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Original Article

Psychiatry Section

Assesment of Heart Rate Variability As A Measure of Cardiac Autonomic Status in Psychiatric Patients Exposed to Chemical Irritants

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ABSTRACT

Background and Purpose: However, little is known about the cardiac autonomic activity due to chemicals in psychiatric patients. Therefore, the objective of this study was to assess the effect of chemical irritants on the ANS of the person and measure that in the form of Heart Rate Variability (HRV), a noninvasive method to estimate the cardiac autonomic activity. The autonomic nervous system can significantly compromised by use of chemical irritants.

Materials and Methods: A cross-sectional hospital based study was conducted in which 33 patients (mean age: 29.94 years) of depression/anxiety were compared with 37 age matched controls (mean age: 28.10). The patients who were diagnosed as either depressed or anxious by the psychiatry were included in the study group by random sampling. Out of these 8 patients gave positive history of odour use. Thirty seven age matched healthy persons were taken as controls. Grading of patients was done according to DSMV-IV criteria and short- term HRV was recorded. Five minute HRV recording was done and time domain and frequency domain indices of HRV were assessed using RMS Polyearite D. The result in case and control groups was compared.

Results: We have reported a poor HRV compared to control group in patients of depression/anxiety as reflected by NN50 values ($p< 0.05$). Although not significant the trend shows a better HRV control in almost all the time domain and frequency domain parameters in controls compared to cases. Regarding the history of use of chemical irritants the trend showed a poor HRV control in these cases compared to the patients who did not give any such history.

Conclusion: Our results suggest that impaired cardiac autonomic nerve function characterized by sympathetic over activity may occur in depression/phobic patients. The study also proves a poor HRV in psychiatric subjects with history of use of odoriferous substances.

Keywords: Chemicals, Depression, DSMV IV, Phobia

INTRODUCTION

It has been reported in prior research that autonomic nervous system (ANS) is significantly compromised in depression/phobic anxiety patients [1]. Carmilla MM Licht et al., hypothesized that depression is associated with lower heart rate variability (HRV) and decreased cardiac vagal control [2]. In the last 2 decades, various studies have shown a significant relationship between the ANS and cardiovascular mortality, including death [3,4]. HRV is one of the most promising markers in evaluating the ANS. Being an easy derivation, HRV has popularized its use and many commercial devices are now available which provide an automated measurement of HRV. An accurate view of the ANS as well as the variability of the heart is tested by HRV. The analysis is based on measuring variability in heart rate; specifically variability in the intervals between R waves – "RR intervals." Heart Rate Variability (HRV) as a whole monitors the mean heart rate and autonomic nervous system function [5]. Two subjects can have exactly or nearly the same average heart beat, but when the time period between each heartbeat is calculated specifically, the variation of time between each beat is different for different subject.

The main advantage of HRV test is its ability to detect the early signs and symptoms of pathological processes or any functional disorder which may not be detected by the ordinary physical examination. Diminished HRV detects both arrhythmic events and death with higher sensitivity and specificity than conventional methods. It has been shown to be a reliable indicator of overall health but also be a predictor of sudden death [6].

Prior studies suggested that individuals suffering from depression often show decreased vagal tone, increased heart rate, fatigue, sleep disturbance, and sympathetic arousal. Maria Karavidas in her study of Biofeedback for HRV has proved that improving LF component of HRV and SDNN values is a useful adjunctive treatment for major depressives [1]. A study of HRV in patients of depression with history of chemical irritants can go a long way in effective treatment of depression. As we know there is a close link between autonomic nervous function and function of SA node, heart rate and its fluctuations reflect changes in cardiac autonomic control.

The sympathetic and parasympathetic (vagal) activity of ANS on the sinus node can be very easily accessed by a noninvasive technique i.e. HRV. Increased sympathetic stimulation increases the heart rate and decreases the variability of the heart rate. The efferent vagal activity is a major contributor to the HF component the LF component, which is considered as marker of both sympathetic and vagal influences [5]. Important and debilitating feature of multiple chemical sensitivity (MCS) is its ability to augment the effects of other problems like Depression and Asthma. The augmentation of this kind is reported by 50% of all multiple chemical sensitivity syndrome sufferers [7-9].

Terri Perry reported that many people were adversely affected by chemical toxins in the form of perfumes, detergents, bleaches, etc and these toxins can affect our CNS and may cause behavioural changes [10]. Usually, the medical conditions which can worsen by the use of these chemical toxins are: Headaches; Depression, some phobias, anxious personality, Panic attacks, skin diseases like

allergies and eczema, OCDs, and some hormonal problems, but those who were exposed to chemicals was reported to be quiet high and the subjects was mainly having symptoms of dizziness, anxiety, trembling, unable to stand, extreme fearful and in these cases it is usually laundry detergents, room fresheners or fragrances [11,12]. Therefore this study was designed to investigate the cardiac autonomic function in psychiatric patients. The hypothesis was that cardiac autonomic tone would shift towards sympathetic dominance in depression patients.

