Effects of Electrode Placement, Stimulus Parameters, and Anaesthesia on the Response to Modified ECT

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Abstract

The present study was conducted on two categories of patients with mood disorders (diagnosed according to DSM-IV). Category I consists of 40 patients with bipolar disorder (currently manic) while Category II consists of 40 patients with major depressive disorder. Each category consists of 4 groups according to the electrode placement, stimulus type, and anesthetic agents. They were subjected to full clinical and psychometric assessment using Wechsler Memory Scale, Brief Psychiatric Rating Scale. Manic State Rating Scale and Raskin's Depression Rating Scale. They were examined one day before and one day after a course of 6 ECTs (given 3 times weekly). It was demonstrated that the cognitive adverse effects following ECT were more with sine-wave stimulation, bilateral electrode placement and using midazolam as an anesthetic agent.Both wave-form stimuli had a similar therapeutic response (slightly higher with sine-wave). Bilateral electrode placement had more therapeutic improvement than unilateral placement on the expense of memory impairment.Increasing the stimulus intensity excessively could result in more memory impairment without any therapeutic benefits.

Introduction

ECT is an effective treatment for a wide range of psychiatric disorders. Because of memory dysfunction associated with ECT, there has been interest in developing alternative modes of convulsive treatment that would result in less memory impairment without compromising therapeutic efficacy. Unilateral nondominant electrode placement was one example of these modes (Sackeim et al. 1986). Recently, there have been suggestions that seizure therapeutic adequacy and adverse effects are dependent on the extent to which the stimulus exceeds the seizure threshold.

There were some studies which compared the effects of brief-pulse stimulation with that of the sine-wave the overall results of which were controversial. While some reported superiority of the brief-pulse over the sine-wave (particularly in producing less memory impairment with equivalent therapeutic efficacy), others denied that (Weiner et al., 1986).

Many psychiatrists believe that the decline in ECT utilisation has now reached a turning point, with a growing emphasis on its continual clinical role among other available therapeutic alternatives. Until the day comes when more effective and less toxic drugs or procedures become available, it is likely that ECT will continue to be used (Sackeim and Weiner, 1995).

This study aim at:
(1) Comparing the use of sine-wave stimulation and brief-pulse stimulation in ECT given to a group of patients with mood disorders.
(2) Studying the relationship of the various stimulus parameters to seizure duration, ECT therapeutic efficacy and memory side effects in these patients.

(3) Comparing the effects of unilateral versus bilateral electrode placement on the symptoms and memory seizure characteristics.

Material and Methods

The present study was conducted on 80 patients with mood disorders in the Psychiatry Department in Mansoura University Hospital. These patients were classified into two categories (according to DSM-IV):
1. Category A: bipolar disorder currently manic; 40 patients.
2. Category B: major depressive disorder; 40 patients.

The diagnosis was made by two psychiatrists independently. Their ages ranged from 20 to 40 years, with no clinical evidence of organicity, no ECT given during the preceding 6 months, strong right handedness (to determine the non-dominant side for unilateral ECT). Also no drugs were given to the patients (only sedatives or hypnotics were administered when necessary).Each category of patients were subdivided into 4 groups according to electrode placement, stimulus type and anesthetic agent. These groups were matched for age, sex and education.

Group 1: receiving bilateral ECT with sine-wave stimulus type (10 patients).
Group 2: receiving bilateral ECT with brief-pulse stimulus type (10 patients).
Group 3: receiving bilateral ECT with brief-pulse stimulation and using thiopentone as anesthetic agent (10 patients).
Group 4: receiving bilateral ECT with brief-pulse stimulation and using midazolam as anesthetic type (10 patients).

All patients were examined on the first day of admission (before starting the ECT course) and re-examined one week and month after. They were subjected to full clinical assessment and some routine laboratory investigations to avoid complications and to exclude organicity.

The psychometric studies done to them included:
1.Wechsler Memory Scale "WMS" (Wechsler and Stone,1955).
2.Brief psychiatric Rating Scale "BPRS" (Overall and Gorham, 1962).
3.Manic-state Rating Scale "MSRS" of (Beigel et al., 1971).
4.Raskin's Depression Rating Scale "RDRS" (Raskin et al., 1970).

