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Assessment of cardiac autonomic activity by studying heart rate variability in adult psychiatric patients subjected to electroconvulsive therapy

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ABSTRACT

The autonomic nervous system (ANS) plays a crucial role in normal functioning of the heart and is responsible for normal cardiac variability, which can be studied by recording (HRV) heart rate variability. HRV is an excellent, noninvasive tool used to show variation over time of period between consecutive heart beats and for assessment of cardiovascular regulation of ANS. Available literature is insufficient to document effect of Electroconvulsive therapy (ECT) on HRV in psychiatry patients.

Aim: To explore the effect of ECT on HRV with a view to assess the safety of ECT in various age groups of patients requiring ECT.

Materials and Methods: This Non-Randomized comparison study without a control was conducted at a tertiary care teaching hospital in Ludhiana Punjab in 100 cases of ECT over a period of 2 years. A detailed general physical examination as well as systemic examination was done and observations were documented. Each patient was screened for indication for the ECT by the Psychiatrist. HR prior to ECT and HRV in immediate post procedure period were noted.

Observations and Results: This study indicates that heart rate increased significantly after ECT but this variation remains within the homeostatic limits.

Conclusion: Although the study shows safety of ECT in psychiatric patients, it would be advisable to monitor HRV in ECT given in pre-existing cardiac illness.

1. Introduction

The autonomic nervous system (ANS) is highly adaptable system responsible for maintaining the milieu interieur despite changes in the external environment. It plays an indispensable role in normal functioning of the heart.[1] Altered cardiac autonomic activity is considered to be an important risk factor for cardiovascular events especially in patients suffering from psychiatric illness.[2] ANS is accountable for regulation of essential functions like excitability, conductivity and auto rhythmicity through sympathetic and parasympathetic nervous system. These systems act on the myocardium and responsible for normal cardiac variability, which can be studied by recording heart rate variability (HRV)[1] HRV is an excellent, noninvasive tool used to show variation over time of period between consecutive heart beats and for assessment of ANS because it can evaluate sympathetic and parasympathetic activity separately.[3–5] HRV can be measured with standard electrocardiography (ECG) devices and appropriate software by recording successive beat-to-beat heart activity to assess the instantaneous heart rate.[6] HRV analysis. Time-domain and frequency-domain measures of HRV are used most commonly to analyze variations. HRV changes significantly with age. Moreover, it may be influenced by other factors such as body position, physical and mental activity, body mass index, sex or even diet.[7–11] Available literature indicates that reductions in HRV are found in individuals with psychiatric disorders, including depression, schizophrenia, anxiety disorders and substance dependence.[12–14] No or little variation in heart rate with different levels of activity is an indicator of

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poor cardiac function. While there are several intrinsic mechanisms to directly or indirectly stimulate or inhibit ANS activity, external stimulation by subjecting the heart to galvanic current from an external device like pacemakers or other forms of stimulators primarily used to maintain and sustain electrical activity in the heart bear a great impact on how the myocardium behaves electrically. Electroconvulsive therapy (ECT) is an important non-pharmacological intervention that consists in inducing a controlled convulsive seizure by electric stimulation of the brain. It is one of the available effective modality for treatment in patients suffering with severe neuropsychiatric disorder.[15] It is a potent stimulus to the ANS regarding effects on the heart.[16] Its use has increased due to its immediate profound effects and often in cases where medication proves ineffective or is contraindicated due to other prevailing factors or disease. The association between improvement in depression after ECT and changes in HRV has been reported by several groups of researchers which indicates that ECT might affect the HRV in these patients.[16] There are evidences which show that psychiatry illness is a major risk factor for cardiovascular adverse events and ANS dysfunction is assumed to be the intrinsic force behind these events.[2] Available literature is not sufficient to support that there is major change in HRV values after ECT in psychiatry patients. There is need to examine the effect of ECT on HRV in these patients. So, this study was attempted to assess the effects of ECT on cardiac autonomic activity in adult Psychiatric patients by studying their HRV so that we can better understand the role of ECT in these patients with respect to the changes in the HRV parameters and realize its significance in treatment planning keeping in mind the possible complications of cardiovascular system during the course of the treatment.