MATERIALS AND METHODS

This study was conducted in autonomic function laboratory of Department of Physiology in collaboration with Department of Psychiatry , VMMC and Safdarjung Hospital, New Delhi. A total of 33 psychiatric patients of depression/anxiety in age group 29.94 ±2.23 years were selected on the basis of DSMV-IV criteria [13]. The study group consisted of patient visiting the psychiatric OPD and having history of depression/ anxiety with or without the history of exposure to the odoriferous substances. The control group consisted of 37 age and sex matched healthy subjects who were workers of Department of Physiology. After the approval from the Institutional Research and Ethical Clearance committees, written and informed consent was obtained from the psychiatric patients. A thourough history was taken and history of chemical odour use was emphasized and proper examination was done of all the subjects. Five minutes HRV recording was done [14,15].

Anthouropomretric measurements- The patient were screened after measuring the body weight (kg) using a weighing machine (mechanical one) and Height (cms) was measured with the help of a stadiometer with sliding head board while the subjects stood bare feet together on the floor.

Inclusion Criteria

1. The subjects were diagnosed on the basis of DSMV-IV criteria (American Psychiatric Association-"DSM-IV of mental disorders 4th ed) as depression/anxiety patients.
2. The history of exposure to low level chemicals in the form of smoke, pesticides synthetic fabrics, petroleum products and paint fumes were recorded in detail.
3. Substances with strong smell i.e. Dhoopbati, agarbati, hairsprays, shampoos, hair oils, fragrances, nail polish, aftershave lotion, room or air fresheners, deodrants and scented candles, Petrol or diesel fuel, Fertilizers, pesticides and other agricultural products, formaldehyde.

Exclusion Criteria

1. Subjects with history of substance abuse (alcohol, etc).
2. History of any drug abuse (CNS stimulant).
3. Central nervous system damage.
4. Endocrinal disorders leading to depression/anxiety.
5. Other autonomic disorders.

Experimental protocol- The subjects were explained in detail about the recording procedure of HRV and a proper written consent was taken. The procedure was done in quiet room, patient lay supine with eyes closed, awake and breathing normally. The subjects were instructed to have their dinner by 9:00 pm on the previous day and not to take any sedatives. Since our subjects were psychiatric patient their medication could not be discontinued prior to the study. The subjects were suggested to take at least 8 hours of sleep so they remain free of any mental and physical stress before the day of procedure. They were instructed to avoid tea or coffee before the examination and attend the Autonomic Function laboratory in the Department of Physiology of VMMC and Safdarjung Hospital, India.

Assesment of Heart Rate Variaility- Short term HRV- 5 minutes HRV recording was done. A total of 10 minutes HRV recording was done. First 5 minute is to relax the subject and then next 5 minutes was recorded. ECG Lead II was recorded at (25mm/s and voltage of 10 mm/mV) for 10 minutes to obtain the recording using RMS Polyearite AD. The recommendation of Task Force was followed for short-term HRV recording [5]. The recorded data was analysed under two main domains i.e. time domain and frequency domain parameters using a software (RMS Polyearite D) for analysis of HOUR V. The time domain parameters contain: SDNN, RMSSD, NN50 & pNN50. SDNN- (estimate of overall HRV) i.e. the mean of the 5-minute standard deviations of NN intervals, RMSSD (estimate of short-term components of HRV). The RMSSD method is preferred to pNN50 and NN50 because it has better statistical properties. NN50, the number of interval differences of successive NN intervals greater than 50 ms. pNN50, the proportion derived by dividing NN50 by the total number of NN intervals. Frequency domain analysis was performed using Fast Fourier Transformation method. The frequency domains include High frequency (HF) component (0.15-0.4Hz), LF/HF ratio.

STATISTICAL ANALYSIS

We have used independent t-test and Shapiro-Wilk test for analysis of the results. All the parameters were expressed as Mean± SD. The analysis of the time domain and frequency domain parameters between the study and control group was done using Independent t-test. The SPSS (version 20.0) software was used to analyse the data.

RESULTS

We have reported a poor HRV compared to control group in patients of depression/anxiety as reflected by NN50 values ($p< 0.05$). [Table/Fig-1] shows that it is not significant but trends show a poor HRV control in almost all the time domain and frequency domain parameters in cases as compared to controls. The values were perhaps not statistically significant because all patients were on medication. In cases we have reported significant value of NN50 ($p= 0.016$) which showed a poor HRV as compared to control group. According to [Table/Fig-2], Mean HOUR is high (6 ms) in patients without the H/o odoriferous substances as the history of use of odouriferous substances though it is not statistically significant ($p= 0.312$), HF value is high (33Hz)in patients without the H/o odouriferous substances as the H/o use of odouriferous substances though it is not statistically significant (0.582).

