Indian Journal of Psychiatry, 1999, 41 (3),236-241

CARDIOVASCULAR RESPONSE TO ECT IS UNAFFECTED BY EXTENT OF MOTOR SEIZURE MODIFICATION

N. MURALI, E.S.M. SARAVANAN, M.G. SANTOSH, B.N. GANGADHAR, N. JANAKIRAMAIAH,G.S. UMAMAHESHWARA RAO, S. SATISH KUMAR, D.K. SUBBAKRISHNA & RITA CHRISTOPHER

ABSTRACT

Effect of the extent of motor seizure modification on cardiovascular responses in ECT was studied at the second ECT session in 50 (ULECT=25) consenting patients. Twenty five patients each received either 0.5 mg/kg or 1 mg/kg of succinylcholine in a random design. Blood pressure and heart rate were recorded on five occasions during the ECT session. Extent of motor seizure was assessed on a five point scale by two raters blind to succinylcholine dose. Two raters had good interrater agreement on the scale. Significantly more patients had poor modification with 0.5 mg/kg (68%) than with 1 mg/kg (12%) of succinylcholine. Rate-pressure-product (RPP=systolic BP x Heart rate) significantly changed over the five occasions, maximal being in ictal occasion, but the two succinylcholine dose groups did not differ. Ictal RPP positively correlated with post-anaesthesia RPP, ECT stimulus dose, seizure threshold and both seizure durations (Motor and EEG). Likewise, postictal RPP correlated with seizure threshold and actual ECT stimulus dose. Neither correlated with the motor seizure modification scores. In multiple, stepwise, linear regression models neither ictal nor post-ictal RPP variance was significantly explained by the extent of motor seizure modification scores. Hence, RPP changes during ECT may be reflecting cerebral mechanisms of ECT.

Key words : Rate pressure product, ECT, motor seizure modification, succinylcholine dose.

Electroconvulsive therapy (ECT) induces a prompt (acute) cardiovascular (CV) response. Electrical stimulus of the ECT and seizures induced by it produce marked cardiovascular responses by direct stimulation of cardiac centres in hypothalamus and indirectly by the generalization of seizure (Abrams,1997). The acute CV responses in an unatropinised individual are an initial asystole followed by a transient tachycardia and increased blood pressure. Blood pressure (BP) responses generally parallel heart rate throughout the treatment. The BP drops sharply during the initial vagal- hypertonic phase and then rapidly increases upto 40% over baseline. The BP elevation is more when atropine premedication is given (Mulgaokar et al.,1985; Prudic et al.,1987). More specifically, systolic blood pressure peaks during immediate poststimulus (ictal) period. These increase in systolic blood pressure is greater than diastolic blood pressure (Prudic et al.,1987).

Rate-Pressure-Product(RPP), a product of heart rate and systolic blood pressure, is an index of myocardial oxygen consumption and is one such measure of CV response during ECT. RPP change during ECT have been described (Mayur et al.,1998a; Webb et al.,1990). RPP increase by 30% to 140% during ECT induced seizure (Jones & Knight et al.,1981; Mulgaokar et al.,1985; Huang et al.,1989; Webb et al.,1990). It reaches its maximum about 30 seconds after

the ECT stimulus (Jones & Knight, 1981). Use of atropine as premedication during ECT increase RPP response (Mayur et al.,1998b). Postical RPP was significantly higher after threshold BLECT than threshold ULECT (Mayur et al.,1998a). However, unilateral threshold ECT produced significantly lower RPP than unilateral suprathreshold and bilateral suprathreshold ECT conditions within the same group of patients (Gangadhar et al.,1999).

Succinylcholine is a muscle relaxant, commonly used in ECT. By its depolarising properties it increases serum potassium levels and variably modifies peripheral motor convulsions. These factors can affect cardiovascular responses both directly and indirectly. It is likely that a more pronounced convulsive response contributes to higher RPP, which was examined in this study.

MATERIAL AND METHOD

Patients :

Consenting consecutive patients referred for ECT (n=50; 31 males; Unilateral=25, Bilateral=25) formed the sample. Their mean ± SD age was 27.92±9.9 years and mean ± SD body weight 49.25±10.65 kilograms. Their diagnoses were schizophrenia (n=27), mania (n=4) and depression (n=19). After obtaining additional consent for this trial, they were part of the study at the second ECT session. All patients were right handed and continued to receive one or more psychotropic drugs, not lithium. None had cardiovascular clinical abnormalities or liver dysfunction (supported by biochemical liver function tests).

Anesthesia :

Patients were anesthetised with thiopentone (4 mg/kg) and atropine (0.65 mg). During the second ECT session, they were equally randomized to receive either 0.5 mg/kg or 1.0 mg/kg body weight of succinylcholine. Intermittent positive pressure ventilation with 100% oxygen was provided till resumption of spontaneous and regular breathing.

