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Research Article

Association of Dietary Intake to Atrial Fibrillation Detection in Patients with Cryptogenic Stroke Who Undergo Implantable Loop Recorder Placement

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Abstract

Background: Atrial Fibrillation (AF) is the most common cardiac dysrhythmia in the world, leading to consequential morbidity and mortality due to its significant ramifications. One of the most important sequelae is stroke, for which 20% of its incidence is attributed to AF. Detection of AF is thus critical to offset stroke risk by utilizing early treatment strategies, which include anticoagulation therapy. Diet has been shown to affect AF risk, however detection of AF as it relates to different diets has not been fully clarified. We analyzed through a retrospective cohort series the detection of AF after Implantable Loop Recorder (ILR) placement as it relates to different dietary regimens between 2019 – 2023 in a single site outpatient medical clinic.

Objective: To inform the reader whether certain dietary regimens resulted in earlier detection and increased prevalence of AF through ILR recordings and how these findings may assist with improved patient care and outcomes.

Results: We analyzed a total of 120 consecutive patients who underwent ILR placement from one outpatient cardiac clinic site and monitored for AF occurrence between June 2019 to July 2023. Using statistical analysis, AF was detected more frequently in patients who had a higher carbohydrate diet (p<0.0001, 95% C.I. [6.49 - 14.95]) and lower vegetable diet (p<0.0001, 95% C.I. [-14.57 - -5.8]) and lower fluid intake (p<0.001, 95% C.I. [-2.14 - -1.04]). Different protein consumption amount was not shown to be statistically significant in relationship to AF detection (p=0.65, 95% C.I. [-4.44 - 2.8]).

Conclusion: Early detection of AF has been shown to decrease stroke risk and thereby prevent stroke. Our findings suggests that a diet rich in vegetables and low in carbohydrates while maintaining adequate hydration may result in a reduction of AF occurrence by ILR monitoring.

Keywords: Atrial fibrillation; Dietary habits; Implantable loop recorder; Nutrition

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Introduction

Atrial Fibrillation (AF) is one of the most common and ubiquitous cardiac conditions. Resulting from the electrical and mechanical discoordinated activity of the atria of the heart, it may lead to increased risk for thrombus formation through stasis of atrial blood flow. What characterizes AF is its irregular pulse and often times unpredictable fast heart rate, termed tachycardia or rapid ventricular response. When this happens, the ensuing tachycardia may result in intra-atrial turbulent blood flow with consequential dislodgement of the thrombus into the bloodstream. If this happens, embolization of the blood clot into the cerebral circulation with resultant stroke, termed Cerebrovascular Accident (CVA), may occur. Because this is not uncommon, AF is known to be the leading cause of strokes [1].

Background

AF is the most common cardiac dysrhythmia, both in the United States and in the world [2]. Associated with significant morbidity and mortality, AF comes with a significant cost to our society as a whole. It has been estimated that by 2030, there will be approximately 12.1 million cases in the United States [3]. In addition, estimates approximate the global prevalence of AF to 50 million in 2020 [4], and likely undiagnosed AF cases in the US approximate at greater than 5 million/year [5]. Many factors lead to this observation, including increased arrhythmic detection in our medical communities, the expanding aging population with increasing prevalence of chronic illnesses, escalating obesity in our society and increased survival from patients with Cardiovascular Disease (CVD). These factors and numbers are important because they implicate AF as a critical burden to our societal well-being, both in terms of overall health and cost. Using data from the administrative claims database in the US, individuals with AF account for an estimated annual cost of $63,031 which equates to approximately $28.4 billion per year in health care expenditure [6]. This represents a substantial sum used to treat this ubiquitous disease during a time of increasing medical costs and limited medical resources.