S.no	Variable	Cases (mean±sd)	Control (mean±Sd)	p-value
1	Mean HRV	77.23± 14.61	75.45±9.64	0.683
2	SDNN	48.37±22.45	48.40±15.74	0.630
3	RMSSD	34.30±16.06	40.12±16.57	0.144
4	NN50	40.44±42.26	66.97±46.93	0.016
5	PNN50	16.78±16.85	22.51±17.29	0.167
6	VARIANCE	2829.3± 2926	2583.85±1708	0.624
7	HF	155.5±135.9	185.7±162.9	0.405
8	LF/HF	3.16±0.98	2.67±1.32	0.087

[Table/Fig-1]: Comparison between means of cases and controls
The Shapiro-Wilk test Shapiro-Wilk test is used for analysing the normality. We find that Mean HRV, SDNN, Variance does not follow normal. Therefore we transform the data to make it "normal". Now we have used independent t test to compare between means of cases and controls

DISCUSSION

Heart Rate Variability (HRV) monitors the mean heart rate and autonomic nervous system function. It is a reliable indicator of overall health but also be a predictor of sudden death. Initially it was started as a clinical and research tool for cardiologists only but now days it has been used widespread in all the fields of medicine. Hon and Lee noticed that fetal distress was associated with 'alterations

SN	Variable	WITH ODOUR HISTORY(n= 8)	WITHOUT H/O ODOUR (n=25)	p-value
1	Mean HRV	81.87±22.76	75.8±13.97	0.312
2	SDNN	41.04±22.76	50.63±22.28	0.298
3	RMSSD	28.59±16.26	36.05±15.67	0.257
4	NN50	28.5±42.82	44.11±42.30	0.369
5	PNN50	10.43±17.04	18.73±16.84	0.229
6	VARIANCE	1824±2971.22	3139.1±3080.69	0.273
7	HF	181±203.4	148±116.19	0.582
8	LF/HF	3.25±0.25	3.13±1.1	0.626

[Table/Fig-2]: Comparison between cases with odour history and no odour history
Using SPSS 20.0 version, the Shapiro-Wilk test is used for analysing the normality. We find that Mean HRV, SDNN, Variance, HF, LF/HF does not follow normal. Therefore we transform the data to make it "normal". Now we have used independent t test to compare between means of cases and controls

in interbeat intervals before any appreciable change occurred in heart rate itself [16].

Kawachi et al., reported that people with phobic anxiety show lower HRV scores and therefore were more prone to sudden cardiac death [17]. This finding is consistent with the result of our study as we have also reported a poor HRV compared to control group in patients of depression/anxiety as reflected by NN50 values ($p < 0.05$). NN50 parameter is a good predictor of overall HRV. It has been found that it is statistically significantnt p-value (p=0.016), so we can say that it shows poor HRV in cases as compared to control group. The previous studies reported that long- term depression in patients show lower HRV, but this may also be due to some toxic food ingestion, e.g. wheat, maize, corn and coffee these are usually seen to be associated with depression. Carmilla MM Licht et al., hypothesized that depression is associated with lower HRV and decreased cardiac vagal control [2]. As depression and anxiety due to chemical irritants is a preventable cause so in our present study we want to calibrate the definite correlation between the chemical irritants causing significant depression and other psychiatric illnesses.

In our study we have also reported although not a better HRV control in almost all the time domain and frequency domain parameters in controls as compared to cases. The values were perhaps not statistically significant because all patients were on medication and as our study group belongs to psychiatric patients so we cannot ask them to stop their medication. As reported in previous studies we have also reported a poor HRV compared to control group in patients of depression/anxiety as reflected by NN50 values ($p< 0.05$). Although not significant we found a better HRV control in almost all the time domain and frequency domain parameters in controls compared to cases. Regarding the history of use of chemical irritants again trends showed a poor HRV in these cases compared to controls who did not give any such history. [Table/Fig-1] shows that it is not significant but trends show a poor HRV control in almost all the time domain and frequency domain parameters in cases as compared to controls. The values were perhaps not statistically significant because all patients were on medication. In cases we have reported significant value of NN50 (p= 0.016) which showed a poor HRV as compared to control group. According to [Table/Fig-2], mean HOUR is high in patients without the history of odoriferous substances as the history of use of odoriferous substances though it is not statistically significant, HF value is high in patients without the H/o odoriferous substances as the history of use of odoriferous substances though it is not statistically significant.

