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Preventing Stroke with a Plant-Based Diet

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Abstract

Current known modifiable risk factors for stroke together account for more than 90% of population attributable risk. A plant-based diet has been shown to reduce the risk of stroke by 28-48%, and to significantly reduce the biggest risk factors – hypertension, coronary heart disease, and type 2 diabetes. Vegetarians have been found to have a 34-44% lower risk of developing hypertension, and a 40% reduced risk of ischemic heart disease. Vegans have a 78% lower risk of type 2 diabetes and a 75% reduced risk of hypertension compared to meat eaters with an otherwise healthy lifestyle. In addition, plant-based diets may reduce the likelihood of other risk factors that are associated with stroke, such as atrial fibrillation and heart failure. One of the main goals in stroke risk reduction is to control vascular risk factors such as hypertension, diabetes, dyslipidemia, and smoking cessation. Changes in lifestyle such as a healthy diet and aerobic exercise are recommended strategies for all of these. Patient compliance on plant-based diets has been good in almost all studies, with the degree of compliance often very high. The patient should be informed that while a plant-based diet reduces the risk of stroke, it will also reduce the risk of a number of other diseases.

Keywords: Atrial fibrillation; Hemorrhagic stroke; Hypertension; Ischemic stroke; plant-based diet; stroke; Vegetarian; Vegan

Abbreviations: AF: Atrial Fibrillation; ApoB/ApoA1: Apolipoprotein Ratio; BP: Blood Pressure

CAD: Coronary Artery Disease; CHD: Coronary Heart Disease; CRP: C-Reactive Protein; HDL: High Density Lipoprotein; HF: Heart Failure; hsCRP: High sensitivity C-reactive Protein; LDL: Low Density Lipoprotein tPA; Tissue Plasminogen Activator

Introduction

Nearly 800,000 people suffer from a stroke each year in the United States. Stroke is the fifth leading cause of adult death and disability. With up to 40% of survivors not expected to recover independence from severe disabilities, it results in over $72 billion in annual cost in the US alone [1]. Stroke results in immense human suffering, and an excessive financial burden on health systems worldwide. Treatment is difficult hence prevention strategies are all the more important. Therefore, physician education on stroke prophylaxis with a plant-based diet would be especially valuable in preventing the incidence of stroke. Stroke is a heterogeneous, multifactorial disease regulated by modifiable and nonmodifiable risk factors. Modifiable factors include a history of hypertension, diabetes mellitus, C-Reactive Protein (CRP), high sensitivity CRP (hsCRP), and coronary heart disease amongst others. Nonmodifiable factors include age, sex and race. Other less-well documented risk factors include geographic location, socioeconomic status and alcoholism. Approximately 80% of stroke events could be reduced by making simple lifestyle modifications [2].

The majority, 82–92%, of strokes are ischemic although the relative burden of hemorrhagic versus ischemic stroke varies among different populations [3]. Hemorrhagic strokes can be either primarily intraparenchymal or subarachnoid. Ischemic stroke can be further divided into what have been referred to as etiologic subtypes, or categories thought to represent the causes of the stroke: cardioembolic, atherosclerotic, lacunar, other specific causes (dissections, vasculitis, specific genetic disorders, others), and strokes of unknown cause [4]. As far as treatment goes, the intravenous administration of tissue plasminogen activator (tPA) within 3 hours of stroke onset, or within 4.5 hours of stroke onset in select patients, is currently the only U.S. Food and Drug Administration (FDA)-approved therapy for ischemic stroke [5]. Because of the time-dependent nature of tPA therapy and a fear of hemorrhagic complications, only 1%–8% of potentially eligible patients have been treated with tPA [6]. Mechanical thrombectomy may also be performed. Restoring blood flow can mitigate the effects of ischemia only if performed quickly. Mechanical clot disruption is an alternative for patients in whom fibrinolysis is

ineffective or contraindicated [7]. In the case of cardioembolism due to atrial fibrillation, mechanical valves, or cardiac thrombus, anticoagulation is the mainstay of therapy (8). In contrast to treatment for ischemic stroke, the recommendation for managing hemorrhagic stroke is supportive treatment, because no specific medication has been developed [9,10]. Therefore, treatments for acute ischemic and hemorrhagic stroke continue to be a major unmet clinical need, making prevention even more important.

