significantly higher than that in the control group (70%,40/57), with a statistically significant difference (P<0.05). The specific data of the differences between the study group and the control group are shown in Figure 3.

Table 1. Fetal growth in the second trimester was compared between the two groups

Group	BPD	FL	HC	AC	LL
Control group (n=57)	67.76 ± 5.22	48.58 ± 5.36	247.44 ± 17.21	219.78 ± 17.82	31.92 ± 3.83
Observation group (n=57)	68.57 ± 4.93	49.57 ± 4.72	244.45± 16.33	220.44 ± 18.67	36.23 ± 4.55

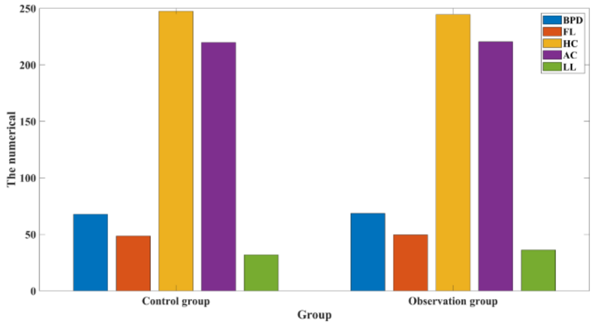

Figure 2. Fetal growth in the second trimester was compared between the two groups

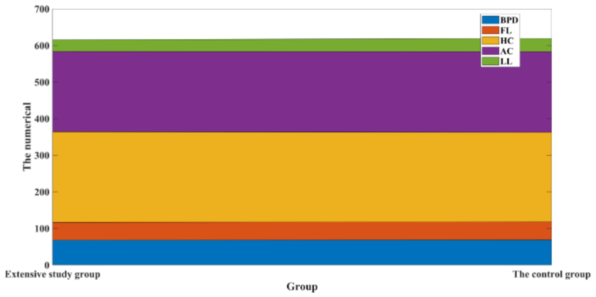

Figure 3. Specific data on significant differences between study groups and control groups

Ultrasound Observation of Fetal Biological Indicators

Ultrasound can intuitively observe the condition of the fetus, measure its biological indicators, and estimate the risk of delivery based on the condition of the mother. In clinical examination, for pregnant women with gestational diabetes, attention to ultrasound examination can be strengthened, especially in biological indicators, and repeated measurement to improve the accuracy of measurement. Among them, double top diameter and head circumference are often used to estimate the gestational week and weight in the third trimester, but in the third trimester, fetal position changes, and there will be some difference in accuracy. According to the experimental data, there was no significant difference in biological indicators between the two groups at 25-28 weeks of gestation; the length of the fetal liver at 38-41 weeks of gestation was statistically significant, while the other indicators showed no significant difference. The detailed values are shown in Table 2:

Table 2. Biological indicators of fetal gestational age in the two groups

Biological indicator	The team	The control group	P
BPD	95.25±6.22	94.89±6.30	>0.05
FL	348.17±21.45	343.22±23.56	>0.05
HC	358.34±25.24	342.27±27.22	>0.05
AC	38.55±4.18	33.13±4.15	<0.05
LL	73.22±5.84	72.87±3.90	>0.05

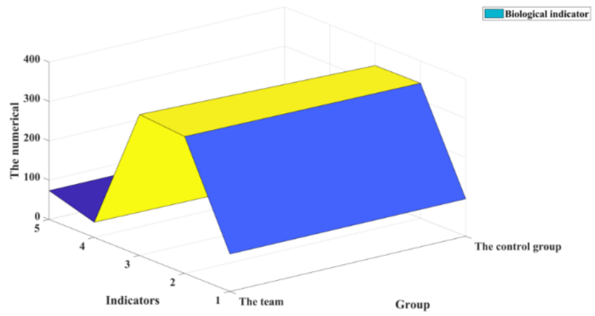

Figure 4. Biological indicators of fetal gestational age in the two groups

In pregnant women with gestational diabetes, blood glucose rises and enters fetal blood circulation through the placental barrier, making the fetal pancreas produce excessive insulin. The liver is the primary site of fetal metabolism, which converts excess nutrients into sugars and stores them in liver cells, making them larger. When the fetal liver length is measured by ultrasound, the data of normal fetuses can be used as a reference so as to assess whether the pregnant woman and fetus have abnormal glucose tolerance and calculate the fetal weight. The results of this study showed that there was a significant difference in the incidence of macrosomia between the two groups (P<0.05), and the coincidence rate of ultrasound measurement between the two groups was higher, with no significant difference in comparison (P>0.05), as shown in Figure 5.

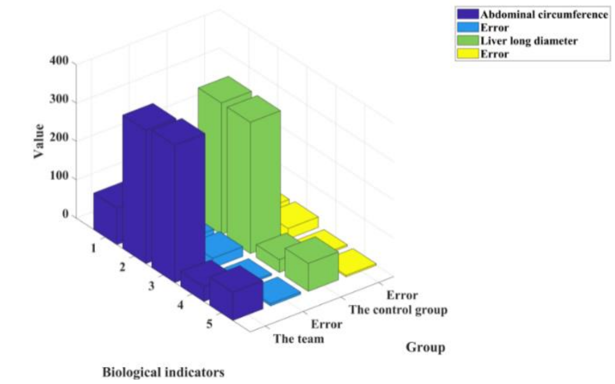

Figure 5. Fetal circumference and liver diameter were measured in the study group compared with those in the control group

Conclusions

According to our research, fetal biophysical score (BPS) includes fetal movement, fetal respiratory movement, fetal muscular tension, amniotic fluid depth and no-load test. Fetal biophysical score by ultrasound is a multi-parameter comprehensive analysis and evaluation method for intrauterine fetal conditions. That is, it can accurately understand fetal intrauterine conditions and screen the existence of fetal distress through comprehensive observation and judgment of FM, FT, FBM, NST and AFV. Especially for fetal chronic intrauterine distress effect is better. In the perinatal period, GDM pregnant women are more likely to report placental dysfunction and decreased placental blood supply, leading to fetal distress.

Due to the constant changes in the current environment and the changes in genetic genes, some maternal factors will affect the fetus during pregnancy and, with the extension of gestational weeks, limit or contribute to fetal development. In clinical work, it is found that poor fetal development status may lead to a low body mass index, low immunity, lack of function and insufficient adaptability after delivery, which will affect the growth and development of newborn babies. Therefore, after a lot of women are pregnant, they will carry out certain nutritional supplements for themselves. It is believed that under the condition of adequate maternal nutrition, the better the fetal development condition is, the more beneficial it is to the growth and development of newborn babies. But in fact, fetal development must be appropriate. If the mother's birth canal is relatively narrow and the physical quality is poor, the worse the fetal development, the greater the risk of childbirth and the possibility of complications after childbirth newborn is higher.

In recent years, clinical studies have also found that gestational diabetes can increase the incidence of macrosomia, thus seriously endangering maternal and newborn health. Some clinical workers put forward that it is necessary to strengthen the detection of macrosomia and give corresponding intervention as soon as possible. However, in the previous clinical work, the fetal weight and height were mostly estimated by palpation. After the statistics of delivery results, it was found that the diagnosis method had a large error and low applicability. At the same time, pregnant women with gestational diabetes have no obvious symptoms, which increases the difficulty of clinical obstetrics and gynecology work.

Acknowledgments

Not applicable.

Interest conflict

The authors declare that they have no conflict of interest.

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