Brief Reports

Low dose mivacurium is less effective than succinylcholine in electroconvulsive therapy

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Purpose: To compare the efficacy of low dose (LD) mivacurium (0.08 $mg \cdot kg^{-1}$) with LD succinylcholine (0.5 $mg \cdot kg^{-1}$) in modifying seizure activity during electroconvulsive therapy (ECT). Partial muscle relaxation is used in ECT to prevent violent muscle contractions. Current practice is to use LD succinylcholine which has several undesirable side effects.

Method: Sixteen depressed, but otherwise healthy, patients, aged 27-67 yr were studied. In a randomized, double-blind, cross-over study, either LD mivacurium or LD succinylcholine was given at consecutive ECTs 120 and 30 sec respectively before inducing ECT. Neuromuscular blockade following mivacurium was not reversed. Seizure modification was scored - 0 = no seizure activity, 1 = over-modified, 2 = desired level, 3 = under-modified, 4 = unmodified. Duration of seizures, time to first breath and adequate ventilation, ability to protrude tongue and sustain hand grip for five seconds were recorded. Paired t- tests and Wilcoxon matched pairs test were used to compare data. $P < 0.05$ was considered significant.

Results: Seizure modification was better (mean (range)) after succinylcholine 2.06(1–3) than after mivacurium 2.56(2-4) ($P < 0.05$). Mivacurium was unsatisfactory in eight cases compared with two cases after succinylcholine. The study was terminated early because of unsatisfactory seizure control. Clinical assessments of recovery from both relaxants were similar.

Conclusion: Low dose mivacurium is unsuitable for use in ECT.

Objectif : Comparer l'efficacité d'une faible dose (FD) de mivacurium (0,08 $mg \cdot kg^{-1}$) à celle d'une FD de succinylcholine (0,5 $mg \cdot kg^{-1}$) dans le but de modifier la crise convulsive pendant une sismothérapie par électrochoc (SPE). La relaxation musculaire partielle est utilisée lors de la SPE pour empêcher des contractions musculaires violentes. En général, c'est avec une FD de succinylcholine, mais elle présente quelques effets secondaires indésirables.

Méthode : Seize patients déprimés, par ailleurs bien portants, âgés de 27 à 67 ans, ont été étudiés. Pendant l'étude randomisée, croisée et en double aveugle, on a administré une FD de mivacurium ou de succinylcholine, 120 et 30 s respectivement avant le début d'électrochocs consécutifs. Le blocage neuromusculaire qui a suivi l'administration de mivacurium n'a pas été renversé. La modification des convulsions a été notée comme suit : 0 = aucune crise convulsive, 1 = surmodification, 2 = niveau recherché, 3 = sous-modification, 4 = aucune modification. La durée des convulsions, le temps de parvenir à la première respiration et à la ventilation adéquate, l'habileté à tirer la langue et à serrer la main pendant cinq secondes ont été notés. On a utilisé le test t et le test d'appariement de Wilcoxon pour comparer les données. $P < 0,05$ a été considérée comme significative.

Résultats : La modification des convulsions a été meilleure (moyenne (limites)) après l'administration de succinylcholine 2,06 (1-3) qu'après l'administration de mivacurium 2,56 (2-4) ($P < 0,05$). Le mivacurium n'a pas été satisfaisant dans huit cas, mais la succinylcholine, dans deux cas. L'étude a été rapidement abandonnée, puisque le contrôle des convulsions n'était pas satisfaisant. Les évaluations cliniques de la récupération à partir des deux relaxants ont été similaires.

Conclusion : Une faible dose de mivacurium n'est pas appropriée lors de la SPE.

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SUCCINYLCHOLINE has been used since the 1950s to modify seizures and thus preventing violent muscular contractions during electroconvulsive therapy (ECT).[1,2] In 1988 Konarzewski *et al.* studied different doses of succinylcholine during ECT and concluded that the ideal dose was 25 mg or 0.5 mg·kg^{-1},[2] which is the dose commonly used today. Unfortunately, succinylcholine has many undesirable and potentially harmful side effects.[3] A potential replacement for succinylcholine is the ultrashort acting, non-depolarising, neuromuscular blocking agent mivacurium.[4] It has fewer side effects and in low doses (i.e. 0.08 mg·kg^{-1}) may not need to be reversed,[5] thus avoiding polypharmacy and unwanted cardiovascular and autonomic effects. Several authors have reported on the use of mivacurium during ECT for specific medical problems[6–8] and multiple monitored ECT, a procedure lasting up to 30 min.[9] In these reports full paralysing doses of mivacurium (0.16 – 0.2 mg·kg^{-1}) were used, prolonging block and necessitating reversal. Such doses abolish muscle movement making the duration of seizures difficult to assess. This is not so for low dose mivacurium which allows visual assessment. The present study compared seizure modification during ECT using low dose mivacurium with low dose succinylcholine. The timing of the doses before inducing ECT were 120 and 30 sec respectively. A double blind, cross-over, study design was used.

Patients and methods

After obtaining local ethical committee approval, written informed consent was obtained from 16 depressed, but otherwise healthy, adult patients who required a course of ECT. Each patient was studied twice, thus enabling a cross-over study. On the first treatment they were randomised to receive either succinylcholine or mivacurium. On the second treatment they received the alternate relaxant. Patients were unpremedicated and fasted over night and ECT was performed the next morning.

Patients received pre-oxygenation and standard anesthetic monitoring was attached. Anesthesia was induced with 3.5 mg·kg^{-1} thiopentone *iv* followed, depending on randomisation, by 10 ml of normal saline containing either 0.08 mg·kg^{-1} mivacurium or placebo and 90 sec later by a second 10 ml containing either placebo or 0.5 mg·kg^{-1} succinylcholine. Bipolar ECT was then performed 30 sec later.