Risk Factors

Some risk factors of stroke are nonmodifiable, such as older age and male sex. Current known modifiable risk factors -hypertension, current cigarette smoking, high waist-to-hip ratio, poor diet, lack of regular physical activity, diabetes mellitus, alcohol consumption, psychological factors, cardiac causes, and apolipoprotein (ApoB/ApoA1) ratio - together account for more than 90% of population attributable risk for stroke [11,12]. Risk factors for hemorrhagic and ischemic stroke are similar, but there are some notable differences. There are also differences in risk factors among the etiologic categories of ischemic stroke. Hypertension is a particularly important risk factor for hemorrhagic stroke, though it contributes to atherosclerotic disease that can lead to ischemic stroke as well. Hyperlipidemia, on the other hand, is a particularly important risk factor for ischemic strokes due to atherosclerosis of extracranial and intracranial blood vessels, just as it is a risk factor for coronary atherosclerosis. Recent evidence has firmly established heart failure as a risk factor for stroke, most commonly for ischemic stroke [13]. Metabolic syndrome and high Low-Density Lipoprotein (LDL) cholesterol have also been identified as risk factors for intracranial atherosclerosis, an important mechanistic step in the pathogenesis of ischemic stroke [14].

Atrial Fibrillation (AF) is also a risk factor for cardioembolic stroke [11].

Impact of diet

According to the American Heart Association statistical report of 2015, only 0.1% of Americans consume a healthy diet and only 8.3% consume a moderately healthy diet [1]. Within the last decades, plant-based nutrition has experienced increased interest in the medical community, because it can reduce the risk factors of diseases such as hypertension [15], type 2 diabetes [16], and coronary heart disease [17]. Generally, a Mediterranean diet is a much more plant-rich diet than the standard American diet. In one Dutch cohort followed for 10-15 years, those with the highest adherence to the diet had an adjusted relative risk of incident stroke of 30% less than compared to those with the lowest adherence [18]. In one study comparing vegetarians to nonvegetarians who otherwise practice a healthy diet, a 29% reduction in the risk of stroke was noted [19]. In another study, researchers found vegetarians had a 48% lower risk of overall stroke than non-vegetarians, a 60% lower risk of ischemic stroke, and a 65% lower risk of hemorrhagic stroke [20]. However, one study did show an increased risk of hemorrhagic stroke [21] Nearly 80% of vegetarians in this study drank varying degrees of alcohol. Alcohol consumption (as measured by γ-glutamyl transferase) has been suggested in a previous cohort study to modify the effect of low serum cholesterol typical of vegetarians on hemorrhagic stroke risk [22]. Dietary intake of fruits and vegetables may reduce the risk of stroke. These foods may protect against stroke through antioxidant mechanisms or by raising potassium levels [23-25].

Dyslipidemia

Vegetarians have a 40% reduced risk of ischemic heart disease [19,26]. Epidemiological research also points to the lower total cholesterol and LDL cholesterol levels in those already following plant-based diet. One study showed that vegans had on average a total cholesterol of only 142 mg/dl and an LDL cholesterol of only 69 mg/dl [27]. Other studies have also shown a much lower than average level of total cholesterol and LDL [28, 29]. One study showed am LDL/HDL ratio 1.63 for vegans compared to 2.27 for meat eaters. [28] Vegans have also been shown to have lower ratios of ApoB/Apo1 ratios [17,30,31]. A newer area of research has focused on the role of the gut microbiota in the pathogenesis of atherosclerosis. It has been found that vegetarians and vegans have bacterial flora that produce less trimethylamine-N-oxide (TMAO), thought to be atherogenic, than the flora of meat eaters [32]. Several studies found an association between high serum CRP level and development of stroke [33-37] Rooco et al. found an independent association between high serum CRP level with mortality and intracerebral hemorrhage after thrombolysed stroke [38]. Lower levels of hs-CRP were found in those following a vegetarian diet for more than 2 years [39,40]. An interventional study found that after 8 weeks on a vegan diet hs-CRP was reduced 32% even more than the American Heart Association diet [41].

Hypertension and Type 2 Diabetes

DASH (dietary approaches to stop hypertension) was developed by the National Heart, Lung, and Blood Institute to help people prevent high blood pressure. The plan focuses on eating plenty of fruits, vegetables, and whole grains while lowering salt. Adherence to the DASH-style diet is associated with a lower risk of stroke among middle-aged women during 24 years of follow-up [42]. Studies have found that vegans and vegetarians have lower blood pressure than their meat-eating counterparts. Observational studies have found that vegetarian diets are associated with a 6.9 mmHg lower mean systolic blood pressure and 4.7 mmHg lower mean diastolic blood pressure compared to omnivorous diets. Clinical trials of vegetarian or vegan diets of at least 6 weeks duration resulted in mean decreases of 4.8 mmHg systolic BP and 2.2 mmHg diastolic BP [43]. This finding may, in part, be related to increased potassium intake from plant foods (particularly if accompanied by a low sodium intake). A high sodium to potassium ratio has been associated with increased

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risk of stroke [15]. In a prospective cohort study of 1546 non-hypertensive subjects followed for three years, those consuming more phytochemical rich foods (plant-based foods) had lower risk of developing hypertension [44]. In a matched cohort study of 4109 non-hypertensive subjects followed for a median of 1.6 years, vegetarians had a 34% lower risk of developing hypertension than non-vegetarians [45]. In a study comparing black vegetarians with non-vegetarians who had a healthy lifestyle, the risk of hypertension was reduced 44% [46]. Diabetes causes various microvascular and macrovascular changes often culminating in major clinical complications, one of which, is stroke [47]. Vegans have a 78% lower risk of type 2 diabetes and a 75% reduced risk of hypertension compared to meat eaters with an otherwise healthy lifestyle lifestyle [48].

