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ECT and Heart Rate Changes: An Alternative to EEG Monitoring for Seizure Confirmation During Modified ECT

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Abstract

Background: Detection of seizure demands attention in modified ECT, because of muscle relaxation. The "cuff method" is not always reliable, as it may sometimes fail to detect seizures of adequate duration.
Aim: To examine if increase in heart rate can be an additional guide to detect adequate cerebral seizures.
Method: Heart rates before and following the stimulus were estimated in 100 ECT sessions (52 patients) of adequate (60) and inadequate (40) EEG seizures. The peak heart rate, the ratio of peak to the baseline heart rate and time required to reach peak were obtained for each of these recordings.
Result: The group with adequate EEG seizure had significantly higher peak heart rate, higher peak to baseline heart rate ratio and longer time to reach peak heart rate.
Conclusion: The time required to reach the peak heart rate along with normalized peak heart rate (the ratio of baseline to peak heart rate) in that order can be additional measures to detect adequate seizure during modified ECT (German J Psychiatry 2003; 3: 60-63).

Keywords: Electroconvulsive therapy, heart rate

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Introduction

Modification during Electroconvulsive therapy (ECT) masks motor convulsions. Therefore the rate of incomplete or missed seizures in contemporary ECT practice may be unacceptably high (Snaith & Simpson, 1987). Pippard and Ellam (1981 and 1992) noted that the attending medical staff failed to recognise a missed seizure. EEG is hence recommended and a seizure of 25 seconds length is considered adequate (Freeman, C.P, 1995). We examined if heart rate response to ECT can be used as an alternative index to seizure monitoring.

Elicitation of seizure and its adequacy is essential for the therapeutic effects of ECT (Dubovsky, S. L., 1995). Modified ECT however poses some problems in this regard. Cuff method, which blocks the distribution of muscle relaxant to a limb (Addersely and Hamilton 1953), is an alternative widely used. EEG (electroencephalogram) seizure monitoring (Christensen and Koldbeak, 1982) has however become the gold standard. Seizure duration by cuff method correlates well with that of EEG (Fink, and Johnson, 1982). However cuff method still misses a sizeable proportion of motor seizures prompting inadvertent repeat stimulus although an adequate cerebral seizure has occurred (Mayur *et al*, 1999 & Scot *et al*, 1989). EEG monitoring is hence encouraged (Freeman, 1995 & American Psychiatric Association, 2001). But additional instrumentation, cost, training and time discourage its use in routine ECT practice. Larson *et al.*, suggested that ECT induced tachycardia could be alternate to seizure monitoring. ECG monitoring has become a routine practice during ECT (American Psychiatric Association, 2001). Elevation in heart rate occurs during seizure (Abrams 1997; Gangadhar *et al.*, 2000). In the absence of cerebral seizure the heart rate response in blunted (Gill *et al.,* 2002). Cardiovascular response seen during seizure is independent of motor convulsion and dose of muscle relaxant (Murali *at al.,* 1999). Put together ECG monitoring and in turn the heart rate response has the potential guide to be an alternative to detect seizure. In a preliminary study heart rate response (Peak to baseline heart rate ratio of 1.5 or more) distinguished seizures from no seizures (Project report-submitted to Vishweshwaraya Technical Institute, Unpublished Data). This is a larger study with EEG and ECG monitoring.

Material and Methods

Patients

Fifty-two patients who were prescribed ECT by the treating psychiatrists at National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore formed the sample for the study. After obtaining an informed consent for ECT, a pre-ECT evaluation was done. Patients with cardiovascular (including hypertension) and neurological illness were excluded from the study. Mean (SD) age of the patients was 27.52 (6.49) years; there were 30 (57.7%) males; 10 (19.2%) had schizophrenia; 11 (21.2%) had mania and 27 (51.9%) had depression. Of these 52 patients 18 (34.6%) were on antidepressants, 15 (28.8%) on antipsychotics, 7 (13.5%) on lithium and 12 (23.1%) had no drugs. EEG and ECG recordings of 100 modified ECT sessions of these 52 patients formed the data.

ECT

Modification was achieved using thiopentone (4mg/kg), atropine (0.6mg) and succinylcholine (0.75 mg/kg) intravenously. The stimulus dose was selected by varying the stimulus train duration (0.2 to 3.6 seconds). Bilateral ECT was given with the electrodes in the bitemporal position. Right unilateral ECT was given with the electrodes in the d'Elia position (temporoparietal). Threshold was assessed at the first ECT session using titration method. The starting stimulus dose was 20-30mC. If the patient failed to obtain a seizure or had sub-shock, he/she was re-stimulated at a higher dose (with an increment of 15-20 mC) after ventilation with 100% oxygen for 30 seconds. Adequate EEG seizure was defined as seizure lasting for more than 25 seconds. The mean (SD) stimulus dose for adequate seizures was 120.6 (56.28) and for inadequate or no seizures was 89.6 (64.31) mC.

EEG and ECG monitoring

Seizure activity was recorded on four channels left and right frontal and temporal leads referenced to linked mastoids. One channel ECG was recorded using chest leads.

