

## LIMITATIONS OF MOTOR SEIZURE MONITORING IN ECT

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### ABSTRACT

*Seizures were monitored using both cuff method and EEG, during the first ECT session in 158 consecutive patients. All developed adequate EEG seizures ( $\geq 25$  seconds). Twelve patients (8%) did not develop adequate motor seizures (15 seconds), of whom ten had no convulsive response. EEG seizure duration was less than 120 seconds in 117 patients (Group-A) and 120 or more seconds (prolonged) in the remaining 31 patients (Group-B). Adequate but not prolonged motor seizure (15-89 seconds) occurred in 111 patients in group A and 18 patients in group B. Motor seizure of 90 or more seconds (prolonged seizure) occurred in four patients in group A and 13 patients in group B. Based on the motor seizure criterion, 60% (18/31) of patients with prolonged EEG seizure were missed. The motor and EEG seizure durations correlated significantly in both groups. The correlation coefficient in group A was 0.78 ( $p < 0.01$ ), which was significantly larger (Fisher's 'Z' transformation test,  $t = 3.12$ ,  $p < 0.01$ ) than that in group B (0.37;  $p < 0.05$ ). Out of the total 158 patients, motor seizure monitoring alone did not correctly classify 21.4% of ECT seizure. This could have resulted in either unnecessary restimulation or failure to detect prolonged seizure. The findings suggest that in ECT motor seizure monitoring alone is unsatisfactory and therefore the need for EEG seizure monitoring.*

**Key Words :** *Electroconvulsive therapy, EEG monitoring, prolonged seizures*

Seizure is the essential ingredient of ECT procedure and its occurrence should be ascertained mandatorily by cuff-method, but EEG monitoring is strongly recommended (American Psychiatric Association, 1990). Fink & Johnson (1982) in their study found that motor seizure duration correlated highly with EEG seizure duration and recommended the cuff method for routine use. Without EEG monitoring, seizure duration is underestimated in 40 out of 70 sessions (60%). Seizure duration lasted longer than 25 seconds on EEG (adequate seizure) but considered as subconvulsion by the treating doctor who was monitoring only the clinical seizures. These ECT sessions therefore had the risk of unwarranted restimulation, which can be prevented by EEG monitoring (Scott et al., 1989). Liston et al. (1988) pooled their findings

with nine previous studies on the duration of motor and EEG seizures. The mean motor seizure duration (48 seconds) was lesser than mean EEG seizure duration (71 seconds). The mean motor seizure duration/mean EEG seizure duration (M/E) ratio was 0.68 (range, 0.46-0.90). The M/E ratio was lowest (0.46) in seizures lasting beyond 120 seconds and therefore, EEG monitoring is suggested to detect prolonged seizures (Greenberg, 1985).

Although the adequate seizure duration is defined as 20-30 seconds, in most patients seizure continues beyond 30 seconds but ends spontaneously. Royal College of Psychiatrists (1995) defines adequate motor seizures as 15 secs and adequate EEG seizures as 25 seconds duration. The APA Task Force (American Psychiatric Association, 1990) defines a

prolonged seizure if the duration exceeds 180 seconds, but seizure lasting longer than 120 seconds is defined as prolonged seizure by Royal College of Psychiatrists (1995). In a retrospective study of 1233 ECT seizures in 126 patients, Greenberg (1985) found that 4.3% of seizures lasted more than 120 seconds and 1.1% lasted more than 180 seconds. Monitoring motor seizure alone, it would not have been possible to detect prolonged seizure in 79.6% (43/54) of the seizures. In his study, prolonged seizures occurred in unilateral ECTs only. An occasional patient receiving ECT may not develop motor seizure but may have prolonged seizure (Van Haren & Fontaine, 1986). Albeit rare, seizure without motor convulsions can last very long resulting in nonconvulsive status (Jyoti Rao *et al.*, 1993). An undetected and untreated prolonged seizure carries risk for the patients; duration of seizure correlated modestly and significantly with retrograde and anterograde amnesia (Miller *et al.*, 1985). Failure to recognise a prolonged seizure in which spontaneous respiration may not be assured could lead to persistent brain dysfunction (Fink, 1993). Therefore, it is desirable that prolonged seizures are detected early and/or prevented.