Atrial fibrillation

Atrial fibrillation can lead to thrombus development within the atria [49], particularly the left atrial appendage [50-51] which can cause thromboembolic events. Multiple risk factors and clinical conditions that are associated with the development and progression of AF have been identified in the last decades [52-53]. Although there are several nonmodifiable risk factors, such as gender or advancing age, a gradual shift in awareness toward modifiable predisposing conditions has been observed [54]. Conventional cardiovascular risk factors that are associated with atrial fibrillation include hypertension, coronary heart disease, heart failure, and valvular heart disease [52, 55]. Other well-established concomitant risk factors include diabetes, overweight, obesity, and hyperthyroidism. Additionally, there are a number of emerging and less well-researched risk factors, such as subclinical atherosclerosis, inflammation, obstructive sleep apnea, and chronic kidney disease [56]. Plant-based diets may reduce the likelihood of many traditional risk factors that are associated with AF [56], including hypertension [43, 57, 58], hyperthyroidism [59-60], obesity [48], and diabetes [16]. One study showed that a vegan diet reduced the risk of hyperthyroidism by 51% while a vegetarian diet reduced the risk by 28% showing a dose response relationship [60]. Several lines of epidemiological research have also shown a lower risk of chronic kidney disease among vegetarians. It also shows a substantially increased risk among omnivores, especially those who eat red and processed meats [61].

Contrary to recent interest, both fish and fish oil do not seem to have an antiarrhythmic effect or protect against atrial fibrillation [62,63].

Heart failure

Traditionally, the following are the known causes of ischemic stroke:

(a) embolism to the brain of cardiac or aortic origin (i.e., myocardial infarction, AF, valvular heart disease, complicated aortic plaque, or patent foramen ovale);

(b) cerebral ischemia due to perfusion failure and artery-to-artery embolism (i.e., large artery atherosclerotic plaque, small vessel disease or occlusion, or vasculitis); and

(c) thrombosis (prothrombotic state). Not surprisingly, heart failure (HF) comprises all of these [13].

Several epidemiological investigations have identified the following key risk factors for heart failure: increasing age, hypertension, coronary artery disease, diabetes, obesity, valvular heart disease, and the metabolic syndrome [64].

Since those following a plant-based diet are at lower risk of coronary artery disease, diabetes and obesity, they can be expected to be at lower of heart failure as well. Several population-based cohort studies that have demonstrated an inverse relationship between increased consumption of plant-based foods and incidence of heart failure [65-69]. Five prospective studies examined the association between meat consumption and HF incidence in separate medium to large, middle-aged cohorts. All of these studies found increased HF risk with meat consumption [70-74]. In a prospective cohort study of 21,275 participants from the Physicians' Health Study I, consumption of one egg a day increased the risk of heart failure by 28% and consuming two eggs a day increased the risk of heart failure by 64% [75]. In another prospective study of over 15,000 participants, those who ate a plant-based diet most of the time had a 42% reduced risk of heart failure [76]. The beneficial effects of a low-fat vegetarian diet are indicated for patients at risk of heart failure and who also have CAD. One study showed significant improvements in such patients with documented CHD, regardless of ejection fraction, in lifestyle behaviors, body weight, body fat, blood pressure, resting heart rate, total and LDL-cholesterol, exercise capacity, and quality of life by 3 months. Most improvements were maintained over 12 months [77].

A recent case report demonstrated the effects of a plant-based diet in a 79-year-old male with documented triple vessel disease (80–95% stenosis) and left ventricular systolic dysfunction (ejection fraction 35%) in the context of progressive dyspnea. Two months on a plant-based diet led to clinically significant reductions in body weight and lipids, with improved exercise tolerance and ejection fraction (+15%) [69]. In another case study, a 54-year-old female with grade 3 obesity (body mass index (BMI) 45.2 kg/m^2) and type II diabetes (hemoglobin A1c 8.1%), coronary artery disease with a 30% proximal left anterior descending artery stenosis, a 25% proximal and a 60% distal left circumflex artery stenosis, and a 65% first obtuse marginal artery lesion. Echocardiography revealed a left ventricular ejection fraction of 25% without significant valvular pathology; heart failure was diagnosed. After 5 months on a plant-based diet, her baseline dyspnea on exertion improved considerably. Repeat echocardiography revealed a normal left ventricular ejection

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fraction of 55% [78] Comorbid diabetes showed a reduction of HbA1c from her diabetes resolved, with her hemoglobin A1c falling from 8.1% to 5.7% without the use of diabetes medications.

