MERITS OF EEG MONITORING DURING ECT: A PROSPECTIVE STUDY ON 485 PATIENTS

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ABSTRACT

Eliciting cerebral seizure during electroconvulsive therapy (ECT) is essential for therapeutic purposes. When it exceeds beyond 120 seconds (Freeman, 1995) i.e., prolonged, it adds to adverse effects of ECT. Estimating seizure duration using 'cuff method' alone has limitations. This study examined the merits of electroencephalographic (EEG) monitoring in routine ECT practice on a large representative sample. Modified ECT, either unilateral or bilateral electrode placement, was administered to 485 patients under EEG monitoring at first ECT session. Ninety one (18.8%) patients had prolonged seizures of which only 59 would have been detected if 'cuff method' alone was used. Twenty nine (6%) patients had inadequate motor seizures but had adequate EEG seizure duration. Twenty five (5.2%) of them had no motor seizure and two such patients even had prolonged seizures. The prolonged seizure was unpredictable in majority. In conclusion, EEG monitoring during ECT is essential to detect both adequacy of cerebral seizure in patients having no or inadequate motor seizures and also to detect prolonged seizures.

Key words: EEG monitoring, electroconvulsive therapy, prolonged seizure

Obtaining seizure during electroconvulsive therapy (ECT) is essential for therapeutic purpose (Ottosson, 1960). Electroencephalographic (EEG) monitoring detects cerebral seizure. The EEG seizure duration is nearly 30 percent longer than motor seizure duration (Greenberg, 1985; Abram, 1997). Hence, it is possible that though the motor seizure ends the cerebral seizure may continue. The motor-EEG ratio decreases by four folds when the seizure duration is prolonged (EEG ≥ 120 sec) (Jayaprakash et al., 1997). With only motor monitoring, clinician is likely to miss a set of patients who develop prolonged EEG seizure. About 5-20% of patients on ECT developed prolonged seizures (Greenberg, 1985; Mayur et al., 1999). More importantly, occurrence of prolonged seizure is mostly unpredictable. It is also possible that some patients had no motor seizures but had adequate EEG seizure duration. In such circumstances, patient is likely to receive repeated stimulus at higher dose. Both of these contribute to the adverse effects of ECT (Miller et al., 1985). Though the Royal college of Psychiatrists (Freeman, 1995) and the American Psychiatric Association (2001) guidelines on ECT encourage EEG monitoring, it is not considered mandatory. This study examined the merits of EEG monitoring in routine ECT practice at first ECT session. Though uncontrolled, the data was from a large and representative sample.

MATERIAL AND METHODS

Consecutive patients prescribed ECT by the treating psychiatrist at National Institute of Mental Health and Neurosciences, Bangalore, were
considered for the study (n=485). The mean±SD age of the sample was 29.9±7 years (range 20-46). Patients on clozapine, xanthine alkaloids and anticonvulsants other than benzodiazepines were excluded from the study. None of these patients had received ECT in the last six months or suffered from any neurological illness. Informed consent was obtained. All patients were right handed. Clinical details are listed in Table-1

| Variables | Adequate seizure group (n=394) | Prolonged seizure group (n=91) |
|-----------|--------------------------------|-------------------------------|
| Age (mean±SD) (in years) | 31.6±11.2 | 26.9±8.2 |
| Gender | | |
| Male | 204 | 57 |
| Female | 190 | 34 |
| Diagnosis | | |
| Depression | 221 | 41 |
| Psychosis | 146 | 37 |
| Mania | 27 | 13 |
| Antidepressant* | | |
| Absent | 235 | 69 |
| Present | 159 | 22 |
| Antipsychotic* | | |
| Absent | 151 | 32 |
| Present | 243 | 59 |
| Benzodiazepine* | | |
| Absent | 310 | 76 |
| Present | 84 | 15 |
| Lithium* | | |
| Absent | 365 | 78 |
| Present | 29 | 13 |

* Cell contents refer to number of patients.
* Patient may receive more than one psychotropic drug

ECT was administered under modification using thiopentone (3mg/kg), atropine (0.6mg) and succinylcholine (0.75mg). 100% positive pressure ventilation was maintained through out the ECT procedure. The ECT stimulus was administered using NIMHANS-NIQR (National Institute of Quality and Reliability) machine. The machine delivered bidirectional, brief pulse, constant current stimulus of 800mA, 1.5msec and 125 pulses per second. The stimulus dose (mC) was selected by varying the stimulus train duration (0.2 to 3.6 seconds). The referring psychiatrist chose the stimulus laterality. In case of bilateral electrode placement, the stimulus electrodes were applied one-inch above the mid point of the imaginary line joining the outer canthus of the eye and the tragus on either side (bifrontotemporal). In case of unilateral electrode placement, one electrode was placed as in bilateral electrode placement and the other half-an-inch lateral to the vertex on the non-dominant hemisphere (d' Elia).

