

## Remarkable Weight Reduction for Low Carbohydrate Diet (LCD): Case Report

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### Abstract

**Background:** There have been discussion for years concerning Calorie Restriction (CR) and low carbohydrate diet (LCD). As to LCD, we have reported clinical experience and research for glucose variability and ketone bodies.

**Case and results:** The patient was 41 yo man with type 2 diabetes mellitus (T2DM). His data includes height 186 cm, BMI 31.2, fasting blood glucose 151 mg/dL, HbA1c 9.4%. He was on super LCD diet with 12% of carbohydrate, and has continued aerobics exercise and muscle training. Average glucose level on day 2,4 and 10 was 161 mg/dL, 117 mg/dL and 102 mg/dL, respectively. Body weight decreased from 107 kg to 100 kg in 4 weeks. As ketone body, 3-hydroxybutyric acid (3-OHBA) was elevated to 2350  $\mu\text{mol/L}$  (-85). Lipid profiles from day 2 to day 28 showed that Triglyceride 215 to 46, HDL 32 to 44, LDL 89 to 93.

**Discussion and conclusion:** Authors have proposed 3 types of LCD so far, which are petit, standard and super, with 12%, 26%, 40% of carbohydrate ratio. Continuing super-LCD usually brings elevated ketone bodies and significant weight reduction. As for successful result, influenced factors would be application of super LCD, aerobics and anaerobic exercise, understanding and adequate continuation, adequate support of co-medicals.

**Keywords:** Low carbohydrate diet; Calorie restriction (CR); Type 2 diabetes mellitus (T2DM); Weight reduction, Petit-low carbohydrate diet (petit-LCD); Standard-low carbohydrate diet (standard-CD); Super-low carbohydrate diet (super-LCD); 3-hydroxybutyric acid (3-OHBA)

**Abbreviations:** LCD: Low-Carbohydrate Diet; CR: Calorie Restriction; T2DM: Type 2 Diabetes Mellitus; VLCKD: Very Low-Carbohydrate Ketogenic Diet; 3-OHBA: 3-hydroxybutyric acid

### Introduction

There has been lots various discussion for long yeas concerning Calorie Restriction (CR) and low carbohydrate diet (LCD). Several studies have showed the efficacy of LCD, and its understanding and practice have been spread [1-5]. In Japan, the authors firstly reported the practice of LCD and developed clinical usefulness of LCD with patients with type 2 diabetes mellitus (T2DM) [6,7]. We also investigated the clinical significance of ketone bodies in fetus, placenta, newborn and pregnant mother [8].

In this study, case of T2DM with remarkable weight reduction would be presented and discussed.

### Case Report

The patient was 41-year-old man whose occupation has been policeman. His lifestyle is hard and working until late every day with less holidays. He was diagnosed type 2 diabetes mellitus (T2DM) in another clinic, and was introduced to our DM clinic for further evaluation and treatment.

On physical examination, he showed 186 cm in height, 108 kg in weight, BMI 31.2 at admission. His vitals and consciousness are normal, and lung, heart, abdomen and neurological findings were unremarkable.

Laboratory data were as follows: fasting blood glucose 151 mg/dL, postprandial glucose-120 min 200 mg/dl on day 2. HbA1c was 9.4%, with GOT 25 IU/mL, GPT 19 IU/mL, r-GTP 18 IU/mL, Alb 4.6 mg/dL, Hb 16.7 g/dL.

### Diet Therapy for Super LCD

The patient was given usual diabetes meal in day 1 and 2, which is traditional Japanese formular diet for diabetes with 60% of carbohydrate, 1900 cal/day. From day 3, he was given super LCD formular diet with 12% of carbohydrate which was originated by Dr. Ebe, Japan, one of the authors.

As to super LCD diet, calorie taken per day was calculated as follows: ideal weight (kg) is  $1.86 \times 1.86 \times 22 = 76.1$  kg, daily calorie taken per day is  $76.1 \text{ kg} \times 25 \text{ kcal/kg/day} = 1900 \text{ kcal/day}$ . As super LCD diet contains 12% of carbohydrate, he took 228 calories of carbohydrate per day. As 1 gram of carbohydrate has 4 kcal, then carbohydrate intake per day is  $228 \text{ g}/4 = 57$  grams per day.

Japanese style meal has always includes one bowl of rice, but super LCD meal does not include rice, bread or noodles. One example of lunch was shown in Figure 1, which is Japanese style Sukiyaki with 26 g of carbohydrate.

### Exercise Therapy

The patient was formerly a judo athlete when he was college student, then he is accustomed to train himself. During admission, he went out for a walk with large stride length 1 hour in the morning and 1 hour in

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the afternoon. Moreover, He has continued muscle training on trunk and extremities for more than 1 hour in his admitted room.

He continued these exercises spontaneously by his own decision, and he usually sweated well with comfortable feeling.

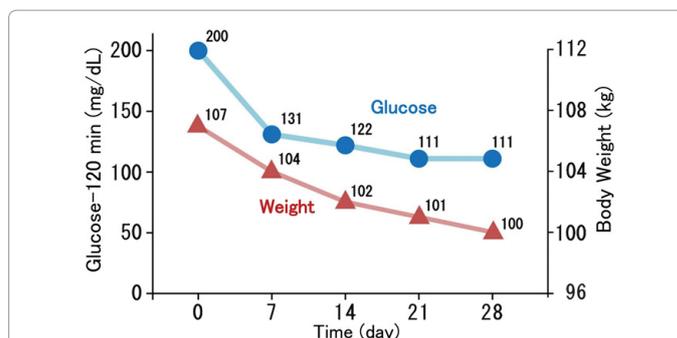
### Changes of Biomarkers

Daily profile of blood glucose was investigated on day 2, 4 and 10 (Figure 2). Glucose profile revealed remarkable decrease.

