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Influence of Flexible Insulin Dosing with Carbohydrate Counting Method on Metabolic and Clinical Parameters in Type 1 Diabetes Patients

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Abstract

OBJECTIVE: The purpose of providing and maintaining a proper metabolic control is to prevent the development of chronic complications. In this study, we aimed to determine the influence of flexible insulin dosing with carbohydrate counting method on metabolic and clinical parameters in type 1 diabetes patients.

MATERIAL AND METHODS: This study was conducted with patients following up at the Endocrinology Clinic with a diagnosis of type 1 diabetes mellitus between 2012 and 2015. Metabolic and clinical parameters before and after carbohydrate counting were compared.

RESULTS: Forty patients were included in the study. Of the patients, 40% (n = 16) were female, and 60% (n = 24) were male, and mean age was 21.5 ± 7 year at the time of diagnosis. Statistically significant differences were not detected when haemoglobin A1c, fasting plasma glucose, post-prandial glucose, LDL-cholesterol, and HDL-cholesterol levels were compared at standard dose insulin use and after carbohydrate counting ($P < 0.005$). Among the parameters measured when the patients received standard dose of insulin without counting carbohydrate and flexible insulin dosing by counting carbohydrate, statistically, significant differences were not detected for baseline insulin dose, bolus insulin dose, triglyceride level, body mass index, or monthly hypoglycemia episodes ($P > 0.05$).

CONCLUSION: Flexible insulin dosing with carbohydrate counting provides significant improvements in clinical and metabolic control. We detected improvements in lipid profiles and glycemic control. Additionally, patients generally did not gain weight despite flexible nutrition, and frequency of hypoglycemia remained unchanged despite strict glycemic control.

Introduction

Diabetes mellitus is a critical health problem. Its prevalence is gradually increasing, leading to higher morbidity and mortality. Approximately 5 to 10% of diabetic patients have type 1 DM [1]. Diabetes prevalence has been determined to range from 7.2 to 11.4% worldwide according to data from the International Diabetes Federation. In Turkey, the prevalence of diabetes among individuals 20 years and above is 13.7% [2].

The goal of providing and maintaining proper metabolic control is to prevent the development of chronic complications. Various treatment methods have been investigated for this purpose [1] [2] [3]. Reducing HbA1c levels through effective insulin treatment was shown to reduce the risk of microvascular complications of diabetes. Carbohydrate counting enables diabetic patients to pursue flexible nutrition and flexible insulin dosing [4]. In this study, we aimed to investigate the influence of flexible insulin dosing with carbohydrate counting method on metabolic and clinical parameters in type 1 diabetes patients.

Material and Methods

This study was conducted with 40 patients who are presented at the Endocrinology Clinic with a diagnosis of type 1 diabetes mellitus between 2012 and 2015. Definition of type 1 DM followed the criteria defined by the World Health Organization. Subjects were evaluated regarding age, gender, clinical signs and symptoms at the time of diagnosis, duration of symptoms, and blood and urine biochemistry. Glycosylated haemoglobin concentrations (HB A1c%) were measured using the tribometric inhibition immunoassay method with a Cobas Integra analyser. Biochemical tests-fasting plasma glucose, postprandial plasma glucose, total cholesterol, triglyceride, LDL-cholesterol, HDL-cholesterol levels were measured using an Olympus AU600 (Olympus Optical Co. Ltd., Japan) auto-analyser following manufacturer instructions.

Patients who participated in the study completed three stages of carbohydrate counting. The patients who have been using flexible insulin dosing with carbohydrate counting were doing this for 6 to 24 months. A total of 56 patients with type 1 DM younger than 18 years were assessed for eligibility in the study, or those who were pregnant (n = 4), lactating (n = 2), or unaware of carbohydrate counting (n = 6) and had not completed all three stages of carbohydrate counting (n = 4) were excluded from the study. Body composition was determined using Tanita BC-418 via height, weight, bioelectric impedance analysis, and body mass index (BMI) calculations. Data about insulin dosing before carbohydrate counting, hypoglycemic event count, biochemical and metabolic parameters were obtained from patient files. Those patients who had missing data were not included in the study.

Subjects were compared regarding metabolic and biochemical parameters before and after carbohydrate counting.