ECT administration :

ECT was administered using a computerized constant current (800mA) bidirectional brief pulse (1.25 msec width) device (NIVIQURE) with EFG monitoring (F_3 & F_4 referenced to linked mastoids). The ECT machine provides pulses at a rate of 125 pps. The total stimulus dose (mC) is adjusted by setting the stimulus train length (0.2-3.6s). The stimulus laterality was as prescribed by the referring psychiatrist. Standard bifrontotemporal and nondominant (right) D'Elia stimulus electrode positions were used for bilateral (BLECT) and right unilateral (ULECT) ECT patients respectively. ULECT patients received 2.5 times threshold stimulus and BLECT patients received 60 mC above the threshold. Motor seizure was monitored with the cuff above the right ankle. Last clonic movement on any part of the body was considered the end of motor seizure and unequivocal absence of epileptiform transients for more than five seconds on both channels was considered as the end of the EEG seizure (Gangadhar et al.,1995).

Cardiovascular monitoring :

Online cardiovascular and pulse oximetric parameters were monitored using Cardiocap-II. Blood pressure and heart rate were recorded before and after induction of anesthesia, 20 seconds poststimulus (ictal), postical and after spontaneous resumption of respiration.

Assessments :

One independent investigator (MN) was responsible for recruiting and randomising patients to two different doses of succinylcholine. The anaesthetist (Rater - A; SKS) and one other psychiatrist (Rater - B; SESM) who were unaware of the dose of succinylcholine, independently rated the extent of motor seizure modification using a standardized scale (Appendix). A score of less than three and 3 or more on the scale were operationally defined as 'poor' and 'good' modifications respectively. Rater-B noted the motor and EEG seizure durations using the digital counter in the ECT machine. Two milliliters

of blood was drawn from the patients before the administration of anesthetic agents and immediately after ECT for the estimation of the serum potassium levels. Serum potassium assays on coded samples were performed without knowledge of patient data(RC).

Statistics :

Independent sample t-test and chi-square test were used to compare variables of patients with 'low dose' (0.5 mg/kg) and 'high dose' (1mg/kg). Change in serum potassium levels from pre- to post- ECT occasions was examined using paired t-test. Interrater reliability on the modification score between raters (Rater-A and Rater-B) was assessed using Kappa correlation. For further analyses, scores by the psychiatrist (Rater-B) were used. Two way repeated measure analysis of variance (RMANOVA) was used to examine the change of RPP across five occasions (within-subject factor) with 'poor'/'good' modification as between-subject factor. RMANOVA was repeated with succinylcholine dose and with laterality as between-subject factors separately. Pearson's correlation was applied to determine factors influencing RPP in each of the five occasions. Multiple, step-wise, linear regression was used to determine the factors influencing ictal and postictal RPP for entire patient sample. The probability (alpha) was fixed at <0.05.

Results :

Socio-demographic and ECT variables were comparable between patients who received 'low' and 'high' dose succinylcholine (Table-1). The two raters showed good agreement for the scores of extent of modification (Kappa Coefficient=0.88) as well as for recorded scores of 'good' and poor modification (Kappa Coefficient=0.91) respectively. The modification score was higher in the 1 mg/kg group. Also only 3 (12%) patients in this group had 'poor' modification as against 17 (68%) of the 0.5 mg/kg group. Serum potassium levels (mean±SD meq/L) significantly rose from pre- (4.34±0.2) to post- (4.58±0.3) ictal occasion in the patients with succinylcholine of 1 mg/kg (t=4, df=23, p=0.001). No such changes were noted in the ECT session with 0.5 mg/kg (pre=4.53±0.3; post=4.57±0.3 : t=0.57, df=23, p=0.57).

RPP changed significantly over the five occasions, being highest in ictal recording (Table.2). Neither, succinylcholine dose, nor stimulus laterality, nor extent of modification (as between-subject factors) affected RPP differentially (Table.2). Ictal RPP positively correlated with post-anaesthesia RPP, ECT stimulus dose, and seizure threshold, seizure durations (both motor and EEG) but did not correlate with motor seizure modification scores. Likewise, postictal RPP correlated with threshold and actual ECT stimulus dose but not with motor seizure modification scores.(Table.3).

