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Disha Bindra
O.P.J.S. University, Churu, Rajasthan, India

Dr. Manju Kumari
O.P.J.S. University, Churu, Rajasthan, India

Correspondence
Disha Bindra
O.P.J.S. University, Churu, Rajasthan, India

Diabetes mellitus

Disha Bindra and Dr. Manju Kumari

Abstract
Diabetes mellitus is a common endocrine disorder. According to studies by ICMR, the prevalence of diabetes in India is about 2.1% in the urban population and 1.5% in the rural areas.
Therefore 2% population in India suffers from Diabetes mellitus and almost an equal number goes undetected with the disorder. Urbanization has increases the prevalence rate. The disorder is due to diminishedly ineffective or deficiency of the hormone insulin.

Keywords: Insulin, diminishedly, endocrine

Introduction
Diabetes mellitus is a disease of metabolic dysregulation, most notably dysregulation of glucose metabolism, accompanied by characteristic long term vascular and neurological complications. It is due to defective or deficient insulin sensatory process, which lead to glucose underutilization and hyper glycemia. Inadequate secretion of insulin, inadequate structure or function of insulin or its receptors result in impaired metabolism of glucose, carbohydrates, proteins and fats, characterized by hyperglycemia and glycosuria (Pawar, 1999).

Physiology of Normal Glucose Homeostasis
The chief hormones involved in glucose homeostatis are insulin, glucagon, epinephrine, corticosteroids, growth hormone and somatostanin. Insulin is responsible for lowering blood glucose levels through lipogenesis, glycogenesis and inhibiting gluconeogenesis and glycogenolysis while the other counter regulatory hormones act to raise the glucose level through glycogenolysis and gluconeogenesis. The duodenum is considered to be a sensor that detects the type and amount of food entering the intestine for digestion and absorption. It then sends hormonal signals to the pancreas. Receipt of these signals by the pancreatic cell determines the amount and type of pancreatic secretion to be added to the gut lumen for digestion of various foods. The duodenum also sends hormonal signals to the endocrine cells of pancreas which, in the presence of an elevated circulating glucose or amino acid concentration resulting from food digestion, stimulates release of pancreactic hormones important in the metabolism of the absorbed food products. Thus duodenum and upper jejunum may be considered to be not only sensors but also integrators, which by signaling the pancreas directly and in complmentary fashion with absorbed nutrients, ensure that ingested foods are eficiently digested, absorbed and stored for latter use by the organism.
Beside insulin, certain hormones are identified which are released from specific intestinal mucosal cells in response to presence of food in upper intestine. They include gastric inhibitory polypeptide (GIP), secretin, cholesystokinin (CCK) and glucagons like peptide 1-7-36 amide (GLP-1-7-36 amide), the hormones in facilitating insulin secretion after the ingestion of glucose or of glucose containing food.

Classification of Diabetes Mellitus and other categories of glucose regulation
While there has been number of sets of nomenclature and diagnostic criteria proposed for diabetics, no generally accepted systematic categorization existed until the National Diabetes Data Group (NDDG) classification system was established in 1979. This group classified diabetes into five distinct types:
1. IDDM: Insulin dependent Diabetes Mellitus

2. NIDDM: Non insulin dependent Diabetes Mellitus
3. GDM: Gestational diabetes mellitus
4. IGT: impaired glucose tolerance
5. MRDM: Malnutrition related diabetes mellitus
a. FCPDM: Fibro calculous pancreatic diabetes mellitus
b. PDDM: protein deficient diabetes mellitus

Clinical characteristics of Diabetes Mellitus

a) Type 1 Diabetes

The symptoms occur late in the course of disease, when most of the β cells have been destroyed. However, the classical symptoms are excessive thirst, frequent urination, polyphagia, weight loss, electrolyte disturbance, ketosis and hyperglycemia which develop rapidly in a chronic disease process.

b) Type 2 Diabetes

Approximately 90 to 95 per cent patients with Diabetes Mellitus are of Type 2, which increased steadily with age. It is a complex multifactorial disease involving deranged insulin secretions and insulin resistance with possible genetic defects, obesity and fault in the insulin receptors.

c) Gestational diabetes mellitus

It occurs in 2-3 per cent of all pregnancies. Glucose intolerance occurs during pregnancy usually at 24 to 30 weeks of gestation and is associated with increased pre natal complications.

