ACTA BIOMED 2005; 76; Suppl. 3: 85-88

CONFERENCE REPORT

Physical activity and diabetes

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Abstract. Although physical activity is frequently recommended in the management of type 1diabetes it has not yet been established whether practising regular exercise could actually improve the long-term outcome of metabolic control. In this follow-up study we assessed the impact of long-term physical activity in patients with type 1 diabetes mellitus. We studied longitudinally 69 patients with type 1 diabetes mellitus, 43 boys and 26 girls aged at onset of the disease 8.98±3.90 years with a mean duration of the disease of 97±63 months. The patients were classified according to the duration of the disease in 3 groups [A:24-60 months (69); B: 61-120 months (41); C≥121 months (19)]. The average time spent weekly doing exercise was recorded for each patient in the three duration periods taken into account. On average our patients reported 3,0±2,9 hours of physical activity per week. On the basis of the hour/week of physical activity we divided the patients into 4 groups [G1: <2hrs/week (46%); G2: 2-4 hrs/week (29%); G3 >4 hrs/week (22%) ≥7 hrs/week (3%)]. The duration group B showed a significant lower HbA1c and HbA1c adjusted for duration of the disease in G4 compared to G2($p<0.05$) and G3 ($p<0.05$). No differences were found for insulin requirement, weight excess, blood pressure and heart rate between active and sedentary patients. According to our results we concluded that exercise can improve the quality of metabolic control only if it is adjusted to the training level of the patient. (www.actabiomedica.it)

Key words: Type1 diabetes, exercise, sport, physical activity

Introduction

Although Type 1 diabetes treatment is mainly based on insulin replacement therapy and dietary advise, a program of regular physical activity is frequently recommended in order to achieve a better metabolic control and to prevent macrovascular complications (1-3). Intense exercise (>80% VO_{2max}) is normally followed by a sudden hyperglycaemic response caused by transient insulin-resistance due to α and β-adrenergic receptor activation (4). However 24 hours after intense exercise or immediately after moderate exercise (<50-60% VO_{2max}) an increase of the insulin sensitivity causes a fall in blood glucose reaching eu- or hypoglycemia (5). Furthermore it is well known that exercise increases protein lipase activity with favourable changing of blood lipids such as reduction of triglycerides and cholesterol and increase of HDL cholesterol (5). Thus long-term regular physical activity should reduce insulin requirement and improve metabolic control and lipoprotein profile. However it must be taken into consideration that the limited number of cross-sectional and longitudinal studies on long-term influence of physical activity in type 1 diabetes have often failed to show any clear improvement in glycemic control as measured by HbA1c (2, 6, 7).

The aim of this study is to evaluate in a longitudinal way the influence of exercise on metabolic control, insulin requirement, weight excess and blood pressure in children, adolescents, and young adults practising different types of physical activity and the amount of time dedicated to physical activity.

Patients and methods

Sixty-nine Type 1 diabetic subjects, 43 boys and 26 girls aged at onset of the disease 8.98±3.90 years with a mean duration of the disease of 97±63 months, were studied over a seven year period (08/01/1996-08/01/2003). All patients, treated with 2/4 daily subcutaneous shots of regular and/or long acting insulin, attended the diabetic clinic every two-three months. The clinical assessment included height and weight measurement, pubertal stage evaluation, glycosylated haemoglobin (HbA1c) measurement (DCA 2000, Bayer Diagnostics) and computerized download of the blood glucose monitoring of the last four weeks. The total time spent practising physical activity every week and the types of sport chosen was investigated every three months by a specific questionnaire. Moreover we recorded the number of hypoglycaemic events both symptomatic and non-symptomatic as reported in the personal diary on the last four weeks. Patients were also annually evaluated for retinopathy (fundus *oculi* and fluorangiography when indicated), nephropathy (nocturnal microalbuminuria), neuropathy (EMG) autoimmune thyroiditis and celiac disease (antibodies). Thirty-one patients were studied from the onset of diabetes and the remaining 38 patients had, at start of the study, a disease duration ranging from 1 to 14 years (mean±1SD 4.7±3.7 years). Eighteen patients were followed-up for 7 years, 11 for 6 years, 8 for 5 years, 10 for 4 years, 6 for 3 years, 10 for 2 years and 6 for 1 year.

Statistical analysis

The results are reported as mean±1SD and the statistical analysis was performed by ANOVA, multiple regression analysis, paired and unpaired Student's t test, paired sign test and Mann-Whitney Test where appropriate. The 5% level of significance was used. The sample size was sufficient for a power of 0.80 to detect a 10 % decrease of HbA1c.

