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The effect of ketogenic diet on type II diabetes

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Abstract :

Changes in dietary habits influence the glycemic level.using the low-carbohydrate ketogenic diet (LCKD) were found to be quite promising in controlling diabetes mellitus. Therefore, by analyzing the therapeutic effects of LCKD in experimental diabetic rats following the administration of streptozotocin (STZ) , Adult rats were divided into three groups: normal diet, LCKD, and high-carbohydrate diet. Each group was subdivided into normal, sham, and diabetic groups.The results showed that LCKD was effective in bringing glucose level to normal ($P<0.01$).This study indicates that LCKD contains a significant beneficial effect in ameliorating the diabetic state and helping to stabilize hyperglycemia .

Introduction :

Diabetes mellitus (DM) could be a serious universal ill health. The prevalence of this condition is rapidly increasing in the world ، Changes in lifestyle and dietary habits, in conjunction with genetic susceptibility, have resulted in a very remarkable increase within the incidence and prevalence of diabetes within the world.

Type 1 diabetes, or insulin-dependent diabetes (IDDM), is caused by the autoimmune destruction of pancreatic b cells leading to insulin deficiency. Hence, the administration of insulin is important for the metabolism and survival of those patients. Type 1 diabetes accounts for less than 5–10% of all the diabetic cases , Type 2 diabetes, on the opposite hand, is due to impaired insulin secretion and/or insulin resistance ، This type of insulin-independent diabetes is far more widespread and accounts for nearly 90–95% of the DM cases.

Maintaining blood sugar levels within the conventional range is of utmost importance within the management of diabetes , and Diet is a one factor which will have a good impact upon stabilizing blood glucose levels in diabetic patients. Recent studies have reintroduced the concept of employing a ketogenic diet with low-carbohydrate content in a very form of disease states like diabetes. {1}

In a diabetic patient , the ingested carbohydrates are absorbed mainly as glucose, there's an instantaneous rise within the blood glucose level. The contents of anketogenic diet with low-carbohydrate (LCKD) are mainly absorbed as triglycerides and proteins instead of glucose, so this might alleviate one among the key factors in diabetes . (2) This this study is geared toward investigating the therapeutic effects of LCKD in diabetic rats .

Materials and methods :

This experment was preformed by some animals were randomly assigned to the three diet groups: (1) normal diet (ND) of regular commercial rat food ; (2) high-carbohydrate diet (HCD) of 70% carbohydrate, 10% fat, and 20% protein; and (3) LCKD of 60% fat, 10% carbohydrate, and 30% protein. Each group was further subdivided into three subgroups: control, sham, and diabetic rats (each group consisting of seven rats).

All the groups had free access to water and food based on the type of diet. Each group of rats was fed with the specific type of diet for 8 wk.

Diabetes was induced first in rats by the intraperitoneal injection of STZ freshly prepared[3], at a concentration of 55 mg/kg in saline, and the animals in the sham control group were given only saline.

Before STZ injection, rats were caged singly in metabolic cages for 24 h to collect urine for analysis and for measuring the urine output. On the day of STZ injection, the level of blood glucose was measured from the rat tail using a glucometer ,Daily measurements of food and water intake as well as weekly measurement of body weight was taken during the whole experiment. In addition, blood glucose level (diabetic————————————250 mg/dL) and urine output were measured once a week.

At the end of 8 wk, animals were anesthetized using ether ،

and blood was collected in vacutainer tubes by cardiac puncture. After the collection of blood samples, the animals were sacrificed, the abdomen opened with a midline incision, and the pancreas taken for histologic analysis by routine hematoxylin and eosin and Gomori's chrome alum hematoxylinphloxine staining methods. Gomori's chrome alum hematoxylin-phloxine stain was used to distinguish endocrine cells of pancreas and to highlight insulin-producing b cells fromaan alpha and gamma cells . Briefly, the Gomori's chrome alum hematoxylin-phloxine staining method is as follows. Sections after their initial fixation in 10% formalin were treated with Bouin's fluid for 16–24 h.

The slides were then washed in tap water to remove picric acid and then treated for 1 min with a mixture containing an equal amount of 0.3% potassium permanganate and 0.3% sulfuric acid. The tissues were decolorized with 2–5% solution of sodium bisulphate and washed well in running tap water.The slides were then stained with hematoxylin solution for 15 min until thebcells became deep blue. The slides were further rinsed in water and differentiated in acid alcohol for about 1 min to remove the background staining. Again the slides were washed for 10 min in running tap water until the sections were clear blue. After that, the slides were stained in 0.5% aqueous phloxine for 5 min, rinsed in water, and then treated with 5% phosphotungstic acid for another min. The slides were washed in running tap water for 5 min so that sections became red and then differentiated in 95% alcohol. Finally, the slides were dehydrated, cleared and mounted with a cover slip using a mixture of distyrene (a polystyrene), a plasticizer (tricresyl phosphate), and xylene (DPX) . The tissue sections were examined using a light microscope (Zeiss, Hamburg, Germany) and images were captured with a Zeiss digital camera using Axiovision software (Zeiss, Germany)