Although glucose intolerance corrects after delivery but Type 2 diabetes occur in 30-50 per cent subjects within 10 years.

Diagnosis and Monitoring Criteria for Diabetes Mellitus

Diagnostic criteria has been revised by the WHO on the basis of glucose concentration of whole blood (mg/dl) for oral glucose tolerance tests. These values are:

Normal

a) Fasting value: 80-100
b) Two hours after meals: 100-120

Impaired glucose tolerance

a) Fasting value: 105- 120
b) Two hours after taking glucose: 120-150

Diabetes mellitus

a) Fasting value: ≥120
b) 2 hrs. after taking glucose: ≥ 180

Monitoring for Diabetes Mellitus

A drop of blood from the tip of the finger is applied to the test strip and glucose concentration can be read with the glucometer. This innovative technique is widely used for self blood glucose monitoring. However, the test strips are costly, so only limited to high income group patients.

Prevalance of Diabetes Mellitus

With altered lifestyle of the present day society there has been a considerable change in dietary habits which has resulted in diabetes mellitus. Diabetes mellitus affects large number of people of all social conditions throughout the world. It has been predicted that number of diabetics will double from 143 million in 1997 to about 300 million in 2025, largely because of dietary and other lifestyle factors. Currently, there are 177.7 million diabetics world wide. Diabetes mellitus has been described in literature as a third world disease with rates high in developing countries. In USA, it is the fourth leading cause of death. The three countries with largest number of diabetics are India (is diabetic capital of world), China and USA.

World wide prevalence

World wide diabetes prevalence rates suggest that increasing westernization and urbanization are associated with higher rate of diabetes In Europe the prevalence of Type 2 diabetes has been estimated to increase from 16 million to 24 million within next 10 to 15 years and world wide the number of diabetic patients may even double with in same period. The age specific prevalence of diabetes mellitus showed the peak prevalence in the sixth decade of life followed by a decline in the seventh decade, presumably because of greater mortality of diabetic individuals. Data on ratio of prevalence in men and women revealed that in most cases sex difference was not statistically significant although impaired glucose tolerance was significantly common in women than men.

Country wide Prevalance

According to WHO (2003) [1] estimates, the prevalence in Indian diabetic population is estimated to touch 57.2 million from the present 32 million by 2025, largely on account of changing food habits and life style.

The ICMR multi centric study on the epidemiology of diabetes based on six centers in India showed that the prevalence of diabetes based on six centers in India showed that the prevalence of diabetes in urban area was higher (2.3 per cent).

Management of Diabetes Mellitus

Diet, drugs, exercise and education are four essential and dispensable modes of management of diabetes.

Specific objectives are to reduce the blood and urine glucose, to maintain serum lipids in normal range, to maintain ideal body weight, to provide relief from symptoms, to provide all required nutrients to prevent, delay or treat nutrition related risk factors or acute and chronic complications.

Last is to improve overall quality of life.

Dietary management

Diet is the corner stone in the management of diabetes mellitus (DM). Importance of diet in diabetes can be traced back to the days of the ancient ayurvedic physician Sushruta. He attributed the consumption of wholesome foods besides hereditary factors for the development of diabetes. Even before discovery of insulin, diet was the only and successful treatment.

The dietary guide lines for diabetics are given below:

Calories

It should be sufficient to maintain reasonable body weight in adults, allow normal growth and development in children, provide adequate nutrition for pregnancy or lactation. The recommended calorie intake per kg body weight is 20 kcal for overweight, 30 kcal for normal weight and 40 kcal for under nourished. A person who is above age of 50 years requires 10 per cent less calories for each decade.

Distribution of calories is as under:

Carbohydrate : 60 to 65 per cent of total calories

Protein : 15 to 20 per cent of total calories
Fat : 15 to 25 per cent of total calories.

