

Exacerbation of Diabetic Control by Large Amount of Sports Drink in Baseball Athlete with Detail Investigation

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Abstract

Authors have continued clinical practice and research of low carbohydrate diet (LCD). The case is 62-year-old men with obesity and type 2 diabetes mellitus (T2DM). For social/sport history, he worked as an administration manager of a large hospital and has been baseball player during 15-62 years old. Regarding medical history, he was on LCD with 96kg and HbA1c 6.0% in 2020. He participated many ballgames March-September 2021. He took oral rehydration solution (ORS) (Pokari Sweat, Otsuka Pharmaceutical) 1000ml/day during Mar-June in rather mild climate, and sports drink solution (SDS) (Body Mainte, Otsuka Pharmaceutical) 2000-3000ml/day during Jul-Sept in severe hot weather. He developed thirsty, polydipsia, polyuria, and fatigue and weight loss in Sept and HbA1c was 14.0%. Treatments started immediately by super-LCD, in which taken food in three meals a day was completely taken pictures by recording diet method. The analyzed carbohydrate amount was 40-90g per day, and LCD meal was effective. Just after LCD was started, blood glucose was normalized soon. HbA1c values were decreased to 10.3% in October and 7.8% in November. Consequently, this case had successful and satisfactory clinical improvement by LCD. Some discussion was described concerning LCD, hydration, ORS, SDS, adequate relationship with sports and so on.

Keywords: Low Carbohydrate Diet (LCD); Hydration; Pokari Sweat; Body Mainte; Hot Weather; Baseball Player

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Introduction

The prevalence of diabetes mellitus (DM) is increasing for long years in the world [1]. The estimated number of the patients would be 463 million in 2019, and rise to 578 million by 2030 from International Diabetes Federation (IDF) [2]. The standard guideline for diabetes has been presented by American Diabetes Association (ADA) [3]. Among them, fundamental therapeutic methods include both of nutritional therapy and exercise therapy. Concerning the former, historically prevalent standard method was calorie restriction (CR). However, low carbohydrate diet (LCD) was introduced to medical and health care region by Atkins and Bernstein [4]. LCD became gradually popular in European countries after that. In Japan, authors and collaborators had initiated LCD and developed LCD movement medically and socially [5]. We have established Japan LCD promotion Association (JLCDA), and presented useful LCD method easy to understand. They are petite-LCD, standard-LCD and super-LCD, which have carbohydrate ratio of 40%, 26% and 12%, respectively [6]. We have applied LCD to lots of obesity patients, and 25% of

them showed more than 10% of weight reduction [7]. Concerning the latter, physical activity and glycemic control status have mutually close relationship [3]. It gives several apparent evidence for lower A1c values of resistance training in older type 2 diabetes mellitus (T2DM) patients [8] and for an additive benefit of combined aerobic and resistance exercise in adult T2DM [9]. If the regular exercise is not prohibited, T2DM patients are recommended to conduct several different resistance exercises using large muscle groups [8]. For patients and athletes with T2DM, medical team can provide various adequate advice or recommendations, such as primary care physicians, athletic trainer, physical therapists, coaches, dieticians, psychologists, and so on [10]. Furthermore, several advises would be required including training principles, athletic conditioning, adequate knowledge of drink/food, sports nutrition, injury prevention and emergent management. Regarding the matter of the exercise and environment, global warming has been important. Hot weather has been observed worldwide, and about half of global population seemed to have heat-related hazards [11]. Moreover, projections of hotter future world may suggest that heat-related mortality and

morbidity would increase more without adequate risk management and research. For maintaining health benefits, functional beverages are used for long. They can be usually used as a medicine and/or performance enhancer. There are various examples, such as energy drinks, sports drinks, associated with ingredients of vitamins, minerals, amino acids and fruits [12]. For athletes, adequate liquids and nutrition balance has been critical [13]. For beverages that people drink, there are categories of oral rehydration solution (ORS) and sports drink solution (SDS) [14]. ORS was originally developed for patients with dehydration due to diarrhea. In contrast, SDS was developed to replenish water, electrolytes, sugars that are lost by sweat during sports. However, many people often confuse these for actual utilization. We have treated lots of various diabetic patients for long, and we have provided them low carbohydrate diet (LCD) associated with great effects of lowering blood glucose. Recently, a 62-year-old male athlete with mild

T2DM had continued drinking a large amount of ORS and SDS for several games in hot weather. Then, his diabetes status became worsened in short period. He was recovered by strict daily LCD meals. In this article, his clinical progress is presented associated with some perspectives.

