GUIDELINES FOR THE USE OF PHYSICAL ACTIVITY IN CHILDREN WITH TYPE I DIABETES

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Abstract. Type 1 diabetes is a metabolic disorder whose treatment depends not only on the administration of insulin and diabetic control, but also on properly applied physical activity to improve insulin sensitivity and thus the patient's condition. In order to fulfill this role, physical exercise must be systematic and properly administered. An adequate intensity depends on the physical fitness level of the patient, which may be determined in a six-minute walk test. Before a training cycle, the patient should be subjected to basic clinical tests. The intensity of training may be determined by the Karvonen or Strunz formula to precisely specify the training heart rate (60–75% of maximum heart rate, depending on the condition of the individual). Blood sugar levels should be measured before and after the training session, while during exercise a heart rate monitor should be used. All these measures should help prevent the occurrence of adverse effects such as hypoglycemia.

Key words: type 1 diabetes, insulin, physical exercise

Introduction

Type I diabetes is an increasingly common metabolic disorder which is beginning to be perceived as a social disease. The disease requires continuous infusion of insulin, dietitian's supervision, as well as adequate physical exercise (Burr et al. 2012). Despite the enormous progress in the dissemination of knowledge about diabetes and its treatment, the question of physical exercise and its proper application is still relatively poorly recognized. Insufficient awareness of the role of fixed and regular physical activity, and fear of hypoglycemia among patients, result in their failure to perform sufficiently frequent and adequately intense exercise. In addition, the low level of knowledge among physical education teachers and parents is responsible for the limited physical activity of diabetic children and thus an inadequate treatment (Marques et al. 2011).

Possible complications that are associated with physical exercise should not be an obstacle for diabetics. It is now known that appropriate precautions prevent the development of complications. In addition, preliminary research shows that regular exercise not only prevents complications but may also have a positive impact on the already existing complications and their development (Gromnacki 2002).

It is known that most organs and tissues (including muscle) require insulin to utilize blood glucose. However, a contracting muscle is capable of absorbing glucose even in the absence of insulin. In peripheral tissues, the penetration of glucose into cells occurs via the interaction of insulin with insulin receptors located on the membrane. This interaction results in the activation of several types of glucose transporters, most of which are insulin-dependent and only two of them are activated by physical activity, i.e. they are produced and exist only in the working muscle. This reaction indicates that systematic physical activity favors this kind of transport of glucose in amounts which are sufficient for the utilization of glucose by muscles, and is manifested in reduced insulin levels in the blood (Brasileiros 2011; Zakusilo et al. 2001).

Methods and Indications

Properly dosed exercise has a profound effect on metabolic control of type I diabetes. If adequately applied, it may prolong the patient's life.

Physical exercise should be present throughout the entire lifetime, so the kind of sport should be in accordance with the interests of the patient.

Training must meet two basic criteria. The first is regularity, which can be achieved if the type of exercise is interesting for the patient. Regularity of exercise is very important for increasing insulin sensitivity. The second criterion is the adequate intensity, in order to avoid side effects such as hypoglycemia.

The intensity of exercise should be determined individually for each patient. To this end, the fitness level of the patient must be determined.

The patient's fitness can be measured by a six-minute walk test, after which the patient's heart rate is measured and the effort is estimated on a Borg scale. The evaluation also includes the distance covered in six minutes. The result is qualified for a particular functional class in accordance with American standards:

550–426 m – equivalent to chronic functional class I,

425–300 m – equivalent to chronic functional class II,

300–150 m – equivalent to chronic functional class III,

<150 m – equivalent to chronic functional class IV.

Children with functional class III or IV are not eligible for physical exercise.

Children with more than 12 points on the Borg scale are not eligible for exercise.

During the test the patient's heart rate is controlled. After the effort, the pulse must not exceed the maximum heart rate, which can be calculated using the following formula:

HR max = 220 – age.

Another type of test that can be used to evaluate the fitness of diabetics is walking up 15 steps × 3 at the maximum possible speed. The test uses a modified Borg scale and the measurement of heart rate as in the previously mentioned test.

Table 1. Method of assessing the subjective perception of exercise intensity

Rate	The level of effort	The sensations of the body
6	In general, no effort	Very simply, without effort
8	Extremely light	normal breathing
9	very lightly	A small effort. Breathing deeper.
10		Arises the feeling that muscles work
11	A little hard	Average effort. Breathing more frequent and in-depth.
12		Feels muscle is working.
13		August can easily sweat
14	Hard	Hard work. Shortness of breath can still talk.
15		It feels like thumping heart. Sweating + +
16		
17	very hard	Very hard work. It's hard to say. Acute shortness of breath.
18	It is difficult to	Muscles hurt. Chest taut. Sweating + + +
19		
20	Maximum effort	

Table 2. Modified Borg scale. The scale of perceived dyspnea

Rate	Description
0	Shortness does not occur
0.5	Extremely weak
1	Very poor
2	Poor
3	Very poor
4	Relatively large
5	Large
6	–
7	Very large
8	–
9	Very very large
10	Max Large

More than 4 points on the modified Borg scale excludes a diabetic child from undertaking physical activity (Tepperman et al. 1987).

