DIETARY FATS AND BLOOD PRESSURE

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Summary

Over recent decades there have been numerous claims for specific effects of dietary fats on blood pressure in humans. These include suggestions that a high saturated fat diet leads to blood pressure elevation, or that ω-6 polyunsaturated fats and/or a high polyunsaturated to saturated fat ratio lowers blood pressure in hypertensive and normotensive subjects. Earlier studies in the area were either uncontrolled, or confounded by concomitant changes in other nutrients and total energy intake. Randomized controlled trials of the effects of varying saturated fat and/or ω-6 polyunsaturated fat intake, while attempting to maintain intake of other dietary components, have demonstrated little or no effects of blood pressure. In contrast blood pressure falls have been seen with the use of complex diets, such as lacto-ovo-vegetarian diets, which include an increase in P/S ratio, a reduction in saturated fat intake and increased intake of fibre from fruit and vegetables. Paradoxically certain populations on a very low saturated fat intake, such as in Japan and mainland China show a high prevalence of hypertension, despite low blood lipid levels and a low incidence of coronary disease. Recent studies suggest that a high intake of fish, or fish oils, may have an antihypertensive effect, particularly in the absence of a high salt intake. The significance of these observations will be discussed in the context of control of hypertension and hypertensive cardiovascular disease.

I. INTRODUCTION

Epidemiology Studies

Evidence for a pressor effect of a diet high in total and saturated fat, in contrast to a diet with a high P/S ratio, comes particularly from studies of vegetarians and vegans (Rouse and Beilin 1984). Early studies of lacto-ovo-vegetarians and vegans living within industralized societies had demonstrated lower average blood pressures and a reduced prevalence of hypertension compared with the general population within which they lived (Rouse and Beilin 1983). In addition, a number of unacculturated populations with a very low fat intake have been reported to have low blood pressures (Rouse and Beilin 1989).

The problem with these studies is the large number of cross-cultural, and constitutional differences in the populations being compared. In the case of inter-population comparisons there are potential biases due to lack of standardization of blood pressure measurement, and possible confounding effects of genetic differences, body fat, age, environmental temperature, sodium intake, alcohol consumption, chronic infection and physical fitness. Even within populations the religious groups and macrobiotic communes studied initially may have had other differences in life style contributing to the differences in blood pressure (Rouse and Beilin 1984). To try and resolve this, Rouse et al, carried out a cross-sectional comparison of Seventh Day Adventists lacto-ovo-vegetarians with Mormon meat eaters in Perth in Western Australia (Rouse et al, 1983).

These two groups were chosen as the groups were comparable for religiosity, and both religions proscribed the use of alcohol, caffeine and nicotine containing products, but differed markedly in their dietary habits.

The 98 Seventh Day Adventists who were strict lacto-ovo-vegetarians (eating meat, poultry or fish less than once a month) showed significantly lower blood pressures than the 113 Mormon meat eaters, with a shift to the left of the entire frequency distribution of blood pressures by about 5mmHg systolic in men and women. The two groups were comparable

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for age and sex distribution (aged 20-44 years), and blood pressure differences remained significant after adjusting for the lower body mass index of the vegetarians. The frequency of mild hypertension, arbitrarily defined as >140mm Hg systolic or >90mm Hg diastolic was 10% in the Mormons versus 2% in the Adventists. No other behavioural factors could be identified which could explain the blood pressure differences other than the diets. Home blood pressure recordings in 47 age, sex and obesity matched pairs of Adventists and meat eaters confirmed the blood pressure differences.

Nutrient analysis of diet records from this study showed that the vegetarians ate significantly more fibre, polyunsaturated fat, potassium, magnesium and calcium, Vitamin C and E and significantly less total, saturated fats, cholesterol, Vitamin B_{12} and iron compared with Mormon omnivores. Mean 24-hour urine sodium excretion was similar in the two groups, with the vegetarians excreting more potassium.

This study illustrates the complexity of dietary changes and other differences between populations whose fat intakes differ, and as with all cross-sectional population studies enables no definite conclusion to be drawn concerning cause and effect relationship. Because of the high degree of association between nutrients in foodstuffs, and the fact that people eat foods, and not specific nutrients, it is easy to draw erroneous conclusions as to cause and effect in sectional population studies (Beilin 1987). However, as discussed below, there is evidence for a direct effect on blood pressure of vegetarian related diets, although whether variations in fat intake per se are responsible is still uncertain.

There are, however, other inter-population comparisons which argue against an effect of dietary total or saturated fat being playing a dominant role in blood pressure elevation; namely, the fact that Japanese and mainland Chinese have a high prevalence of hypertension and stroke despite a very low intake of fat. Their low saturated fat intake is associated with low plasma cholesterol levels and a low incidence of coronary disease but appears to be unable to protect them against other environmental and genetic influences predisposing them to hypertension.