Threshold was assessed at the first ECT session using titration method. The starting stimulus dose was 30 mC. The first two increments, if required, were in terms of 15mC followed subsequently by 30 mC i.e., 30, 45, 60, 90 and 120 up to a maximum of 540mC. When the patient failed to obtain a seizure or had subshock, he was restimulated at next higher dose after ventilation for at least 20 seconds or one minute respectively. The adequate seizure was defined as ≥25 seconds of EEG (Freeman, 1995). The motor seizure duration was measured using the "cuff method" (Addresley and Hamilton, 1953). The cuff was tied to the right calf or arm. The time interval from the stimulus to the end of tonic-clonic movement is the motor seizure duration. The hand electrode switch was held pressed till the end of motor convulsions. The timer incorporated in the ECT device recorded the time in seconds, which was displayed in the front panel of ECT machine.

The EEG was monitored using four channels. The EEG leads were placed on the frontals and temporals referenced to ipsilateral mastoids on either side. The central lead was placed on the middle of the forehead. The data acquired was replayed to confirm the end of EEG seizure duration. The beginning of unequivocal absence of epileptiform transients for five or more seconds on both channels was taken as the end of EEG seizure (Gangadhar et al., 1995).
All patients had adequate seizure durations. The mean±SD of motor and EEG seizure durations were 59.1±35.7 and 81.9±46.2 seconds respectively. 'Prolonged seizure' was defined as EEG seizure duration of 120 seconds or longer (Freeman, 1995). Motor seizure was defined 'inadequate' if it was shorter than 15 seconds and 'prolonged' when it was 90 seconds or longer (Freeman 1995); the rest were considered adequate. Patients with prolonged seizures were noted. Prolonged EEG seizure duration was aborted using intravenous diazepam (5-10mg) or thiopentone (50-100mg). The number of patients who had an inadequate or no motor seizure but had an adequate EEG seizure, and the number of patients who had an adequate motor seizure but who developed prolonged EEG seizure were noted.

The sample was divided on the basis of EEG seizure duration into two groups; one with adequate (<120 seconds) and the other with prolonged EEG seizure durations (≥120 seconds). Independent sample t-test was administered to compare both the groups. Discrete variables were compared using cross-tabs and X². Person's product moment correlation analysis was used to relate motor and EEG seizure durations. Z statistic was used to compare the correlation coefficients in the adequate and prolonged EEG seizure groups. Statistical significance was fixed at p<0.05.

**RESULTS**

All patients had adequate (n=394) or prolonged (n=91) EEG seizures. Motor seizure was inadequate in 29 patients and two of these even had prolonged EEG seizures. Motor seizures were longer than 89 seconds in 15 patients who had EEG seizure shorter than 120 seconds. In thirty patients the EEG seizure was prolonged but the motor seizure was shorter than 90 seconds. In 59 patients the motor seizure were longer than 89 seconds and EEG was also prolonged. Prolonged EEG seizure group was significantly younger and had lower seizure threshold. More patients with mania and those on lithium had prolonged seizure. Gender, stimulus laterality and benzodiazepines were comparable between the two groups (Table 1 & 2). Motor and EEG seizures were highly correlated in the group that had adequate EEG seizure. The correlation was much smaller in the group with prolonged EEG seizure. The difference in the correlations was significant (Table 2).

**DISCUSSION**

This study examined the relative merits of EEG and motor seizure monitoring in ECT. Based on their durations the adequacy and prolonged seizures have been defined. With EEG monitoring we ensured at least adequate seizures in all at first ECT session. In 29 (5%) patients the motor seizure was less than 15 seconds who would have received a restimulation if EEG monitoring was not available. In 91 (18.8%) the EEG seizure was prolonged. Royal College of Psychiatrists (Freeman, 1995) recommended that if motor seizure reaches 90 seconds, it should be aborted. In 32 patients who had prolonged EEG seizure the motor seizure either did not manifest (n=2) or was lesser than 90 seconds (n=30). The clinician
would not have taken precautionary action (aborting prolonged seizure).