Regarding the history of use of chemical irritants again trends showed a poor HRV control in these cases compared to cases which did not give any such history. Mean HRV is high (6 ms) in patients without the history of odoriferous substances as the history of use of odouriferous substances though it is not statistically significant (p= 0.312), HF value is high (33Hz)in patients without the history of odouriferous substances as the history of use of odouriferous substances though it is not statistically significant (0.582).This finding correlates well with the findings of Terry Perry –(Thought field therapy issue 150 –Aug/Sept 2008) who found poor HRV control in patients suffering from depression /phobias who had a history of use of odoriferous substances [10].

LIMITATIONS OF THE STUDY

- Sample size of patients who gave history of use of odorous substances was small.
- Most of the patients of depression/anxiety were already on medication which might have affected HRV values.
- The compliance of patients in the follow up schedule was poor.

CONCLUSION

As depression and anxiety due to chemicals use is a preventable disease so we want to find out the different correlation between the chemical uses and their effect on persons HRV. MCS (Multiple chemical sensitivity Syndrome) had been identified worldwide as a major culprit in psychological illness and skin diseases and asthma like conditions etc. by various researchers, so it is a preventable condition and if we find out the exact source of a patient disease we can easily get rid of the patients symptoms just by getting the patient away from the source of disease. The results of our study suggest that impaired cardiac autonomic nerve function characterized by sympathetic over activity may occur in depression/phobic patients. Our study also proves a poor HRV in psychiatric subjects with history of use of odoriferous substances.

REFERENCES

[1] Karavidas MK, Lehourer PM, Vaschillo E, Vaschillo B, Marin H, Buyske S, et al. Preliminary results of an open label study of heart rate variability biofeedback for the treatment of major depression. *Applied Psychophysiology and Biofeedback*. 2007;32(1):19-30.

[2] Licht CM, de Geus EJ, Zitman FG, Hoogendijk WJ, van Dyck R, Penninx BW. Association between major depressive disorder and heart rate variability in the Netherlands Study of Depression and Anxiety (NESDA). *Archives of General Psychiatry*. 2008;65(12):1358-67.

[3] Carney RM, Freedland KE, Stein PK, Skala JA, Hoffman P, Jaffe AS. Change in heart rate and heart rate variability during treatment for depression in patients with coronary heart disease. *Psychosomatic Medicine*. 2000;62(5):639-47.

[4] Copie X, Hnatkova K, Staunton A, Fei L, Camm AJ, Malik M. Predictive power of increased heart rate versus depressed left ventricular ejection fraction and heart rate variability for risk stratification after myocardial infarction. Results of a two-year follow-up study. *Journal of the American College of Cardiology*. 1996;27(2):270-76.

[5] Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. *European Heart Journal*. 1996;17(3):354-81.

[6] Gorman JM, Sloan RP. Heart rate variability in depressive and anxiety disorders. *American Heart Journal*. 2000;140(4 Suppl):77-83.

[7] Miller CS. Toxicant-induced loss of tolerance--an emerging theory of disease? *Environmental Health Perspectives*. 1997;105(Suppl 2):445-53.

[8] Cui X, Lu X, Hisada A, Fujiwara Y, Katoh T. The correlation between mental health and multiple chemical sensitivity: a survey study in Japanese workers. *Environmental Health and Preventive Medicine*. 2015.20:123-29.

[9] Ross PM, Whysner J, Covello VT, Kuschner M, Rifkind AB, Sedler MJ, et al. Olfaction and symptoms in the multiple chemical sensitivities syndrome. *Preventive Medicine*. 1999;28(5):467-80.

[10] Terri P. Chemical Fragrances: Effects on the Autonomic Nervous System. Positive Health. 2008(150):29.

[11] Graveling RA, Pilkington A, George JP, Butler MP, Tannahill SN. A review of multiple chemical sensitivity. *Occupational and Environmental Medicine*. 1999;56(2):73-85.

[12] Black DW, Okiishi C, Schlosser S. The Iowa follow-up of chemically sensitive persons. *Annals of the New York Academy of Sciences*. 2001;933:48-56.

[13] Association AP. Diagnostic and statistical manual of mental disorders 4 ed. 2000.

[14] de Castro BC, Guida HL, Roque AL, de Abreu LC, Ferreira C, Marcomini RS, et al. Auditory stimulation with music influences the geometric indices of heart rate variability in response to the postural change maneuver. *Noise & health*. 2014;16(68):57-62.

[15] Esco MR, Flatt AA. Ultra-short-term heart rate variability indexes at rest and post-exercise in athletes: evaluating the agreement with accepted recommendations. *Journal of Sports Science & Medicine*. 2014;13(3):535-41.

[16] Hon EH, Lee ST. Electronic evaluation of the fetal heart rate. Viii. Patterns preceding fetal death, further observations. *American journal of obstetrics and gynecology*. 1963;87:814-26.

[17] Kawachi I, Sparrow D, Vokonas PS, Weiss ST. Decreased heart rate variability in men with phobic anxiety (data from the Normative Aging Study). *The American Journal of Cardiology*. 1995;75(14):882-85.

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