



A plant-based diet and heart failure: case report and literature review

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J Geriatr Cardiol 2017; 14: 375–378. doi:10.11909/j.issn.1671-5411.2017.05.003

Keywords: Heart failure; Lifestyle; Plant-based diet; Vegetarian

Heart failure is associated with high rates of morbidity and mortality, and is a burden to the healthcare system.^[1] There is a growing appreciation for the role diet may play in the development and treatment of heart failure.

A 79-year-old-man presented with progressive dyspnea on exertion for three months. Previously able to walk more than one and a half miles, he needed to stop after walking only a few blocks. Three-vessel coronary artery disease, left ventricular systolic dysfunction with an ejection fraction of 35%, and moderate to severe aortic regurgitation were identified. The left anterior descending artery had 80% proximal stenosis and diffuse distal disease. The left circumflex had a 95% mid-vessel stenosis and the right coronary had a 95% proximal and an 80% mid stenosis. Endocarditis was not appreciated.

His medications included aspirin 81 mg daily, atenolol 25 mg daily, and candesartan 32 mg daily. He was advised to undergo coronary artery bypass grafting and aortic valve replacement surgery. However, he declined, and instead chose to adopt a whole-food plant-based (WFPB) diet, citing his desire to “stay healthy” and “avoid surgery”. Following his decision, he enrolled in the Cardiac Wellness Program at Montefiore Health System, which provides monitoring and counseling for patients who decide to adopt a WFPB diet. The diet consisted of all vegetables, fruits, whole grains, potatoes, legumes, and nuts and excluded all animal-derived foods including eggs, dairy, and meat.

On initial presentation to our clinic his weight was 180 pounds [body mass index (BMI): 26.6 kg/m²], blood pressure (BP) was 127/50 mmHg and heart rate was 49 beats/min. Two months after adopting a WFPB diet, his

weight fell 18 pounds to 162 pounds (BMI: 23.9 kg/m²) and his BP and heart rate were 129/50 mmHg and 48 beats/min, respectively. In addition, his total cholesterol fell from 201 mg/dL to 137 mg/dL, triglycerides fell from 112 mg/dL to 96 mg/dL, and low-density lipoprotein cholesterol (LDL-C) fell from 105 mg/dL to 67 mg/dL, while his high-density lipoprotein cholesterol (HDL-C) fell from 74 mg/dL to 51 mg/dL; these lipid changes were attained without cholesterol lowering medications or supplements. His exercise tolerance improved to ambulating two miles at a measured pace without shortness of breath or other complaints. He began a light aerobic exercise program and practiced yoga for one hour three times per week, in addition to beekeeping and gardening without any symptomatic limitations.

At his two-month follow-up, his atenolol was changed to carvedilol 3.125 mg twice daily, and pravastatin 40 mg nightly was added to his regimen; he was continued on aspirin 81 mg and candesartan 32 mg, daily. On follow-up echocardiogram six weeks later, his left ventricular ejection fraction increased to 50%. His moderate to severe aortic regurgitation persisted without change. In the interim he increased his exercise level, participating in a mild to moderate intensity exercise class without difficulty.

To our knowledge, this is the first report of an improvement in heart failure symptoms and left ventricular ejection fraction following adoption of a plant-based diet. Although causality cannot be ascertained, the temporal association of his improvements in the context of minimal medication and blood pressure change suggests that his plant-based diet may have played a meaningful role.

Our report adds to the growing body of evidence that plant-based foods are beneficial for cardiovascular health. This evidence includes several population-based cohort

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studies that have demonstrated an inverse relationship between increased consumption of plant-based foods and incidence of heart failure.^[2-5] Furthermore, plant-based diets may improve blood pressure,^[6-8] glycemic control,^[9] and obesity,^[6,7] additional risk factors for heart failure.^[10]

Plant-based diets may slow the progression of atherosclerosis, a risk factor for heart failure, and may even reverse atherosclerosis.^[11-14] A plant-based diet may lead to a decrease in total LDL-C and LDL-C particles that are more resistant to oxidation.^[15-17] Oxidized LDL-C is cytotoxic to endothelial cells, promotes chemotaxis of monocytes and T-cells, which leads to endovascular inflammation and atherogenesis,^[18] and oxidized LDL-C attenuates the response of endothelial cells to nitric oxide.^[19] Accordingly, a recent case report demonstrated a whole-food plant-based diet's ability to reverse angina without medical or invasive therapy.^[20]

Reactive oxygen species (ROS) induce myocyte hypertrophy, aortic stiffness, apoptosis, and interstitial fibrosis, potentially contributing to the progression of heart failure.^[21,22] Furthermore, ROS may reduce myocardial contractility,^[23,24] and an inverse relationship between anti-oxidant uptake and heart failure has been described.^[25,26] Plant-based diets are rich in anti-oxidants and in part by reducing ROS may improve myocardial contractility.^[27-29] Animal based foods, with lower amounts of anti-oxidants,^[28] may lead to greater levels of ROS and may have the opposite effect.^[30] In addition, advanced glycation end-products, which are less prevalent in plant-based foods than in high-fat, animal rich foods^[31-33] lead to the formation of ROS and may further contribute to systolic, diastolic, and vascular dysfunction.

Reactive oxygen species may also deleteriously impact HDL-C, in part by decreasing HDL-C efflux capacity.^[34,35] Increased HDL-C efflux capacity has been independently associated with improved cardiovascular outcomes.^[7,36,37] And, while plant-based diets may lower HDL-C levels, they are associated with increased HDL-C efflux capacity.^[7]

Inflammation, which is associated with incident heart failure,^[38] may be reduced with a plant-based diet.^[39,40] Accordingly, plant-based diets are associated with decreased serum concentrations of the inflammatory biomarkers, C-reactive protein, soluble intercellular adhesion molecule-1, and interleukin-6.^[32,41,42]

Trimethylamine N-oxide (TMAO) is formed via the interaction of the nutrients choline and L-carnitine with the gut microbiome and subsequent hepatic metabolism.^[43] TMAO decreases reverse cholesterol transport^[44] and may promote platelet reactivity and vascular inflammation.^[43]

Higher TMAO levels are associated with worse cardiovascular outcomes, including myocardial infarction, heart failure, and death.^[45,46] The microflora of vegans and vegetarians is such that they produce less trimethylamine, a precursor for TMAO when compared with their omnivore counterparts.^[44] This difference may account, in part, for their association with fewer cardiovascular events.^[43]

In summary, plant-based diets may be effective in preventing and treating heart failure. Further study to elucidate their roles in the setting of left ventricular dysfunction is needed.

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This article is part of a Special Issue “**A plant-based diet and cardiovascular disease**”.
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