Six ECTs were administered three times a week in the morning at 9 o'clock with the standard usual precautions for ECT. Testing for cerebral dominance was determined as described by Levy and Roid (1976). Midazolam (Dormicum) in a dose of 0.07-0.15 mg/kg slowly IV, was given to patients of group 4.

Stimulus electrode placement for bilateral or unilateral ECT was done as described in Noys and Kolb (1977). Stimulation was done using ECTONUS TIM MKU apparatus (sine-wave stimulus) or MECTA JRI apparatus (brief-pulse stimulus. Seizures were monitored clinically with a stop watch from the end of the electrical stimulus till cessation of all motor activity during every session.

Statistical analysis of the collected data was obtained through the computer using Microstat program.

Results:

Manic State Rating Scale (of Beigel) (MSRS) Scores:

Tables (1 and 2) show the (MSRS) scores one day before and one day after the ECT course for patients with bipolar disorders (Manic) demonstrating the extent of therapeutic response in relation to the stimulus type and electrode placement.

In Group I, the mean MSRS scores before ECT was 433.3+ 24.86, while it was 111.3 +8.91 with a very highly significant decrease in the mean score ($P<0.0001$), and the mean percent decrease in the mean score

was 74.31. In group II, the mean MSRS scores before ECT was 435.5 + 25.17, while it was 113.40 + 12.88 with a highly significant decrease in the mean score (P< 0.0001), and the mean percent decrease in the mean score was 73.96.

In group III, the mean MSRS scores before ECT was 436.7 + 16.04, while it was 170.2 + 8.89 with a highly significant decrease in the mean score (P < 0.001), and the mean percent decrease in the mean score was 61.02.

In group IV, the mean MSRS scores before ECT was 441.3+32.52, while it was 176.1+6.0 with a highly significant decrease in the mean score (P < 0.001), and the mean percent decrease in the mean score was 60.09.

Table (6) shows that there is a mildly significant increase in the seizure threshold over the ECT course in both diagnostic categories. Also, the threshold in the manic groups appear lower than that in the depressive group.

Table (7) shows that, there are no significant differences between the mean seizure duration in various groups (P> 0.05).Table (8) shows that, there is a highly significant difference of recovery time in different groups (p < 0.0001) with the highest value in group I followed by group II, group III and then group IV. Table (9) shows a positive significant correlation between the seizure duration and therapeutic response which was highest in group IV, followed by groups II and III, then by group I.

Table (1):
Effects of stimulus on the therapeutic response to bilateral ECT in bipolar disorders (manic) using MSRS.

	MSRS Score				Paired t-test	P
	Before ECT		After ECT			
	Range	Mean + SD	Range	Mean + SD		
Group I (n = 20)	393-465	433.3+24.865	105-131	111.3+8.91	31.69	< 0.0001
Group II (n = 20)	393-454	435.5+25.17	107-140	113.4+12.88	25.39	< 0.0001

MSRS = Manic State Rating Scale.

Group I = Patients receiving bilateral ECT with sine-wave stimulus type

Group II = Patients receiving bilateral ECT with brief-wave stimulus type.

Table (2):
Effects of electrode placement on the therapeutic response in bipolar disorders (manic) using MSRS.

	MSRS Score				Paired t-test	P
	Before ECT		After ECT			
	Range	Mean + SD	Range	Mean + SD		
Group I (n = 20)	393-454	435.5+25.17	107-140	113.4+12.88	25.39	< 0.0001
Group II (n = 20)	420-452	435.5+25.17	119-136	170.2+8.89	49.84	< 0.0001

Group II = Patients receiving bilateral ECT with brief-wave stimulus type.

Group III Patients receiving unilateral ECT with brief-wave stimulus type.

Table (3):
Effects of stimulus type on the therapeutic response to bilateral ECT in major depressive disorders using MSRS.

	MSRS Score				Paired t-test	P
	Before ECT		After ECT			
	Range	Mean + SD	Range	Mean + SD		
Group I (n = 20)	11 -14	12.5+1.29	3 -4	3.30+0.5	18.28	< 0.0001
Group II (n = 20)	12 - 15	13.25+1.26	3 -4	3.7+0.0	14.70	< 0.0001

MSRS = Raskin's Depression Rating Scale.

