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Current topics of theory and practice for low carbohydrate diet (LCD) in diabetic patients

Abstract

Both humans and animals generate energy by tricarboxylic acid (TCA) cycle from carbohydrates, fats and proteins. Among them, carbohydrates axis seemed to be the main route for energy production so far. In the case of diabetes, however, the restraint of glucose metabolism would be beneficial by low carbohydrate diet (LCD) or newly-introduced oral hyperglycemic agent (OHA), Sodium-Glucose Cotransporter 2 Inhibitors (SGLT2i). Author and colleagues have developed LCD movement by Japan LCD promotion association (JLCDPA). Our lectures include useful and practical 3 LCD meals, which are petite-LCD, standard-LCD and super-LCD with carbohydrate content ratio as 40%, 26% and 12%, respectively.

Keywords: tricarboxylic acid (TCA) cycle, low carbohydrate diet (LCD), sodium-glucose cotransporter 2 inhibitors (SGLT2i), Japan LCD promotion association (JLCDPA), carbohydrate-insulin model

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Abbreviations: LCD, low carbohydrate diet; JLCDPA, Japan LCD promotion association; SGLT2i, sodium-glucose cotransporter 2 inhibitors

Text

Both humans and animals have used much energy when they move, work and continue activities.[1] This energy is from the tricarboxylic acid (TCA) cycle which is well-known for years.[2] It is also called as citric acid cycle (CAC) or Krebs cycle.[3] It can produce much energy by the oxidation of acetyl-CoA derived from carbohydrates, fats, and proteins.[4] Among them, carbohydrates axis seemed to be the main route for energy production in usual basic and clinical education and biochemistry in the medical school. However, there is a possible perspective that glucose had not made a central role.

Human beings in ancient times had showed evolutionary changes of metabolic programs.[1] There were two situations for human nutritional circumstances. One was fasting which was common about 4-7million years. Due to food deprivation, elevated ketone bodies had main energy-producing system. Another was overeating which has been found in recent decades. Due to food abundance, people have gradually taken much refined cereals of carbohydrates.[5] Consequently, insulin resistance has been elevated, which has brought non-communicable diseases (NCDs) such as diabetes, obesity and metabolic syndrome.[6] These changes caused social and medical problems in the world.[5]

Regarding the concept of energy, there are some kinds of theories. There has been the energy balance theory for long, which was widely known. However, this theory alone has been not enough to explain various situations.[7] From the nutritional balance, there are two principles which are conservation energy law and dissipation law. Some controversies are present in some situations as follows: i) low carbohydrate diet (LCD) brings more weight reduction than usual isocaloric diets,ii) there are metabolic advantages in comparison with energy laws, iii) protein can be changed to glucose by glucogenesis.[7]

Other theories or concepts are observed among them.The theory of Glycemic Index (GI) or Glycemic Load (GL) can change glucose variability to some extent.[8] If a person restricts high GI foods and takes low GI foods more, his energy amount will be reduced.Another theory would be explained as "A calorie is not a calorie". It means that various cases include different ratio of carbohydrate, lipid or protein, whereas they indicate the same total calories.[9] Consequently, the metabolism of glucose differs in a variety of cases with macronutrient balance.

Recently, a new idea was introduced that is the conventional calorie balance theory. It may be possible to explain the clinical phenomena where excessive insulin secretion will bring obesity.[10] From this concept, a new theory was proposed as a carbohydrate-insulin model. The theory was advocated by Ebeling and Ludwig, who are on research association at the obesity prevention center of the Harvard University. Using this theory, the effective situation can be explained in the case of LCD and low GI meal in comparison with CR.[11] When applying this theory into the research of Calorie Restriction (CR) for long term continuation, the result was not successful to explain the actual medical changes.[12]