The findings reviewed above suggest that motor seizure monitoring is a less satisfactory method for not only detecting an adequate seizure but also for monitoring reliably the duration of seizures. The present exercise was aimed at confirming the earlier reports and to compare limitations and merits of the two methods of seizure monitoring in ECT.

## MATERIAL AND METHOD

**Sample :** consisted of 158 consecutive patients referred for ECT following informed consent. All first ECTs were administered with stimulus titration to determine the threshold. Data refers to first ECT only. Sample characteristics are given in table 1.

**ECT technique :** Thiopentone (3 mg/kg), succinylcholine (0.75 mg/kg) and Atropine (0.6 mg) were used for modification. Patients were

ventilated with 100% oxygen throughout the procedure until resumption of spontaneous and regular breathing. All patients received bilateral, brief pulse, threshold ECT. Threshold was defined as stimulus at which a patient obtained atleast 25 seconds of EEG seizure. Stimulus was started at 60 millicoulombs (mC) and on subsequent steps increased by 60 mC in each step using NIMHANS-NIQR ECT machine which delivered constant current brief pulse stimulus. Stimulus was administered by standard bifronto temporal electrode placement (Fink, 1979). Seizure duration was monitored by cuff as well as EEG method. In cuff method, motor seizure was monitored by a clinician unaware of EEG seizure. EEG was recorded from frontal electrodes (F<sub>3</sub> and F<sub>4</sub>) referenced to ipsilateral mastoids. EEG output was displayed on the computer screen and the duration was monitored by another psychiatrist. Unequivocal absence of seizure transient for five or more seconds was taken as endpoint of seizure (Gangadhar *et al.*, 1995). Patients who had EEG seizures for more than 180 seconds received 10 mg diazepam intravenously to terminate the seizure.

## RESULTS

The demographic, drug treatment and ECT variables of the patients are given in table 1. All patients developed seizures of atleast 25 seconds duration on EEG. EEG seizure duration was less than 120 seconds in 117 patients (Group A) and 120 or more seconds (prolonged) in remaining 31 patients (Group B). Twelve patients had inadequate (<15 seconds) or no motor seizures. Motor seizure of 15-89 seconds occurred in 111 patients in group A and 18 patients in group B. Motor seizure of 90 or more seconds (prolonged seizure) occurred in four patients in group A and 13 patients in group B (table 2). Based on the motor seizure criterion ( $\geq 90$ secs) 60% (18/31) of patients with prolonged EEG seizure were missed. Ten patients did not develop any motor seizure (table 2) and these patients were excluded from further

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**TABLE 1**  
**PATIENTS, DRUG TREATMENT AND ECT VARIABLES**

VARIABLE	SAMPLE N=158	GROUP A N=117	GROUP B N=31	Significance Group A vs B
Age (years)	29.3 (10.5)	30.3 (10.7)	25.9 (8.2)	t=2.12, p<0.05
Male : Female*	85 : 73	63 : 54	15 : 16	NS
Affective : Non affective*	87 : 71	66 : 51	17 : 14	NS
Antipsychotics* <sup>Ⓢ</sup>	108	80	21	NS
Antidepressants* <sup>Ⓢ</sup>	48	41	4	p<0.05
Benzodiazepines* <sup>Ⓢ</sup>	57	38	14	NS
No drugs*	13	7	6	p<0.05
Stimulus (mC)	97.9 (39.2)	100.4 (38.9)	96.1 (41.4)	t=0.53, NS
Motor seizure (sec)	53.5 (34.9)	47.0 (19.6)	95.1 (44.3)	t=5.89, p<0.05
EEG seizure (sec)	83.0 (52.8)	60.6 (24.1)	167.3 (45.9)	t=12.48, p<0.05
M/E ratio	0.75 (0.22)	0.80 (0.20)	0.58 (0.24)	t=4.60, p<0.05

<sup>Ⓢ</sup> Patient's could be on more than one psychotropic drug.

\*Number of patients; Chi-square test was used to test the properties of distribution of these variables across two groups. Values in other cells refer to mean (SD); independent samples 't' test was used to compare the two groups on these variables.

analysis. The group A had significantly larger M/E ratio (table 1).