There is a wide spectrum of AF presentations. While some patients may be asymptomatic, others may find that their AF results in varying

symptoms of nausea, palpitations, chest pain, dyspnea, lightheadedness, diaphoresis or overall fatigue. Their atrial fibrillation may be intermittent with differing frequency, termed paroxysmal, or it may be occurring all the time, described as permanent. Treatment usually is focused on rate control and/or rhythm control geared towards symptom management, as well as anticoagulation to decrease the overall risk of stroke. Refractory cases to the above treatments may necessitate more aggressive strategies such as electrical cardioversion or cardiac interventional procedures such as radiofrequency ablation. AF has also been associated with a 1.5- to 2-fold increased risk of death; studies suggest that the mortality risk may be higher in women than in men [7].

Detection of AF visually first came about in 1906, when Willem Einthoven, known as the father of the electrocardiogram (ECG), published an ECG depicting AF [8]. Since then, there have been many new modernizations to detect this arrhythmia. Current ways include real-time telemetry monitoring, short term 24–72-hour Holter monitors, intrinsic functions of pacemakers and Intracardiac Defibrillators (ICD) during interrogation, longer term 7-30 day external cardiac loop monitors, and long term implantable loop recorders (ILR). It has been shown through Randomized Clinical Trials (RCT) that long term ILR placements in individuals with AF risk factors results in a 3-fold increase in AF detection compared with normal screening [9]. In the CRYSTAL AF Study, investigators also presented data revealing the superiority of ILR monitoring over routine standard of care for patients who had a cryptogenic stroke in the detection of AF occurrences, 8.9% vs 1.4% at 6 months ($p<0.001$) and 12.4% vs 2.0% at 12 months ($p<0.001$) [10] (Figures 1-3).

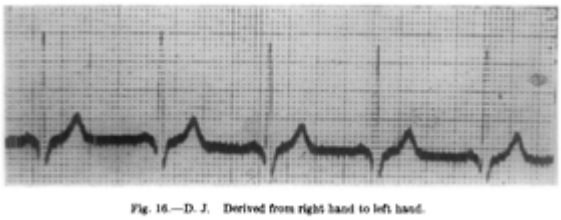

Fig. 16.—D. J. Derived from right hand to left hand.

Figure 1: First ECG recording from Willem Einthoven in 1906 [8].

Figure 2: Example of ILR [11].

Moreover, there are many risk factors for AF. Some of these include: advanced age, heavy alcohol consumption [13], hypertension [14], cardiac disease, endocrine disorders such as hyperthyroidism and pheochromocytoma, genetic factors, sleep apnea, and inflammation. There have been many prior studies evaluating the roles of different diets and how they play a role in the susceptibility for atrial fibrillation [15]. However, many of these studies revealed conflicting results. For example, the role of caffeine has been postulated to have a proarrhythmic effect by its sympathetic actions, however numerous studies have failed to find evidence of this and one study even proposed a beneficial protective effect against AF [16]. Diets rich in fish intake was shown in certain studies to have a protective effect resulting in less AF episodes [17]. However, in the Framingham Heart Study, there was an increased risk of developing AF for patients who consumed a greater amount of dark fish per week [18]. Even nutritious foods such as soybean and snow peas may trigger AF episodes due to their high tyramine content and its relationship to this arrhythmia [19].

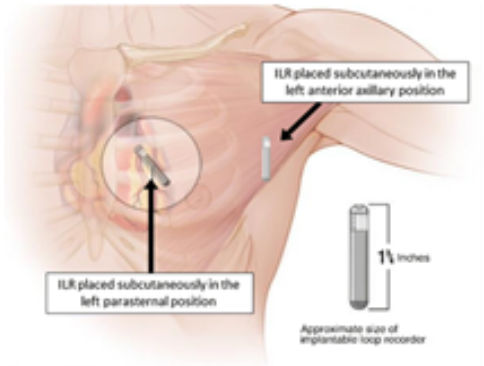

Figure 3: Position of ILR in body [12].