Results :

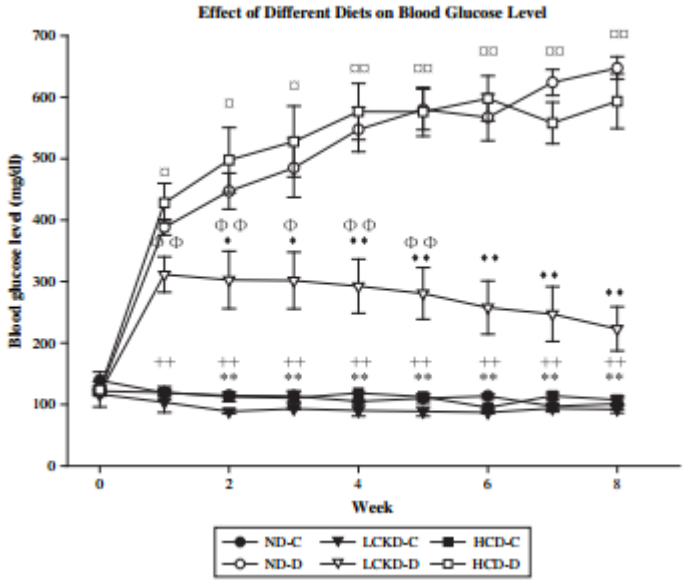

Fig. 1. The effect of different diets: normal diet (ND), high-carbohydrate diet (HCD), and low-carbohydrate ketogenic diet (LCKD) on blood glucose level (mg/ dL) in control (C) and diabetic (D) rats.

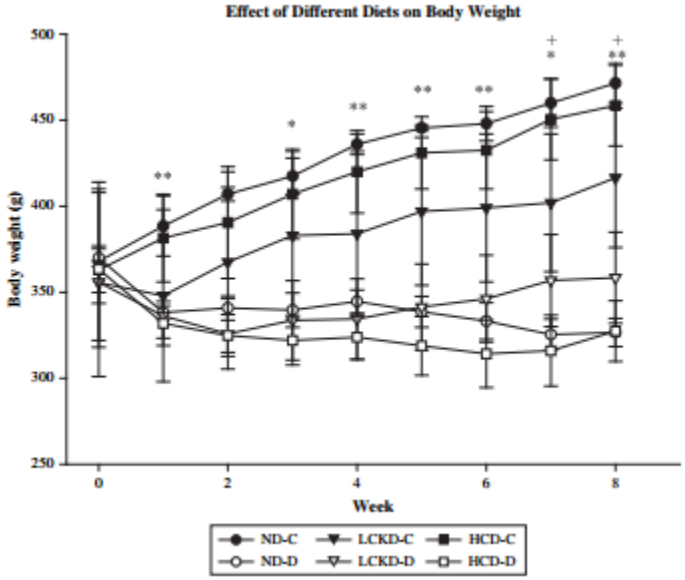

Fig. 2. Effect of different diets: normal diet (ND), high-carbohydrate diet (HCD), and low-carbohydrate ketogenic diet (LCKD) on body weight (g) in control (C(

and diabetic rats.

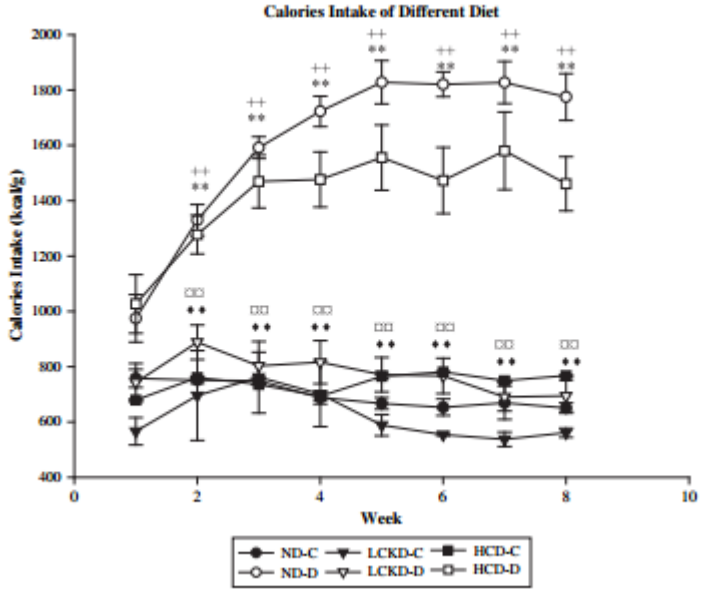

Fig. 4. The calorie intake of different diets: normal diet (ND), high-carbohydrate diet (HCD), and low-carbohydrate ketogenic diet (LCKD) in control (C) and diabetic rats (D).

