CASE REPORT

Positive effect of long-term tailored physical activity therapy on diabetes mellitus management in an obese type 2 diabetic patient

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Abstract

The case history of a 44-year-old, severely obese Caucasian man with serious decompensation of diabetes and subsequent withdrawal of high-dose insulin is reported. Insulin was withdrawn after 5 years of continuous therapy and the patient was treated for 6 months with diet, individualized physical therapy and oral antidiabetic drugs from the group of insulin sensitizers. Six months later, oral antidiabetics were discontinued for low blood glucose levels, and the treatment was limited to therapeutic life style changes. After insulin withdrawal, the patient's condition markedly improved: he showed better diabetes control, decrease in insulin resistance, weight loss, reduced BMI, reduced waist circumference, sagittal abdominal diameter and body fat, increased fitness level, normalized blood pressure and decreased heart rate at rest.

INTRODUCTION

The most important positive effects of increased physical activity on glucose metabolism comprise the reduction of fasting and postprandial glycaemia and insulinemia, improvement of glucose tolerance, enhancement of insulin secretion in response to oral glucose load, and increased insulin sensitivity of peripheral tissues (skeletal muscles, adipose and liver tissues). An obese type 2 diabetic patient is at high cardiovascular risk, resulting primarily from the common presence of all of the major metabolic syndrome components (high insulin resistance, type 2 diabetes mellitus (T2DM), abdominal obesity, insulin resistant dyslipidemia, hypertension, hypercoagulability). Regular physical activity has a positive effect not only on glucose metabolism but on all components of the metabolic syndrome, thus reducing cardiovascular risk, a major threat to obese type 2 diabetics [7,8]. In the light of the positive health and psychological effects of physical activity on T2DM management, we can expect better control of diabetes in patients treated with long-term individualized physical activity in addition to diet and oral antidiabetic drugs [3].

CASE REPORT

A 44-year-old Caucasian male with severe abdominal obesity (BMI 45.7) attending an outpatient diabetes care facility for 7 years for T2DM, who had

List of abbreviations:

T2DM – Type 2 Diabetes Mellitus
OAD – Oral Antidiabetic Drugs
LSC – Life Style Changes
HbA_{1c} – Glycosylated Hemoglobin
IFCC – International Federation of Clinical Chemistry
HOMA-IR – Homeostasis Model Assessment index of Insulin Resistance
BMI – Body Mass Index
SAD – Sagittal Abdominal Diameter
VO_2 max – maximal oxygen consumption
W max – maximal work load
VE max – maximal ventilation

been treated with insulin over the last five years, was admitted to the Department of Medicine of the Motol University Hospital in Prague for severely decompensated diabetes. Based on self-monitoring data, his blood glucose levels ranged from 10 to 30 mmol/l within the last month. At admission, his postprandial blood glucose level was 21.5 mmol/l while being treated with 120 IU of insulin daily in an intensive insulin therapy regime (short acting insulin analogue lispro: 26–24–22 IU + NPH-insulin: 24–0–24 IU). HbA_{1c} at admission was 9.8 % (IFCC calibration).

The patient's C-peptide level indicated sufficient insulin secretion by the pancreas. His high fasting and postprandial C-peptide levels (1 049 pmol/l and 1 629 pmol/l, respectively) showed that insulin resistance was more pronounced than insulin deficiency. Insulin therapy was withdrawn and the patient was prescribed oral antidiabetic drugs (OAD) from the group of insulin sensitizers, e.g. a combination of rosiglitazone 4 mg/day + metformin 1 g/day. The patient was instructed on diabetic weight loss diet. Based on spiroergometry, maximum oxygen consumption (VO_2 max, indicator of the aerobic fitness level) was estimated and individualized physical activity intervention was set up and started during his hospitalization. He began the exercise programme consisting of 60 minutes aerobic interval training on a bicycle and rowing ergometer – intensity of 50–80 % VO_2max with 10 minutes warming up and 10 minutes cooling down on low intensity of 30–40 % VO_2. The programme was repeated twice a week. After one week of the physical activity programme, the insulin therapy could have been discontinued and the patient was discharged receiving a combination of two oral insulin sensitizers. At discharge, his fasting and postprandial blood glucose levels were 5.2 mmol/l and 7.0 mmol/l, respectively. The patient was referred to the outpatient diabetology centre of the Motol University Hospital to continue the comprehensive therapeutic regimen. He was followed at 1-month intervals for half a year, and then at 2-months intervals. He continued his weight loss diet and individualized physical activity programme, i.e. combined 60 minutes cycling and rowing ergometer sessions 3 times a week under supervision of a physiotherapist.