Clinical Considerations

One out of four strokes is recurrent. Secondary stroke prevention starts with deciphering the most likely stroke mechanism. One of the main goals in stroke risk reduction is to control vascular risk factors such as hypertension, diabetes, dyslipidemia, and smoking cessation. Changes in lifestyle such as a healthy diet and aerobic exercise are recommended strategies for all of these. In general, a plant-based diet, low salt intake, and a limited intake of saturated fats and simple sugars are likely to have significant cardiovascular benefits in the secondary prevention of stroke [8]. Patient compliance on plant-based diets has been good in almost all studies. The degree of compliance has often been very high. For instance, one study obtained a 99% compliance [79]. In a 22-week study 94% of subjects on a vegan diet were compliant [80]. In a somewhat longer study, 84% of the participants in each group completed all 24 weeks [81]. In studies of patients placed on plant-based diets for coronary artery disease, high compliance has been noted even over several years. For instance, one study of patients placed on a plant-based diet showed 89% compliance for 3.7 years [82].

Compliance may be enhanced when the rationale for the treatment, and that the treatment is backed by research, is explained to the patient [83]. The doctor should prescribe the treatment by writing it down on a prescription form or other stationery with the physician's name on it. This written prescription is not only valuable to the patient but can also be valuable in enlisting the support of family, friends and social contacts. Vegetarian and vegan diets and food are not as uncommon as they used to be. The sales and availability of meat and dairy substitutes are have grown enormously in recent years. These products make dietary changes much easier in most cases, and when combined with a diet composed of vegetables, whole grains, fruits, legumes and nuts they can be very healthy. When starting the patient on a plant-based diet, foods with high levels of dietary fiber should be introduced slowly to avoid flatulence. When prescribing a plant-based diet for the prevention of stroke, many patients may already be being treated with other medications for other pathologies. Patients concurrently being treated for type II diabetes, hypercholesterolemia, coronary artery disease, hypertension and other pathologies such as rheumatoid arthritis, ulcerative colitis and Crohn's disease, can be treated with a plant-based diet. Medications being prescribed for any of these pathologies may need to be titrated as the effects of the plant-based diet become evident.

For instance, a plant-based diet is more effective for treating type II diabetes than Metformin. The dosage may have to be titrated down as blood glucose is lowered. Similarly, a plant-based diet is as efficacious in treating hypercholesterolemia as Lovostatin [84]. The plant-based diet is also very effective for treating angina pectoris, with patients experiencing a 91% decrease in frequency [85]. It may take several weeks to two months for the full effect to take place. Lab work should be done with this time factor in mind. A bit of patience on the part on the part of the patient is necessary for compliance to take place. The patient should be informed that while a plant-based diet reduces the risk of stroke, it will also reduce the risk of a number of other diseases. This risk reduction of several diseases by one prescription may help maintain patient compliance as the perceived benefit is increased.

Discussion

The plant-based diet has the advantage of having no side effects, adverse reactions and no contraindications. It can also help prevent and treat a number of pathologies including common comorbidities of stroke patients. It is also very affordable for the patient. We live in an age of advanced medical technology. These advances have alleviated much suffering and saved countless lives. They have an unquestioned place in modern medicine. However, this can sometimes lead towards a kind of technological fundamentalism. Little notice is taken of treatments that, while lacking in technological sophistication, are nevertheless quite efficacious. Fortunately, many doctors have already started to integrate therapeutic plant-based diets into their patients' prevention and treatment of CAD. The former president of the American College of Cardiology, Dr. Kim Williams, uses this modality of treatment for his patients. In a recent article, he states

" Unlike many of our cardiovascular prevention and treatment strategies, including antioxidants, vitamin E, folic acid and niacin to name a few, that have disintegrated over time, the truth (i.e., evidence) for the benefits of plant-based nutrition continues to mount. This now includes lower rates of stroke, hypertension, diabetes mellitus, obesity, myocardial infarction and mortality, as well as many non-cardiac issues that affect our patients in cardiology, ranging from cancer to a variety of inflammatory conditions. Challenges with the science are, however, less daunting to overcome than inertia, culture, habit and widespread marketing of unhealthy foods. Our goal must be to get data out to the medical community and the public where it can actually change lives-creating healthier and longer ones " [86].

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