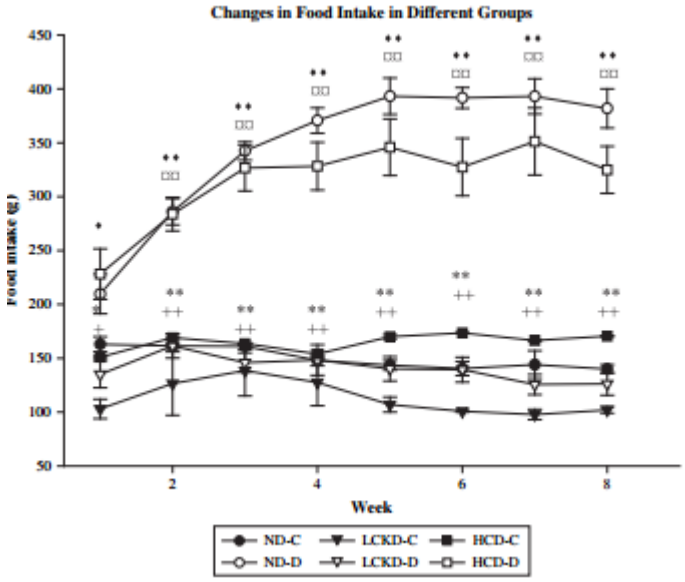

Fig. 3. The effect of different diets: normal diet (ND), high-carbohydrate diet (HCD), and low-carbohydrate ketogenic diet (LCKD) on food intake (g/wk) in

control (C) and diabetic rats (D).

Discussion :

The data presented during this study clearly indicate the beneficial effects of LCKD in improving in terms of weight, blood sugar, urine output, and food and water intake. during this study, after STZ injection, the rats were randomly assigned to the three diet groups to confirm that the results were thanks to the dietary effects instead of the other factors. It is also important to point out that this experiment was distributed without the use of any hypoglycemic medication. (1)

Effect of diets on blood glucose levels **:**

Effect of diets on blood glucose levels Following administration of STZ, there was a significant increase in blood glucose levels in all diabetic groups compared to their controls. However, the blood glucose level in the LCKD-D group was significantly lower. ($P<0.005$ and $P<0.01$) than the other groups. As shown in Figure (1) , there was a decrease in the blood glucose level in response to the LCKD diet from week 1, which reached almost normal levels (<200 mg/dL) at week 6. On the other hand, the rats assigned to the other two diets showed continuous increase in the blood glucose levels, reaching approximately 650 mg/ dL. Therefore, the data presented in this study suggest that even short-term use of the LCKD has significant beneficial effects in STZ-treated diabetic rats. Moreover, the results on the metabolic improvement were similar when a 6% carbohydrate diet was given 11 days after the induction of diabetes , as well as with a carbohydrate-free diet given after 6 wk for spontaneously diabetic BB Wistar rats . In 1990, Henry and his colleagues , showed that the improvement in the blood glucose levels is also due to the direct effect of the ketone bodies on the hepatic glucose output (6) .

Effect of diets on body weight and food intake :

As the figure (2) and (3) shows ,There was a significant ($P<0.01$) reduction in the body weight and an increase in the food and caloric intake of the diabetic groups except for the LCKD group, confirming the beneficial effect of LCKD on the diabetic status.

Effects of diets on water intake and urine output :

As polydipsia and polyuria are conditions that are concomitant with the diabetic state, water intake and urine volume were markedly increased in the diabetic groups of ND and HCD. On the other hand, water intake in the LCKD-D group was within the normal range, whereas urine volume during the first 2 wk was considerably above the

normal range due to glucose excretion. Gradually urine volume in the LCKD-D group returned to the normal level. [1]

Calorie intake of different group

All the control groups and LCKD-D ingested almost the same number of calories throughout the experiment. Figure (4)

Urine glucose and other analysis :

Urine analysis showed that the glucose level in the ND-D and HCD-D was above 1000 mg/dL throughout the experimental period. However, in the LCKD-D group, high-level glucose was present only during the first 3 wk. Thereafter، the level of glucose in the urine of the LCKD-D group became almost normal. These results further suggest the beneficial effects of LCKD in the regulation of diabetes .

Conclusion:

In conclusion, the histologic and biochemical data presented during this study support the view that the LCKD contains a significant beneficial effect on ameliorating the diabetic state and helping to stabilize hyperglycemia and will end in improved b-cell function. Although the LCKD (fatty acids and ketone bodies) may have a major role in reducing oxidative stress . Therefore, the LCKD may be effective in diabetes management by improving glycemia and reducing the requirement for medication in patients with diabetes .

References :

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