Group I = Patients receiving bilateral ECT with sine-wave stimulus type

Group II = Patients receiving bilateral ECT with brief-wave stimulus type.

Table (4):
Effects of anaesthetic type on the therapeutic response to unilateral ECT in major depressive disordes using RDRS.

	RDRS Score				Paired t-test	P
	Before ECT		After ECT			
	Range	Mean + SD	Range	Mean + SD		
Group III (n = 10)	12-14	13.0+ 1.44	4 -5	5.5+ 0.71	17.0	< 0.0001
Group IV (n = 10)	13 -14	13.5+ 1.70	4 -5	5.9+ 0.71	19.23	< 0.0001

Group II = Patients receiving unilateral ECT with thiopentone anasthetic agent.
Group III Patients receiving unilateral ECT with midazolam anathetic agent..

Table (5):
Effects of electrode placement on the therapeutic response in major depressive disorders using RDRS.

	RDRS Score				Paired t-test	P
	Before ECT		After ECT			
	Range	Mean + SD	Range	Mean + SD		
Group II (n = 20)	12 -15	13.25+ 1.26	3 -4	3.7+ 0.0	14.70	< 0.0001
Group III (n = 10)	13 -14	13.0+ 1.44	4 -5	5.5+ 0.71	17.0	< 0.0001

Group II = Patients receiving bilateral ECT with brief-pulse stimulus type.

Group III = Patients receiving unilateral ECT with brief-pulse stimulus type.

Table (6):
Seizure threshold (in joules) over the course in both diagnostic categories.

	Manic Group	Depressive Group
First treatment (Mean)	18.18 + 4.76	22.50 + 6.45
2 nd treatment	23.66 + 7.84	24.60 + 8.98
3rd treatment	26.40 + 9.13	27.34 + 3.90
4th treatment	26.72 + 6.08	31.12 + 3.39
5th treatment	29.18 + 5.52	30.80 + 6.68
6th treatment	32.24 + 4.98	35.62 + 3.99
F	2.692	3.301
P	< 0.05	< 0.05
Mean percent increase in	77.33	58.31

Table (7):
Seizure duration in different groups.

	Group I	Group II	Group III	Group IV	F	P
Range	25 -40	27 -3 7	26 -42	27 - 40		
Mean+SD	30.1+3.627	30.76+0.57	32.42+4.498	31.99+4.06	0.899	<0.05

Table (8):
Recovery time (In minutes) in all the sample.

	Group I	Group II	Group III	Group IV	F	P
Range	5 -13	3 - 7	3 - 6	3 - 5		
Mean+SD	8.8 + 2.05	4.7 + 1.03	4.3 + 0.9	3.4 + 0.52	47.0	<0.0001

Table (9):
Correlation between the seizure duration and therapeutic response.

	n	p
Group I (20)	0.41	< 0.05
Group II (20)	0.576	< 0.01
Group III (20)	0.845	< 0.01
Group IV (20)	0.706	< 0. 001
Total (80)	0.558	< 0.05

Table (10):
Correlation between seizure threshold in Joules and both memory impairment and theraputic response.

	Memory Impairment		Theraputic Response	
	r	p	r	p
Threshold	0.120	<0.001	0.860	> 0.05
Mod. Supra Threshold	0.165	<0.001	0.760	> 0.05
Grossly Supra Threshold	0.94	<0.001	0.301	> 0.05

Table (11):
Correlation between the electrical dosage and both theraputic response and memory impairment .

	r	p
Electrical dosage and theraputic response	0.899	> 0.05
Electrical dosage and memory impairment	0.99	< 0.001

Discussion:
In the present study, therapeutic response as well as memory impairment were studied by comparing pre-to-post ECT change in the mean scores and finding out some correlation regarding certain variables e.g. seizure duration, threshold and electrical dosage.
As mentioned before, cognitive effects of ECT depend on various technical factors e.g. wave form and electrode placement.
Bipolar Disorder (Manic):
There was marked improvement as shown by manic state rating scale scores in all the groups.

Wave-form:
There was similar efficacy of both sine-wave and brief-pulse ECT with tendency to be higher with sine-wave stimulation.
However, Mukherjee (1989) reported equal therapeutic efficiency of both unilateral and bilateral ECT in mania although half of the patients who failed to respond to unilateral ECT improved after switch over to bilateral ECT.