From mentioned above, such new concept will possibly contribute the development of clinical research for diabetes, obesity and metabolic syndrome. Such problems have become crucial medical problems across the world. By International Diabetes Federation (IDF), diabetes mellitus has been more prevalent,[13] which has been increasing from 8.8% to 10.4%, in 2015 to 2040, respectively. Then, effective preventive method would be expected. In North American and European regions, Bernstein and Atkins had initiated LCD as a diet therapy.[14,15] After LCD became rather popular, the clinical evidence was shown by Shai et al.[16]

On the other hand, author and colleagues have started LCD since the 2000 in Japan.[17] Successively, we have continued various clinical research concerning LCD and related matters.[18] Continuation of LCD for type 2 diabetes mellitus brings weight reduction, improved

HbA1c level and hyperketonemia, which are all beneficial to glucose variability.[19,20] We have reported the physiological hyperketonemia in the axis of newborn, pregnant mother, placenta and fetus.[21] Furthermore, authors' group have proposed the establishment of Japan LCD promotion association (JLCDPA) and developed various seminars, lectures, and social movement for LCD.

Among the activity of JLCDPA, there are three recommended methods for continuing LCDs. They are petite-LCD, standard-LCD and super-LCD with the carbohydrate content ratio as 40%, 26% and 12%, respectively.[22] In these 3patterns, restricted carbohydrate amount per meal would be approximately <40g, <30g, <20g, respectively.[20,22] A person who plans to start LCD is advised to choose either type, according to the situation. People usually take 3meals a day. If a person skips taking carbohydrate food in 1, 2 or 3meals a day, it times a day, it is equivalent to petite-, standard-, or super-LCD. Medical staffs always consult with the subject to enough degree.

One of the common educational handouts for seminar is shown in Figure 1. The important points were as follows: i) rice and fruits have much carbohydrates, ii) some dressings include moderate carbohydrate, iii) there are differences between fried chicken (0.1g) and deep-fried food (7g), iv) this meal has totally 118g of carbohydrate more than supposed. The subjects who want to continue LCD have to know the carbohydrate amount included in any kind of food.[22]

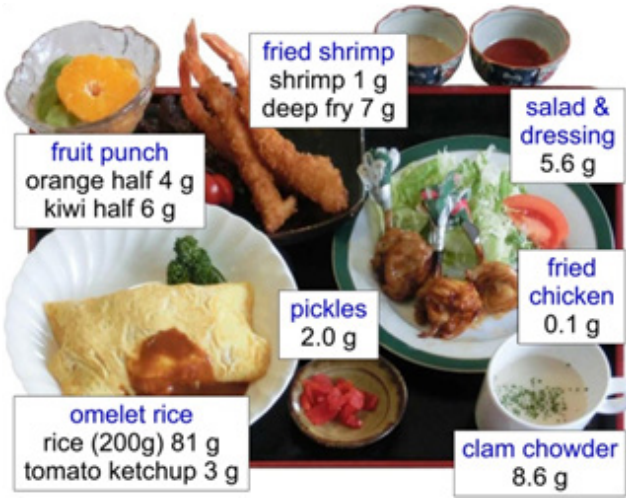

Figure 1 Educational handout for LCD showing carbohydrate amount in a meal.

Recently, there has been an impressive topic about oral hyperglycemic agent (OHA), which is the clinical introduction of Sodium-Glucose Cotransporter 2 Inhibitors (SGLT2i).[23] The characteristic point of the pharmaceutical function of SGLT2i would be increasing excretion of glucose into the urine.[24] Clinical common mechanism of LCD and SGLT2i would be decreasing the metabolism of carbohydrate.[25] Consequently, in the light of glucose variability, the presence of glucose in T2DM would be risky for various aspects, and its reduction would be beneficial for the prognosis.

In summary, some topics of diabetes were described including energy production, LCD, new theory of glucose and insulin, three patterns of LCD meals, SGLT2i. From clinical point of view, restraint of glucose would be beneficial for better diabetic control and less glucose metabolism in various situations. This article will hopefully become some reference for future diabetic research.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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