2. Materials and Methods

This Non-Randomized comparison study without a control was conducted over a period of two years in the department of Physiology and Department of Psychiatry in a tertiary care hospital in Punjab, north India. The proposal was duly approved by the institutional research and ethics committees. 100 cases of ECT in the department of Psychiatry were included in the study (50 of modified ECT and 50 of unmodified ECT). An informed consent for inclusion in the study was taken. None of the patients had history of preexisting cardiac illness. The patient was reassured of the noninvasive nature of the test and any questions regarding the procedure by the patient, if any, were duly addressed to allay any apprehension. Patient data such as his/her history, prevailing illness, diagnosis, ongoing medication, associated or concurrent medical illness was recorded. A detailed general physical examination as well as systemic examination was done and observations were documented as per the protocol of the study. Each patient was screened for indication for the ECT by the Psychiatrist who also complied with the pre requisites and consent of ECT in each case. Prior to ECT, vital signs of each patient were recorded including Heart rate, Blood Pressure and Respiratory rate. A standard 12 lead EKG was recorded on BPL CARDIART 108T / MK-VII machine prior to ECT in each case. Electroconvulsive therapy was given by the Psychiatrist using constant current, brief pulse ECT machine which is able to deliver a wide range of electrical dose in the range of 70-130 volts. The ECT machine used to deliver therapy was MEDICA BPE-791. Electroconvulsive therapy was scheduled between 8:00am and 11:00am. Patients were kept fasting for at least 8 hours prior to ECT. Dentures, contact lenses or any other ornaments were removed prior to the procedure. The procedure room was equipped with a defibrillator and drugs necessary for cardiopulmonary resuscitation. Electrodes were placed bifrontotemporally with the centre of each electrode about 1 inch above the midpoint of an imaginary line drawn from the tragus to the external canthus. The electrical stimulus given was 70-130 volts and the. current was allowed to flow up to 0.5-1.5 seconds. A repeat 12 lead EKG was done 10 mins after the ECT to allow time for settling of muscle tremor associated with ECT. The HRV parameters in Pre and Post ECT were noted and compared. The observed results were analyzed using t-test.

3. Observations and Results

A total of 100 psychiatric patients in the age group of 10-60 years were included in the study. Majority of the patients were males. The age group distribution of the subjects is as given inTable 1.

Table 1 shows the age distribution of the patients. It was noted that majority of the patients were in the age group of 21-30 years and the least number of patients were between the ages of 10-20 years.

Figure 1 and Figure 2 indicate that resting (pre ECT) heart rate ranged between 60 – 122 bpm with mean of 87.36bpm while 10 mins post ECT HR varied between 75 and 150 bpm with a mean value of 107.38 bpm indicating that there was increase in the HR in the post ECT period. This change was statistically found to be significant when applied to whole data across all age groups ($p < 0.001$).

Therefore, it is clear from the Table 2 and Table 3 that there is significant increase in the value of average HRV post ECT sessions when different age groups psychiatric patients are exposed to modified and unmodified ECT.

Table 1 shows the age distribution of the patients. It was noted that majority of the patients were in the age group of 21-30 years and the least number of patients were between the ages of 10-20 years.

Table 1: Age groups

Age Group	Patients
10-20	1
21-30	45
31-40	29
41-50	18
51-60	7

Table 2: Average HRV: RR variation in different age groups psychiatric patients subjected to modified ECT

Age group	Av HRV: RR variation pre ECT (ms)	Av. HRV: RR Post ECT (ms)	T (t test score)
10-20 (n=1)	1.20	1.47	-
21-30 (n=22)	1.554±0.242	1.944 ± 0.34	T = 6.5075 statistically significant p< 0.0001
31-40 (n=11)	1.354 ± 0.202	1.666± 0.216	T = 5.4328 statistically significant p =0.00028
41-50 (n=9)	1.156 ± 0.194	1.501 ± 0.256	T = 7.626 statistically significant p =0.00006
51-60 (n=7)	1.357 ±0.181	1.918 ± 0.303	T = 6.1724 statistically significant p =0.00083

All the age groups are showing extremely statistically significant and p value is < 0.0001

Table 3: Average HRV: RR variation in different age groups psychiatric patients subjected to unmodified ECT

Age group	Av. HRV: RR Pre-ECT (ms)	Av. HRV: RR Post ECT (ms)	T (t test score)
10-20 (n = 0)	0	0	-
21-30 (n = 23)	1.3786 ± 0.168	1.769 ± 0.167	T = 9.4339 statistically significant p< 0.0001
31-40 (n =18)	1.4478 ± 0.228	1.712± 0.1958	T = 9.0263 statistically significant p< 0.0001
41-50 (n = 9)	1.3400 ±0.1136	1.6833±0.1772	T = 9.4026 statistically significant p< 0.000013
51-60 (n=0)	0	0	