Major Depressive Disorders:
The present study showed a significant decrease in the mean Raskinís Depression Rating Scale Scores indicating marked therapeutic improvement in all groups.
Similar efficacy was reported for both groups on sine-wave and brief-pulse stimulation. These confirm the findings obtained Allan et al. (1992). While Andrade et al. (1988) found that more patients recovered when treated with sine-wave stimulation.

Electrode Placement:
The mean percent decreases in the mean Raskinís Depression Rating Scale Scores in group II (bilateral ECT) and group III (unilateral ECT) were 72.1 and 57.7 respectively. This indicates that unilateral (ECT treatment is associated with less therapeutic response than bilateral treatment. A very similar finding was reported by Philip et al. (1985) who found a difference of 6 % favouring bilateral over unilateral non-dominant ECT, but that was on the expense of memory impairment. This was in agreement with other studies (Sackeim et al., 1993). Fawzy et al. (1989) found a therapeutic improvement of 74.9 with bilateral ECT and 48.2 with unilateral non-dominant ECT in treating depressive patients using sine-wave stimulation compared to our results of 72.1 and 57.7 in bilateral brief-pulse and unilateral brief-pulse ECT respectively. The difference in the therapeutic response between unilateral and bilateral ECT reported in the mentioned study was found to be less in the present study where unilateral brief-pulse ECT results were more close to bilateral brief-pulse ECT. This could be related to the use of new ways of ECT administration including the use of new stimulus generators e.g. brief-pulse machines controlling the amount of electricity given and administration of 100% oxygen.
This was also consistent with Lamy et al. (1994) who reported that non-dominant unilateral ECT (D'Elis position) with a special technique, avoidance of , prolonged hyperventilation, with oxygen and high energy stimulus, could produce results close to bilateral treatment.

Seizure Characteristics:
The present study revealed a significant increase in the seizure threshold (the minimal intensity of electrical stimulation needed to elicit adequate seizure) over the ECT course in the diagnostic categories. However, manic patients appear to have a lower seizure threshold than that of depressive patients. Coffey et al. (1994) had similar findings. To compare seizure duration in this study, the seizure duration of the first treatment was the one considered. Sine-wave stimulation was found to produce longer seizure duration than that produced by brief-pulse stimulation.

Unilateral ECT had longer seizure duration than bilateral ECT. Also, depressives had longer seizure duration than manics. This was consistent with Weiner et al. (1991).

Sackeim et al. (1991) stated that patients with high seizure threshold (thereby requiring a more intense electrical stimulus to elicit seizures) generally had shorter duration. This was explained by the higher intensity stimulation-required by the high threshold patients, leading to a more profound potentiation of endogenous inhibitory processes used to terminate the seizure.

The recovery time and regaining of consciousness was found to be significantly affected by the technique of ECT administration. It was shorter when using midazolam as anesthetic agent than when using thiopentone. Also, it was shorter with non-dominant unilateral, brief-pulse stimulation than with bilateral sine-wave stimulation. These findings were in agreement with other studies (Smith and White, 1994) who reported that with right unilateral ECT, patients took 4 minutes to have full orientation following seizure termination and eye opening. With higher intensity stimulation and using inefficient wave forms, the recovery time was longer, may be hours.

In the present study, there was a significant correlation between the therapeutic response and seizure duration I.e. the longer the seizure duration, the stronger the response. This confirms Ghazy and Mawsouf (1996). Sackeim et al. (1991) talked about the therapeutic window where patients whole cumulative seizure duration fall below this window are unlikely to respond and should be considered as having been given an inadequate course of ECT, while patients with cumulative seizure duration beyond the upper range of this window are unlikely to respond to additional treatment and their course of treatment should be terminated. The window for cumulative seizure duration was reported by many clinicians to start from 210 seconds up to 1000 seconds.However, Alexander et al. (1987) cited that there is no evidence that the antidepressant efficacy of ECT is a function of seizure duration. A number of variables (level of oxygenation, electrode placement anesthetic dosage, concurrent medications, treatment stage) can influence the seizure duration.

