



Heart Rate Variability and Atrial Fibrillation

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The idea that the autonomic nervous system (ANS) may be intimately involved in LAF was first put forward in 1982 by Philippe Coumel, MD of the Lariboisiere Hospital in Paris, France. Dr. Coumel proposed that LAF is caused by a particularly sensitive heart tissue, a dysfunction of the autonomic nervous system or both[1]. In the 20 years since Dr. Coumel first outlined his findings, much research has been done in the field and it is now generally accepted that there is a close connection between LAF and an ANS imbalance.

Most, if not all, of the research on the LAF/ANS connection has involved the use of highly sophisticated equipment designed to measure **heart rate variability [HRV]**.

Normally the heart beats at a rate of 60 to 80 beats per minute, but the rate can be as low as 50 (in trained athletes) or as high as 100 (during illness or in a highly emotional state) without it being cause for concern. The heart rate is a measure of the number of contractions made by the left ventricle in a one-minute period and is usually measured on the radial artery near the wrist or on the carotid artery in the neck.

So while the heart rate itself has long been known to be an indicator of the physical and psychological condition of an individual it is only recently that attention has focused on the significance of the beat to beat variability. Research has shown that the interval between one heart beat and the next varies and that this variation is a powerful indicator of the state of the autonomic nervous system.

Measurement of Heart Rate Variability

The variation in the heart beat interval is usually measured via a 5-minute electrocardiogram or a 24-hour Holter monitoring. The original and still commonly used measure for the variation is referred to as **SDNN** which is the standard deviation of the heart beat intervals, that is, the square root of the variance. Powerful and fast calculation techniques developed in the late 1960s made it possible to extract more sophisticated and valuable information from the heart rate recordings. Most scientific work on heart rate variability now uses power spectral density (PSD) analysis to relate the relatively simple measurement of beat to beat variability to the state of the autonomic nervous system. PSD analysis uses a mathematical technique (fast Fourier transform) to determine how the power (variance in heart beat interval) is distributed across different frequency bands. There is now general agreement that the power in the low frequency band (LF) from 0.04 to 0.15 Hz (cycles/second) is an indication of sympathetic (adrenergic) branch activity and that the power in the high frequency band (HF) from 0.15 to 0.40 Hz is primarily an indication of parasympathetic (vagal) activity. It follows that the ratio of LF/HF is a measure of the balance of the autonomic nervous system with a higher number indicating an excess of adrenergic activity

and a lower number indicating an excess of vagal activity. The total power (TP) in the PSD analysis, that is the power obtained by considering the whole frequency spectrum, is another important measure of heart rate variability[2].

Significance of Heart Rate Variability

Not surprisingly, heart rate variability analysis was first used as a measure of heart health. In 1996 researchers involved in the Framingham Heart Study concluded that a lower than normal heart rate variability (SDNN) was associated with an increased risk of angina, heart attack, and other cardiac events[3]. Other researchers have found correlations between low SDNN and the risk of neuropathy in diabetics and between low SDNN and depression[2,4]. There is also a very significant association between low SDNN and the risk of dying after suffering a heart attack. It is postulated that decreased SDNN correlates with increased sympathetic (adrenergic) or decreased vagal tone, which may predispose to ventricular fibrillation[5]. British researchers report that reduced SDNN is a risk factor for atherosclerosis in both diabetic and non-diabetic patients[6]. A group of American and Dutch researchers recently concluded that a low SDNN not only increases the risk of heart disease especially death from a heart attack, but may indeed precede a number of different diseases. As a matter of fact, they make the profound statement that "sympathetic predominance, as reflected in low SDNN and high heart rate, may be indicative of less favorable general health, with SDNN being a more sensitive indicator than heart rate". The researchers also point out that SDNN decreases with age, high insulin levels, physical inactivity, smoking, and rapid and shallow breathing[7].

It is clear that low SDNN is a predictor of poor health and an increased risk for cardiac death. Does this mean that high SDNN is beneficial? Not necessarily. A recent study carried out by Dutch researchers clearly shows that elderly people with a very high SDNN have an even higher risk for sudden cardiac death than do elderly people with a very low SDNN. So it would seem that there is an optimum range, the exact limits of which still need to be determined[8].

HRV and Atrial Fibrillation

HRV analysis has been used extensively in the study of atrial fibrillation. LAF episodes can be divided into two groups; those that are preceded by an increase in LF power and a decrease in HF power consistent with an increase in sympathetic (adrenergic) tone, and those that are preceded by a decrease in LF power and an increase in HF power consistent with an increase in parasympathetic (vagal) tone. The changes in HRV are apparent at least 5 minutes before the actual episode[9,10]. It is also clear that most vagal afibbers have no underlying heart disease while adrenergic type afibbers often do. There is also considerable evidence that the number of ectopic (premature) beats increases prior to an episode in patients with lone atrial fibrillation[11].

Atrial fibrillation patients with focal ectopy originating from the pulmonary veins experience a significant increase in HF power and a decrease in LF power during the 20 minutes preceding an episode[12]. This may mean that focal AF is primarily found among vagal afibbers raising the interesting question "Is pulmonary vein ablation likely to be more beneficial for vagal afibbers than for adrenergic ones?"

Other research has established that afibbers who have undergone cardioversion for atrial fibrillation are twice as likely to have another episode if their LF/HF ratio is high[13,14].

External Influences on HRV

It is clear that the autonomic nervous system is dysfunctional in lone atrial fibrillation patients and that the extent of this dysfunction manifests itself in several measures of HRV. HRV is highly influenced by emotional state. Anger and anxiety increases LF power while depression reduces overall HRV[4]. Alcohol consumption increases the LF/HF ratio and the blood level of norepinephrine[15]. Exposure to air pollution (particulates) may reduce HRV[16]. Physical exercise, on the other hand, has been found to increase HRV[17,18]. The ingestion of sugar (glucose) is associated with a significant increase in the LF/HF ratio[19]. Melatonin increases

vagal tone (HF power) in men when they are lying down so this may not be the greatest supplement for vagal afibbers[20].