All the age groups are showing extremely statistically significant and p value is < 0.0001

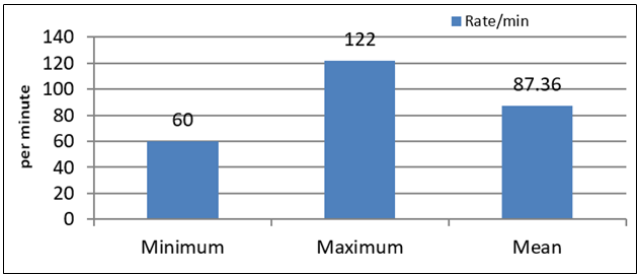

Fig. 1: Heart Rate - Pre ECT

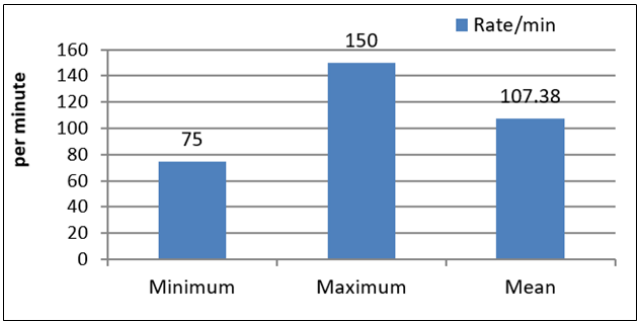

Fig. 2: Heart Rate - Post ECT

4. Discussion

The hemodynamics effects due to ECT may leads to vulnerable patients to significant risk for cardiovascular complications. It has been explained that there are changes in myocardium autonomic activity under the exposure of ECT.[17,18] The electrical stimulation of the nucleus of the vagus nerve via the parasympathetic nervous system produces sinus bradycardia.[17] There is significant rise in blood pressure (BP) and heart rate (HR) due to initial parasympathetic response which is promptly followed by sympathetic discharges. This sympathetic excitatory response continues until the seizure ends, when the

This change was statistically found to be significant when applied to whole data across all age groups ($p < 0.001$).

parasympathetic nervous system is reactivated. Eventually, blood pressure and heart rate return to their baseline levels.[18] There are some studies which indicated variable changes in HRV after ECT,[19–22] but none of the studies done involved 24 -hour ECG monitoring (holter), which is essential because circadian rhythms may impact HRV**.** It has been assumed that there is interrelation between improvement in treatment of depression after ECT and changes in HRV.[19–23]It was found that there was significant increase in heart rate in adults but baseline values were achieved in 25 min only among the young;[24] heart rate remained elevated after 1 h in the elderly.[25] The analysis of heart rate variability revealed increased sympathetic activity during ECT.[25] No critical detrimental effects occurred and ECT did not activate malignant arrhythmias or ischemia.[24,25] There was remarkable increased in blood pressure and heart rate at the time of shock. These changes may be due to myotonic reflexes, direct stimulation of the sympathetic nervous system and norepinephrine release from the adrenal medullae.[26,27] A study done by Takada et al. revealed that sudden elevations of blood pressure and heart rate after ECT may increase the chance of cardiovascular events, especially in older patients which were recorded in some studies.[25] Decreased HRV is considered to be a strong and appreciable predictor of cardiovascular mortality.[28] Nahshoni et al.[22] reported variations in HRV 72 h after ECT in older people, with a remarkable reduction of the low frequency component and of the low frequency to high frequency ratio. Similarly, Gould et al.[29] described ECG changes indicating myocardial infarction in a 75-year-old woman accepted to ECT who did not reveal myocardial necrosis or pericarditis. Other investigators have documented the same observation.[30] There is increases in blood pressure, heart rate, ventricular ectopic beats and T-wave inversions during hypothalamic stimulation even in animals.[31] Our study is unique in that it analyzed heart rate variability before the treatment and after the treatment, it was found that there was significant increase in the value of HRV after ECT which is supported by various studies.

5. Conclusion

We conclude that there is definite and significant change in the heart rate in the post ECT period, but this change remains within the homeostatic range and therefore does not adversely affect the cardiac activity. Moreover, patients with preexisting organic diseases and the elderly deserve special medical attention as they may be at risk for cardiovascular events because of the observed cardio circulatory changes. Therefore, it is recommended that health care practitioners should monitor the HRV at regular intervals during ECT treatment so that this knowledge may be help to determine the optimal number of treatments for each patient.

6. Source of Funding

None.

7. Conflict of Interest

None.

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