All data are given as mean±standard deviation (SD). Statistical analyses were done with SPSS 16.0 (SPSS Inc., Chicago, IL). Correlation analyses were performed using Pearson correlation analysis. Statistical analyses of averages were done using independent paired t-test and Wilcoxon test. A p level of < 0.05 was accepted as statistically significant.

Results

A total of 40 patients completed the study. Of the patients, 40% (n = 16) were female, 60% (n = 24) were male. Mean age was 21.5 ± 7 years at the time of diagnosis. A statistically significant difference was not detected between groups regarding gender distribution (P > 0.05). Socio-demographic characteristics of the subjects are shown in Table 1. Clinical and laboratory outcomes of the patients when using standard insulin dosing and flexible insulin dosing with carbohydrate counting are shown in Table 2.

Table 1: Socio-demographic characteristics of the patients

Parameters	
Age (year), median	21.5 ± 7
Body mass index (BMI, kg/m^2)	22
Diabetes age (year)	12.8 ± 9.1
Gender (M/F)	n:24.60%/n:16.40%
Duration of carbohydrate counting (month) median	18.4 (6-24)

Median haemoglobin A1c values with standard insulin dosing and flexible insulin dosing were 8.0% and 7.30%, respectively (P = 0.007). Fasting plasma glucose was found to be 165.90 mg/dl before carbohydrate counting and 140.70 mg/dl after carbohydrate counting (P = 0.049).

Table 2: Clinical and laboratory outcomes of the patients when using standard insulin dosing before carbohydrate counting and when using flexible insulin dosing according to carbohydrate counting

Parameters	Standard insulin dosing before carbohydrate counting	Flexible insulin dosing according to carbohydrate counting	P value
BMI (kg/m^2)	22	22	0.121
Hemoglobin A1c (%)	8.1	7,3	0.007
Fasting plasma glucose (mg/dL)	165.9	140.7	0.049
Post-prandial glucose (mg/dL)	241.1	149.43	0.001
Triglyceride (mg/dL)	85	94	0.863
HDL-cholesterol (mg/dL)	55.5	66.5	0.039
LDL-cholesterol (mg/dL)	85.5	78.5	0.036
Hypoglycemia (episodes/month)	4	4	0.124
Total insulin dose (IU/day)	38.5	37	0.738
Basal dose (IU/day)	16	20	0.056
Bolus dose (IU/day)	19	18	0.224

Post-prandial plasma glucose was 241.10 mg/dl before carbohydrate counting and 149.43 mg/dl after carbohydrate counting (P = 0.001). LDL-cholesterol level was detected to be 85.50 mg/dl when patients used a standard dose of insulin and 78.50 mg/dl when they used flexible insulin dosing (P = 0.036). HDL-cholesterol levels were 55.50 mg/dl before carbohydrate counting; they reached 65.50 mg/dl with flexible insulin dosing (P = 0.038). However, a statistically significant difference was not detected between the periods before and after carbohydrate counting regarding basal insulin dose, bolus insulin dose, triglyceride level, body mass index, or monthly hypoglycemia episode count (P > 0.05).

Discussion

Very strict low carbohydrate intake was a method used to treat type 1 DM before the discovery of insulin. Lower glucose levels are obtained with a flexible dose of multiple insulin injections with

carbohydrate counting. Therefore; actual guidelines recommend intensive insulin treatment paired with a flexible diet [5]. The target of carbohydrate counting is to promote glycemic control by implementing a consistent pattern of carbohydrate consumption with meals and snacks from day to day. Since carbohydrate intake directly identify postprandial blood glucose, management of carbohydrate consumption and suitable insulin adjustments for identified amount of carbohydrate can improve glycemic control [6]. In our study, patients are applying short-acting insulin with carbohydrate counting for 18.4 (6-24) months. This method provides flexibility in carbohydrate intake. Many patients may not optimally follow this method due to the high carbohydrate content of foods or being unable to estimate the proper dose [7]. In follow-ups with our patients, they were seen to match short-acting insulin and carbohydrates according to fasting and post-prandial plasma glucose. This may be explained by close monitoring of the patients and long-lasting education about carbohydrate counting.

Studies are available indicating that carbohydrate-restricted diet may be a lifestyle option in patients wanting to lose weight. A carbohydrate-restricted diet leads to weight loss in patients with type 1 DM [8] [9]. Our patients did not have a change in weight when they used flexible insulin dosing with carbohydrate counting compared to a standard dose of insulin use with a conventional diet ($P > 0.05$). Some studies showed that the patients eating with carbohydrate counting had higher BMI compared to the patients eating a conventional diet [10]. These studies reported that intensive insulin treatment and a flexible eating plan might lead to an increase in BMI of patients with type 1 DM [11].