Case report

The patient is a 62-year-old man, who had no remarkable illness before. When he was 40 years old, his body weight began to increase. At the age of 50, his weight was 104 kg, which was maximum level (Figure 1). During his 50's, he tried LCD in order to decrease his weight. At the age of 59, his weight was 94kg, and his HbA1c was 6.7%. Then he was given oral hypoglycemic agents (OHAs) of Metformin, Canagliflozin and Tenueligliptin. After December 2020, he did not come to the clinic because he had to work long hours in medical administration section.

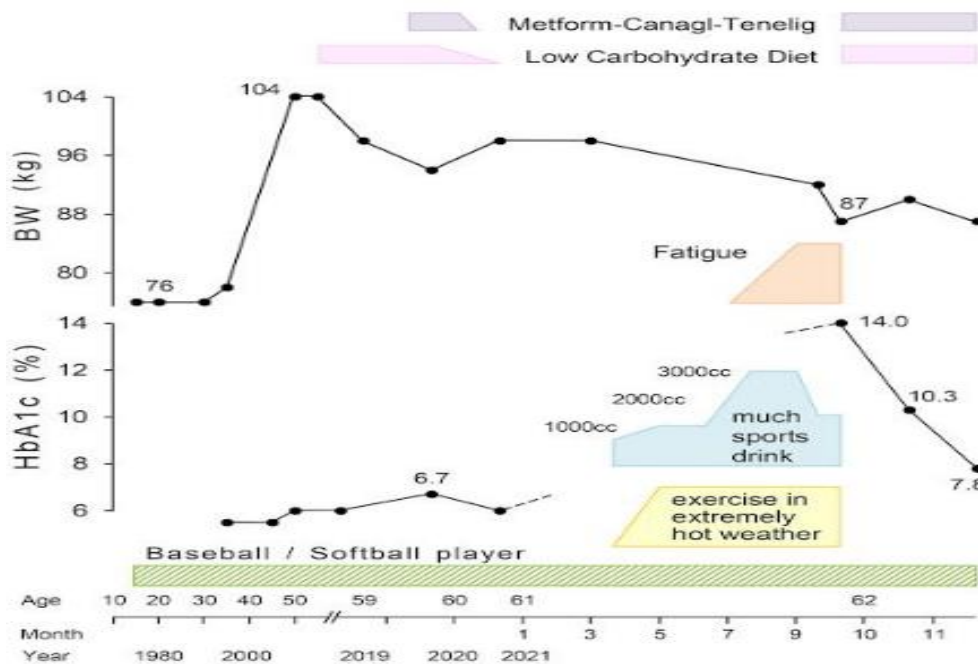


Figure 1: Clinical progress of the case Medical & sports history with detail situation of diabetes and hydration.

Social and Sports History

The patient has been working as an administration manager in a large hospital, and also been a baseball / softball player for more than half century. His life-long course from 15-62 years was shown in Figure 1. When he was a senior high school student, he was one of the best baseball pitchers. He could throw fast ball about 150 km/hr, and he had to throw so many games. Such lifestyle influenced his shoulder and elbow heavily too much. He could not enter Nippon Professional Baseball (NPB) Organization. During 20's – 40's, he contributed national sports festival in Japan which would be the largest sport festival in the world. He won all Japan baseball games as a baseball player and manager in Tokushima team. During his 50's, he was engaged in master's softball. His team often won the tournament to all Japan level. His batting average was about .700-.800 with usually 1-2 homeruns in a game.

There is the Master' tournament baseball games, in which 500 ages in total for 9 players. He hit an runs batted in (RBI) double over the center fielder to give his team a walk-off victory, which was shown in Tokushima Press (Figure 2). For half century, he has been highly evaluated for his work in the hospital. Furthermore, he has been one of the main boards of Research Association of Baseball Tokushima (RABT), and always teaches the tips of baseball practice and games to many baseball managers in senior high school teams in Tokushima. Furthermore, RABT members have continued various research of sports medicine.

Physical and Other Examinations

For his physical examination, consciousness is alert, and speech is normal and ordinary. Vitals showed pulse rate 60/min, and blood pressure 132/78 mmHg. His physique showed 181 cm in height,

87kg in weight with 26.6 kg/m² in body mass index (BMI). For his physicals, lung, heart and abdomen showed unremarkable changes. Neurological findings were unremarkable. The results of several examinations in Sept, 2021 were as follows: Hb 16.2 g/dL, RBC 508 x 10⁶ /μL, WBC 8600 /μL, Plt 21.1 x 10⁴ /μL, BUN 14 mg/dL, Cr 0.7 mg/dL, uric acid 3.0 mg/dL, TG 100 mg/dL, HDL-C 65

mg/dL, LDL-C 142 mg/dL, TP 7.3 g/dL, Alb 4.3 g/dL, AST 22 U/L, ALT 28 U/L, GGT 25 U/L, ALP 193 U/L (100-340), LDH 141 U/L (120-240), CRP 0.02 mg/dL, Concerning diabetes, HbA1c 14.0%, post-prandial blood glucose 292 mg/dL. Other examinations were as follows: Chest X-P was unremarkable, and electrocardiogram (ECG) revealed within normal limits.



