Indian J. Psychiat., 1997, 39 (1) 61-63

EEG DELTA BAND SPECTRAL POWER : DIFFERNECES BETWEEN UNILATERAL AND BILATERAL ECT SEIZURES

D. NARAYANA DUTT, P. K. MAHAPATRA, B. N. GANGADHAR, P. K. SADASIVAN, N. JANAKIRAMAIAH, D. K. SUBBAKRISHNA & K. M. JYOTI RAO

ABSTRACT

EEG was recorded from right and left frontal leads during bilateral (n=11) and unilateral (n=14) ECTs. The seizure EEG was analyzed using Fast Fourier Transform and the spectral power of the Delta (1-4 Hz) band was computed. The spectral power on both sides was similar in the bilateral ECT. Unilateral ECT produced asymmetry in the early - (first 8 seconds after stimulus offset) and mid - (17-32 seconds after the stimulus offset) siezure phases: the spectral power was lower on the unstimulated hemisphere. Studies to elucidate the relevance of EEG delta band of the seizure to therapeutic potency of ECT are suggested.

Key words : EEG, ECT, unilateral, bilateral.

Evidence from the earlier classical experiments (Cronholm and Ottosson, 1960) confirmed the need to elicit a seizure during ECT. ECT procedure is defined as adequate based on the duration of the seizure elicited: 25 seconds or more of seizure duration is defined as 'adequate' (American Psychiatric Association, 1990). However, ECT seizures also differ on measures other than duration. A recent study (Krystal et al., 1993) found that seizures differed in the spectral power, regularity and symmetry as a function of the stimulus parameters. It has also been suggested that the delta band of the EEG is relevant to the therapeutic properties of ECT (Staton et al., 1988). In this report we examined the EEG spectral power differences in the delta band between right and left sides in ECT seizures induced by unilateral and bilateral ECT.

MATERIAL AND METHOD

Patients : EEG data was collected from 25 right handed psychiatric patients who consented to receive ECT. Fifteen of them had affective illness. Fourteen (8 males) received right unilateral ECT (d'Elia placement) and eleven (6 males) bilateral ECT (bifrontotemporal). Mean (SD) age of the unilateral ECT group was 19.9 (11.7) years and that of bilateral ECT group 24.6 (6.2) years.

ECT Procedure : ECT stimulus was administered using a brief pulse ECT machine (NIVIQURE) designed at NIMHANS, which delivered 800 mA brief pulses of alternating polarity each of 1.5 msec width at a rate of 125 pulses per second. The total stimulus dose (60-360 mC) was chosen by adjusting the duration of stimulus train. Mean (SD) stimulus dose used for unilateral ECT was 164 (25) mC of charge and that for bilateral ECT 144 (42) mC. Thiopentone (3mg/kg), suxamethonium (.5mg/kg) and atropine (1.2mg) were used intravenously for anesthesia. Mean (SD) thiopentone dose used for unilateral ECT was 110 (16) mg and that for bilateral ECT 110(13) mg. Patients received 100% positive pressure ventilation throughout the procedure until they had spontaneous regular respirations. The unilateral and bilateral ECT groups were not significantly different on the clinical parameters, viz., age, gender, diagnostic status, dose of thiopentone and dose of the stimulus.

EEG Acquisition : EEG was recorded on two channels (right and left) from, F_3 and F_4 sites referenced to right mastoid with a ground on the forehead. The electrode impedance was <10 Kohms. The signals were amplified (X1000), filtered using analog filters (1.6 Hz - High pass; 35 Hz - Low pass and 50 Hz - notch) and digitized at a rate of 256 Hz using

a 12 bit A-D converter. Square wave pulses of 0.1 mV were used for calibration.

EEG Analysis : The EEG data was fragmented into one-second epoch pairs (one from each channel). Each epoch was treated with Hamming window taper and subjected to Fast Fourier Transform. Spectral power of 1-4 Hz (delta) band was computed by squaring the FFT values (Enderle et al., 1986). The spectral power was expressed in dB units ($10*\log_{10}$). The early phase of the seizure was defined operationally as the first eight seconds after the stimulus offset, mid-seizure as 17-32 seconds after the stimulus offset and post seizure as the first eight seconds after seizure termination. A rater blind to the clinical details of the records (PKM), reviewed the EEG on the computer screen and identified the epoch pairs without artifacts between the stimulus offset and seizure termination. The computer program averaged the spectral power of all the artifact free epochs in each of the three seizure phases - early, mid and post seizure - for each channel separately. At least four artifact free epochs were required in each of these phases; since seizure records of all the patients included in this study met this criterion (4 seconds in each phase) none had to be discarded.