Determination of child's fitness should be followed by the necessary clinical tests:

- Measurement of glycated hemoglobin: 5.0–6.5% well controlled diabetes, 6.6–7.5% sufficiently controlled diabetes, >7.5% not controlled diabetes.
- Measurement of blood glucose level.
- Acetone in urine. Blood sugar levels exceeding 14 mmol/l may result in the appearance of acetone in urine.
- Eye examination.
- ECG – control, control of blood pressure.
- Parent's evaluation (subjective) of the child's fitness.
- Establishing the times of meals and insulin injections before the training session.

After obtaining the test results, if the physician finds no contraindications, the diabetic child may undertake exercise.

The purpose of exercise is not the fastest possible reduction in blood sugar, but the induction of adaptive responses from exercise.

There are many reports on the long-term effects of regular physical activity in diabetics, improving insulin sensitivity through the synthesis of glucose transport protein GLUT-4. An exercise-induced increase of GLUT-4 in cell membranes was approximately 70.0% compared to baseline values in a study by Kennedy et al. (Otto--Buczkowska 2006; Tepperman 1987).

Based on traditional pedagogical assumptions, the structure of a physical education class can be adapted to the needs of diabetic children. Many exercises and games can be prepared in a less stressful or non-competitive form, and running may be replaced by walking. In this way, the participation of diabetic children, taking into account the effort curve and monitoring their heart rate during exercise, will influence the transport of glucose from the blood into tissues.

It is recommended that such classes be held three times a week. Initially, the class duration should be 30 minutes, and then may be extended to 45 minutes. During the first two weeks the presence of a physician is recommended.

Studies have shown that the patient's heart rate during exercise has a significant impact on improving the work of his heart and lungs.

Ideal HR can be calculated by the Karvonen formula:

HR during exercise = (max HR – resting HR) × 40.0–60.0% + resting HR

max HR = 220 – age

Resting HR = after waking up in the morning without an alarm clock, HR is measured for one minute before getting out of bed.

Or according to the formula by Strunz:

Resting HR + (220 – 3/4 age – resting HR) × 0.6 (for people without preparation), or × 0.65 (moderate preparation), or × 0.7 (good preparation).

If the child has exercised previously, training HR should be 75.0% of the maximum heart rate, and the perception of effort intensity on the Borg scale should be 13.

If the child has not exercised before, HR during training should be 50.0–60.0% of the maximum HR, and the perception of the effort on the Borg scale should be 12 (Zakusiło 2001) .

The exercise should be followed by the rest period during which restitution processes occur. The most common form is a passive rest which does not require muscle activity. One can also use other forms of active rest, with stimulation of muscles that have not been previously active (Kasatkina 1990, 1996).

Thus, prepared physical activity significantly improves metabolic control in children with type 1 diabetes. The form and organization of physical activities may vary, but taking the intensity of exercise into account, the best suited are walking, swimming and cycling.

Prior to the start of classes the child's blood sugar levels should be measured, which can also be checked during and after exercise. During the class, the child should have a heart rate monitor so one can constantly monitor their heart. This helps to avoid a sudden drop in blood sugar concentration and other negative reactions.

Discussion

Exercise is an integral component of the treatment of type 1 diabetes. It is well known that exercise significantly increases insulin sensitivity, improves the ability to perform daily activities, improves overall health and normalizes lipid parameters (Ponikowska et al. 2006).

Unfortunately, fear of hypoglycemia induced by physical activity is very much prevalent. This results in the reluctant attitude of patients with type 1 diabetes to enter into physical activity (Krzemińska 2009).

In the case of exercise-induced hypoglycemia, glucagon administration does not always produce the expected increase in blood glucose levels, as exercise results in the depletion of glycogen from which glucose is released by glucagon. In order to avoid hypo- and hyperglycemia during exercise, glucose should be frequently monitored by a glycose meter before, during and after exercise. It should also be remembered that long-term physical activity during the day, such as hiking, can lead to low blood sugar at night. Before the exercise, one usually needs to eat extra carbohydrates, and sometimes also reduce insulin administered with a meal before exercise, or even consider reducing the dose of long-acting insulin given for the night. Importantly, physical exercise is not recommended for type 1 diabetes if initial glucose levels are higher than 250 mg/dL (14 mmol/l) and urine ketones are present (Kemmer 1992).

However, the manageable complications that are associated with physical exercise should not be an obstacle to diabetics. Apart from the physiological effects, exercise also has a large impact on the mental state of patients. Very often the patient is afraid of any physical activity. It is therefore important to carry out educational activities and inform patients about the possibility and benefits of exercise.

Patients who regularly undertake exercise also tend to improve their mental status. In children, even minor successes in sport encourage them to get involved in further activity and increase their self-confidence. A person with type 1 diabetes should make every effort to make their life active. Diabetes is not a sentence, but a disorder whose effects can be minimized by the adequate behavior and proper preventive actions.

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