Studies have shown that the A1c level was lower in patients who used flexible insulin dosing with carbohydrate counting [12]. Prandial insulin dose was shown to lead to 1-1.5 units of a decrease in A1c value, as it is performed according to total insulin dose [13]. The appearance of chronic complications is delayed when glycemic control and A1c control are achieved with intensive insulin treatment. Complication development slows down between 30% and 75% [14] [15]. In our study, we detected that patients could achieve a better glycemic control when they used flexible insulin dosing with carbohydrate counting. We detected a 9.8% decrease in HbA1c value ($P = 0.007$), a 15% decrease in fasting plasma glucose ($P = 0.049$), and a 37.9% decrease in post-prandial plasma glucose ($P = 0.001$). These differences are statistically significant.

Hypertriglyceridemia correlated with hyperglycemia and low HDL-cholesterol is seen in patients with type 1 DM. This impaired lipid profile may improve with active insulin treatment [16]. Studies have shown that while triglyceride, HDL-cholesterol decrease, LDL-cholesterol was shown to increase in patients using flexible insulin dosing [13]. In our study, triglyceride level was seen to increase 11.7% ($P = 0.863$), HDL-cholesterol level was seen to increase 19.8% ($P = 0.039$), LDL-cholesterol level was seen to decrease 8.1% ($P = 0.036$) when treatment was switched to flexible eating, flexible insulin dosing from conventional eating. This lipid profile may be explained by better glycemic control through flexible eating and intensive, flexible insulin dosing.

Studies have not detected a difference between patients who use flexible insulin dosing with carbohydrate counting and who use standard insulin dosing regarding insulin dose and hypoglycemia frequency [10] [11] [12] [13] [14] [15] [16]. Meta-analysis could not be done due to inconsistency between hypoglycemia measurement and reporting; however, the frequency of hypoglycemia was estimated to decrease [17]. In our study, a statistically significant difference could not be detected about basal and bolus insulin dose or some hypoglycemic episodes when treatment was switched to flexible insulin dosing from standard insulin dosing ($P > 0.05$). Daily total insulin dose decreased by 3.8% ($P = 0.738$), bolus insulin dose decreased by 5.2% ($P = 0.224$), and basal insulin dose increased by 25% ($P = 0.056$). Monthly median hypoglycemic episode count was equal in both conditions at 4 hypoglycemic episodes/month. HbA1c levels would be normal in all diabetic patients if hypoglycemia did not occur. Hypoglycemia limits long-term benefits of glycemic control in patients with type 1 DM [18] [19]. Flexible insulin dosing, carbohydrate counting, and flexible eating provide better glycemic control without increasing hypoglycemia risk in patients with type 1 DM.

In conclusion, flexible insulin dosing with carbohydrate counting provides a significant improvement in clinical and metabolic control. We detected that frequency of hypoglycemia did not change despite improvements in lipid profile, glycemic control, lack of weight gain despite flexible eating, and strict glycemic control. This method enables the patients to enjoy a more flexible life and is more sustainable. Patients should be provided with a more flexible lifestyle through better nutrition education and more active participation in the treatment of their diseases.

References

1. Dias VM, Pandini JA, Nunes RR, Sperandei SL, Portella ES, Cobas RA, et al. Effect of the carbohydrate counting method on glycemic control in patients with type 1 diabetes. Diabetol Metab Syndr. 2010; 17(2):54. https://doi.org/10.1186/1758-5996-2-54 PMid:20716374 PMCid:PMC2933609

2. Satman I, Omer B, Tutuncu Y, Kalaca S, Gedik S, Dinccag N, et al. Tuomilehto J. Twelve-year trends in the prevalence and risk factors of diabetes and prediabetes in Turkish adults. Eur J Epidemiol. 2013; 28(2):169-80. https://doi.org/10.1007/s10654-

013-9771-5 PMid:23407904 PMCid:PMC3604592

3. Eppens MC, Craig ME, Cusumano J, Hing S, Chan AKF, Howard NJ, et al. Prevalence of diabetes complications in adolescents with type 2 compared with type 1 diabetes. Diabetes Care. 2006; 29(6):1300-06. https://doi.org/10.2337/dc05-2470 PMid:16732012

4. James ML, Green L, Amiel SA, Choudhary P. Evaluation of the Effect of Carbohydrate Intake on Postprandial Glucose in Patients With Type 1 DiabetesTreated With Insulin Pumps. 2016; 10(6):1287-1293.