Figure 2: Social and sports history of the case He hit gave his team a walk-off victory in masters' baseball tournament.

Clinical Progress

When he visited diabetic clinic in Sept 2021 with thirsty, polydipsia, polyuria, fatigue and weight loss, his HbA1c was proved to be 14.0%. Then, he was advised to re-start super-LCD meal and take oral hypoglycemic agents (OHA) [6]. After that, he continued almost complete daily meal with precise monitoring of carbohydrate amount. Actual dishes of three meals per day on Oct

6, 12, and 19 are shown in Figure 3. Thus, daily amount of carbohydrate was kept 40-90 g/day. Daily calorie taken per day varied day to day, which was not necessary to decrease. Clinical changes in HbA1c were as follows: 14.0% in September, 10.3% in October and 7.8% in November, in every 4-5 weeks. His body weight was 92kg in August, decreased to 87kg in September with general fatigue and decreased muscle volume. It was recovered to 91kg in October with increased muscle volume (Figure 1).

Day	breakfast	lunch	supper	snack	Carbo/ Calorie
Oct 6					50.2 g/ 1787 kcal
Oct 12					39.4 g/ 1688 kcal
Oct 19					56.1 g/ 2082 kcal

Figure 3: Actual meals for LCD with carbohydrate amount 2a: Carbohydrate 50.2g/day on Oct 6 2b: Carbohydrate 39.4g/day on Oct 1 2c: Carbohydrate 56.1g/day on Oct 19.

Results

The detail analyses of actual daily meals on Oct 6, 12, 19 are summarized (Figure 3).

- On Oct 6th, the patient had three meals and snack (Fig.3a). Breakfast included bran bread (Blancpain) 2.2g, egg 0.1g, bacon 0.1g, salad 1.5g, coffee 1g as total carbohydrate in 4.8g and calories in 461kcal. For lunch, grilled salmon and herbs 0.5 g, pumpkin and green beans 0.5g, salad and ham 0.5g wheat and rice 27g, as total carbohydrate 28.5g and 456 kcal. For supper, sautéed chicken 1.4g, steamed vegetables 5g, vinegar 1.8g, egg tofu 0.4g as total carbohydrate 8.6g and 832 kcal. For snack, 1/4 of pear 8.3g. The total daily carbohydrate and calory intake was 50.2 g and 1787 kcal, respectively.
- On Oct 12th, taken meal was shown in Figure 3b. Breakfast included bran bread 2.2g, egg 0.1g, bacon 0.1g, salad 0.5g, coffee 1g, yogurt 1.5g as total carbohydrate 5.4g and calories 507kcal. For lunch, mackerel boiled with miso seasoning 13g, asparagus and bacon saute 0.4g, omelet 0.1g, salad 0.5g, as total carbohydrate 13.5g and 563 kcal. For supper, grilled pork ginger 7.8g, Japanese mustard spinach and egg 2g, vinegared food of seaweed and cucumber 0g, miso soup 3.3 g as total carbohydrate 13.1g and 579 kcal. Snack included one citrus with 6.9g carbohydrate 6.9g and 39 kcal. Total carbohydrate and calory amount per day was 39.4 g and 1688 kcal, respectively.
- On Oct 19th, the case had the meal in Figure 3c. For breakfast, the carbohydrate amount showed bran bread of special melon flavor 2.8g, sunny-side up 0.1g, vegetable soup 9.0g, coffee 1g, as total carbohydrate 13.9g and calories 417kcal. Lunch included chicken with tomato sauce 17.1g, chicken nuggets 0.1g, salad 0g, onion soup 2.3g as total carbohydrate 19.5g and 687kcal. Supper included stir-fried meat and vegetables 9.5g, tomato and wakame salad 0g, and miso soup 0.2g as total carbohydrate 9.7g and 915 kcal. For snack, persimmon 1/2 amount included carbohydrate 13g and 63 kcal. Total carbo and calory per day was 56.1 g and 2082 kcal, respectively.