In view of multiple correlations, ictal and postictal RPP as dependent variables, were examined in two separate multiple, stepwise, linear regression models. Age, threshold, actual

TABLE 1
COMPARISON OF VARIABLES (MEAN±SD, *NUMBER) ACROSS LOW AND HIGH DOSE SUCCINYLCHOLINE PATIENTS GROUPS

Subjects → Variable ↓	'low' dose (0.5mg/kg) (n=25)	'high' dose (1mg/kg) (n=25)	T/x^2, df, p
Age(years)	27.2±9.6	29.2±10.2	0.68, 48, 0.50
Gender M:F*	15:10	16:9	0.08, 1, 0.77
BLECT:ULECT*	12:13	13:12	0.08, 1, 77
ECT stimulus dose (mC)	139.2±58.6	151.2±49.4	0.78, 48, 0.44
EEG seizure duration in (s)	66.52±26.3	63.1±25.7	0.48, 48, 0.64
Motor seizure duration in (s)	58.1±22.2	50.8±22.7	1.14, 48, 0.26
Extent of motor seizure modification on five point scale	2.4±0.7	3.32±0.85	4.15, 48, 0.001
Poor :Good modification	14:11	3:22	10.7, 1, 0.001

TABLE 2
COMPARISON OF MEAN±SD RPP VALUES ACROSS DIFFERENT GROUPS

Occasion -› Group ↓	Pre-anaesthesia	Post-anaesthesia	Ictal	Post-ictal	Post- RR recovery	Two-way RMANOVA F; df; p
Succinylcholine 0.5mg/kg (n=25)	12253 ±3584	13814 ±2468	17700 ±4064	13649 ±3156	14248 ±4012	F_1=0.18; 48, 1;0.64 F_2=0.12; 4; 0.19 **F_3=0.64; 4; 0.001**
1mg/kg (n=25)	11338 ±2272	13504 ±2370	17953 ±4735	15318 ±2977	14983 ±2651	
Laterality						
ULECT (n=25)	11939 ±3046	13242 ±2170	18971 ±5062	15089 ±3397	14620 ±3419	F_1=0.78; 48; 1; 0.38 **F_2=0.19; 4; 0.03** **F_3=0.68; 4; 0.001**
BLECT (n=25)	11652 ±3020	14075 ±2586	16683 ±3259	13878 ±2824	14611 ±3429	
Modification						
'poor' (n=20)	12203 ±1877	13666 ±1962	18020 ±4485	14140 ±2816	14791 ±2197	F_1=0.13, 48; 1; 0.71 F_2=0.11; 4; 0.24 **F_3=0.65; 4; 0.001**
'Good' (n=30)	11004 ±3401	13646 ±2662	17452 ±4365	15151 ±3299	14275 ±3879	

F_1=Group effect; F_2=Interaction effect; F_3=Occasion effect; RR-Respiratory recovery

TABLE 3
PEARSON'S CORRELATION MATRIX, (VALUES REFER TO 'r' VALUES; TWO TAILED SIGNIFICANCE **p<0.01, * 'p<0.05)

	RPP post anaesthesia	RPP ictal	RPP postictal	Seizure threshold	ECT actual stimulus dose	Motor seizure duration	EEG seizure duration	Motor seizure modification score
RPP post anaesthesia								
RPP ictal	0.49**							
RPP postictal	-0.34**	-0.06						
Seizure threshold	-0.12	0.37**	0.34**					
ECT actual stimulus dose	-0.16	0.34**	0.36**	0.80**				
Motor seizure duration	0.05	0.52*	0.25	-0.33**	-0.35**			
EEG seizure duration	0.07	0.32*	0.23	-0.34**	-0.30*	0.89**		
Motor seizure modification score	-0.09	0.03	-0.19	0.13	0.09	-0.23	-0.09	
age	-0.25	-0.14	-0.11	0.56**	0.51**	-0.40	-0.39**	0.18

stimulus dose, stimulus laterality, postanaesthesia RPP, extent of modification scores, EEG and motor seizure durations were the independent variables. Postanaesthesia RPP (ß=0.54, t=4.9, p=0.001), stimulus laterality (ß=-0.37, t=3.4, p=0.01) and motor seizure duration (ß=0.31, t=2.9, p=0.006) explained respectively 24%, 13% and 10% of variance in ictal RPP. Unilateral ECT and longer motor seizure duration were associated with higher ictal RPP. Actual stimulus dose used (ß=0.36, t=2.7, p=0.009) explained 13% of variance in postictal RPP; higher stimulus was associated with higher postictal RPP. Motor seizure modification scores (continuous or dichotomous) were not significant in both regressions.

DISCUSSION

In this study most of the patients with 1 mg/kg succinylcholine had deeper muscle relaxation and good motor seizure modification. Succinylcholine being a depolarising muscle relaxant, mobilizes intracellular potassium to extracellular compartment. Significant increase in serum potassium levels from pre- to post- ECT occasion was seen only in patients with 'high' dose succinylcholine, which validates the dose effect. However none had clinical complications, such as cardiac arrhythmia or prolonged apnea. Succinylcholine dose used in this study did not produce differential cardiovascular responses (Table.2).

Twenty patients had 'poor' motor seizure modification. However, modification status did not affect RPP measures (Table.2). This observation is contrary to the belief that the violent seizures may increase myocardial stress. Subjects of this study had no cardiovascular problems, and were relatively young. Thus findings of this study may not apply to elderly or cardiac compromised patients.