Plant based diets have been suggested to improve AF risk by indirectly affecting other known risk factors for AF, including diabetes mellitus, hypertension, coronary artery disease and systemic inflammation. In contrast to this, clear evidence has shown the association between AF risk and dietary intake of ultra-processed foods, even after factoring in lifestyle activities and body mass index (BMI). Some studies have shown that an increase of 10% of ultra-processed foods equate to a 5% increased risk of AF [20]. In terms of carbohydrate intake, there also has been mixed results. The clear association between high carbohydrate sugary drinks and AF has been established recently showing a clear link between them, thought to be the result of cardiometabolic changes in the body that influence the risk of AF. However, In the ARIC Study, a low carbohydrate diet was shown to increase the incidence of AF regardless of the type of fat or protein used to replace the carbohydrate [21].

Methods

The investigators conducted a retrospective cohort observational study from one outpatient cardiac clinic site. The study participants included patients who were diagnosed with Cryptogenic Stroke (CVA) or Transient Ischemic Attack (TIA) and underwent Implantable Loop Recorder (ILR) placement with a Medtronic Reveal Linq device [11] to evaluate for AF occurrence. Through a dietary questionnaire on average daily intake of carbohydrates, protein, vegetables, and fluids, researchers compiled data from a total of 120 consecutive patients over the course of four years. The daily average intake was expressed as a percentage of average consumption on a 100-point scale. Fluid intake was determined by the average consumption of 10 ounce (oz.) cups per fluid per day. These results were analyzed for any associations between certain dietary patterns and atrial fibrillation findings on the ILRs by unpaired two-sample t-test. A p-value of <0.05 was considered statistically significant. The atrial fibrillation detections from the ILRs were transmitted from the patients to a reading center (Medtronic) and analyzed for AF. When verified, these ILR ECG

recordings were sent to a cardiologist for validation, and artifactual readings were eliminated from the study.

Results

A total of 138 consecutive patients from one outpatient cardiac clinic site were followed and evaluated for AF occurrence by ILR placement from June 2019 to July 2023. 18 total patients (13%) were lost to follow-up due to unexpected death leading to a total of 120 patients (86.9%) analyzed. The cumulative AF rate found by ILR was 59 patients (42.7%), 10 patients (7.2%) were lost to follow-up. A cumulative of 79 patients (57.2%) were without AF, with 8 patients (5.8%) lost to follow-up. On analysis, total carbohydrate intake mean percentage was found to be 48.37% (SD=10.53) in the AF group versus 37.65% (SD=12.13) in the non-AF group ($p<0.0001$, 95% C.I. [6.49 - 14.95]). Total vegetable intake mean percentage was found to be 24.08% (SD=9.28) in the AF group versus 34.07% (SD=13.45) in the non-AF group ($p<0.0001$, 95% C.I. [-14.57 - -5.8]). Total protein intake mean percentage was 27.55% (SD=10.51) in the AF group versus 28.37% (SD=9.36) in the non-AF group ($p=0.65$, 95% C.I. [-4.44 - 2.8]). Evaluating fluid intake, a mean average of 3.82 cups (SD=1.41) were noted in the AF group versus 5.41 cups (SD=1.55) in the non-AF group ($p<0.001$, 95% C.I. [-2.14 - -1.04]).

Discussion

We compared clinical characteristics from 2 cohorts of patients, including patients found to have developed Atrial Fibrillation (AF) on Implanted Loop Recorder (ILR) monitoring and those without any evidence of AF on ILR monitoring. All patients from both cohorts were enrolled at the same outpatient cardiac clinic site between June 2019 to July 2023. A total of 85.5% and 89.8% of patients were analyzed in the AF and non-AF groups respectively.

Patients who were found to have developed AF were noted with statistical significance to have higher carbohydrate intake and lower vegetable and total fluid intake. There was no statistical association observed between protein intake and AF occurrence. There are several possible factors which may explain these observed findings.

AF risk has been shown to be increased by certain medical conditions, including hypertension, diabetes, obstructive sleep apnea (OSA), as well as obesity. With increased caloric intake, these conditions become more common. This may result in a downstream secondary augmented risk for AF. Hypertension has been shown to increase risk for new-onset AF by 1.7-fold versus normotensive patients [22]. In Diabetes Mellitus (DM), approximately 15% of diabetics have AF and approximately 30% of AF patients have DM [23]. In addition, obesity and obstructive sleep apnea often times are not mutually exclusive, as more than 40% of obese patients have OSA [24]. While obesity increases the risk for AF by 30% [25] OSA confers a 4 time increased likelihood of developing AF [26]. The findings observed may reflect the associations between developing these risk factors by having a high carbohydrate diet and these same conditions conferring a higher risk for AF. Strategies to offset this by limiting carbohydrate intake to promote a healthier diet may result in decreasing these medical conditions and lowering AF risk.