Discussion

This case developed the exacerbation of diabetic status by several factors. They include i) sports performance in hot weather, ii) much drinking of sports drinks, iii) possible dehydration, iv) probable hyperglycemia, and v) combination of these factors. The case did not develop severe clinical condition such as acute dehydration, soft-drink ketosis or acute distress, but showed the gradual aggravation of blood glucose and HbA1c for some weeks. In this discussion, perspectives for clinical problems of hydration and LCD would be presented. Continuous exercise in hot circumstance causes body-fluid loss. The changes in circulatory body-water volume would be expressed as decreased percent plasm volume (decPV). Meta-analysis (28 studies) on decPV was conducted for three ingested beverages including hypertonic, isotonic and hypotonic drinks (>300, 275-300, 275 mOsm/kg) [15]. The results showed that mean decPV were -7.4%, -8.7%, -6.3%, respectively.

Consequently, hypotonic-water was likely superior to other two. As to sports drinks there are two types, which are isotonic and hypotonic. The climate of May and June 2021 was not so hot, then the patient took isotonic sports drink. It was one of the most famous solutions, Pocari sweat (Otsuka Pharmaceutical, Japan) about 1000ml/day [16]. In contrast, the climate during July – September was very hot, then he took hypotonic solution. It was Body mainte (Otsuka Pharmaceutical, Japan) about 2000-3000ml/day [17]. The ingredients of these two drinks vary as follows (/100ml): Pocari sweat has energy 25kcal, protein and fat 0g, carbohydrate 6.2g, NaCl 0.12g, K 20mg, Ca 2mg, Mg 0.6mg. Body mainte has energy 18kcal, protein and fat 0g, carbohydrate 4.4g, NaCl 0.13g, K 20mg, Ca 2mg, and Mg 0.6mg associated with lactic acid bacterium B240. Lactic acid bacterium B240 is a plant-derived lactic acid bacterium found in fermented tea "Miyan", which is traditionally eaten in northern Thailand [18]. "Miyan" has been popular as "food tea" or "chewed tea" that puts fermented tea leaves in the mouth, and has supported the health of local people for a long time. Taking most advantages of *Lactobacillus pentosus* ONRICb0240 (B240), novel conditioning beverage was developed [17]. Intake of B240 showed beneficial enhancements, such as IgA/IgG levels, blood T-helper, NK cell as well as increasing immune functions. It is expected biological utility beneficial for increased sports performance, leading to useful functional drink and potential health-related implications [18]. B240 has a positive effect on improving immunity [19], physical exercise [20], and elderly people [21]. Concerning LCD treatment for DM, rather long clinical situation has been observed. Diabetes has chronic complications including macrovascular and microvascular disorders [22]. The pathophysiological problems originate from elevated blood glucose. Then, lowering daily profile of blood glucose is necessary. The evidence of clinical effect of LCD was reported by some researchers [23, 24]. Recently, beneficial LCD has been also observed from several reports [25, 26]. According to the official comment of American Diabetes Association (ADA), only carbohydrate directly affect blood glucose levels [27]. Authors have previously reported the comparison of 75g oral glucose tolerance test (75gOGTT) and meal tolerance test (MTT) using breakfast [28]. For practical LCD performance, we have developed "food pyramid for LCD" [29]. It emphasizes seven golden rules for LCD [30]. Among them, three main suggestions are in the following. i) Reduce carbohydrate as possible. For actual practice, petite-LCD, standard-LCD and super-LCD can be applied. ii) Add protein. We recommend to increase protein intake using fish, meat, egg, tofu, and others. iii) Do not have to limit fat food. Recent research showed that restriction of fat food is not necessary [31]. From mentioned above, this case could continue LCD meal for long with the adequate cooking of his family, intake of regular OHAs and various cooperation from others. It seems to be successful and satisfactory. However, there are some limitations for this report as follows: i) only one case, ii) not all triggers were detected, iii) probable other involvements of pathophysiology, iv) possible other effective treatment method, and so on. In summary, this report showed the diabetic athlete who took large amount of

sports drink, leading to exacerbation of diabetic condition. Some perspectives were discussed from various points of view. This article will be hopefully a reference for future diabetic practice and research.

Ethical Considerations

This research was performed in compliance with the ethical principles that is based on the Declaration of Helsinki. Furthermore, some comment was conducted for the Ethical Guidelines for Research for the medical field for Human beings as well as the Good Clinical Practice (GCP). Authors obtained the written informed consent from the patient in this research. In addition, authors established the ethical committee for the clinical research including experts in the legal and medical specialties. We have discussed much concerning the research content and made the confirmation that this research is adequate and agreed with all experts.

Conflict of interest: The authors declare no conflict of interest.

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