II. Dietary Trials

Vegetarian and Related Diets

To resolve whether or not the dietary patterns of Seventh Day Adventist vegetarians could account for their lower blood pressures Rouse et al. (1983) and Margetts et al. (1986) conducted randominized controlled trials of the effect of introducing vegetarian diets to meat eaters in respectively normotensive, and untreated mildly hypertensive volunteers. Both studies were carried as cross over trials with parallel groups alternating 6 week periods of vegetarian or omnivore diets, or continuing a normal diet throughout. In both trials eating a vegetarian diet was associated with significant falls in blood pressure over the order of 5-6mmHg systolic and 2-3 mmHg diastolic. These differences remained significant after adjusting for small differences in body weight, and could not be accounted for by changes in sodium intake. The vegetarian diets used in these trials were similar to those eaten by Perth Seventh Day Adventists, with a P/S ratio around 1.0 compared with the omnivores of 0.3 to 0.4. Puska et al. (1983) have also published a number of population based trials in which their prime objective was initially to influence blood cholesterol levels. Although these trials are reported as demonstrating effects on blood pressure of saturated fat intake or P/S ratio per se, the dietary regimes have all involved a reduction in meat consumption, and increased dietary fruit and vegetables. These studies have also led to a reduction in total energy consumption, which it may itself influence blood pressure levels. Such studies therefore also involve complex food and nutrient changes akin to those involving vegetarian diets, and leave unclear the question of a specific and unique effect of dietary fats on blood pressure.

Along similar lines, Kestin et al. (1990) compared the effect of a strict lacto-ovo-vegetarian diet, a normal `Western' diet and a 'prudent' diet, the later including lean meat, but with saturated fat comprising less than 30% energy, P/S ratio >1.0 and a high fibre intake. Blood pressures in their normotensive subjects were reduced by 3-4 mmHg systolic by the 'prudent' and vegetarian diets with no significant difference between them.

In contrast Sciarrone et al. (1990) in a two-by-two factorial study of sodium restriction and a `prudent' diet study of treated hypertensives showed only a blood pressure

lowering effect of sodium restriction, although the `prudent' diet lowered blood LDL cholesterol levels as predicted.

More specific trials of saturated /ω-6 polyunsaturated fats

A number of the earlier trials claiming specific effects of changing fat intake have been reviewed critically elsewhere (Rouse and Beilin 1983). Most of the earlier trials involved small numbers of subjects and/or were flawed in experimental design with regard to either controls, randomization, blood pressure measurements, analysis or interpretation. The problems of conducting 'double-blind' dietary intervention studies are formidable, but have been tackled successfully in some studies, particularly where oil containing capsules have been administered.

Margetts et al. (1985) carried out a three group cross over trial in 60 normotensive subjects, increasing P/S ratio from 0.4 to 1.0 whilst holding other nutrients and total fat intake constant, and were unable to show any effects on blood pressure over periods of 6 weeks. Similar negative findings were reported by Sacks et al. in normotensives (Sacks et al. 1987a) and 21 hypertensives (Sacks et al. 1987b) given polyunsaturated vs saturated fat oil supplements double blind.

Heagarty et al (1986) reported a 4mm Hg reduction in supine systolic pressures only in 22 normotensive volunteers fed safflower seed oil versus placebo, but as reviewed elsewhere were unable to confirm this in a larger study (Shinton et al. 1989). Changing a Mediterranean diet to one with a low P/S ratio has also been reported to raise blood pressure although the study by Strazzullo et al. (1986) was not adequately controlled.

Thus, it appears that blood pressures tend to fall in normotensive or untreated hypertensives in studies of complex dietary changes which usually include increased fruit and vegetable consumption as well as a reduction dietary total and saturated fat and meat products. Studies in which dietary saturated fats and P/S ratio have been changed while attempting to hold energy intake and other nutrients constant, have generally been negative. It seems likely that if these fats are influencing blood pressure, then they do so in conjunction with other nutrients eg. fibre and potassium. Alternatively the population 'substrate' may be crucial to demonstrating specific effects of fats on blood pressure levels.

Fish and Fish Oils

There is now increasing evidence that fish and/or fish oils may have significant blood pressure lowering effects in humans when ingested in the relative large amounts akin to those eaten in marine products by Greenland eskimos. Several randominized controlled trials in normotensive and untreated hypertensive (Norris et al. 1986; Mortensen et al. 1983; Knapp and Fitzgerald 1989; Kestin et al. 1990 and Bonaa et al. 1990) but not treated hypertensive (Wing et al. 1990) subjects have demonstrated such effects. In the larger of these studies by Bonaa et al in Tromso (Bonaa et al. 1990), 150 mild hypertensives were randomly allocated to capsules of fish oil or control ω-6 polyunsaturated equivalent. Significant falls of blood pressure were seen in the fish oil group overall, with subgroup analysis suggesting that the effect was restricted to those subjects who normally ate less than two fish meals a week, and/or who had low levels of baseline levels of ω-3 fatty acids in plasma phospholipids. The active constituents of fish oils are thought to be eicosapentaenoic and doco-hexanoic acids. The mechanism of the blood pressure lowering effect is unclear but may be related to effects on blood vessels with a reduction in pressor sensitivity to noradrenaline and increased endothelial dependent relaxations (Yin et al. 1988). There is also recent evidence that sodium restriction may enhance the antihypertensive effect of fish oils, which follows the suggestion by Codde et al. (1987) from experiments in rats that a high salt diet may negate any blood pressure lowering effect of fish oils and that this phenomenom might account for the high prevalence of hypertension in Japanese whose intake of both salt and fish is high.

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