Sleeping position can also affect HRV. Sleeping on the right side increases HF power and minimizes LF power leading to a low LF/HF ratio; norepinephrine secretion is also minimized when lying on the right side[21,22]. This could mean that adrenergic afibbers should preferably sleep on their right side.

The link between exposure to electromagnetic radiation (EMF) and HRV is still controversial. Some studies have found a link while others have not. Researchers at the Midwest Research Institute in Kansas City have found that changes in HRV may occur when exposure to electromagnetic fields is combined with stress[23]. Does this mean that your HRV could change if you sit in front of your computer screen while under stress? I used to get very anxious after using my regular desktop computer for a couple of hours. Several years ago I replaced the monitor with a LCD monitor, and since then, I have experienced no problems at all. The LCD monitor emits no radiation and it does not flicker either. I highly recommend it.

Russian researchers believe that abnormalities in the structure of the spine particularly around the seventh and eighth cervical or the first thoracic segments can result in irritation of the sympathetic nerve bundles passing from the spine into the inner body. This, in turn, could affect the sympathetic side of the autonomic nervous system and cause changes in HRV[24]. This phenomenon may explain why some afibbers, presumably adrenergic, have gotten relief from chiropractic manipulations.

Pharmaceutical drugs can also affect HRV. Propafenone (Rythmol) has been found to decrease HRV and LF/HF ratio and flecainide (Tambocor) decreased HRV in heart attack patients[37]. ACE inhibitors (quinapril) and beta-blockers (metoprolol) both increased HF power and decreased LF power and LF/HF ratio in heart attack patients. It is interesting that the effect of quinapril was most pronounced between 2 and 4 AM, 8 and 11 AM, and 7 and 10 PM. Metoprolol was most effective between 8 AM and 12 noon and between 7 and 10 PM[25].

Obviously there are many external factors that may affect HRV. The question then is what can be done to control HRV and prevent imbalances?

Control of HRV

Breathing oxygen-fortified air may be helpful for adrenergic afibbers, but should not be attempted except with the cooperation of a physician. Research has shown that breathing air containing 31% oxygen markedly increases HF power and reduces LF/HF ratio in congestive heart failure patients[26]. Hyperbaric oxygen therapy is also effective in increasing HF power and reducing LF power and the LF/HF ratio in both healthy subjects and in heart disease and stroke patients[27]. These effects are only temporary, but could perhaps be useful in aborting an impending episode. For longer-term effects it seems that the mind itself must be engaged. Transcendental meditation has been found to reduce norepinephrine levels and is probably doing this by reducing LF (adrenergic) power[28].

A team of British, Italian and Polish researchers has discovered that repeating a common mantra or reciting the rosary synchronizes and reinforces inherent cardiovascular rhythms. Their experiment involved 23 healthy adults who were instructed to either recite the rosary (in Latin) or to repeat the mantra "om-mani-padme-om" during a 6-minute test period. To their astonishment, the researchers found that the breathing rate of the participants automatically slowed to 6 cycles per minute from the rate of 14.1 observed during spontaneous breathing. This 10-second cycle (6 inhalations/exhalations per minute) is a very important internal rhythm, which synchronizes respiratory and cardiovascular rhythms as well as sympathetic and vagal outflow. Maintenance of the 10-second cycle also increases calmness and well-being. The researchers speculate that the practice of using mantras to achieve the highly beneficial breathing rate of 6 cycles/minute

originated in Tibet and India and was introduced to Europe by the Crusaders where it transmuted into the rosary[29].

Heart Math Techniques

Rollin McCraty and his colleagues at the Heart Math Institute in California have found that emotions are strongly related to HRV. Both anger (negative emotion) and appreciation (positive emotion) increase HRV, but only anger increases the LF/HF ratio as well[30]. McCraty also found that sincere appreciation can significantly increase DHEA levels while decreasing cortisol levels[31]. The Heart Math techniques balance the autonomic nervous system (ANS) and achieve a state of coherence between the brain and the heart. The Freeze-Frame technique deals with immediate disturbances in the ANS while the Heart Lock-In technique is aimed at establishing coherence and balancing the ANS on a long-term basis. Both techniques are very simple.

The idea behind Freeze-Frame is to recognize the stressful feeling, shifting your focus to the heart region, and then recalling a positive feeling or experience to “crowd out” the stressful feeling[31].

The Heart Lock-In technique is meant to be practiced on a daily basis. It is quite similar to meditation and has 5 steps much like the Freeze-Frame technique

The Heart Math techniques are very powerful. A clinical trial carried out at Kaiser Permanente Clinic found that 60 out of 75 atrial fibrillation patients improved markedly and 14 were able to get off all antiarrhythmic medications after practicing the two Heart Math techniques[32].

The Heart Math Institute has a computer program (Freeze Framer) available that will help evaluate progress in using the techniques. However, the program is not necessary in order to apply the techniques effectively.

It is clear there is a strong association between a dysfunctional autonomic nervous system (ANS) and lone atrial fibrillation. Analysis of heart rate variability (HRV) is an excellent method for determining the degree and direction of the ANS abnormality. HRV, in turn, is affected by many external factors and, it would appear, can possibly be changed by the use of new energy psychology techniques such as Freeze-Frame and Heart-Lock-in.

Note: Heart Math, Freeze-Frame, and Heart Lock-In are registered trademarks of the Institute of Heart Math. Freeze Framer is a trademark of Quantum Intech.

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