99 - PHYSICAL EXERCISE AND TYPE 1 DIABETES

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INTRODUCTION

The prevalence of type 1 diabetes mellitus (T1DM) has reached very high rates in recent years. Twelve million people are estimated to have T1DM in the world today, and this number may double by 2030 (WHO, 2008).

Type 1diabetes mellitus is a chronic disease characterized by the autoimmune destruction of insulin-producing beta cells of the pancreatic islets of Langerhans. Their destruction leads to complete insulin deficiency.

The autoimmune reaction in T1DM is caused by an association of environmental and genetic factors. Viral infections, psychological stress and lack of physical activity are some of the environmental factors that may contribute to the destruction of pancreatic beta cells due to inflammation (RANNUS et al., 2007). Although many studies have investigated the etiology of T1DM, the exact mechanism that triggers the events that lead to deficiency in insulin production is still unknown (MIMBACAS et al, 2003).

The incidence of T1DM peaks at 10 to 14 years of age; incidence decreases progressively up to 35 years, and cases of T1DM onset at later ages are not frequent. However, individuals may develop T1DM at any age (GROSS et al., 2002).

Hyperglycemia in patients with T1DM is the result of their inability to use glucose because of inadequate insulin production. Therefore, insulin has to be replaced exogenously, and these individuals are classified as insulin-dependent (FERNANDES et al, 2005; GROSS et al, 2002).

The diagnostic methods recommended by the American Diabetes Association (ADA) are fasting glucose and, in some cases, glucose tolerance tests (GTT). According to a consensus issued by the ADA, the normal fasting glucose upper limit is 99 mg/dl, and fasting glucose levels between 100 and 125 mg/dl are classified as prediabetes (AMERICAN DIABETES ASSOCIATION, 2003).

The risk of complications for patients with diabetes is directly associated with glucose control, which is assessed by glycosylated hemoglobin (HbA1c) levels, a retrospective index of plasma glucose concentrations. HbA1c levels greater than 7% are associated with greater risks of chronic complications (BEM, KUNDE, 2006).

Regular physical exercise is recommended for individuals with diabetes. They should, however, be especially careful when practicing physical exercises because of their insulin deficiency (T1DM) or their deficiency in producing insulin to stimulate glucose absorption (type 2 diabetes). Insulin production and action are critical for proper metabolic responses to physical exercise (FARREL, 2003).

EFFECT OF PHYSICAL EXERCISE ON GLUCOSE CONTROL

The long-term consequences of diabetes are assigned to micro- and macrovascular changes that lead to dysfunction, damage or failure of several organs. Some of its chronic complications are nephropathy and possible progression to kidney failure, retinopathy and the chance of blindness, and neuropathy and possible foot ulcers, amputations and autonomic dysfunctions, such as sexual dysfunction. Individuals with diabetes are at a high risk for atherosclerotic vascular disease, such as coronary artery disease, peripheral arterial disease and cerebral vascular diseases (OLIVEIRA, 2003).

Physical exercises may lower blood pressure, reduce cholesterol and triglycerides concentrations, improve and slow the progression of cardiovascular disease (AMERICAN COLLEGE OF SPORTS MEDICINE & AMERICAN DIABETES ASSOCIATION, 2000) and contribute to weight loss, was well as to the maintenance of normal weight and muscle mass if associated with a balanced diet (NEUHOUSER et al, 2002).

Aerobic physical exercises associated with resistance exercises have satisfactory results on HbA1c concentrations in patients with type 1 diabetes (MOSHER et al., 1998). However, some studies failed to find an improvement in HbA1c, which may be explained by the inadequate reduction of insulin doses administered to avoid hypoglycemia due to exercise although insulin dose-reduction protocols are well established. Also, a longer period of physical activity may be necessary before a metabolic effect is noticed (RAMALHO, SOARES, 2008).

De Angelis et al. (2006) found that one of the effects of physical exercise on type 1 diabetes metabolism was the improvement of insulin action, which occurs primarily due to greater expression and translocation of the insulin-dependent glucose transporter protein GLUT-4 from the center of the cell to its membrane.