Seizure modification was assessed using the scoring system shown in Table I. The duration of the seizure was measured using a single channel electroencephalogram. Recovery from anesthesia and duration of neuromuscular block were assessed by recording the time following the cessation of seizures to: (i) the first spontaneous breath, (ii) adequate ventilatory efforts, (iii) full tongue protrusion and (iv) full strength hand grip for five seconds. Tongue protrusion and hand grip were assessed at one minute intervals. The patient was followed up the next day and asked about any residual effects, such as myalgia.

Statistical comparisons were performed using paired t tests and Wilcoxon matched pairs. Results are presented as mean (range). $P < 0.05$ considered statistically significant.

Results

Six male and ten female patients, age 47 (27 - 67) yr, and weight 58 (40 - 78) kg were studied. The study was terminated after 16 cases following objections from the psychiatrists regarding the adequacy of seizure control. The duration of seizures was similar in both groups (Table II). The extent to which the seizures were modified was better following succinylcholine 2.06 (1 - 3) than after mivacurium 2.56 (2 - 4) ($P < 0.05$) (Table I). Mivacurium was unsatisfactory (scores of 3 and 4) in eight cases (50%) and succinylcholine in to two cases (12.5%) (Table I). Recovery of spontaneous ventilation was similar in the two groups (Table II). Recovery of neuromuscular blockade was delayed by 1 to 1.5 min in the mivacurium group, although this difference did not reach significance (Table II). Four patients following succinylcholine and three patients following mivacurium complained of myalgia the next day and seizure activity in these three patients was under-modified. No other complications were reported.

TABLE I Seizure activity during ECT. Scoring system to assess seizure modification ($P = 0.04$ Wilcoxon).

Seizure modification	*Clinical description*	*Succinylcholine (n = 16)*	*Mivacurium (n = 16)*
0 - no seizure	(no detectable motor activity)	0	0
1 - over modified	(seizure activity barely visible)	1	0
2 - desired level	(well defined, but modified, seizure activity)	13	8
3 - under modified	(excessive seizure activity making the patient difficult to manage)	2	7
4 - full seizure	(full seizure activity with high risk of patient injury)	0	1

Discussion

Compared with conventional doses of low dose succinylcholine (0.5 mg·kg^{-1}), the speed and quality of recovery from low dose mivacurium (0.08 mg·kg^{-1}) was almost as good, without the need for reversal. However, the quality of seizure modification was inadequate in 50% of patients receiving mivacurium, compared with 12.5% of patients receiving succinylcholine. This was sufficiently high to warrant early closure of the study.

Mivacurium is rapidly metabolised by plasma cholinesterase and has a half-life of three minutes.[4] Its ED_{95} (mean dose required to produce 95% paralysis of the adductor pollicis) is 0.08 mg·kg^{-1} and twice this dose is recommended to achieve full paralysis.[4] We used half this dose as only partial paralysis is required for ECT. We did not attempt to assess neuromuscular function using a nerve stimulator because of potential discomfort to the patient. Although mivacurium takes three to four minutes to produce maximum effect,[4] we elected to wait two minutes before inducing ECT because further delay could have resulted in recovery from the induction dose of thiopentone and awareness during ECT. Data from a previous study had shown that good laryngeal mask insertion conditions could be achieved after only 90 sec following doses of mivacurium as low as 0.04 – 0.08 mg·kg^{-1}.[5]

Recovery from low dose mivacurium was similar to that after low dose succinylcholine, although modification of seizures was inadequate. The latter might have been improved by giving a larger doses of mivacurium[6–9] but the duration of neuromuscular blockade would have been prolonged, necessitating the use of reversal.

Previously, Kelly and Brull reported the use of mivacurium in a 29-yr-old manic-depressive woman requiring ECT. Her first treatment caused a neuroleptic malignant reaction thought to be triggered by succinylcholine. In subsequent ECTs mivacurium (0.15 mg·kg^{-1}) was used successfully.[6] Burnstein and Denny reported the use of mivacurium (5-6 mg) in a quadraplegic patient requiring ECT.[7] Janis *et al.* reported the use of mivacurium (0.16 - 0.2 mg·kg^{-1}) in a further three elderly patients in whom succinylcholine was contraindicated.[8] Doses used in these studies were higher than in the present study. Thus, reversal of neuromuscular blockade was required in all these cases.

The incidence of myalgia (19-25%) following ECT was similar when using both succinylcholine and mivacurium. Poor seizure modification may explain the unexpectedly higher incidence of myalgia in patients receiving mivacurium.

In summary, low dose 0.08 mg·kg^{-1} mivacurium is not recommended as a substitute for succinylcholine during ECT. Larger doses of mivacurium (i.e. 0.15 mg·kg^{-1}) are reported to be suitable but may require reversal.

TABLE II Duration of seizure activity and recovery times. No difference between groups.

	Succinylcholine (n = 16)	Mivacurium (n = 16)
Duration of Seizure (sec)	39 (15 - 90)	40 (17 - 84)
First breath (min)	1.3 (0.3 - 4.0)	1.1 (0.5 - 3.0)
Adequate ventilation (min)	2.7 (1.2 - 5.0)	3.0 (1.0 - 8.0)
Tongue protrusion (min)	6.4 (3.0 - 12.7)	7.3 (2.0 - 12.0)
Hand grip (min)	6.5 (3.0 - 12.7)	8.0 (6.0 - 16.0)

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