

# Remarkable improvement and weight reduction in obese diabetic patient by continuation of super low carbohydrate diet (LCD)

## Abstract

The case was 39-year old female patient with T2DM (BMI 33.3). She had a strong hope to receive Laparoscopic sleeve gastrectomy (LSG), but she could not take the operation of LSG because of severe diabetic control (HbA1c 11.4%). She was treated with 5 kinds of diabetic medicine such as, Exenatide, Alogliptin, Metformin, Mitiglinide and Miglitol. She continued LCD successfully, with the improvement of HbA1c 10.8 % to 6.3% and weight reduction 83.2 kg to 66.6 kg. At 7 months, medicine was only Metformin. In our activity of Japan LCD Promotion Association (JLCDPA), super-LCD has been effective with 12% of carbohydrate.

**Keywords:** non-communicable diseases, calorie restriction, super low carbohydrate diet, laparoscopic sleeve gastrectomy, Japan LCD promotion association

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**Abbreviations:** NCD, non-communicable diseases; CR, calorie restriction; LCD, low carbohydrate diet; LSG, laparoscopic sleeve gastrectomy; JLCDPA, Japan LCD promotion association; ESG, endoscopic sleeve gastroplasty

## Introduction

Across the world, the prevalence of obesity has been growing in the public health area including children, adolescents and adults.<sup>1</sup> The population with obese or overweight would be about 33%.<sup>1</sup> This trend also brings a variety of concerns due to high mortality and comorbidity in obese people and influence to medical and economic burden for each country.<sup>2</sup> As the prevalence of obesity and overweight becomes more, non-communicable diseases (NCDs) has been increasing more including diabetes mellitus, hypertension, dyslipidemia and arteriosclerotic diseases.<sup>3</sup> They may bring several influences on medical, social and economic region.<sup>4</sup> Diabetes mellitus cause chronic complications including macroangiopathy and microangiopathy. For the fundamental therapy for diabetes, nutritional treatment has been emphasized for long years by Calorie Restriction (CR), Low Carbohydrate Diet (LCD), and other types of regimen.<sup>5</sup>

Regarding nutritional treatment for obesity and diabetes, there has been a trend from CR to LCD. Lots of reports with comparison of these were found.<sup>6</sup> Bernstein and Atkins had previously initiated LCD in the fields of medical and health area.<sup>7</sup> After that, the predominance effect of LCD was observed in North American and European area.<sup>8,9</sup> On the other hand, authors et al. have started LCD at first in Japan in 2000s.<sup>9</sup> After that, we have continued clinical practice and reported a variety of research. They include glucose daily glucose profile, comparison of CR and LCD, ketone bodies (KB), meal tolerance test (MTT), continuous glucose monitoring (CGM), physiological role of KB in the axis of newborn, mother, placenta and fetus.<sup>10,11</sup> LCD seems to show stronger weight reducing effect for patients with obesity and diabetes in comparison with CR.<sup>12</sup> There have been other treatments for reducing weight, which are surgery procedures. They include Endoscopic Sleeve Gastroplasty (ESG), Laparoscopic Sleeve Gastrectomy (LSG), Laparoscopic Band for Weight Loss, and so on.<sup>13</sup> LSG has been rather known for its simple and higher efficacy.<sup>14</sup> These

operations have been increased worldwide, as patients with extreme obesity increase.

We have treated various patients with obesity so far. Among them, an obese female patient hoped to receive LSG, but could not have the operation because of severe diabetes. Then, we could successfully treat her with LCD. In this article, her general progress course and some discussion would be described.

## Case presentation

**Present history:** The case was 39-year old female patient with T2DM. She had unremarkable diseases until 24 years old. Her body weight was around 54kg until 28 years old. After marriage, her body weight had gradually increased up to 70kg. At 33 years old, she was pointed out to have T2DM, and started to receive oral hyperglycemic agents (OHA). However, her glucose variability had not improved, then she had been on several medicine for diabetes from 36 years old. As her body weight had been increased further, she became to hope reducing the weight by the surgery procedure. The patient had a strong hope to receive Laparoscopic sleeve gastrectomy (LSG). She often visited the surgery clinic in Tokyo, but she could not take the operation of LSG. Some reasons included i) her BMI was 33.3, which was lower than 35.0, ii) diabetic condition was too bad to be tolerated for the operation. Consequently, she was introduced to our diabetes clinic for further evaluation and treatment.

