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Effect of Hyperventilation on Seizure Length During Electroconvulsive Therapy

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Introduction

Hyperventilation reportedly prolongs the seizures during electroconvulsive therapy (ECT) (Bridenbaugh et al. 1972; Holmberg 1953; Holmberg et al. 1956; Weiner 1979; Chater and Simpson 1988). As these studies did not measure the pCO_2 concentration it is unclear if prolongation of seizures was due to hyperoxygenation or hypocapnia. In a controlled study Bergsholm et al. (1984) demonstrated an increase in seizure length by hypocapnia but not by hyperoxygenation. The effect of different levels of hyperventilation-induced hypocapnia as measured by end-tidal pCO_2 on seizure duration in ECT was evaluated in the present study to establish its practical utility in a clinical setting.

Methods

At the University of Michigan Hospital, fifteen depressed psychiatric inpatients who were free of psychotropic drugs were selected for ECT at the University of Michigan Hospital were studied. None had had ECT in the preceding 6 months. Patients were assigned randomly to 1 of 3 groups based upon the end-tidal pCO_2 (30, 25, or 20 mmHg) achieved prior to their ECT. Right unilateral ECT was performed with a pulse wave MECTA SR-2 machine using fixed energy setting (approximately 90 J) for each patient. Difficulty in reducing the pCO_2 level below 25 mm with bag and mask ventilation alone necessitated endotracheal intubation in the lowest pCO_2 group. One minute of rapid ventilation with pure oxygen was allowed from the induction of the anesthesia to achieve the designated pCO_2 level that was maintained for 1 min before electrical stimulation. Ventilation was interrupted to administer the ECT and was resumed immediately afterward but with no attempt to maintain a low pCO_2. Throughout the entire procedure, from induction of anesthesia to return of spontaneous respiration, oxygen saturation was monitored by pulse oximetry and maintained at 100%. Seizure length was monitored by the "cuff" method. Data were collected over the first 5 treatments for all patients.

Because the ventilatory procedure and the need for intubation in some patients were expected to require additional time, slightly higher than normal doses of anesthetic medications were used. Methohexital 1.5 mg/kg and succinylcholine 1.5 mg/kg were used for all patients to keep the drug effect constant in the three groups.

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Results

The subjects in the 3 groups were not significantly different for age (57.3 ± 14.2, 62.4 ± 15.9, 63.4 ± 15.5 years for the 30 mm, 25 mm, and 20 mm pCO_2 groups respectively), although the gender distribution was uneven (Table 1). Comparison of seizure length showed that the lowest pCO_2 group had the longest first seizure among the 3 groups. Within the series of 5 treatments in each group the first seizure was the longest as well. Seizure length declined precipitously by the second treatment, and subsequent treatments were indistinguishable for seizure length either among or within groups. As the data were not normally distributed, a nonparametric (Mann-Whitney) test was used.

Discussion

We found that hyperventilation had a transient effect on seizure length in the early phase of ECT. The first seizure length in the lowest pCO_2 group was longer as compared to the other two groups, but this effect was not sustained for the remaining treatments. The first treatment in a course is known to be the longest (Fink 1979), and hyperventilation may have merely enhanced this effect. The large interindividual variability of seizure length in our sample suggests that intrinsic individual factors may influence seizure length. Because we did not cross patients over from one pCO_2 level to another, we cannot comment on intraindividual responses to different levels of hypocapnia.

There are major methodological differences between this study and Bergsholm et al. (1984), thus making a comparison of results difficult. These authors intubated all patients, used etomidate as the anesthetic agent, and crossed patients from hyper- to normooxygenation and hypo- to normocapnia in successive treatments so as to demonstrate differential effects of the two ventilatory states on EEG-monitored seizure length. On the contrary, we were looking for a clearly demonstrable effect of varying levels of hypocapnia that could have clinical utility. Hence, we adhered as closely as possible to our usual ECT procedure while varying the rate of ventilation to influence the end-tidal pCO_2. Although we used a higher than usual methohexital dose, all groups were subject to the same dose, hence this factor alone may not explain our inability to find as robust an effect of hypocapnia on seizure length as did Bergsholm et al. (1984). We suggest that hypocapnia as a strategy for prolonging seizure duration in routine clinical practice needs further study before it can be adopted into routine ECT practice. Moreover, as Bergsholm et al. (1984) have pointed out, the relationship of longer seizures to the clinical efficacy of ECT is in need of confirmation as well.

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Table 1. End Tidal pCO_2 Levels and Seizure Duration in ECT

	High pCO_2 (30 mm)	Medium CO_2 (25 mm)	Low pCO_2 (20 mm)
Gender (M:F)	2:3	0:5	1:4
Seizure (sec, mean ± SD)			
ECT #1	72.0 ± 13.1	47.0 ± 7.6	105.8 ± 41.7[a]
ECT #2	66.3 ± 33.2	41.0 ± 6.6	54.6 ± 19.1
ECT #3	48.3 ± 14.9	34.0 ± 7.7	58.0 ± 22.8
ECT #4	54.0 ± 32.5	37.8 ± 15.4	52.3 ± 27.9
ECT #5	44.7 ± 17.9	32.6 ± 14.5	34.8 ± 3.6

[a] $p < 0.001$; all others NS (Mann-Whitney test).

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