There was no differences in RPP between BLECT and ULECT patients receiving suprathreshold stimulus. However, Mayur et al. (1988a) reported differences between ULECT and BLECT patients both receiving threshold stimulus. Similar observations have been reported recently (Gangadhar et al.,1999) in an intraindividual crossover design. However in the multiple regression model, unilateral ECT was associated with higher ictal RPP.

As the dose of succinylcholine and extent of motor seizure modification did not influence RPP (ictal or postictal), it can be argued that the observed effects on RPP were mediated by stimulus dose and seizure duration. Thus RPP response may be window to cerebral mechanisms during ECT. RPP response may hence, be a tool to understand the therapeutic or adverse effects of ECT. Some trends suggest that higher RPP during ECT may be associated with better therapeutic potency (Webb et al.,1990). RPP holds promise as a noninvasive, but indirect measure of CNS effects during ECT to understand neurophysiological mechanisms of ECT.

APPENDIX

Scale to score extent of motor seizure modification.
(A score of 2 or less indicates poor modification)

Score	Location & intensity of convulsions
1	Violent convulsions as in unmodified ECT
2	Bilateral motor convulsions and they are equal in intensity in both cuffed and uncuffed limbs.
3	Bilateral motor convulsions and the intensity is more in cuffed limb when compared to corresponding uncuffed limb.
4	Motor convulsions in cuffed limb and face.
5	Motor convulsions only in cuffed limb.

REFERENCES

Abrams, R. (1997) *Electroconvulsive Therapy*, Edn.3, New York:Oxford University Press.

Gangadhar, B.N., Mayur, P.M., Janakiramiah, N., Subbakrishna, D.K. &

Umamaheshwara Rao, G.S.(1999) Cardiovascular response during ECT: A crossover study across stimulus conditons. *Journal of ECT* (in press).

Gangadhar, B.N., Candade, V.S., Laxmanna, G., Janakiramaiah, N. & Mahapatra, P.K.(1995) Computers in ECT and paperless monitoring. *Indian Journal of Psychiatry*, 37, 98.

Huang, K.C., Lucks, L., Tsueda, K., Thomas, M. & Lippman, S.B.(1989) Age related changes in cardiovascular function associated with electroconvulsive therapy. *Convulsive Therapy*, 5, 17-25.

Jones, R.M. & Knight, P.R.(1981) Cardiovascular and harmonal responses to electroconvulsive therapy. Modification of an exaggerated response in an hypertensive patient by beta-receptor blockade. *Anaesthesia*, 36, 795-799.

Mayur, P.M., Gangadhar, B.N., Girish, K., Kiran Prasad, K.M., Subbakrishna, D.K. & Janakiramiah, N. (1998a) Acute Post ECT Cardiovascular Response : A comparison of threshold right unilateral and bilateral ECT. *The Journal of ECT*. 14,2, 94-98.

Mayur, P., Sumansree, R., Gangadhar, B.N., Janakiramiah, N., Umamaheshwara Rao, G.S. & Subbakrishna, D.K. (1998b) Atropine premedication and the cardiovascular response to electroconvulsive therapy. *British Journal of Anaesthesia*, 81, 466-467.

Mulgaokar, G.D., Dauchot, P.J., Duff, J.P. & Anton, A.H.(1985) Noninvasive assessment of Electroconvulsive induced changes in cardiac function. *Journal of Clinical Psychiatry*, 46, 479-482.

Prudic, J. Sackeim, H.A., Decina, P., Hopkins,N., Ross,F.R. & Malitz, S.(1987) Acute effects of ECT on cardiovascular functioning: relations to patients and treatment variables. *Acta Psychiatrica Scandinavica*, 75, 344-351.

Webb, M.C., Coffey, C.E., Saunder, W.R., Cress, M.M., Weiner, R.D. & Sibert, T.R. (1990) Cardiovascular response to unilateral electroconvulsive therapy. *Biological Psychiatry*, 28, 758-766.

N.MURALI,DPM, E.S.M.SARAVANAN,DPM, Non PG Junior Resident,M.G.Santosh,M.Sc., Research Assistant, B.N.GANGADHAR,MD, Additional Professor, N.JANAKIRAMAIAH,MD,Ph.D., Additional Professor, Department of Psychiatry, G.S. UMAMAHESHWARA RAO,MD, Professor, S.SATISH KUMAR,MBBS. Non PG Junior Resident, Department of Neuroanaesthesiology. D.K.SUBBAKRISHNA, Ph.D., Additional Professor of Biostatistics & RITA CHRISTOPHER, MD, Associate Professor, Department of Neurochemistry, National Institute of Mental Health and Neurosciences, Bangalore-560 029.(*E-mail:bng@nimhans.kar.nic.in)*

Correspondence