Results

On average our patients reported 3.0±2.9 hours of physical activity per week. Girls reported significantly fewer hours of exercise per week than boys (2.5±2.1 *vs* 3.9±2.7 ; t=-2.7, p<0.01) (Fig. 1). The difference between boys and girls was more evident after 5 years duration of the disease. Patients were classified according to the duration of the disease in 3 groups [A: 24-60 months (69); B: 61-120 months (41); C≥121 months (19)]. On the basis of the hour/week of physical activity we divided patients into 4 groups [G1: <2hrs/week (44%); G2: 2-4 hrs/week (25%); G3 4-7 hrs/week (23%); G4 > 7hrs/week (8%)]. The distribution in the four groups of the exercise intensity was the same in the three groups of duration of the disease. The duration group B showed a significant lower HbA1c and HbA1c adjusted for duration of the disease in G4 compared to G2 (7.7±0.8% vs 6.3±0.3%; p<0.05) and G3 (7.9±0.8% vs 6.3±0.3%; p<0.05) (Fig. 2). Systolic and diastolic blood pressure and heart rate were adjusted for age, stature, weight excess and gender. No differences were found for insulin requirement, weight excess, adjusted blood pressure and heart

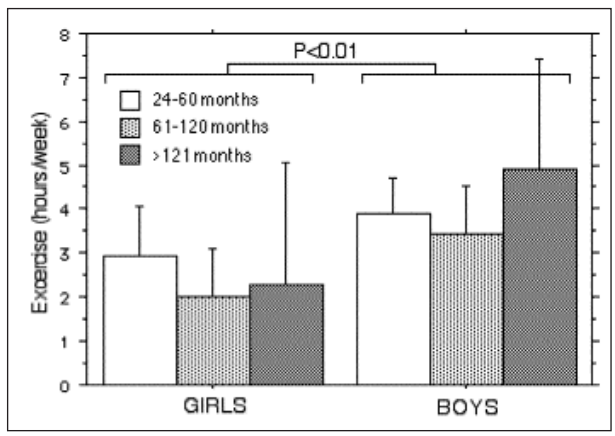

Figure 1. Comparison of the time per week spent doing exercise in girls and boys with different duration of diabetes. Student t-test significance is reported

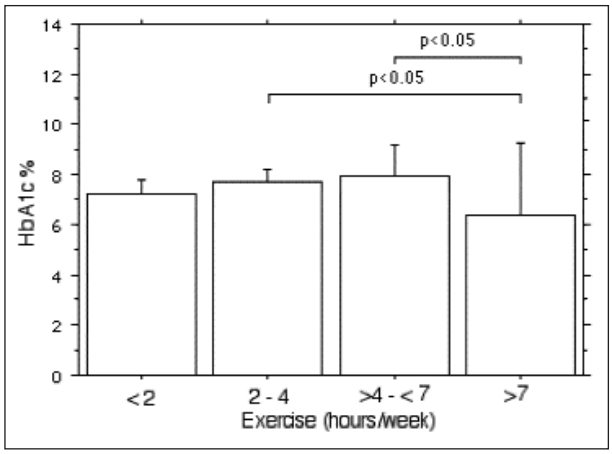

Figure 1. Comparison between mean±1SD HbA1c adjusted for duration of the disease in four groups of patients practising exercise with different intensity. Statistical significance of Mann-Whitney test is reported

rate between active and sedentary patients. Moreover we didn't find any statistically significant correlation between the hours of exercise per week and heart rate adjusted for age and gender.

Discussion

We longitudinally monitored the amount of physical activity performed every week in a group of diabetes children and adolescents with a disease duration ranging from 2 to 20 years. We compared the metabolic control in groups of patients practicing sports at four different intensity levels. We found a significantly lower HBA1c in patients who practice an intense exercise (on average 1 hour per day) compared to those who practice less exercise (<2 or <4 hours/week), only in the group with a diabetes duration of five-ten years. Our results are partially in agreement with a previous cross-sectional study on the effects of long-term physical activity showing no correlation between different levels of exercise and glycemic control in 221 Type1 diabetes patients between 18 and 45 years of age (7). Surprisingly the group of patients who report practicing no exercise at all, showed on average no difference in metabolic control compared to that of strongly active patients. However these results are in agreement with the observation that the same activity (such as a football match) requires a different intensity of exercise depending on the patients' training. Poorly-trained patients with impaired metabolic control work at >80% VO_{2max} leading to a marked prompt catecholamines and glucagon response with a consequent early hyperglycemia and possibly ketonemia and late hypoglycemia. On the other hand the well-trained patients in good metabolic control work at ≤60% VO_{2max} showing both early and late gradual decrease of blood glucose during and after exercise (4). Therefore intense exercise in poorly-trained patients can be detrimental and this can explain why physical activity is not always associated with a better metabolic control.

Conclusion

Exercise can improve the quality of metabolic control only if it is adjusted to the training level.

A well-trained patient can achieve a long-term improvement of his metabolic control. A poorly trained patient can benefit from moderate exercise, while strenuous activity is detrimental for the quality of his metabolic control. Girls tend to practice less exercise than boys do, particularly after the first five years of disease. Thus it would be useful to promote physical activity among diabetic girls.

Acknowledgements

We acknowledge Mrs Catriona Cameron for her revision of the English text. This work was supported by grants (FAR) from University of Insubria - Italy.

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