**Physicals:** Her physicals were evaluated in detail. She had normal consciousness and vitals including pulse, blood pressure, respiration, body temperature. There were no remarkable changes in the lung, heart and abdomen. She showed slight peripheral neuropathy in the hands and feet, no apparent retinopathy or nephropathy. Furthermore, there were no signs or symptoms related to hyper- or hypoglycemia. She has moderate obesity, with the body mass index (BMI) of 33.3 kg/m<sup>2</sup>.

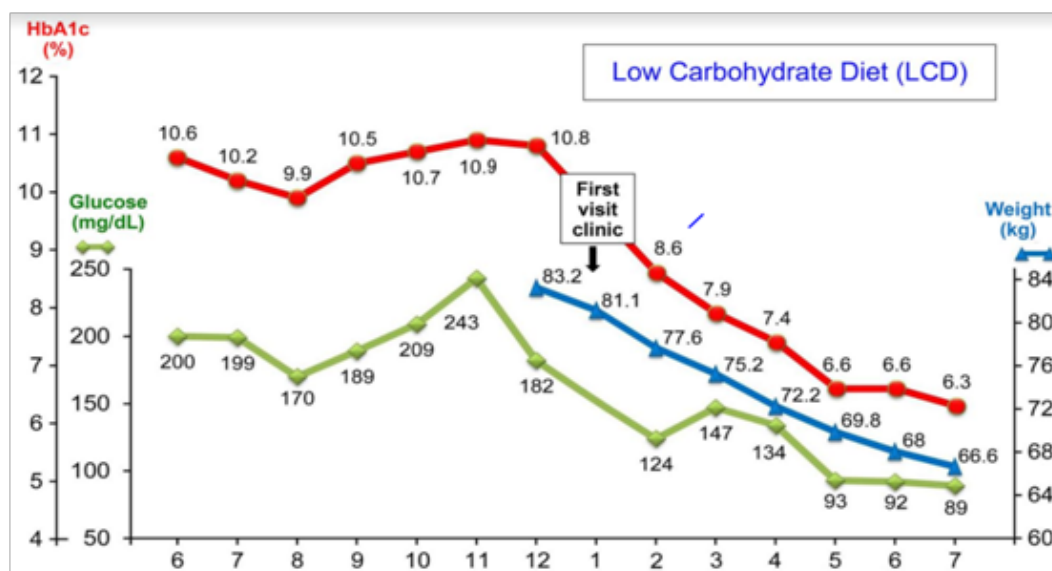
**Laboratory exam:** The data of the laboratory tests in complete blood count (CBC) and biochemical data were revealed as follows: WBC 6200/μL, RBC 4.16 x 10<sup>6</sup>/μL, Hb 13.3 g/dL, Plt 19.4 x 10<sup>4</sup>/μL, AST 25 IU/mL, ALT 35 IU/mL, ALP 202 IU/mL (100-340), LD 164 IU/

mL (100-210), T-Bil 0.6 mg/dL, BUN 15 mg/dL, Cre 0.7 mg/dL, Uric Acid 5.2mg/dL, Na 142mmol/L, K 4.1 mmol/L, Cl 102 mmol/L, HDL 64mg/dL, LDL 151mg/dL, TG 207mg/dL. Data related diabetes were HbA1c 11.8% and post-prandial blood glucose 356mg/dL.

## Clinical progress

Before our visit, the patient showed high HbA1c value as 11-12% for months. At that time, she was treated with 5 kinds of medicine for diabetes. They included GLP-1 receptor agonist (Exenatide, 2mg/

week, D04121), DPP4-inhibitor (Alogliptin 25mg /day, D06553), Metformin 1000mg/day, Mitiglinide calcium hydrate 30mg/day and Miglitol 150mg/day. After our visit, we have explained the patient the significance and method of super-LCD (12% of carbohydrate). She understood well and started and continued super-LCD for long months. Consequently, her HbA1c decreased from 10.8 % to 6.3%, and body weight also decreased from 83.2 kg to 66.6 kg for 7 months (Figure 1). This clinical course was satisfactory in the light of diabetes and obesity. She did not have to consider the operation of LSG. At 7 months, she had on only Metformin 500mg/day as the prescription.