Carbohydrate

Earlier low carbohydrate diets were given to diabetic subjects. The restriction was based on the concept that decrease in carbohydrate content of diet would decrease the post- prandial glucose and insulin response. But now the dietary treatment of DM aims at a diet low in fat and rich in fibre. The main rationale for an increase of carbohydrate is the desire to reduce the content of fat, especially saturated fatty acids, without a concomitant increase of dietary protein. Complex carbohydrates present in cereal and pulses are better than simple carbohydrates. Diet high in cereal fibre and low in refined carbohydrates is also associated with a lower risk of developing diabetes. The starch and non starch polysaccharides have been referred as complex carbohydrates. The quantitative recommendation for starch as per cent of total food energy has been set as 50 to 70 per cent. The specific advantages of consuming starch are:

Starch as a substitute for saturated fat will lead to lower blood cholesterol.

Starchy foods namely cereals, pulses and vegetables, contain a wide variety of micronutrients that sugary foods might limit the risk of obesity.

Its soluble dietary fibre (SDF) component, reduces the absorption of glucose after a meal resulting in improved glucose tolerance.

It decreases rate of gastric emptying. It has ability to absorb bile acids, thereby reduces absorption and recycling of bile acids leading to increased demand on cholesterol for replenishment of bile acids leading to increased demand on cholesterol for replenishment of the pool and decreased availability for low density lipoprotein (LDL) synthetic pathway.

It reduces food intake and provide satiety.

However adding fibre to a high carbohydrate, low fat low energy diet have a therapeutic benefit to NIDDM subjects. Fasting plasma glucose concentration was reduced after 8 weeks of fibre consumption but after 20 weeks no significant reduction was found. Starchy food is a major controlling factor for blood glucose and insulin concentrations.

Starchy foods (high carbohydrate food) increase the satiety value of meal.

Carbohydrate restriction impairs insulin sensitivity and is reversed by high carbohydrate diet.

A diet containing 55 per cent of energy from carbohydrates with a modest increase of dietary fibre, concentrating on soluble fibre and starch rich foods with low glycemic index is probably adequate for diabetics.

Fibre

Dietary fibre constitutes the sum total of non starch polysaccharides and lignin which is not digested by the secretions of human gastro intestinal tract. It includes soluble dietary and insoluble dietary fibre. The long term beneficial effects of high fibre diet were due to less fat and more complex carbohydrate.

Sugars

In the late 1970's and early 1980's the diabetic associations of many countries around the world reviewed their dietary recommendations and began to advise on restriction of sugars (glucose, fructose, sucrose and lactose) along with decreased fat and increased carbohydrate intake. But in 1986, American Diabetic Association (ADA) further revised its dietary recommendation and suggested consumption of a modest amount of sugars, for the maintenance of metabolic control.

Thus it can be concluded that sugar added foods are no more likely to compromise blood glucose control than the naturally occurring sugars or most cooked starches.

Fat

High fat diets increase body weight and adversely affect glucose tolerance, reduce insulin sensitivity and insulin receptor number and increase serum lipids and atherosclerosis risk. Since serum lipids are generally raised in diabetics. Diabetics have to be careful with the amount and nature of fat they consume.

Polyunsaturated fatty acids (PUFA) have no adverse impact on serum lipids but excess PUFA rich oils also can suppress immune function and also HDL cholesterol, which is known to reduce atherosclerosis process. Thus, limited intake of mono unsaturated fatty acid (MUFA) is better and fat is to be divided as 50 per cent poly unsaturated and 50 per cent monounsaturated fats. Since in Indian diets, cereals, pulses and vegetables provide more than 50 percent f fat requirements in form of invisible fat, diabetics can take 20 g visible fat per day. Diabetics should avoid hydrogenated oils and foods which are rich in saturated fat. Saturated fat intake should be less than 10 per cent of calories. Cholesterol intake should not exceed 300 mg per day. Rate of omega-6 to omega-3 fatty acids have also a bearing on serum lipoproteins. Omega-3 fatty acids present in fish reduce serum triglycerides, platelet aggregation and blood pressure ad are good for health.