In the four-channel EEG monitoring, the beginning of unequivocal absence of epileptiform transients for five or more seconds in all channels was taken as the end of EEG seizure (Gangadhar *et al.*, 1995). The data acquired was replayed offline on the computer screen to confirm the end of EEG seizure and the duration. Adequate seizure was defined as EEG seizure of 25 seconds or longer (Freeman, 1995; Dubovsky, 1995). These will be referred to as "Shocks" in the rest of the text and no EEG seizure or inadequate seizure of less than 25 seconds will be referred to as "Subshocks". Such continuous ECG and EEG monitoring was done for all ECT sessions.

ECG analysis

Heart rate was calculated from the RR intervals of these recordings, using NIVIQURE-HRV software offline by a person blind to the status of the sessions (shock/subshock). The base line heart rate was calculated from the RR interval in the ECG just before stimulus application. The subsequent heart rates at any instant during and following seizure were calculated from the RR intervals in the continuous ECG record. From the data so generated, the peak heart rate and time to peak heart rate were obtained.

An illustration comparing the typical recording of 4-channel EEG and ECG during an inadequate seizure with that of an adequate seizure along with baseline and post seizure has been shown in Figure 1.

Results

The baseline heart rate among the subshocks was higher than among the shocks. To avoid its confounding effect a

Table 1. Comparison Between Shocks and Subshocks; t test; df=98; SD=standard deviation

Variable	Subshock (n=40) Mean ± SD	Shock (n=60) Mean ± SD	t	p
Baseline heart rate (beats per minute)	114.3±12.54	105 ±20.32	2.58	0.005
Peak heart rate (beats per minute)	120.7 ±13.3	155.3 ±26.5	-7.61	<0.001
Normalized peak (peak HR/baseline HR)	1.03 ± 0.17	1.51 ±0.26	-10.0	<0.001
Time to peak (seconds from stimulus)	3.22 ± 1.56	22.87± 14.3	-8.61	<0.001
Product of normalized peak and time to peak	3.37 ± 1.83	35.05±23.38	-8.53	<0.001

ratio of baseline to peak heart rate ("normalized peak") was obtained. Peak heart rate, normalized peak and the time to peak heart rate were all significantly higher among the shocks than the subshocks (Table 1).

Forty nine (82%) shocks had peak heart rate of more than 130 bmp as against only six (15%) subshocks. Normalizing this value lowered the error rate. Fifty-nine (98.5%) shocks had a normalized peak of more than 1.18 as against only two subshocks. In all shocks the peak heart rate reached after seven seconds but so only in one subshock. Interestingly this subshock session had a normalized peak heart rate of 1.041. Thus a combination of time to peak of 7 seconds and a normalized peak of 1.18 could segregate all shocks from subshocks (Figure 2). The product of normalized peak heart rate and time to reach peak heart rate could segregate all shocks from subshocks minimizing the error to zero. The cut-off value was nine. All subshocks had a value less than nine and all shocks more than nine.

Figure 1. Comparison of 4 Channel EEG and ECG of a Patient During Subshock and Shock. The first 4 Graphs Illustrate EEG and the Last ECG. a = Baseline (HR = 106 bpm), b = Subshock (HR = 110 bpm), c = Shock (HR = 166 bpm), d = Post Seizure (HR = 106 bpm). Note that the RR Interval is Minimum in the ECG During Seizure "Shock"

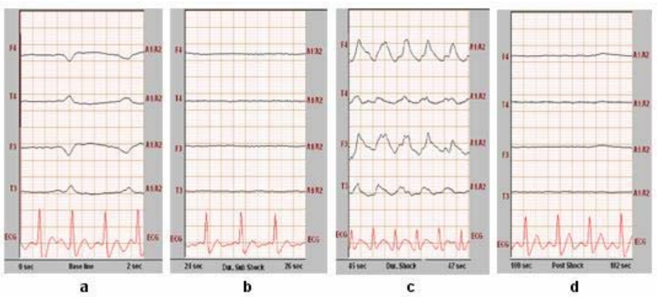
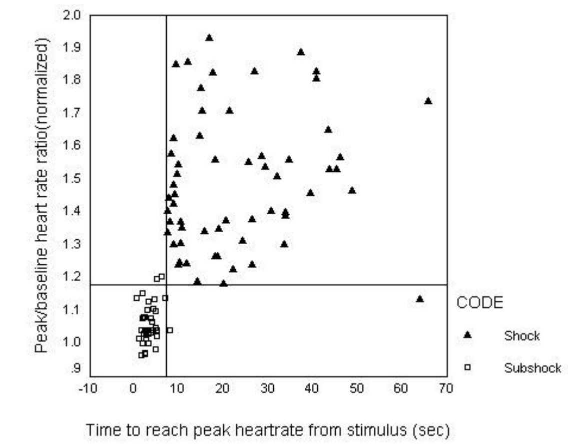


Figure 2. Plot of Normalized Peak Hear Rate versus Time to Reach Peak Heart Rate. All Shocks Had a Time-to-Peak of 7 Seconds or Longer. One of the Subshocks Was Samller than 1.18. Two Outliers Are Not Shown



Discussion

Heart rate response during ECT was evaluated as an indicator of seizure adequacy. Absolute peak heart rate response alone produced about 20% error. Normalized peak heart response was however sensitive with error rate only 3%. Time to peak heart rate of seven seconds was the most successful index. It detected all shocks. One subshock identified as shock by this method amounts to 1% error. However the product of normalized peak and time to peak eliminated even this error. No inadvertent re-stimulations in successful seizure would be attempted. ECG monitoring is a simple, non-invasive routinely used procedure that is necessary. This study exploited another application of this procedure. Extracting heart rate response may aid in seizure monitoring as an alternative guide with success rate up to 100%.