There have been various studies showing a positive relationship between low carbohydrate / high vegetable / healthy protein diets, including the DASH diet [27] and Mediterranean diet, and its relationship to heart health. The observational PREDIMED Trial revealed that a Mediterranean diet with extra usage of extra virgin olive oil (EVOO) resulted in a substantial decrease in AF incidence [28]. This may reflect the beneficial effects of vegetable and plant-based diets, resulting in less oxidative stress and reduction of inflammation, which have been implicated in AF pathogenesis. Furthermore, a Mediterranean diet rich in high fiber, vegetables, and lean protein with moderate EVOO may potentially result in higher HDL levels and lower triglyceride levels, both of which has been shown to decrease AF risk [29]. From our investigation, we found AF to occur more in the patients who consumed less vegetables. This may have been due to several factors. First, this may have been a consequence of the lack of beneficial effects plant-based foods provide, including less oxidative stress and inflammation reduction. In addition, higher percentage intake of vegetables would equate to less carbohydrate intake, lessening the risk for conditions known to have positive associations with AF such as diabetes mellitus, hypertension, and obesity. More likely, both of these mechanisms may be involved resulting in the findings observed.

In our study, AF was more prevalent by ILR recordings in patients who consumed less fluid. This may be due to several factors augmenting AF occurrence. With dehydration, electrolyte imbalances including: hypokalemia, hypomagnesemia, and hyperphosphatemia, may occur which may trigger AF [30]. Moreover, increased catecholaminergic activity seen in low-fluid states may also be playing a role in dehydration, sympathetically driving AF activity. There also has been evidence through cross-sectional studies that revealed a higher incidence of dehydration in patients admitted for stroke suggesting a possible interplay between AF and low fluid intake [31]. Our observations are concordant with prior findings suggesting fluid intake and its role in heart rhythm regulation and AF risk.

Conclusion

Dietary modification is one of the foundations for cardiovascular disease prevention. A nutritious diet supports cardiovascular health, helping to manage risk factors such as hypertension, obesity and diabetes mellitus, which are leading contributors promoting AF. Our retrospective cohort observational study suggests that a diet rich in carbohydrate, low in vegetable intake, and low in fluid intake resulted in more AF occurrences detected by ILR over a 4-year timespan. These findings hopefully will encourage the public to change to a healthier dietary regimen, not only to promote better overall cardiac health, but also to lessen AF risk. Considering the cost to society in treating this ubiquitous disease and the morbidity associated with AF, lessening the burden to society as a whole to this disease will have profound ramifications.

Limitations and Direction for Future Research

The main limitation of investigating direct dietary effects on AF is the lack of a large Randomized Clinical Trial (RCT) assessing the link between the two. There are numerous articles revealing associations between the two, however these studies focus more on correlation and not causation. A RCT would be able to discern between this. Another limitation of our study was the small sample size and data acquisition from only one outpatient cardiac clinic site, leading to lack of generalizability to the public. Also, the use of subjective estimates versus actual measurements of food intake lessened the accuracy of the above findings.

A direction for future research consideration should focus not only on the development of a RCT exploring dietary intricacies and

associations to different medical conditions, but also exploring different racial/ethnic and socioeconomic populations as these populations may have different dietary habits and dietary norms. By doing this, future interventions will have the ability to promote health care equipoise within these oftentimes overlooked groups.

Conflict of Interest

The authors received no specific funding for this work. We hereby confirm, that the manuscript has not been accepted elsewhere for publication. The authors declare that there is no conflict of interest. The authors report no proprietary interest in any product mentioned or concept discussed in this article.

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