Original Article

Incidence and risk factors for oxygen desaturation during recovery from modified electroconvulsive therapy: A prospective observational study

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Abstract

Background and Aims: Electroconvulsive therapy (ECT) is an established modality of treatment for severe psychiatric illnesses. Among the various complications associated with ECT, oxygen desaturation is often under reported. None of the previous studies has evaluated the predictive factors for oxygen desaturation during ECT. The objective of this study was to evaluate the incidence of oxygen desaturation during recovery from anesthesia for modified ECT and evaluate its risk factors in a large sample.

Materials and Methods: All patients aged above 15 years who were prescribed a modified ECT for their psychiatric illness over 1 year were prospectively included in this observational study. The association between age, body mass index (BMI), doses of thiopentone and suxamethonium, stimulus current, ECT session number, pre- and post-ECT heart rate and mean arterial pressure, seizure duration, and pre- and post ECT oxygen saturation, was systematically studied.

Results: The incidence of oxygen desaturation was 29% (93/316 patients). Seizure duration and BMI were found to be significantly correlated with post ECT desaturation.

Conclusion: In this prospective observational study, the incidence of oxygen desaturation during recovery from anesthesia for ECT was high. The study identified obesity and duration of seizure as the independent predictors of this complication. This knowledge is likely to help in identifying and optimizing such patients before subsequent ECT sessions.

Key words: Electroconvulsive therapy, oxygen desaturation, recovery from anesthesia, risk factors

Introduction

Electroconvulsive therapy (ECT) is an established modality of treatment for severe psychiatric illnesses such as depression, drug-resistant bipolar disorder, and schizophrenia. Among the various complications associated with ECT, oxygen desaturation (defined as a SpO_2 <90%) is often under reported.[1] The incidence of oxygen desaturation in smaller studies has ranged from 2.5% to 27.5% depending on the inspired oxygen concentration, preoxygenation and ventilation during the seizure.[1-4] None of these studies has evaluated the predictive factors of oxygen desaturation during ECT. The objective of this study was to establish the incidence of oxygen desaturation during recovery from anesthesia for modified ECT and evaluate its risk factors in a large sample.

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Materials and Methods

The study was approved by the institutional ethics committee and a written informed consent was obtained from the next of kin of the patient. All patients aged above 15 years who were prescribed a modified ECT (with short acting anesthetic and muscle relaxant) for their psychiatric illness were prospectively included in this observational study. Patients with a history of recent myocardial infarction, pregnancy, intracranial hemorrhage and patients with a baseline oxygen saturation (SpO_2) <92% on pulse oximetry were excluded from the study. The clinical and demographic details such as diagnosis, duration of illness, body mass index (BMI), and pharmacotherapy and laboratory investigations were collected for each patient.

Electroconvulsive therapy protocol and anesthetic management: Patients undergoing ECT fasted for solids for 6-8 h and 2 h for clear fluids. They were evaluated prior to the ECT by the attending anesthesiologist and the psychiatrist. A standard monitoring consisting of an electrocardiogram, noninvasive blood pressure (BP) and pulse oximetry (SpO_2) was established in all patients. The anesthetic regimen consisted of administration of atropine 0.6 mg, thiopentone 3 mg/kg and suxamethonium 0.5 mg/kg for rapid muscle relaxation. During apnea, oxygenation was maintained by administering 8 L/min of O_2 through a face mask using manual bag-mask ventilation until spontaneous respiration returned except during stimulus application. Passive oxygenation with 8 L/min of O_2 through a face mask was continued during the seizures. The ECT stimulus was delivered once the muscle fasciculations disappeared using a NIVIQURE® (Technonivilak, Bangalore, India) ECT machine. A brief-pulse stimulus was delivered using a constant current at 800 mA, with a frequency of 125 pulses/s (62.5 Hz) and a pulse width of 1.5 ms; the duration of the train was altered to adjust the dose. The stimulus charge varied from 30 mC to a maximum of 540 mC and was delivered with either bifrontal or bitemporal electrode placement. The need for a repeat-stimulus was decided by the attending psychiatrist depending on the adequacy of seizure quality and duration. The duration of motor seizure was documented. SpO_2 value was recorded continuously throughout the procedure. Once the patient regained spontaneous respiration and consciousness, he was positioned in the recovery position and an oral suction performed. Later, he was shifted to the recovery room for further monitoring and observation.