The benefits of physical exercise on sensitivity to insulin are found both in aerobic and resistance exercises. The mechanisms by which these exercises improve sensitivity to insulin seem to be different, and, therefore, their combination may be beneficial (CIOLAC & GUIMARÃES, 2004; BERLESE et al, 2007).

However, some sports are not recommended because they may expose patients with diabetes to several risks; for example, patients with diabetic retinopathy should avoid intense exercises because of the risk of vitreous hemorrhage or retina displacement (ZINMAN et al, 2004). In cases of peripheral neuropathy, upper limb exercises and lower limb weight-bearing exercises, such as swimming or bicycle riding, should be avoided (ADA, 2007).

The effect of each type of exercise on glucose levels should be clearly understood so that insulin replacement can be adapted as necessary. Insulin should be controlled before, during and after exercise without changes in intensity or duration. The response of glucose levels to exercise is affected by several factors, such as intensity, duration, time, environmental conditions, stress and absorption of insulin and diet supplements. Glucose levels should be controlled to monitor these different responses. (RAMALHO, SOARES, 2008).

METABOLIC RESPONSE TO PHYSICAL EXERCISE

When exercise begins, energy is obtained from glucose stored in the form of glycogen in muscle and in the liver. When exercise is prolonged, glycogen stores are used up and fat becomes the main source of energy (ROBERGS, ROBERT, 2002). During exercise, the amount of insulin should be enough to enable glucose to enter the muscle cell, but also allow the release of glycogen stored in the liver (RAMALHO, SOARES, 2008). The production of glucagon and adrenalin should increase because these two hormones promote the release of stored glycogen. Therefore, the increase in glucose muscle consumption is compensated by an equivalent increase of glucose production in the liver, which takes place since the beginning of the exercise,

and glucose levels remain stable (ROBERGS, ROBERT, 2002).

The amount of insulin required for the absorption of glucose decreases during exercise because muscle contractions stimulate glucose absorption even when insulin is not available (HOLLOSZY, 2003); this reduction, however, does not occur in individuals with diabetes. In addition, exercises enhance the effects of exogenous insulin and liver glucose production decreases as the use of glucose by the muscles increases; this lack of synchronicity leads to hypoglycemia (HERNANDEZ, 2000). Consequently, the capacity to mobilize fuels for exercise from fats and carbohydrates is compromised in individuals with diabetes.

Hypoglycemia may occur during, immediately after or some hours after exercise. To reduce the risk of hypoglycemia induced by exercise, the insulin dose should be reduced, or the amount of carbohydrates ingested should be increased before exercise (SOO, 1996). Additional carbohydrates should be ingested before exercise if glucose is < 100 mg/dl (AMERICAN DIABETES ASSOCIATION, 2002).

CONCLUSIONS

Physical exercises have been recommended for disease prevention and health promotion. However, in the case of diabetes, for example, exercise should be carefully prescribed to reduce risks, increase benefits and, therefore, promote better quality of life.

Regular physical exercise, together with insulin replacement therapy and diet planning, is one of the main approaches to current treatment of type 1 diabetes (DE ANGELIS et al, 2006).

The practice of regular exercises leads to metabolic and endocrine adaptations. In individuals with T1DM, insulin and glucose concentrations, as well as the characteristics of physical exercise, may affect acute and chronic metabolic and endocrine responses. Therefore, exercises may be beneficial or harmful depending on how they are practiced (RAMALHO, SOARES, 2008).

Individuals with T1DM are usually young and often practice physical exercises regularly. Therefore, exercise is recommended, but there might be the risk of hypo- or hyperglycemia. Insulin doses, carbohydrate ingestion and physical exercises should be carefully combined for an adequate control of diabetes (STEPPEL, HORTON, 2003).

In patients that have had the disease for a long time and developed associated complications, exercise may worsen symptoms. For example, in patients with proliferative retinopathy, vigorous exercise may increase the chance of retina displacement or retinal and vitreous hemorrhage (ZINMAN et al, 2004).