To check postprandial glucose-120 minutes and body weight once per week, both value showed remarkable decrease (Figure 3). Body weight decreased from 107 kg to 100 kg in 4 weeks.

Urinary C-peptide excretion on day 2 (CR) and 3 (LCD) was 55.9 mg/day and 45.4 mg/day, respectively, with normal range 23-155 mg/day. Lipid profiles from day 2 to day 28 showed that Triglyceride 215 to 46, HDL 32 to 44, LDL 89 to 93.

The fracture of ketone bodies in blood was measured on day 10, which were total ketone bodies 3055  $\mu\text{mol/L}$  (-131), Acetoacetate 705  $\mu\text{mol/L}$  (-55) and 3-hydroxybutyric acid (3-OHBA) 2350  $\mu\text{mol/L}$  (-85). 3-OHBA has the activity for ketone body.



**Figure 3:** Changes of weight and postprandial glucose-120 min. for 4 weeks. Body weight showed remarkable decrease, with decrease of postprandial glucose-120 min.

### Discussion

After LCD was firstly initiated [9,10], authors have started and continued LCD movement in Japan for years medically and socially, and we have proposed 3 patterns of LCD [6,7,11,12]. There are 1) super-LCD: strictly limited in 3 meals, 2) standard-LCD: limited in 2 meals a day, 3) petit-LCD: limited in 1 meal a day. The ratio of carbohydrate is 12%, 26%, 40%, respectively. On contrast, traditional formula diet for diabetes in Japan was 50-60%.

In our previous study, clinical experience for LCD with 2699 cases are reported [13]. Weight reduction of more than 10% was observed in 25.6% of subjects, and more than 2.5% was observed in 78.8% of subjects, indicating the efficacy of LCD.

There is a useful marker indicating high blood glucose and mean amplitude of glycemic excursions (MAGE), which is Morbus (M) value. Authors have investigated M value and related markers, and clarified the usefulness of M value [14,15].

In this study, daily profile of blood glucose on day 2,4 and 10 indicated remarkable improvement of diabetic status. Average glucose on 2,4 and 10 was  $161.1 \pm 27.2$  mg/dL,  $117.1 \pm 10.7$  mg/dL and  $101.7 \pm 14.2$  mg/dL, respectively.

When we calculate Morbus (M) value on day 2,4 and 10, the result was 28.6, 2.0 and 9.6, respectively. The reason why M value increased from day 4 to day 10 is that Morbus (M) value becomes minimum when glucose level in average is around 120 mg/dL and the fluctuation of glucose becomes less. The reason is that the formula of M value comes from  $10 \times \text{LOG}(\text{glucose value}/120)$  and its cube data. Then glucose profile on day 4 seems to be ideal in the light of M value.

Nutrition diet has been classified into several categories [16]. They are 1) Very low-carbohydrate ketogenic diet (VLCKD): Carbohydrate, 20-50 g/d or <10% of the 2000 kcal/d diet, 2) Low-carbohydrate diet: <130 g/d or <26% total energy, 3) Moderate-Carbohydrate Diet: 26%-45%, 4) High-Carbohydrate Diet: >45% [16].

Super-LCD is one of VLCKD, and contains 12% of carbohydrate. Continuing Super-LCD usually makes the patient elevated ketone bodies and significant weight reduction [13,15,16]. Continuing ketogenic diet seems to be necessary to obtain enough weight reduction [17-19]. Furthermore, the ratio of carbohydrate in LCD showed correlation with the degree of weight reduction [20].

### Conclusion

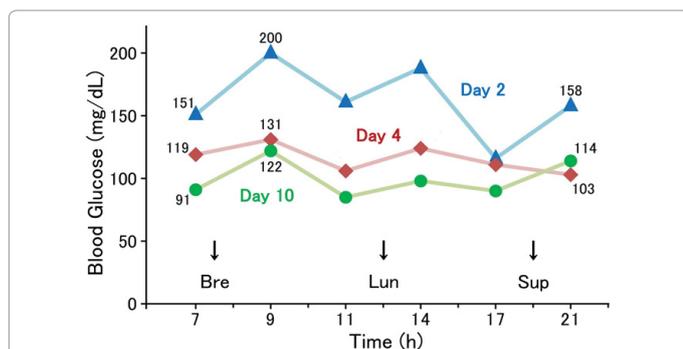
Current study revealed that the case showed remarkable decrease of



In this meal, the kinds of foodstuff and carbohydrate dose are as follows:

- Japanese style Sukiyaki with beef, tofu, egg, jelly, onion, mushroom, edible chrysanthemum, Japanese leek, other vegetable and sukiyaki soup 12 g,
- lotus root and jelly 6.7 g,
- 2 pieces of process cheese 0.4 g
- eggplant 3.6 g,
- broccoli and carrot with sesame 3 g,
- soy sauce (5 g) 0.3 g
- Sum total from a) to f) is 26 g of carbohydrate of this meal.

**Figure 1:** Japanese style Sukiyaki for lunch as formular diet of super LCD.



**Figure 2:** Daily profile of blood glucose on day 2, 4 and 10. Glucose profile showed remarkable decrease from day 2, 4 to 10.

glucose and body weight in 4 weeks. We speculate the influenced related factors, which are 1) application of LCD rather than CR, 2) especially super LCD with 12% of carbohydrate, 3) enough exercise both aerobics and anaerobic movement, 4) right understanding and continuation mentally and psychologically, 5) adequate support of co-medicals such nurse and dietician.

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