In order to avoid any potential source of bias in data collection, the data were recorded by an independent unbiased nursing staff. Furthermore, to exclude the influence of multiple ECT sessions on oxygen saturation in the same patient, only the first session for each patient during the study period was included. The other data that was collected are pre ECT (before administration of anesthesia for ECT) and post-ECT (immediately following termination of ECT-induced seizure) heart rate, BP and oxygen saturation characteristics (SpO_2, time taken for SpO_2 to return to 95%, the lowest SpO_2 value). ECT details (charge delivered, electrode placement [bifrontal/bitemporal], seizure duration, repeat stimulation), and anesthetic variables (doses of thiopentone, suxamethonium and atropine and anesthetic complications) were also collected. The primary outcome measure of the study was oxygen desaturation (defined as SpO_2 <90%) following ECT. Secondary outcome variables were hemodynamic changes during ECT.

Statistical analysis

Univariate analysis was carried out to study the association between individual risk factors versus post-ECT SpO_2 and time for SpO_2 to recover to at least 95% using a Pearson's correlation test for continuous variables and a Chi-square test for categorical variables. The parameters were then entered into logistic and linear regression models, to identify the independent predictive factors for post ECT oxygen desaturation. $P < 0.05$ was considered to be statistically significant.

Results

The demographic data are shown in Table 1. Figure 1 shows the changes in the heart rate, mean arterial pressure, and saturation before and after ECT [Figure 1]. The overall incidence of desaturation was 29% (93/316 patients). Close to 50% (45/93) of the patients who had desaturation, had SpO_2 in the range of 80-89%. The mean duration for return of saturation to >95% was 12 s. The incidence of desaturation was 64% (14/22) in obese patients (BMI >30) and 27% (79/294) in nonobese patients (relative risk = 2.4 [95% confidence interval = 1.6-3.4] $P < 0.001$). Similarly incidence of desaturation was 37% (36/97) in patients with prolonged seizure duration (>45 s) as compared to 26%

Table 1: Demographic parameters in all patients

Parameter	Mean ± SD
Gender (male:female) (*n*)	170:146
Age (year)	32±11
BMI (kg/m^2)	23±5
Dose of thiopentone (mg)	173±34
Dose of succinylcholine (mg)	29±9
Current (mC)	202±95
Seizure duration (s)	39±16
Time for SpO_2 to return to 95% (s)	12±22

SD = Standard deviation, BMI = Body mass index, SpO_2 = Oxygen saturation

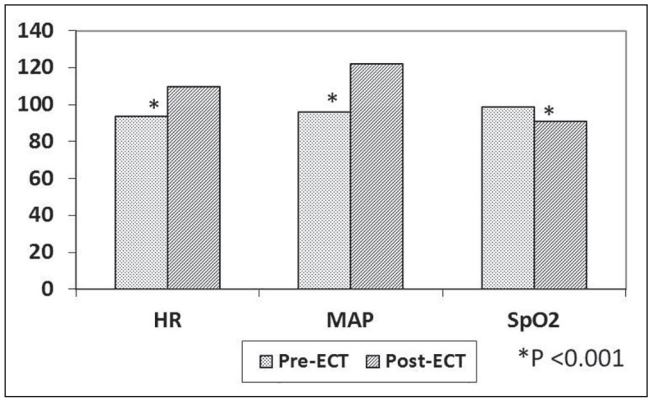

Figure 1: Changes in the heart rate, mean arterial pressure and saturation after electroconvulsive therapy when compared to baseline

(57/219) in patients with shorter seizure duration (<45 s) [Figure 2]. The longest time for SpO_2 to return to 95% was 150 s in an obese patient with a BMI of 32. Correlations between the study variables and outcome measures are shown in Table 2.

The association of the study variables with post-ECT desaturation was also analyzed by nonparametric tests (Chi-square test) using a predefined cut-off value for each variable [Table 3]. In these analyses, age, BMI, dose of thiopentone and suxamethonium and seizure duration correlated with post-ECT desaturation. On multivariate analysis (by bivariate logistic regression and linear regression analysis), only BMI and seizure duration were found to be significantly correlated with post-ECT desaturation [Tables 4 and 5].

