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Conference Report

Self-monitoring adherence to physical activity in children and adolescents with type 1 diabetes

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Abstract. Monitoring blood glucose is essential for good diabetes control and even more important when participating in sports. Many variables can have an effect on blood sugar response to aerobic or anaerobic activities. A moderate exercise produces an average fall in plasma glucose of ~ 40% of baseline values. The majority of hypoglycaemia episodes occurs in children with pre-exercise plasma glucose concentrations < 120 mg/dl, therefore it is advisable to achieve a blood glucose level of at least 120 mg/dl if not higher before starting an exercise in order to prevent hypoglycaemia episodes. Since 15 g of oral glucose result in only about a 20-mg/dl rise in glucose concentrations, 30-45 g of oral glucose may be more appropriate to treat hypoglycaemia during exercise. A sufficient adherence to the physical activity prescribed by the health care professionals it easy to find in the children with Type 1 diabetes. According our experience, 60 per cent of the children report to spend on average 1 hour daily for exercise, proving so to consider physical activity beneficial in the treatment of diabetes mellitus. Glycate haemoglobin levels in these motivated patients were better than in children exercising sporadically and shortly either at school or in the spare time. Although the health care professionals effort, only half of the patients referred to monitor blood glucose levels before, after or before and after the exercise. Only one third of the patients reported to regularly adjust insulin dosage to own response to physical activity. Two third of the patients referred to consume added carbohydrate to avoid hypoglycaemia. (www.actabiomedica.it)

Key words: Type 1 diabetes, exercise, physical activity, children, adolescents

Introduction

Children and adolescents with Type 1 diabetes should be involved in exercising since a regular physical activity has showed beneficial effects on body composition, blood pressure, insulin sensitivity, blood glucose utilization and blood lipid profile (1). In addition, exercise has been reported to positively affect well-being, quality of life and social interaction (2, 3). A further motivation supports the involvement of diabetic children in sport participation: in individuals who regularly exercise less risk of diabetes complications and an improved longevity have been found (4).

Despite these benefits, it is still nowadays easy to find in parents, school staff, or physicians a trend to feel negatively toward physical activity and to discourage children and adolescents with type 1 diabetes from participating in vigorous sports and games. This attitude might be related to the lack of evidence-based recommendations for preventing acute metabolic derangements during exercise (5, 6). The response of blood glucose levels to exercise type and duration is not well known because few studies on physical activity in children with type 1 diabetes have been conducted.

The current guide-lines for a save participation in exercise do not usually distinguish between conti-

nuous and intermittent exercise and recommend similar strategies to manage blood glucose levels, e.g. for soccer and jogging (7). Other recommendations for minimizing the risk of hypoglycaemia suggest a more pronounced reduction in insulin doses administration for vigorous sports, like hockey and baseball, than for moderate or intense prolonged exercises (8).

Self-monitoring before, during and after exercise

The American Diabetes Association and the American College of Sports Medicine recommend for people with diabetes who take insulin to keep blood sugar above 100 dl/mg and below 250mg/dl to 300 mg/dl with ketones. The associations also recommend delaying exercise when blood sugars are above 300mg/dl whether or not ketones are present. Since most aerobic exercise of moderate to heavy intensity will drop blood sugar, it is important to start with a higher blood sugar (i.e., 150 mg/dl) to provide a buffer so the athlete does not go too low during the activity. This pre-exercise blood glucose (BG) level is individualized and may change due to the intensity and/or duration of the activity. The only way to know what BG level works best is to check blood sugars frequently during exercise.

A good goal is to make sure blood sugar is not too low or too high prior to exercise, during exercise and even after exercise. This can only be achieved through prudent monitoring of blood sugar. To avoid wide swings it is advisable to check blood sugar one hour before and thirty minutes before an activity. This will give two BG levels to identify a trend of blood sugars going down (i.e., 150 mg/dl to 90 mg/dl) or possibly up (e.g., 150 mg/dl to 260 mg/dl) and it gives enough time to adjust if needed.

In an ideal situation with good planning and good pre-exercise blood glucose, no changes need to be made during an activity. Athletes who are well controlled usually will not go low during exercise. More often low blood sugars occur several hours after activity and even up to twenty-four hours later. This post exercise delayed-onset hypoglycemia can be prevented with proper planning. Checking blood sugar upon completion of an activity will determine the action needed for replacing glycogen stores lost during exercise. Ideally, an athlete should eat some carbohydrates within thirty minutes of stopping an activity. This will help avoid delayed-onset hypoglycemia as well as aid in performance for activity the next day. It is easy to replace glycogen store immediately after exercise when BG levels are normal or even below normal. The dilemma becomes when an athlete completes an activity and blood sugar is high (i.e., 300+ mg/dl) and glycogen stores need to be replaced. A blood sugar at this level will usually need insulin to bring it down to a normal level as well as water to flush out potential ketones. If insulin is used to bring down a high blood sugar, it is important to check again relatively soon to make sure the levels do not go too far the other way. If using a rapid acting analog it is best to check within a half hour of giving insulin to see the affect it had on the blood sugar. Once the blood sugar is within a relatively normal range, carbohydrates can be consumed.

