DIETS SUITABLE FOR REDUCTION OF SERUM CHOLESTEROL LEVELS

The Cleveland Clinic Dietary Research Project

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FOUR years ago when the Cleveland Clinic Dietary Research Project began, evidence was accumulating that the incidence of ischemic heart disease was associated in some way with dietary fat and serum cholesterol levels.[1] International epidemiologic studies had revealed a high incidence of coronary heart disease in countries such as the United States and Finland, where large amounts of fats are eaten, and a lower incidence (about one third as much) in countries such as Italy and Japan, where less fat is eaten. The average serum cholesterol levels in countries with low-fat consumption were approximately 25 per cent lower than in countries with high-fat consumption. It was also evident that the incidence of coronary heart disease increased in those groups who migrated from a country relatively free of the disease to one where it was prevalent. For instance, a Japanese moving from Tokyo to Los Angeles increased his fat consumption approximately threefold, his serum cholesterol rose to American levels, and his risk of developing heart disease doubled.

Aside from the evidence provided by population studies, it was well known that atherosclerosis was associated with diseases such as diabetes mellitus and hypothyroidism, in which the blood lipid concentrations are elevated. Furthermore, it was known that experimental atherosclerosis could not readily be produced in animals unless the serum cholesterol concentration was first increased with high-fat diets.

Apparently, man is more susceptible to atherosclerosis than other animals; the pathogenesis is not clear-cut and many factors are probably involved. The multifaceted aspects of atherosclerotic heart disease are well demonstrated by the prospective study currently under way at Framingham, Massachusetts.[2] The findings indicate that certain factors are associated with risk: age, sex, a family history of atherosclerosis, hypertension, cigarette smoking, obesity, and serum cholesterol level. The relationship between serum cholesterol level and coronary heart disease is quite striking. Of every thousand persons who were apparently free of the disease at the beginning of the Framingham study, clinical signs of atherosclerosis developed within four years in only 42 persons with initial serum cholesterol levels less than 260 mg. per 100 ml.; in the group with levels higher than 260 mg. per 100 ml., there were three times as many cases (122). The data at the end of eight years of observation are even more convincing: in men with cholesterol levels higher than 260 mg. per 100 ml., four times as much coronary disease developed as in those with initial levels less than 200 mg. per 100 ml. These findings support the hypoth-

esis that reduction of serum cholesterol concentration is a promising approach to the problem of coronary heart disease.

Hypocholesterolemic Diets

There is much to suggest that one of the safest and most effective ways to reduce the concentration of blood cholesterol is the proper modification of food habits. Experimental evidence has shown that to accomplish this, changes in the fat content of the diet are necessary. When our project started, it was known that serum cholesterol levels could be significantly reduced in man by low-fat or low-cholesterol diets and by certain unsaturated vegetable oils.[3] Carefully controlled studies of humans on fat-containing formula diets[4] had demonstrated that cholesterol reduction depended upon the degree of unsaturation of dietary fat; saturated animal fats tend to increase serum cholesterol levels while unsaturated vegetable oils reduce them. The work of Keys, Anderson, and Grande[5] suggests that saturated fats may be twice as effective in raising the cholesterol level as the polyunsaturated fats are in reducing it.

Today there are three types of diet, each of proved merit, in clinical use for the reduction of serum cholesterol levels. In all three, the intake of saturated animal fat is restricted to 25 gm. (less than 1 ounce) per day, and the cholesterol content is less than 1/2 gm. The first is the low-fat diet in which *all fat* is reduced to less than 1 ounce daily. The second is the vegetable-oil food pattern in which a normal amount of fat (40 per cent of total calories) is allowed; only 5 per cent however, is derived from meat fat, and the remaining 35 per cent from vegetable oils. The third is a similar vegetable-oil diet with 30 per cent of calories from fat[6] rather than 40 per cent.

During the past four years the aim of the Cleveland Clinic Dietary Research Project has been to achieve and to maintain reduced serum cholesterol concentrations by means of practical, palatable, everyday foods. We have studied two of the three diet patterns outlined above—the low-fat, and the vegetable-oil food pattern in which 40 per cent of calories are derived from fat.

The project began simply, with a small group of Clinic outpatients who had high serum cholesterol levels. At that time there was a lack of accurate information concerning the kind and amount of fat in ordinary foods. It was obvious that if an effective food pattern for reduction of serum cholesterol levels were to be developed, it would be necessary to devise methods for the preparation and evaluation of palatable foods. With these needs in view, a research kitchen was established, patterned on home-cooking methods rather than on institutional procedures. A quantitative diet test[7] was developed to test the effect of foods of known fat composition when fed to subjects for 18 days; serum cholesterol concentrations were determined every five to seven days. In this way the effectiveness of the various dietary regimens was determined.

At first we worked with the low-fat diet and attempted to give it as much variety as possible. In spite of this effort, the diet became monotonous after several months because of the necessary restriction of fat-containing foods.