Prolonged seizure is one of the common complications of ECT (Weiner et al., 1991). Some patients even developed tardive seizures/non convulsive status epilepticus (Rao et al., 1993; Grogan et al., 1995). The acute confusional state (delirium) and agitation may be prolonged, memory impaired is worse and patient may have untoward systemic side effects such as headache, vomiting and myalgia with prolonged seizures. Hence, during ECT procedures, one has to detect and abort prolonged seizures. On the other hand, repeated stimulus when not warranted can also produce similar side effects, especially in patients who had adequate seizures. To avoid such adverse effects, EEG monitoring is essential.

This is the largest study examining the EEG seizure durations at first ECT session. Though uncontrolled, patients were from a representative sample prescribed ECT. 18.8% had prolonged seizures similar to the findings of Jayaprakash et al. (1997) and Mayur et al. (1999). The risk differs from the western studies (Greenberg, 1985; Liston, 1988). Higher age of their sample could explain this variation.

Predicting prolonged EEG with ECT in individual patient is currently under research. Our study showed that patients with younger age were at risk of prolonged seizures. This replicates earlier finding (Weiner et al., 1991). Seizure threshold was lower in the prolonged EEG group. This is in concordance with the fact that seizure duration is shorter with higher stimulus dose (Krystal et al., 1993). Other factors such as gender and laterality were comparable in both the groups in contrast to other (Weiner et al., 1991). This suggests that predicting prolonged seizure is difficult.

Lithium increased the risk of prolonged seizures (Milstein and small, 1988). Nearly half (45%) of the patients on lithium had prolonged seizure although this effect was at trend level of significance. Hence lithium should be stopped before starting ECT. This was recommended both by Royal College of Psychiatrists (Freeman, 1995) and the American Psychiatric Association (2001) guidelines on ECT. In case one has to prescribe ECT along with lithium, EEG monitoring is essential. Manic patients also had higher propensity for developing prolonged seizures. This may be confounded because of co-administration of lithium in these patients. 55% (22/40) of them were on lithium. Antidepressant had a protective effect against prolonged seizures, which is difficult to explain. At the doses used, antidepressants (tricyclic in particular) may have quinidine like effects. Neither the antipsychotic nor benzodiazepine had effects on prolonged seizure group.

The motor seizure duration measured by cuff method and EEG seizure duration had high correlation (Fink et al., 1982). The linear relation perhaps holds good for those with adequate seizures. The correlation drops significantly in those patients with prolonged EEG seizure (Table 2). The recent ECT guideline by the American Psychiatric Association (2001) defines prolonged seizure as 180 seconds or more of EEG seizure duration. Looking at our data, when the EEG seizure duration is 180 seconds or more, the correlation between motor and EEG seizure durations become even poorer (n=26; r=0.251; p=0.2). It hence suggests that motor seizure monitoring alone is undependable.

One of the limiting factors in this study was lack of control over co-administrated psychotropic drugs and stimulus laterality. This was because the treating psychiatrist was fully incharge of the patients clinical condition. EEG was monitored only at first ECT session for practical reasons. It is not sure whether the incidence of prolonged seizure remained the same at later ECT sessions.

It is arguable that EEG monitoring involves expensive instrumentation, time consuming and needs additional training. EEG devices attached to ECT machine are indigenously available at affordable costs. In busy centers with high case load EEG monitoring may be offered at first ECT to all and for those who manifest complications. Rest of the patients may be given ECT with motor
seizure monitoring using cuff method. Professional bodies should encourage CME and workshops on this subject for additional training.

In conclusion, motor seizure monitoring alone results in poor clinical decision. Without EEG monitoring there would have been a theoretical risk of restimulation in 29 patients, unwarranted anticonvulsant injection in 15, and in 32 patients the EEG seizure would have remained prolonged without intervention. Though younger age and patients on lithium had higher risk of prolonged seizures, by and large it is unpredictable. Hence the professional bodies should encourage EEG monitoring and optimize its use in routine clinical use in ECT practice.

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