Motor seizure duration correlated significantly with that of EEG seizure duration in Group A (Pearson's  $r=0.78$ ,  $p<0.01$ ) as well as in Group B (Pearson's  $r=0.37$ ,  $p<0.05$ ). However, the correlation coefficient of group B was significantly lower than that of group A (Fisher's 'Z' transformation test,  $t=3.12$ ,  $p<0.01$ ). In patients having motor seizure ( $n=148$ ), a linear regression equation was developed to predict EEG seizure duration. Motor seizure duration accounted for 55% of variance in EEG seizure duration (Beta = 0.75,  $t=13.5$ ,  $p<0.0001$ ). The equation is as follows- EEG seizure (secs) = (Motor seizure (secs)  $\times 1.2$ ) + 14.9.

Applying this equation an EEG seizure duration of 120 seconds is predicted by a motor seizure of 88 seconds. Hence motor

seizure of 90 seconds or longer was operationally defined as prolonged.

There were other significant differences between the two groups. Group B had lower

**TABLE 2**  
**COMPARISON OF MOTOR AND EEG SEIZURE MONITORING**

EEG seizure Motor seizure	25-119 sec Adequate n %	$\geq 120$ sec Prolonged n %	Total
<15 sec inadequate	11 (6.9)	1 (0.6)	12
< 90 sec adequate	111 (70.3)	18 (11.4)	129
$\geq 90$ sec prolonged	4 (2.6)	13 (8.2)	17
Total	126	32	158

Percentage in parenthesis. Bold values indicate the misclassification.

mean age with only one patient being older than 40 years. Smaller proportion of patients in group B were either drug free or were not on tricyclic antidepressants as compared to group A. There was no significant difference between the two groups on stimulus dose.

## DISCUSSION

Twelve patients (8%) failed to obtain adequate motor seizure on the cuffed forearm although their EEG seizures were adequate (25 secs). These patients carried the potential risk of restimulation with higher stimulus. The finding is in conformity with that reported by Scott *et al.* (1989). Mean M/E ratio in our study (0.75) is similar to that reported by several earlier studies (Liston *et al.*, 1988). In our sample the mean motor and EEG seizures are slightly longer than in other studies (Fink & Johnson, 1982; Larson *et al.*, 1984; Miller *et al.*, 1985). The group B was younger and this is in keeping with the fact that younger subjects have lower seizure threshold (Sackeim *et al.*, 1987). The association between drugs and antidepressant-free status with prolonged seizures cannot however be explained.

The proportion (20.3%) of our patients having seizures of > 120 seconds is higher than in Greenberg's (1985) study. The mean age of our sample is lower than in that study and also we have limited our data to first ECT only; Greenberg has taken data pooled from all ECT sessions. The EEG seizure reached 180 seconds in twelve patients necessitating termination using diazepam. However, in these patients seizures lasted till 190-270 seconds. The results of our study indicates that once the seizure duration crosses 120 seconds the risk of further prolongation (> 180 seconds) increases by almost two folds. Therefore, we support earlier authors (Greenberg, 1985; Murugesan, 1994) that seizures crossing 120 seconds should be terminated to prevent potential complications such as cognitive dysfunction. The fall in the correlation between motor and EEG seizures when the latter exceeds 120 seconds

indicates that the motor seizure duration is unreliable for estimating EEG seizure duration.

Using linear regression equation from our data, motor seizure duration of 90 seconds predicts EEG seizure of just over 120 seconds. However, the results from our study (table 2), cautions against this simplistic approach of replacing EEG monitoring by motor monitoring. Motor seizure of 90 seconds failed to predict prolonged EEG seizures (120 secs or more) in 60% (18/31) of occasions (table 2).

Motor seizure correlated well with EEG seizure in our study in keeping with the available literature. However, this correlation by itself cannot be considered as indicative of the reliability of motor seizure monitoring. Out of the total 158 patients, motor seizure monitoring alone does not correctly classify 21.4% of ECT seizures. All missed/inadequate motor seizures had adequate EEG seizures and 60% of prolonged EEG seizures were missed by motor monitoring. This can result in either unnecessary restimulation or failure to detect and terminate prolonged seizure. The findings suggest that in ECT motor seizure monitoring alone is unsatisfactory and therefore the need for EEG seizure monitoring.

In summary, a) motor seizure monitoring alone can miss about 8% of adequate EEG seizures, b) motor seizure duration is a poor predictor of prolonged (120 secs) EEG seizures, and, c) EEG monitoring should be preferred over cuff-method.

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