

Research Article

Integrative Diabetes and Cardiovascular Diseases

Maternal Exercise Uncovers Placental Insufficiency in Diabetic Mothers

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Abstract

Regular physical activity during pregnancy improves or maintains physical fitness, helps with weight management, reduces the risk of gestational diabetes, and enhances patient's psychological well-being. We studied the possibility to use maternal exercise to test placental reserves in diabetic mothers. We used a motorized treadmill in a moderate exercise regimen (15-minute fast walk at a speed of 3 mph with an incline of 15-25 degrees). Fetal monitoring was provided by using standard Phillips equipment (Avalon CTS and FM40). Adverse fetal outcomes were considered if one or more of the following were present: Category III Fetal Heart Rate (FHR) tracing, 5-minute Apgar score of less than 7, admission to the neonatal intensive care nursery, fetal growth restriction, and fetal and early neonatal death. A total of 819 fetal assessments were performed: 160 patients had gestational diabetes, 80 had pregestational diabetes. The most common complication in fetuses with positive prenatal test results was abnormal FHR in labor (36%) followed by low Apgar score (21%) and need for NICU admission (19%). Most of the adverse outcomes had good correlation with positive results of the exercise test. In conclusion, it appears that maternal exercise causes changes in FHR, which may be used to assess placental and fetal reserves.

Keywords: Fetal assessment, Diabetes in pregnancy, Placental insufficiency

Introduction

Regular physical activity during pregnancy improves or maintains physical fitness, helps with weight management, reduces the risk of gestational diabetes, and enhances patient's psychological well-being [1]. In 2008, the US Department of Health and Human Services issued physical activity guidelines for adults, including pregnant women [2,3]. For healthy pregnant women, the guidelines recommend at least 150 minutes per week of moderate-intensity aerobic activity. In The USA, the total number of people above the age of 18 that have diabetes in some form is 30.2 million, (or 12.2% of all adults); 14.9 million or 49.3% (6% of the USA population) of women [1]. Among women with gestational diabetes mellitus (GDM),

19.7% had a subsequent diagnosis of diabetes, and this is not including the significant number of people that go undiagnosed [2].

Fetal testing in pregnant women with diabetes remains a challenge because of a limited number of tests capable of diagnosing occult placental insufficiency, which may negatively affect the fetus. Diabetes, being also a vascular disease, often damages placental circulation. We studied the possibility to use maternal exercise to test placental reserves in diabetic mothers.

Methods

For maternal exercises, we used a motorized treadmill

in a moderate exercise regimen (15-minute fast walk at a speed of 3 mph with an incline of 15-25 degrees). The research protocol was approved by the Institutional Review Board of NY Downtown Hospital (North America study group) and Helsinki Committee at Moscow University School of Medicine. All participants of the study signed an informed consent. As soon as the exercise program was finished, the pregnant mothers were subjected to fetal testing. Fetal monitoring was provided by using standard Phillips equipment (Avalon CTS and FM40).

Patients' age varied from 19 to 42, with a mean of 29. Two hundred and twenty pregnant patients between 34 and 40 weeks of pregnancy were included. A total of 819 fetal assessments were performed. One hundred and sixty patients had gestational diabetes, 60 had pregestational diabetes; ninety-six women were receiving insulin or oral hypoglycemic medications, the rest of the patients were managed by a diet alone.

Adverse fetal outcomes were considered if one or more of the following were present:

1. Category III FHR tracing (persistent late and/or deep variable decelerations, fetal bradycardia, sinusoidal rhythm).
2. 5-minute Apgar score of less than 7.
3. Admission to the neonatal intensive care nursery (NICU), unrelated to prematurity.
4. Fetal growth restriction.
5. Fetal and early neonatal demise.

Statistical analysis

Statistical analysis was performed using PSAW statistics (version 18.0; IBM Corporation, New York, NY). Fisher's exact test was used for normal variables when the total sample size was relatively small; chi-square test was used for larger sample sizes. Wilcoxon rank test was used as a non-parametric alternative.

Results

Results of fetal assessment fall into two categories: negative (normal) or positive (abnormal). Fetal heart rate (FHR) in response to maternal exercise under normal circumstances exhibited transient mild tachycardia, normal beat to beat variability and absence of decelerations (negative results). Results were labeled positive if the FHR tracing showed decelerations (late or persistent variables or sustained bradycardia).

Table 1 reflects the relationship between the results of fetal testing after maternal exercise in patients with pregnancy complicated by diabetes and perinatal outcome.

Table 1: A relationship between positive and negative fetal responses to maternal exercise and incidence of adverse perinatal outcome.

Results of fetal testing	Incidence of Adverse Outcome
Negative	4
Positive	19

P < 0.05

The most common complication in fetuses with positive prenatal test results was abnormal FHR in labor (36%) followed by low Apgar score (21%) and need for NICU admission (19%). Fetal or early neonatal death occurred in 5 cases, two of which were due to severe shoulder dystocia and macrosomia (likely unrelated to placental insufficiency) [3,4].

Discussion

In 2008, we proposed a novel test to assess fetal reserves in high-risk pregnancies [5,6]. Current modalities in antepartum fetal surveillance had been largely developed in the 1990's and have not changed significantly since. Most of the tests currently used are not designed to assess fetal reserves. The only existing test of occult placental insufficiency is the oxytocin challenge test, which requires administration of oxytocin in order to cause uterine contractions. This can lead to unwanted premature labor [5]. In view of the research data confirming the safety of exercise in pregnancy, we proposed to use maternal exercise to test fetal resources [5]. Fetal resources are determined by the type of fetal responses to decrease placental perfusion caused by maternal exercise. Healthy fetuses do not exhibit abnormal FHR tracings in response to maternal exercise [6]. Our preliminary observation demonstrated that if utero-placental circulation has been compromised, the FHR will deteriorate during or soon after maternal exercise [6]. The American College of Obstetrics and Gynecology (ACOG) committee opinion states that exercising regularly during pregnancy reduced the risks of developing GDM in obese women [7-9]. The preservation of the exercise-sensitive pathway in insulin-resistant states, such as type 2 diabetes, provides a rationale for the promotion of regular physical activity in the management of mothers with diabetes mellitus and GDM. Muscle glucose uptake

is influenced by exercise intensity and duration. The process is controlled by feedback signals, which reflect the metabolic state of the muscle cell, including but not limited to calcium, AMP, phosphocreatine, and glycogen levels [10].

Resistance training (RT) or weight training is understudied in pregnancy, but has its own potential benefits [11]. A common complaint during pregnancy, especially in the susceptible, is low back pain, which has been shown to decrease with RT [12]. RT increases muscular strength, endurance, and flexibility in pregnant women safely and efficiently [13]. RT is also known to be effective in increasing glycemic control and can even reduce insulin requirements in women who have gestational diabetes [14].

In conclusion, it appears that maternal exercise causes changes in FHR, which may be used to assess fetal reserves.

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