Discussion

Despite advances in the anesthetic techniques, hypoxic complications during anesthesia for ECT are not uncommon.[1-4] In this study, the incidence of oxygen desaturation during modified ECT was significantly high (29%) though the mean duration of desaturation was short (12 ± 22 s). The most important independent risk factors for such desaturation were BMI and seizure duration.

Episodes of oxygen desaturation constitute a potential threat to the safety of the patient undergoing ECT procedure. Occurrence of oxygen desaturation during perianesthetic

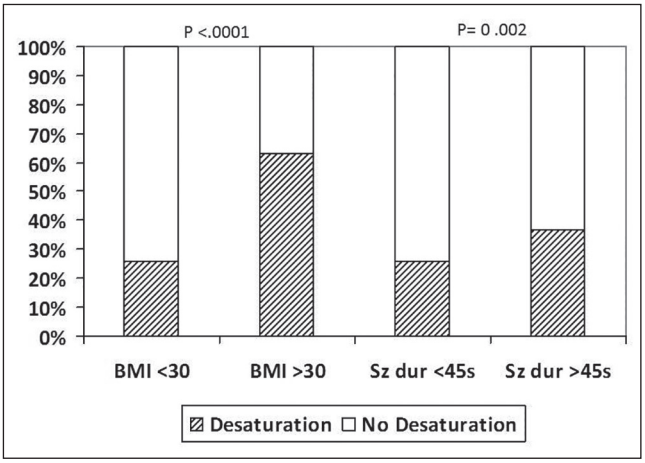

Figure 2: Significant variables associated with desaturation

Table 2: Pearson's correlations between study variables and outcome measures (parametric analysis) in 316 patients for 1st session

Variable	Post-ECT SpO_2		Time taken for recovery of SpO_2 to 95%	
	Correlation	*P* value	Correlation	*P* value
BMI	−0.41	<0.001	0.46	<0.001
Age	−0.17	0.003	0.16	0.004
Seizure duration	−0.09	0.12	0.08	0.14
Thiopentone dose	−0.29	<0.001	0.26	<0.001
Suxamethonium dose	−0.29	<0.001	0.28	<0.001
Current stimulus	−0.08	0.16	0.07	0.25
ECT no	−0.04	0.48	0.002	0.9

BMI = Body mass index, ECT = Electroconvulsive therapy, SpO_2 = Oxygen saturation

Table 3: Significant variables associated with desaturation on univariate analysis in 316 patients for 1st session (nonparametric analysis)

Parameters	Desaturation (*n*)	No desaturation (*n*)	χ^2	*P*	Odds ratio	95% CI	Relative risk
Age (year)							
<45	77	203	4.4	0.04	0.47	0.23-0.96	1.6
>45	16	20					
BMI							
<30	79	215	13.3	<0.001	0.21	0.98-0.52	2.4
>30	14	8					
Thiopentone dose (mg)							
<200	79	210	7.2	0.008	0.35	0.16-0.78	1.9
>200	14	13					
Suxamethonium dose (mg)							
<30	62	183	8.9	0.003	0.44	0.25-0.76	1.7
>30	31	40					
Stimulus current (mC)							
<240	76	193	1.2	0.27	0.69	0.36-1.3	1.3
>240	17	30					
Seizure duration (s)							
<45	57	162	3.9	0.046	0.60	0.36-0.99	1.4
>45	36	61					

BMI = Body mass index

Table 4: Linear regression analysis in 316 patients for post-ECT SpO_2

Parameters	*B*	SE	Beta	*t* value	Significance
BMI	−1.079	0.197	−0.358	−5.468	<0.0001
Seizure duration	−0.179	0.056	−0.177	−3.178	0.002

BMI = Body mass index, ECT = Electroconvulsive therapy, SpO_2 = Oxygen saturation

Table 5: Logistic regression analysis in 316 patients for post-ECT SpO_2

Parameters	*B*	SE	Wald	df	Significance
Seizure duration	−0.692	0.282	6.015	1	0.014
BMI	−1.187	0.513	5.356	1	0.021

BMI = Body mass index, ECT = Electroconvulsive therapy, SpO_2 = Oxygen saturation

period may lead to prolonged stay in the postanesthesia care unit with substantial utilization of manpower and material resources. The cumulative impact of multiple episodes of desaturation on cerebral function, especially in the elderly patients, has not been explored. Evidence from similar areas of the study suggests that repeated episodes of oxygen desaturation are associated with impairment of attention and executive function.[5] It would be interesting to explore if cognitive changes associated with ECT have an association with the degree of desaturation. Furthermore, any damage occurring during ECT from these episodes of desaturation may not be apparent until late, when it is likely to be attributed to other causes. Oxygen desaturation together with ECT-induced autonomic changes may increase the myocardial oxygen demand and compromise the normal cardiac function. Quantification of the incidence of hypoxia and identifying the patients at risk and the factors contributing to desaturation will help to improve the safety of patient care.