In this study, these calculations have been made offline. A simple device, which can indicate if an adequate seizure has occurred or not by monitoring the heart rate, can be incorporated into the existing ECT machine. This would eliminate the need for a computer to analyse the heart-rate changes and would indicate the occurrence of a 'shock' or a 'subshock' by analysing the changes occurring within 30 seconds after the stimulus is given, so that the doctor can decide on restimulation within that time. This would be an inexpensive and less cumbersome alternative to EEG-monitored ECT and would require little training. However, EEG-monitored ECT still remains the gold-standard method of monitoring the adequacy of seizures.

Atropine premedication adds to heart rate response (Mayur *et al*, 1998a). Since in this study atropine and other anaesthetic agents were used during both sessions ('shocks' and 'subshocks') the difference in heart rate can be attributed only to the difference in the adequacy of seizures and is independent of the effect of these agents. Unilateral ECT yields lower cardiovascular response compared to bilateral (Gangadhar *et al.*, 2000 and Mayur *et al.*, 1998b). The present sample despite having both unilateral and bilateral ECT sessions still yielded high accuracy of seizure detection from cardiovascular response.

The error rate using this method is virtually nil as opposed to about 7% in the case of cuff-method. However, one would require a study comparing these two methods head-to-head in order to conclude as to whether this method is indeed better than the cuff-method.

References

Abrams R, Electroconvulsive Therapy. 3rd Edn. Oxford University Press, New York; 1997.

Addersely DJ & Hamilton M, Use of succinylcholine in ECT. British Medical Journal; 1953;1:195-197.

American Psychiatric Association, A task force report of the American Psychiatric Association, American Psychiatric Association, The practice of ECT. Recommendations for treatment and privileging. Second Edition, Washington DC: APA; 2001.

Christensen P & Koldbeak IB. EEG monitored ECT. British Journal of Psychiatry; 1982; 141:19-23.

Dubovsky SL. Electroconvulsive therapy. In Kaplan HI and Saddock BJ 3rd Eds. Comprehensive Textbook of Psychiatry. Williams and Wilkins, Baltimore, pp. 2129-40, 1995.

Fink M & Johnson L. Monitoring the duration of electroconvulsive therapy seizure: cuff and EEG methods compared. Arch Gen. Psychiatry; 1982; 39:1189-1191.

Freeman CP. The ECT Handbook, Royal College of Psychiatrists, Gaskell, London. 1995

Gangadhar BN, Candade VS and Laxmanna G, et al., Computer in ECT and paperless monitoring. Indian Journal of Psychiatry; 1995; 37: 98.

Gangadhar BN, Prashanth M Mayur, Janakiramaiah N, et al., Cardiovascular response during ECT differs across stimulus condition. Journal of ECT; 2000; 16:177-182.

Gill NS, Girish K, & Gangadhar BN. Ictal RPP-A supplement to cuff method in detecting ECT-induced cerebral seizure. Indian Journal of Psychiatry; 2002; 44(1):29-33.

Mayur P, Sumansri R, Gangadhar BN, et al., Atropine premedication and the cardiovascular response to electroconvulsive therapy. British Journal of Anaesthesia; 1998a; 81:466-467.

Mayur PM, Prasad K, Gangadhar BN, et al. Cardiovascular responses to electroconvulsive therapy: Differences between unilateral and bilateral electrode placement. Journal of ECT; 1998b; 14:94-98.

Mayur PM, Gangadhar BN, Janakiramaiah N, et al., Motor seizure monitoring during electroconvulsive therapy. British Journal of Psychiatry; 1999; 174:270-273.

NIVIQURE Heart Rate Variability (HRV) Software, developed by Techno Nivilak, 311/2, 10th E Main, Jayanagar 1st Block, Bangalore-560011, India. http://business.vsnl.com/niviqure

Pippard J & Ellam L. Electroconvulsive treatment in Great Britain. British Journal of Psychiatry; 1981; 139:563-568.

Pippard J. Audit of Electroconvulsive treatment in two National Health Service regions. British Journal of Psychiatry; 1992; 160:621-37.

Scott AIF, Shering PA, and Dykes S. Would monitoring by electroencephalogram improve the practice of electroconvulsive therapy ? British Journal of Psychiatry; 1989; 154:853-857.

Snaith RP & Simpson K. ECT Practice. Bulletin of Royal College of Psychiatrists; 1987; 11:203.