RESULTS

The mean (SD) duration of EEG seizure in the unilateral ECT group was 63 (18) seconds and that of bilateral ECT 62 (12) seconds. The difference was not significant (Student's 't' = 0.2, p = 0.8). Mean (SD) spectral power of the delta band of the two groups changed significantly through the three successive phases of the seizure in right (Rt) as well as left (Lt) channels (one way RMANOVA, $p < 0.005$ for all comparisons, Table), being highest in the mid-seizure phase and least in the post-seizure phase. Rt-Lt differences occurred only with unilateral ECT in the early and mid-seizure phases; unstimulated (Lt) side having significantly lower spectral power (paired 't' test, early-seizure: $t = 2.7$ and $p < 0.05$; mid-seizure : $t = 4.5$, $p < 0.005$). In contrast, there were no significant differences between the channels in any of the three seizure phases with bilateral ECT procedure.

Table : Mean (SD) spectral power (dB) of 1 - 4 Hz band

	UNILATERAL ECT (N = 14)		BILATERAL ECT (N = 11)	
	Right	Left	Right	Left
Early - Seizure	25.0 (4.3)	22.5 (4.9)	25.2 (3.7)	24.4 (3.3)
Mid - Seizure	27.1 (5.1)	25.7 (5.7)	27.3 (3.7)	27.1 (4.4)
Post - Seizure	10.4 (5.6)	08.7 (5.2)	12.7 (8.4)	12.5 (9.3)
RMANOVA; F & d f	20.4 & 2,13	19.0 & 2,13	66.9 & 2,10	57.1 & 2,10

Significant ($p < 0.005$) changes occured in the EEG spectral power in both channels (rt & lt) in unilateal as well as bilateral ECT conditions through the course of the seizure. Differences in spectral power of EEG seizure between the right and the left channels was significant in the unilateral ECT (Early & Mid-seizure) but not in bilateral ECT.

DISCUSSION

Unilateral and bilateral ECTs with comparable doses of electrical stimuli yielded seizures of comparable durations. Whereas bilateral ECT resulted in symmetrical seizure spectral power, unilateral ECT seizures had significantly lower spectral power on the unstimulated side, confirming the earlier report (Krystal et al., 1993). It has been suggested that the delta band of the EEG is relevant to the therapeutic properties of ECT (Staton et al., 1988). Therefore, in this study the seizure differences were measured on the delta band (1-4 Hz) of the EEG. The therapeutic differences observed between unilateral and bilateral ECTs and the findings of this study - asymmetrical delta power in unilateral ECT seizures - lend support to this suggestion. Prospective studies to elucidate the relevance of EEG delta band of the seizure to therapeutic potency of ECT are suggested.

ACKNOWLEDGEMENT

This project was funded (BNG) by the Karnataka State Council for Science and Technology, Bangalore.

REFERENCES

American Psychiatric Association. (1990) The practice of ECT: Recommendations for treatment, training and privileging. *Convulsive Therapy*, 6, 85-120.

Enderle, J.D.; Staton, R.D.; Gerst, J.W.; Barr, C.E. & Brumback, R.A. (1986) Electroencephalographic pattern during electroconvulsive therapy : III. Analysis of frontotemporal and nasopharyngeal spectral energy. *Clinical Electroencephalography*, 17, 66-77.

Krystal, A.D.; Weiner; R.D.; McCall, W.V.; Shelp, E.F., Arias, R. & Smith, P. (1993) The effects of ECT stimulus dose and electrode placement on the ictal electroencephalogram: An intraindividual crossover study. *Biological Psychiatry*, 34, 759-769.

Staton, R.D.; Enderle, J.D. and Gerst, J.W. (1988) The electroencephalographic pattern during electroconvulsive therapy: V. Observations on the origins of phase III delta energy and the mechanism of action of ECT. *Clinical Electroencephalography*, 19, 176-198.

D. NARAYANA DUTT[1], PhD, Associate Professor, P. K. MAHAPATRA[2], MD, Senior Resident, B. N. GANGADHAR[2], MD, Additional Profesor, P. K. SADASIVAN [1], PhD , Research Scholar N. JANAKIRAMAIAH[2], MD, PhD, Additional Professor, D. K. SUBBAKRISHNA[3], PhD, Associate Professor & K. M. JYOTI RAO[2], MD, Senior Resident.*

[1] Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, India.

[2] Departments of Psychiatry and [3] Biostatistics, National Institute of Mental Health and Neurosciences, Bangalore.

** Correspondence*