Three months after insulin withdrawal, being treated with the combination of the two insulin sensitizers, diet and exercise, his HbA_{1c} decreased from 9.8 % at baseline (while still on insulin therapy) to 4.8 %. During the following three months the OAD were progressively withdrawn by reason of low blood glucose levels until conversion to therapeutic life style changes (LSC) alone, i.e. weight loss diet and physical activity. At one year after the end of insulin therapy and at six months after the end of antidiabetic pharmacotherapy while treated with life style changes alone, his HbA_{1c} was 4.0 %. Based on the HOMA index, we found reduced insulin resistance for the treatment with OAD and/or therapeutic LSC compared to insulin therapy. Changes in the parameters studied are presented in Table 1.

The changes of the patient´s body weight play a crucial role in the development and progression of macrovascular complications of T2DM which are the leading cause of death in diabetic patients. Anyway, monitoring of body weight and body mass index (BMI) does not allow estimating the proportion of fat in the body. Distribution of fat in the body is the most important risk factor for the development of obesity-related metabolic and cardiovascular diseases. That is why we focused not only on BMI but we used also anthropometric methods to determine the distribution of fat in the body. We measured waist circumference and sagittal abdominal diameter (SAD) at supine position at the L4–L5 level at the end of normal expiration. When treated with OAD and/or life style changes, the patient showed body weight loss and decreased BMI, waist circumference and SAD; changes in the studied parameters are shown in Table 2.

The patient's physical fitness level was tested by spiroergometry. Three months and one year after insulin withdrawal, the following improvements were observed: increased maximal oxygen consumption (VO_2 max), maximal work load (W max) and maximal ventilation (VE max), moderately reduced heart rate and normalized blood pressure (with the dosage of antihypertensive drugs remaining unchanged); changes in the studied parameters are shown in Table 3.

DISCUSSION:

The reported case illustrates the importance of regular physical activity in diabetes management in an obese patient. We succeeded to discontinue the antidiabetic pharmacotherapy while achieving a satisfactory diabetes control by diet and exercise alone. Patient's eating habits remained unchanged after insulin withdrawal, but interestingly, he reported to feel less desire for food after insulin withdrawal which was helpful to his adherence to the low energy diet. The withdrawal of high dose of insulin, subsequent discontinuation of OAD treatment and good T2DM control by life style changes alone is an impressive outcome. Moreover, the benefit of adequate T2DM management in preventing the development of

long-term micro vascular complications is to be underlined. One year after insulin withdrawal the patient had HbA_{1c} of 4.0 %, i.e. the same level as reported in non-diabetic subjects. Blood glucose normalization alone can prevent the development and progression of specific complications of DM2T. The reduction of HbA_{1c} was not associated with either clinical or laboratory hypoglycemia while the patient was treated with OAD, diet and exercise. The patient received a combination of insulin sensitizers having an antihyperglycemic but not hypoglycemic effect, in other words, once a normal blood glucose level was achieved, no further reduction in blood glucose occurred.

Nevertheless, in an obese diabetic patient, body weight control and physical fitness level play crucial roles in determination of life expectancy and quality of life [1,4]. Weight loss has a marked effect for the prevention and/or of progression of macro vascular complications of T2DM, the leading cause of death or disability in T2DM patients compared to the non-diabetic population. We focused on BMI, waist circumference and SAD, recently considered to be the most precise anthropometric indicator of insulin resistance and, at the same time, the most important indicator of visceral fat and thus an indicator of the cardiovascular risk [5,6].

Enhanced fitness level as a result of regular physical activity is an important factor in cardiovascular risk reduction [7,8]. Regular physical activity not only leads to body fat reduction but also has a positive effect on all major risk factors implicated in the insulin resistance syndrome, more precisely it reduces blood insulin level, blood glucose level and triacylglycerols, increases HDL-cholesterol, reduces heart rate and blood pressure at rest and enhances procoagulant levels as well as caused changes in the amount of any hormone values [2]. Physical activity also has a considerable motivation effect in diabetes management and a highly positive psychological effect. Diabetes mellitus is a psychosomatic disease and a positive effect on the patients´ mental condition improves not only the control of diabetes but also their quality of life.

Table 1: Diabetes control and insulin resistance

Parameter	Baseline (Insulin therapy)	At 3 months (OAD)	At 1 year (OAD/LSC)
Fast glycemia (mmol/l)	19.9	8.2	5.4
HbA_{1c} (%)	9.8	4.8	4.0
HOMA-IR	8.5	5.3	3.5

Legend: HbA_{1c} is determined using IFCC calibration

Table 2: Anthropometric data

Parameter	Baseline	At 3 months	At 1 year
Body weight (kg)	140	129	127
BMI ($kg.m^{-2}$)	45.7	42.1	41.5
Waist circumference (cm)	128	124	118
SAD supine position (cm)	34	31.5	28

Table 3: Physical fitness level

Parameter	Baseline	At 3 months	At 1 year
VO_2 max ($ml.min^{-1}.kg^{-1}$)	22.3	30.8	31.2
W max ($W.kg^{-1}$)	2.1	2.8	3.16
VE max ($l.min^{-1}$)	87.5	134	134
Heart rate at rest (min^{-1})	79	79	77
Blood pressure at rest (mmHg)	145/90	125/85	120/80

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