5. Chiang JL, Kirkman MS, Laffel LMB, Peters AL. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. Diabetes Care. 2014; 37:2034-54. https://doi.org/10.2337/dc14-1140 PMid:24935775 PMCid:PMC5865481

6. Nuttall FQ. Carbohydrate and dietary management of individuals with insulin-requiring diabetes. Diabetes Care. 1993; 16:1039-42. https://doi.org/10.2337/diacare.16.7.1039 PMid:8359099

7. Lawton J, Rankin D, Cooke D, Elliott J, Amiel S, Heller S. Patients' experiences of adjusting insulin doses when implementing flexible intensive insulin therapy: a longitudinal, qualitative investigation. Diabetes Res Clin Pract. 2012; 98:236-42. https://doi.org/10.1016/j.diabres.2012.09.024 PMid:23084281

8. Krebs JD, Parry Strong A, Cresswell P, Reynolds AN, Hanna A, Haeusler S. A randomised trial of the feasibility of a low carbohydrate diet vs standard carbohydrate counting in adults with type 1 diabetes taking body weight into account. Asia Pac J Clin Nutr. 2016; 25(1):78-84. PMid:26965765

9. Nansel TR, Lipsky LM, Iannotti RJ. Cross-sectional and longitudinal relationships of body mass index with glycemic control in children and adolescents with type 1 diabetes mellitus. Diabetes Res Clin Pract. 2013; 100:126–32. https://doi.org/10.1016/j.diabres.2012.12.025 PMid:23339757 PMCid:PMC3634913

10. Souto DL, Zajdenverg L, Rodacki M, Rosado EL. Impact of advanced and basic carbohydrate counting methods on metabolic control in patients with type 1 diabetes. Nutrition. 2014; 30(3):286-90. https://doi.org/10.1016/j.nut.2013.08.010 PMid:24360781

11. Hayes RL, Garnett SP, Clarke SL, Harkin NM, Chan AK, Ambler GR. A flexible diet using an insulin to carbohydrate ratio for adolescents with type 1 diabetes: a pilot study. Clin Nutr. 2012; 31:705–9. https://doi.org/10.1016/j.clnu.2012.02.012 PMid:22464678

12. Trento M, Trinetta A, Kucich C, Grassi G, Passera P, Paganin V et al. Carbohydrate counting improves coping ability and metabolic control in patients with type 1 diabetes managed by group care. J Endocrinol Invest. 2011; 34:101–05. https://doi.org/10.1007/BF03347038 PMid:20440106

13. Son O, Efe B, Son NE, Akalin A, Kebapçi N. Investigation on carbohydrate counting method in type 1 diabetic patients. Biomed Res Int. 2014; 7:44–48. https://doi.org/10.1155/2014/176564

14. Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. British Medical Journal. 2000; 321:405-412. https://doi.org/10.1136/bmj.321.7258.405 PMid:10938048

15. Chiesa G. Piscopo MA, Rigamonti A, Azzinari A, Bettini S, Bonfanti R, et al. Insulin therapy and carbohydrate counting. Acta Biomedica. 2005; 76:44–48. PMid:16915796

16. Kulkarni KD. Carbohydrate counting: a practical meal-planning option for people with diabetes. Clin Diabetes. 2005; 23:120–2. https://doi.org/10.2337/diaclin.23.3.120

17. Bell KJ, Barclay AW, Petocz P, Colagiuri S, Brand-Miller JC. Efficacy of carbohydrate counting in type 1 diabetes: a systematic review and meta-analysis. Lancet Diabetes Endocrinol. 2014; 2(2):133-40. https://doi.org/10.1016/S2213-8587(13)70144-X

18. Franz MJ. The glycemic index: not the most effective nutrition therapy intervention. Diabetes Care. 2003; 26(8):2466-8. https://doi.org/10.2337/diacare.26.8.2466 PMid:12882880

19. DAFNE Study Group. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. BMJ: British medical journal. 2002; 325(7367):746. https://doi.org/10.1136/bmj.325.7367.746