The American Psychiatric Association "APA" (1990) reported that seizures, that are briefer than 20 seconds and seizures that do not bilaterally generalize are believed to have reduced therapeutic properties. Also in the present study, there was found a positive significant correlation between electrical dosage and memory impairment after ECT. Grossly suprathreshold stimuli may be associated with cognitive side effects. Also, there was a positive significant correlation between electrical dosage of minimally and moderately suprathreshold stimulus intensity (moderately suprathreshold stimulus is 1-5 times the threshold) and the therapeutic response. On the other hand, our study did not find significant correlation between electrical dosage of grossly suprathreshold stimuli (grossly supra threshold stimulus is 3 times the threshold) and the therapeutic response. These findings indicate that increasing the stimulus intensity excessively will result in more memory impairment without any therapeutic benefits. These findings were consistent with Bean et al. (1991); Enns and Reiss (1992) and Enns and Karvelas (1995).

The APA (1990) reported that stimuli marginally above the seizure threshold may be less therapeutic than those delivered at a higher intensity. On the other hand, it confirmed that grossly suprathreshold stimuli may be associated with greater side effects. Because of these issues a moderately superathreshold dosing strategy is recommended.

The present findings illustrate the following conclusions:

1-There was a significant memory impairment after the ECT course using Wechsler Memory Scale in all groups.

2-Seizures induced with sine-wave stimuli could elicit greater cognitive side effects than those induced with brief-pulse stimuli.

3-Bilateral ECT was associated with more memory impairment than unilateral ECT.

4-Using the anesthetic agent midazolam in induction of ECT was associated with less memory impairment than using thiopentone.

5-Both wave forms (sine-wave and brief-pulse) could induce similar improvement but tends to be slightly higher with sine-wave stimuli.

6 - Bilateral ECT was associated with greater therapeutic efficacy than unilateral ECT.

7-There was a significant increase in seizure threshold over the ECT course.

8- Using sine-wave stimulation could produce seizure duration less than that produced by brief-pulse stimulation also, bilateral ECT had shorter seizure than unilateral.

9-The recovery time is the longest in group I and shortest in group IV.

10-There was a significant correlation between the therapeutic response and the seizure duration i.e. the longer the seizure duration the stronger the response.

11-There was positive correlation between electrical dosage administered to patients and memory impairment.

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تأثير وضعية الالكترود و معاملات المؤثر و عقاقير التخدير على الاستجابة للصدمات الكهربائية المعدلة

اشتملت الدراسة الحالية على فئتين من مرضى اضطرابات المزاج طبقا للتشخيص الامريكى الرابع تتكون الفذة الاولى من ٤٠ مريضا ممن يعانون من اضطراب ثنائى القطبية (هوس) كما تضم الفئة الثانية ٤٠ مريضا ممن يعانون من اضطراب الاكتئاب الجسيم، ثم تضمنت كل فئة ٤ مجموعات طبقا لوضع الالكترود و نوعية المثير و المخدر.

و قد اجرى لهم تقييم اكلينيكى شامل و قياسات نفسية شملت اختبار وكسلر للذاكرة و المقياس النفسى المختصر و مقياس بيجل للهوس و مقياس الاكتئاب لراسكن. و قد فحصوا قبل الجلسات الكهربائية بيوم و بعد انتهائها بيوم و اعطيت الجلسات بمعدل ثلاث مرات اسبوعيا.

و قد استنتج من الدراسة ما يلى:

١- التأثيرات المرضية المعاكسة الناتجة من الجلسات كانت اكثر مع الالكترود الثنائى الوضعية و المؤثرات ذات الموجات الجيبية مع استخدام الميدازولام فى التخدير.

٢- لكل من الموجة الجيبية و النبض اللحظى نفس التأثير العلاجى و لكن يكون التحسن اكثر قليلا مع المجة الجيبية عنه في النبض اللحظى، كما لوحظ تحسن علاجى افضل مع استخدام الالكترود احادى القطبية.

٣- قد تؤدى زيادة الجرعة الكهربية المستخدمة فى اعطاء الجلسات و التى تفوق العتبة التشنجية بنسبة كبيرة الى زيادة الخلل بالذاكرة دون اي فوائد علاجية اضافية.