Fat is the macro nutrient associated with over eating and obesity. Fat is eaten in excess because it is highly palatable and because it provides more energy in a given volume of food. Low fat diet increases insulin binding and also reduces LDL and VLDL levels and thus reduces the incidence of atherosclerosis which is more common in diabetics. Still some amount of fat is essential in diabetic diet. In comparison to high carbohydrate high fibre diet, low carbohydrate diet with increased level of fat as MUFA was more useful. Improved glycemic control, reduced VLDL and serum TG level and unchanged LDL to HDL ratio was observed in diabetic subjects. Hence, 20 g of fat is recommended according to recommended dietary allowances for Indians.

Protein

A diet high in protein is good for the diabetics because it supplies essential amino acids needed for tissue repair. Protein does not raise blood sugar during absorption as do carbohydrates and it does not supply as many calories as fats. In patients with NIDDM, consumption of protein along with carbohydrate lowers blood glucose concentration due to amino acid stimulation of insulin secretion. This helps to compensate for reduction in glucose mediated insulin secretion. Protein also promotes satiety.

Protein from vegetarian sources are better than flesh foods as they add fibre and do not contribute cholesterol. In diabetics with associated renal problems protein is restricted to 0.5g/kg body weight. However it should be of high biological value such as egg.

In people with NIDDM, ingested protein is relatively stronger stimulus for insulin secretion of greater interest was an identified synergistic interaction on insulin secretion when protein was ingested with glucose. This resulted in a smaller rise in a glucose concentration and the rise was even less with a second identical meal when the meals were ingested four hours apart. Also, when protein is taken with glucose, there occurs a delayed amino acid rise due to a reduced rate of protein digestion and absorption of the resulting amino acid. Thus, an increased protein content of meals for people with NIDDM should be considered.

Blood glucose response was diminished after ingestion of meal containing protein. More decrease in FFA was observed after ingestion of protein with glucose rather than glucose alone.

Wolf and Giovannetti (1991) reported that mean total cholesterol, VLDL, LDL, cholesterol and TG becomes lower and HDL cholesterol higher on substitution of protein for carbohydrate.

A reduction of plasma cholesterol by vegetable proteins (legumes) which is attributable to protein, saponins, unsaturated fat, fibre, isoflavones and sterols.

Feeding of hypercholesterolemic rats with animal proteins resulted in significant decrease of triacylglycerol (70 per cent) which reflected decrease in the VLDL fraction. However, some contradictory results have been reported. Protein meal (250g beef steak) enhanced gluconeogenesis which was evidenced by unchanged plasma glucose. Chronic ingestion of a low carbohydrate, high protein diet has been shown to result in increased hepatic glucose production and decreased peripheral glucose utilization i.e. insulin resistance in both animals and man. Consumption of protein also stimulates glucagon secretion which promotes glyogenolysis and gluconeogenesis and is thought to offset any insulin induced decline in plasma glucose.

Vitamins and Minerals

Vitamins and minerals have to be supplemented to meet daily requirements (especially fat soluble vitamins) in diabetics. Zinc, chromimum and magnesium, copper and pyridoxine deficiency may result in glucose intolerance and also uncontrolled diabetes may produce deficiency of Vitamin C and D. Studies from NIN, Hyderabad showed that administration of Vitamin D improved glucose tolerance.

Chromium along with zinc is essential for proper functioning of insulin in the body. Zinc is necessary for the binding of insulin to the Islets of Langerhans in the pancreas, which is necessary for the functional and morphological integrity of β- cells. Cobalt and selenium may also be involved since they vary in concentration with glucose and insulin administration. Diabetics have also been found to suffer from hypomagnesemia. Vitamin A, D, E, C, thiamine, riboflavin, pyridoxine, folic acid, cynacobalamine and niacin deficiency has been observed in diabetics.

Deficiency of niacin, pantothenic acid, pyridoxine leads to diabetes. Niacin is required for synthesis of insulin and is also involved in glucose tolerance factor (GTF) synthesis. Pantothenic acid deficiency leads to hypoglycemia as it affects adrenal function. Diabetics also suffer from potassium deficiency because potassium binds with glycogen and helps in its storage. When diabetic acidosis patients are treated with insulin, glucose is converted to glycogen so potassium from serum goes to glycogen and creates hypokalemia. Hence, minerals play an important role in treatment of diabetes.

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