The guidelines for ECT published several years ago advocate preoxygenation and ventilation during apnea after suxamethonium until the administration of the ECT.[6,7] Lew *et al.* have demonstrated a significant reduction in the incidence of desaturation by ventilating the lungs during seizure period in a small number of patients.[1] Räsänen *et al.* showed that merely increasing the inspired oxygen concentration (FiO_2) from 30% to 100% did not significantly decrease the incidence of desaturation.[4] On the contrary, high FiO_2 prolonged the seizure duration, which was an independent risk factor for desaturation in our study. The number of positive breaths administered during suxamethonium apnea seems to be an important factor that affects oxygenation. Swindells and Simpson observed that desaturation was inversely related to the number of positive pressure ventilations performed after administration of suxamethonium and prior to administration of ECT stimulus.[3] Thus, it appears that adequate positive pressure ventilation during apnea and not merely increasing the FiO_2 is the key to prevent desaturation. As regards optimal PCO_2, one study demonstrated that hyperventilation lead to prolongation of the seizure.[8] Both the above facts taken together, an appropriate ventilatory strategy during ECT seems to be one that employs modest increase in FiO_2 and maintenance of normocapnia.

As in our study, Lew *et al.* had also observed a 27.5% incidence of desaturation during 40 ECT sessions.[1] A similar incidence in a larger population in our study (316 patients) reaffirms the need to recognize the magnitude of this problem and improve the strategies to minimize it. In this context, the effect of independent predictors namely, BMI and seizure duration on oxygen desaturation needs to be examined in future studies. An important approach to minimize desaturation during ECT could be to promote weight reduction in patients prescribed maintenance ECT sessions.[9] Consideration may also have to be given to prescription of antipsychotic medications that tend to cause weight gain. In our study, we observed that as the seizure duration increased, especially more than 45 s, there was a significant increase in the incidence of post-ECT desaturation. It is therefore, advisable to limit the seizure to the minimum duration compatible with good clinical recovery. Earlier reports indicate that the efficacy of ECT is dependent on administration of 5-12 adequately generalized tonic-clonic seizures of at least 20 s duration.[10,11]

Limitations

We did not monitor end-tidal carbon-dioxide ($ETCO_2$) pressure during ECT as it was not a standard of care in our country at this time. Secondly, our patients were not preoxygenated before administering anesthesia for ECT. The incidence of post-ECT desaturation could have been decreased with preoxygenation. The Royal College of Psychiatrists recommends preoxygenation only if necessary, leaving open the choice of routine preoxygenation for ECT, as is done in elective anesthesia practice.[12] Future studies need to examine whether preoxygenation reduces the incidence of desaturation during ECT, at least in obese patients and to recommend it as a standard of care during ECT. Thirdly, we provided only passive oxygenation and not positive pressure during the seizure period as it was done in a previous study that reported a 17% incidence of desaturation.[2] Gastric hypomotility can occur from psychiatric illnesses like depression or schizophrenia and also from antipsychotic agents prescribed to treat these conditions.[13-15] Combined with ECT-induced convulsions, this may predispose the patients to pulmonary aspiration.[16,17] Traditional recommendation during anesthesia for patients at risk of aspiration includes rapid sequence induction without positive pressure ventilation.[18] Apart from the fear of aspiration, ventilation is not always effective during seizure. Endotracheal intubation could be an alternative to protect at-risk patients against this risk.

Conclusion

In this prospective observational study, the incidence of oxygen desaturation during recovery from anesthesia for ECT is 29%. The study identified obesity and duration of seizure as independent predictors of this complication. This knowledge is likely to help in identifying and optimizing such patients during ECT sessions. Future studies should evaluate if measures like preoxygenation and intubation in selected patients at risk, will decrease the incidence of desaturation during ECT without additional complications.

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