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Original Research Article

Influence of diabetes on static efficiency of pregnant women's feet

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ABSTRACT

Introduction: During pregnancy, a range of hormonal and metabolic changes occurs in a woman's body. The body weight increase and the shift of the center of gravity are factors which have a disadvantageous effect on a pregnant woman's feet. Diabetes is another factor with a negative effect.

Aim: The aim of the study involved an assessment of the influence of pregnancy and diabetes on foot mechanics.

Material and methods: The study included pregnant healthy women, pregnant women suffering from type 1 diabetes and healthy women and women suffering from type 1 diabetes. To assess foot statics, a plantar analysis was performed, i.e. a print of the supporting part of the foot surface. The analysis was performed using a podoscope. The podoscope allowed for determining the distribution of foot pressure on the glass plate, on which the patient stood. The results analysis of the examination involved the determination of appropriate indices, including the length, the width of the foot, the Wejsflog index, the Sztriter–Godunov and the Clarke index.

Results and discussion: It was shown that pressure on individual areas of the feet increases during pregnancy. This is caused by an increase in the body weight. After delivery, pressure on individual areas of the feet decreases.

Conclusions: In type 1 diabetes, the pressure exerted on individual parts of the feet was higher than in healthy women and stress on the feet did not go back to the initial values after delivery. Some feet deformities in type 1 diabetes were lasting.

1. Introduction

In Poland, there are 2.5 million diabetes sufferers in the general population. The number of persons diagnosed with diabetes increases every year. Owing to progress in diabetes treatment, it is complications that are the greatest problem now, including the diabetic foot syndrome. Poor diabetes management, neuropathy, ischemia, and inappropriate footwear very often lead to ulceration, which

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is a frequent cause of amputation of part of the foot or the entire foot.

Pregnancy is another factor which has a negative effect on diabetes. Embryo implantation and development, and subsequently fetus development, cause a range of hormonal and metabolic changes in a woman's body. During the initial period of pregnancy, the concentrations of estrogens, progesterone, cortisol, prolactin, placental lactogen, chorionic gonadotropin, and leptin increases.[1] Pregnancy development is accompanied by an increase in the woman's body weight mostly connected with fetal development. Initially, the fetal weight increases 10 g per week. In mid-pregnancy, the fetal growth accelerates significantly, reaching approx. 200 g per week in the period from week 24 to week 26. An increase in the body weight and the center of gravity shift are factors which have a disadvantageous effect on a pregnant woman's feet. The anatomical arches of the foot become lower. The excessively and incorrectly burdened muscle and ligament mechanism of the foot are exposed to damage.

Diseases accompanying pregnancy, including diabetes, are additional factors which have a disadvantageous effect on the foot condition. Pregnant women may suffer from impaired collagen metabolism and distribution, i.e. co-existence of two phenomena: excessive collagen accumulation in the subcutaneous and periarticular tissues and its glycation. They are the basis for pathologies of joints and periarticular tissues in diabetes. Feet, due to their complex structure and individual variability, are often subject to deformities, which inhibit their proper function. Appropriate preventive treatment may significantly reduce the frequency of foot defects and their severity.

2. Aim

The research conducted aimed at assessing the influence of pregnancy and diabetes on changes in foot biomechanics. Data on this subject available in the literature are scant and incomplete.

3. Material and methods

3.1. *Participants*

The study participants included pregnant women with type 1 diabetes, healthy pregnant women and both healthy women and women suffering from diabetes, who were not pregnant during the study period. Women suffering from gestational diabetes were treated with an appropriate diet, while women suffering from type 1 diabetes were treated with insulin. In all pregnant women, diabetes was metabolically stable.

Women with lesions resulting in pathological disorders of foot statics and mechanics, e.g. defects of the musculoskeletal system, considerable obesity, and neurological diseases including neuropathy, were excluded from the study. The women were divided into the following groups:

- Experimental Group 1 – including 16 women with physiological pregnancy,
- Experimental Group 2 – including 16 women with a few years' history (2–9 years) of type 1 diabetes treated with insulin,
- Experimental Group 3 – including 20 healthy non-pregnant women,
- Experimental Group 4 – including 20 women suffering from type 1 diabetes, who were not pregnant during the study.

All women participating in the study were aged from 18 to 35.

Table 1 – Age, height, weight and anthropometric data in groups of female subjects who were not pregnant.

	Not pregnant women (n = 20)	
	Healthy	With diabetes type 1
Age ± SD, year	26.75 ± 3.95	26.55 ± 4.61
Height ± SD, cm	164.43 ± 5.83	164.66 ± 5.03
Weight ± SD, kg	56.65 ± 4.96	60.65 ± 5.41
BMI, kg/m^2	20.53 ± 2.90	22.63 ± 2.52
HbA1c	–	5.38 ± 0.41
Glycemia before meal, mg%	–	118.23 ± 15.74
Glycemia after meal, mg%	–	114.04 ± 15.25

3.2. *Methods*

Upon acceptance to the study, each patient was subject to a physical examination and an interview as well as a neurological examination. An analysis of anthropometric data was performed for body weight and height.[2] On the basis of glycemia and hemoglobin measurements, the degree of metabolic stability of diabetes was assessed (Tables 1–3).

To assess foot statics, a plantar analysis of the foot was performed, i.e. a print of the supporting part of the foot surface. The examination was performed using a podoscope, i.e. an instrument built from appropriately arranged mirrors, a lighting lamp and a camera. The podoscope allowed for determining the distribution of foot pressure on the glass plate, on which the patient stood. The plantar analysis was performed using a podoscope by the ''Orthoprint'' company and software from the CQ Electronic System Artur Świerc company. The device was connected to a computer and it recorded the reflection of the feet of a standing person using a camera and transmitted the image to the computer. After analysis, the image was displayed in a graphic form on the monitor screen and next, it was saved to the computer

Table 2 – Weight, height, and age in the healthy pregnant women groups.

	Healthy pregnant women (n = 16)			
	I trimester	II trimester	III trimester	After birth
Weight ± SD, kg	58.91 ± 6.20	63.25 ± 5.01	68.91 ± 7.07	59.41 ± 4.54
Height ± SD, kg	164.43 ± 5.83			
Age ± SD, year	26.45 ± 3.43			