At the same time, physical activity can increase the capture of glucose by muscle cells, and physical exercises induce an increase to sensitivity to insulin (KOIVISTO et al, 1986, FERREIRA, et al 2008). Similarly to the effects observed in populations without diabetes, physical exercises may positively affect cardiovascular risk factors usually associated with diabetes. Hemodynamic and metabolic benefits are assigned to physical exercises because of improved resistance to insulin, which is also found in T1DM.

Changes in the lifestyles of individuals with T1DM, diets with lower contents of saturated fats and increased physical activity are efficient to improve glucose control and lipid profile in the long term (PERRY et al, 1997).

Therefore, the regular and supervised practice of physical exercises may contribute to control glucose concentrations, delay disease progression, and prevent chronic complications of T1DM.

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ABSTRACT

Type 1diabetes mellitus (T1DM) is a chronic disease characterized by the autoimmune destruction of insulin-producing beta cells of the pancreatic islet of Langerhans. Their destruction leads to complete insulin deficiency. The autoimmune reaction in T1DM is caused by an association of environmental and genetic factors. Uncontrolled glucose levels and diabetes may lead to blindness, damage to the nervous system, cardiovascular diseases and other complications. Physical exercises are associated with the reduction of cardiovascular mortality in patients with T1DM, and there seems to be an important association between physical exercise and glucose control in patients with T1DM.

Key words: Diabetes; physical exercise; glucose control.

EXERCICE PHYSIQUE ET DIABÈTES MELLITUS DE TYPE 1

RÉSUMÉ

Le diabète Mellitus de type 1 est une maladie chronique qui résulte de l'attaque auto-immune des cellules bêta des îlots de Langerhans du pancréas. Elles sont responsables de la production d'insuline et leur destruction entraîne la déficience totale de cette hormone. La réaction auto-immune dans ce diabète mellitus de type 1 provient d'une association entre des facteurs environnementaux et génétiques. Dans les diabètes, la glycémie non contrôlée peut provoquer cécité, lésions du système nerveux, maladies cardio-vasculaires et autres complications. La pratique d'exercices physiques est liée à la réduction de la mortalité cardio-vasculaire chez des patients atteints de diabètes Mellitus de type 1. Il semble donc y avoir un lien important entre l'exercice physique et le contrôle glycémique de ces patients.

Mots-clés: Diabètes Mellitus, exercice physique, contrôle glycémique.

EJERCICIO FÍSICO Y DIABETES MELLITUS TIPO 1

RESUMEN

El Diabetes Mellitus tipo 1 (DM1) es una enfermedad crónica que resulta del ataque autoinmune de las células beta de los islotes de Langerhans del páncreas. Ellas son los responsables de la producción de insulina y su destrucción resulta en la absoluta deficiencia de esta hormona. La reacción autoinmune en el DM1 es consecuencia de una asociación entre factores ambientales y genéticos. En la diabetes la glicemia no controlada puede causar ceguera, daños en el sistema nervioso, enfermedades cardiovasculares y otras complicaciones. La práctica de ejercicios físicos está relacionada a la reducción de mortalidad cardiovascular en pacientes con DM1, así parece haber una relación importante entre el ejercicio físico y el control glicémico de estos pacientes.

Descriptores: Diabetes Mellitus, ejercicio físico, control glicémico.

EXERCÍCIO FÍSICO E DIABETES *MELLITUS* TIPO 1

RESUMO

O Diabetes *Mellitus* tipo1 (DM1) é uma doença crônica que resulta do ataque auto-imune das células beta das ilhotas de Langerhans do pâncreas. Elas são responsáveis pela produção de insulina e a sua destruição resulta na absoluta deficiência deste hormônio. A reação auto-imune no DM1 é decorrente de uma associação entre fatores ambientais e genéticos. No diabetes a glicemia não controlada pode causar cegueira, danos no sistema nervoso, doenças cardiovasculares e outras complicações. A prática de exercícios físicos está relacionada à redução de mortalidade cardiovascular em pacientes com DM1, assim parece haver uma relação importante entre o exercício físico e o controle glicêmico destes pacientes.

Palavras chave: Diabetes *Mellitus*, exercício físico, controle glicêmico