Another promising approach to a practical and palatable diet suitable for decrease of serum cholesterol levels was the substitution of vegetable oils for the usual, hard, saturated fats. We undertook the development of such a vegetable-oil food pattern,[8] and this is now the major activity in the research kitchen. For the vegetable-oil diet to be effective, we found it was necessary to replace the major portion of animal fat in the normal American diet with vegetable oil. It is *not* enough merely to use an unsaturated margarine in place of butter, or to trim the visible fat from pork or rib roasts. The quantitative tests established that in order to achieve a reduction in serum cholesterol concentration of 15 per cent or more, the saturated animal fat must be limited to no more than 25 gm. per day.[9] This means that only lean meats, well-trimmed, and poultry may be used; fish is also appropriate since the fat of these animals often contains appreciable amounts of polyunsaturated oils. The intake of saturated fat was reduced further by eliminating egg yolks and butter fat. To maintain palatability and to achieve an additional hypocholesteremic effect, unsaturated vegetable oils were substituted for the saturated fats normally present in the diets. By means of these substitutions, the total fat in the diet remained at average American levels—40 per cent of calories.

Serum Cholesterol Reduction

In patients with abnormally high cholesterol levels the degree of reduction attainable depends upon the type of hyperlipemia.[10] There are three types, in each of which the serum cholesterol level is high; they differ in the proportions of the various lipid fractions. In hyperglyceridemia the triglyceride fraction is disproportionately high; in mixed hyperlipemia, all lipid fractions are high, but they are normally distributed; in hypercholesteremia, the cholesterol fraction is disproportionately high.

Our four-year experience with approximately 75 patients continues to be the same as that reported for a small number of patients studied over a two-year period.[11] These patients have now been on the diets for from 6 to 50 months. Hyperglyceridemia is the most responsive, and hypercholestermia the least responsive to diet modification. Of 25 hypercholesteremic patients, more than half were unresponsive or later became so.

Both the low-fat and the vegetable-oil food pattern (40 per cent of calories from fat) have been used by these patients while living at home. The methods of adapting these patterns to the needs of individuals have been described previously in this journal.[12] The low-fat and vegetable-oil diets were equally effective in all but the hyperglyceridemic patients. Their characteristically variable serum cholesterol levels were steadier and lower (by 5 per cent) on the vegetable-oil diet.

The experience of other investigators [6,13] as well as our own, has demonstrated conclusively that significant reduction of serum lipid levels may be accomplished with practical diets in both hyperlipemic and normolipemic persons. Studies now in progress may eventually demonstrate the role of diet modification in the treatment of atherosclerosis and coronary heart disease.

The prevention of atherosclerosis is an even more important challenge. This disease is one of the foremost public health problems in the United States today, especially in middle-aged men. Will such persons, currently free of clinical disease, benefit from modifications of their habitual diet?

A New Approach

Most patients with heart disease tolerate the inconveniences imposed by these diets.[14] They eat according to a set plan rather than by whim. This requires careful food selection at the market or in the restaurant and often many favorite items are omitted. These diets, although useful in the Clinic, are usually not feasible for the healthy active person who does not have an incentive of pain or physical disability. Many of the difficulties could be avoided, however, if properly prepared commercial foods were available.

For these reasons, we turned our efforts toward the commercial preparation of certain important fat-containing foods. With the practical experience gained in the research kitchen, we knew that palatable foods could be made, and that food manufacturers could probably provide even better products because of their technical experience. Fortunately, we have been able to obtain the cooperation of several companies able to produce a variety of fat-containing foods according to our specifications. These include lean, closely trimmed meats, meats and dairy products "filled" with vegetable oil, baked goods and entrees containing oil. Polyunsaturated margarine and shortening are also available. Because many "filled" vegetable-oil products are illegal, it was necessary to obtain the permission of governmental agencies for the production, distribution, and use of these products.

A one-year experiment has been initiated to test the possibility that the use of these commercially prepared foods by subjects, with only a minimum of dietary instruction, will reduce serum cholesterol levels significantly. In this experiment the quantity and the quality of fat in the foods is controlled by the producer; the subjects are not required to limit the amounts of these foods consumed. At present, 25 normal families are following a low-saturated—high-unsaturated-fat diet using these foods. The families shop in a special research commissary. Other foods that contain little or no fat (e.g., fruits, vegetables, plain bread, and rolls) are purchased in regular retail markets. Only a few foods are entirely prohibited; these include bacon, duck, and rib cuts of meat. The consumption of egg yolks is limited to five per week. If successful, this study will demonstrate that practical and palatable diets using commercially prepared foods, cooked in the usual manner, can effectively reduce serum cholesterol levels. Our preliminary results are encouraging.

Future Plans

The need for adequate means to cure, to retard, or to prevent the atherosclerotic process and its sequelae is unquestioned. The studies we have described can provide information only concerning the efficacy of these diets in reducing serum cholesterol levels; they *will not* examine any of the possible cause and effect relationships between blood cholesterol levels and the incidence of atherosclerotic heart disease. To obtain a valid answer to that vital question, a great many persons will have to modify their diets and they will have to be studied for several years. If preliminary studies, such as these currently under way at the Clinic, prove to be widely applicable, then mass field trials of this type may be the next logical step. Possible methods for the conduct of such a large-scale experiment are currently being explored by a national committee of investigators.

The Cleveland Clinic Dietary Research Project is contributing knowledge of the critical amounts and kinds of fat in the diet suitable for reduction of serum cholesterol concentration. When this knowledge is combined with an adequate variety of properly prepared commercial foods we shall have an effective method to determine whether or not atherosclerosis can be affected by diet.

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