**Figure 1** Clinical course of the case with HbA1c, blood glucose and body weight.

## Discussion

Authors and colleagues have begun LCD in Japan and developed LCD in medical and social area. We established Japan LCD Promotion Association (JLCDPA), and continued various activities. They include English papers, books about how to continue LCD, lectures for LCD, cooking workshops for LCD, and so on.<sup>15</sup> There are many divisions of JLCDPA in Japan so far, and we developed anti-aging movement with LCD, adequate exercise and ordinary life style habit.<sup>16</sup> In order to propose a simple and easy to understand protocol of LCD, we have proposed three types of LCDs. They are petite-LCD, standard-LCD and super-LCD. Those LCDs have the ratio of carbohydrate by calorie measurement a day as 40%, 26% and 12%.<sup>17</sup> In the case of super-LCD with 1400 kcal/day, the carbohydrate is 168 kcal/day, because including 12% of carbohydrate. The calorie 168kcal of carbohydrate (4 kcal/g) means taking 42g of carbohydrate a day. Consequently, super-LCD generally means the limited intake of carbohydrate about 42g a day. When super-LCD is provided to diabetic patient with remarkable high glucose profile, glucose variability will be drastically improved within 2 days.<sup>17</sup>

LSG has been well-known restrictive bariatric surgical procedure for the surgery of the obesity. The reason would be from rather simple technique, satisfactory effect for weight loss and reduced morbidities.<sup>14</sup> There was a comparison study of surgical interventions between LSG and Endoscopic Sleeve Gastroplasty (ESG) by cohort study.<sup>13</sup> As a result, LSG showed greater reduction of BMI and percent total body weight loss (%TBWL) than those of ESG at 12 months (29.3% vs 17.6%, significant difference).<sup>18</sup>

For LSG, systematic review of 27 relevant articles with 5218 cases were studied.<sup>19</sup> It showed as follows: mean age was 41.1 years old, BMI decreased from 43.8±8.0 to 30.7±3.9 (1 year), remission rate

of diabetes, hypertension and dyslipidemia was 81.9%, 66.5% and 64.1%, respectively.<sup>19</sup> These results show the efficacy of LSG. Quality of Life (QoL) after the operation of LSG were investigated.<sup>20</sup> From 702 reports, 13 articles with 1630 cases in total were analyzed. Six kinds of QoL assessment tools were used. As a result, SF-36 revealed significant improvement between pre- and post-operative assessment. From BAROS score, 77-96% of cases evaluated achieving “good” to “excellent” outcomes.<sup>20</sup>

Historically speaking, there were different dietary approaches for diabetes and obesity. They include CR, Mediterranean, vegetarian, moderate carbohydrate, LCD, high-protein, low glycemic index/ glycemic load (GI/GL) and others.<sup>21</sup> According to the comment of on American Diabetes Association (ADA) and European Association for the Study of Diabetes (EASD), LCDs have been recommended for the treatment of diabetic patients.<sup>22</sup> LCD has been defined as the meal with carbohydrate less than 26% of total daily energy intake. LCD has been known to have beneficial effect for improving glucose variability in diabetic patients. In contrast, there was no additional effect in the case of moderate restriction (26-45%) of carbohydrate.<sup>22,23</sup>

In our previous report, we investigated 2699 cases of obesity with the treatment of LCD.<sup>24</sup> As a result, the patient ratio of weight reduction more than 10% was 25.6%, and those more than 5% was 57.6%. This clinical achievement would be satisfactory by LCD.<sup>24</sup> The energy proportion of carbohydrate intake in a day would be furthermore studied including several factors such as longer term, countries and nutritional recommendations.<sup>25</sup> In summary, a female patient with T2DM case was described. Her characteristic points include trying to receive LSG, successful LCD continuation and remarkable effects for HbA1c and weight reduction. Hopefully this information will be reference data for future clinical diabetic research.

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## Conflicts of interest

Author declare that there is no conflict of interest.

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