Evidence-based recommendations

The majority of the guide-lines type 1 diabetes on management during exercise are not supported by evidence-based findings and are due to personal experiences or clinical practice. Two groups of investigators have recently studied the changes in glucose and counter-regulatory hormones during various exercise patterns, simulating the spontaneous plays in children and adolescents, and collected a series of evidence-based recommendations very useful for people exercising with type 1 diabetes.

Guelfi et al. (9) examined the effects of exercise on a bicycle ergometer over 30-min period with (Intermittent high-intensity exercise =IHE) and without (Moderate-intensity exercise: MOD) brief maximal spurts, and showed for the first time that the decline in blood glucose levels is less with IHE compared with MOD during both exercise and recovery time. This unexpected response to exercise may be due to the increase in catecholamine and growth hormone observed during the repeated bouts of IHE that would have in turn blunted the fall in glucose concentrations. The observations performed in this study ha-

ve at least two practical implications: 1) since the risk of hypoglycaemia seems to be higher with MOD than with IHE, individuals with type 1 diabetes have not to be afraid to engage a vigorous exercise ; 2) the decline in blood glucose levels during MOD, such as cycling or jogging, may be attenuated by brief spurts of activity (9).

The acute glucose-lowering effects during MOD have been more recently examined by the DirecNet Study Group in adolescents with type 1 diabetes involved in a prolonged moderate aerobic exercise (75-min of walking followed by a 5-min seated rest period) (10). This experience highlighted several practical messages: 1) a moderate exercise produces an average fall in plasma glucose of ~ 40% of baseline values; 2) the majority of hypoglycaemia episodes occurs in children with pre-exercise plasma glucose concentrations < 120 mg/dl, therefore it is advisable to achieve a blood glucose level of at least 120 mg/dl if not higher before starting an exercise in order to prevent hypoglycaemia episodes; 3) since 15 g of oral glucose result in only about a 20-mg/dl rise in glucose concentrations, 30-45 g of oral glucose may be more appropriate to treat hypoglycaemia during exercise.

The increase in counter-regulatory hormones observed during exercise in DirecNet Study Group failed to prevent the fall in glucose levels, indicating that exercise-induced increases in glucose utilization had not been compensated by appropriate increases in endogenous glucose production (10). This finding is in contrast with that observed by Guelfi et al. (9) and may be likely due, in DirecNet Study, to the lack of adjustment of basal insulin before exercising that could have contributed to the inability of the liver to meet the increased metabolic demands of prolonged physical activity.

Adherence to exercise

The recent news on type 1 diabetes management in active individuals focus how the glycaemic response to exercise depends on different factors: plasma glucose and insulin levels at the start of exercise, intensity and duration of the exercise, and previous food intake. All these parameters should be regularly monitored before, during and after exercising in order to safely exercise.

The highest degree of adherence in adults with diabetes has been related to the home-based exercise programs (11). Sporting habits in children and adolescents with diabetes have been sporadically analyzed (12) and consequently few information is available on their adherence to exercise.

We had the opportunity to investigate time spent exercising, adherence to physical activity and ability to take appropriate measures to reduce potential exercise in a cohort of young people with diabetes attending the out-patient clinics of our Regional Centre (13).

Interviewed subjects by an appropriate questionnaire showed a sufficient adherence to the physical activity prescribed by the health care professionals. Sixty per cent of them reported to spend on average 1 hour daily for exercise, proving so to consider physical activity beneficial in the treatment of diabetes mellitus. Glycate haemoglobin levels in these motivated patients were better than in children exercising sporadically and shortly either at school or in the spare time.

The key to success in exercise prescription is individualization. Whenever possible, an exercise contract should be arranged with the patient taking into account age, lifestyle and motivation. Following this guideline, the patients enrolled in our study approached a large range of physical activities, as a confirmation that each one chose the exercise he enjoyed and usually that he was performing before diabetes diagnosis. All the interviewed patients obtained at discharge and in out-patient clinic specific instructions for a safe exercise and information on the risk of hypoglycemia during and after exercise, and on the risks of physical activity if diabetes was minimally controlled. Although the health care professionals effort in this field, only half of the patients referred to monitor blood glucose levels before (29%), after (41%) or before and after (30%) the exercise. Nobody reported to check blood glucose levels during exercising. Patients herein studied were instructed to use blood glucose monitoring to identify when changes in insulin or food intake were necessary.

Concerning insulin, only one third of the patients reported to regularly adjust insulin dosage to own response to physical activity. The things went better for

adjusting food intake .Two third of the patients referred to consume added carbohydrate to avoid hypoglycemia, but a small number of them were used to drink liquid with sugar and salt or fluid snacks during exercise. These results should press health care professionals to review regularly the ability of their patients in managing physical activity and to check their adherence to the program for a safe exercise.

Thanks to the adherence to the guidelines for a safe exercise, our patients reported a low number of severe episodes of hypoglycaemia which usually appeared at the end of exercise. A few patients experienced hypoglycemia several hours after the exercise, during the night. Post-exercise hypoglycemia and delayed onset of hypoglycemia can occur up to 24 hours after exercise. This is due to increased insulin sensitivity and depleted glycogen stores which occur also after a moderate physical activity (14). Some studies showed that this nocturnal neuroglycopenia reduces the sense of wellbeing, increases subjective determinants of fatigue and affects physical performance during the following day (15). In order to prevent these complications and to identify when changes in insulin or food intake are necessary, it is helpful for patients to monitor blood glucose levels before, during and after exercise.

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