Study of memory changes after electroconvulsive therapy

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**Background:** Electroconvulsive therapy (ECT) is said to have few adverse effects and among them, cognitive impairment is the most significant side effect limiting its use. However, recent studies have suggested it to be due to illness rather than due to ECT, hence a need to study the memory changes following ECT. **Aim:** This study aimed to assess the memory changes following ECT and subsequent recovery in the short period of 4 weeks. **Materials and Methods:** Fifty consecutive first-episode cases of depression requiring ECT and scoring at least 27 on initial Mini–Mental State Examination were studied using Becks Depression Inventory and Wechsler Memory Scale Ill-Indian adaptation at baseline, after six ECTs, and 4 weeks after last ECT. Findings were analyzed using appropriate statistical methods. **Results:** Memory improved significantly after a course of six ECTs and further 4 weeks after the last ECT. Depression scores had dramatically reduced after a course of six ECTs. Significant correlation was found between baseline depression scores and baseline general (delayed) memory scores. **Conclusions:** The memory changes seen after ECT were likely to be mediated by changes in depression. Probably, ECT had no deleterious effects on memory or its negative effects were more than balanced by the changes due to improvement of depression.

**Keywords:** Cognitive impairment, depression, electroconvulsive therapy

Even though there was no evidence to suggest that ECT causes any permanent brain damage and it was known that ECT in fact stimulates neuroplasticity, the use of electricity, triggering of a seizure, and the cognitive adverse effects of the treatment are together responsible for the treatment being held with suspicion despite several decades of successful use. It is known to have few adverse effects and among them, cognitive impairment is the most significant side effect limiting its use. However, recent studies have suggested it to be due to illness rather than due to ECT, hence a need to study the memory changes following ECT. This study aimed to assess the memory changes following ECT and subsequent recovery in the short period of 4 weeks. Materials and Methods: Fifty consecutive first-episode cases of depression requiring ECT and scoring at least 27 on initial Mini–Mental State Examination were studied using Becks Depression Inventory and Wechsler Memory Scale Ill-Indian adaptation at baseline, after six ECTs, and 4 weeks after last ECT. Findings were analyzed using appropriate statistical methods. Results: Memory improved significantly after a course of six ECTs and further 4 weeks after the last ECT. Depression scores had dramatically reduced after a course of six ECTs. Significant correlation was found between baseline depression scores and baseline general (delayed) memory scores. Conclusions: The memory changes seen after ECT were likely to be mediated by changes in depression. Probably, ECT had no deleterious effects on memory or its negative effects were more than balanced by the changes due to improvement of depression.

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Electroconvulsive therapy (ECT) was introduced to psychiatric practice in 1938 by Lucio Cerletti and Ugo Bini. Presently, ECT is widely used as an effective therapy for a variety of psychiatric disorders including severe depression, acute psychosis, and suicidal patients, and it is known to be quicker when compared with other modalities of therapy. Nearly 85% of the patients currently receiving ECT have major depression as the diagnosis. ECT is the most effective treatment for depression in the acute stages. About 100,000 US patients and 1 million worldwide annually receive ECT.

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of manifestation of acute effects mentioned from 24 h in some reviews to 3 days after last ECT in others. Current research regarding persistence, severity, and precise pattern is inconsistent. For example, 7–8 days after a course of brief-pulse bilateral ECT, memory function relative to pretreatment assessment has been described as impaired, recovered, or improved.\[^{[13-18]}\] Regarding long-term side effects, descriptive reviews agree that after 6 months, no deficits persist and no significant differences are noted between real or simulated ECT, between outmoded sine-wave ECT or contemporary brief-pulse ECT, or between ECT and pharmacotherapy.\[^{[6,19]}\] Hence, this study was undertaken to assess the memory changes following ECT and subsequent recovery in the short period of 4 weeks.

**MATERIALS AND METHODS**

This analytical study was carried out in Psychiatry Unit of a large tertiary care hospital. Fifty consecutive first-episode cases of depression requiring ECT and scoring at least 27 on initial Mini–Mental State Examination (MMSE) were included in the study. Institutional Ethical Committee approval and informed consent were taken. Diagnoses of severe depressive episode without psychotic symptoms were made using the International Statistical Classification-10 criteria by two psychiatrists independently. Patients were evaluated clinically, were started on antidepressants, and the decision to administer ECT was usually taken within a week of admission. Patients with a past history of any psychiatric illness, who were previously given ECT, having relative or absolute contraindications for ECT, and on any sedatives were excluded from the study.

A semi-structured sociodemographic pro forma was administered to assess the demographic, family, clinical, and social domains of participants along with data from collateral sources. Beck's Depression Inventory (BDI) was administered to measure the severity of depression at baseline before ECT.\[^{[20]}\] and Wechsler Memory Scale-III Indian adaptation (WMS III-Indian adaption) was used to evaluate memory at baseline, that is, before ECT which was usually done 2 days prior to administration of the first ECT.\[^{[21]}\]

All participants received twice-weekly, modified, bi-temporal ECT treatments by brief pulse machine, starting 2 days after the baseline cognitive evaluations. The ECT stimulus settings were Brief Pulse/Constant current—800 mA, pulse width–1.5 ms, frequency–125 PPS, and duration–0.4–3.6 s which corresponds to 60–540 mC. After administration of course of six such ECTs and after recovery from the acute disorientation following the last ECT, the Wechsler Memory Scale III Indian adaptation was readministered at the most convenient time for the patients. BDI administered after the course of six ECTs was also noted. Patients were continued with appropriate antidepressants based on their clinical condition and as per standard guidelines. They were reevaluated after 4 weeks with Wechsler Memory Scale III Indian adaption and the BDI. There was also no loss to follow-up of any patients during the study.

The sum of age-adjusted scaled scores of the eight primary subtests of the Wechsler Memory Scale III, Indian adaptation, was calculated at three points in time, namely baseline, after the course of six ECTs, and 4 weeks after the last ECT. The resultant means and standard deviations (SDs) at the three points in time were compared by analysis of variance (ANOVA) with repeated measures. This was done to assess whether the scores differed significantly over the three time points.

Similarly, the mean BDI scores were also compared at the three time points (baseline, after the course of six ECTs, and 4 weeks after the last ECT), and the BDI scores at the three time points were also correlated with the corresponding memory scores using Pearson's correlation coefficient.

In addition, the mean dose of six ECTs and the mean duration of seizure of the six ECTs were correlated with the immediate, general, and working memory scores. This correlation was done for the memory scores at time points after ECT, that is, after the course of six ECTs and 4 weeks after the last ECT. All correlations were done using Pearson's correlation coefficient. All tests, wherever relevant, were two tailed. Alpha for statistical significance was set at 0.05. All analyses were performed using SPSS 20, (IBM, Armonk, NY, United States of America software) version 20.

**RESULTS**

The age of the patients was in the range of 26–55 years with a mean of 35.58 years (SD = 7). All of them were males, who had stable jobs in the same organization. They also had a minimum of 10 years of schooling (Class X). The mean years of schooling was 10.5 years (SD = 0.81). All (50) patients were married and were from an urban background. The mean BDI score at baseline was 34.6 (SD = 2.57). The mean MMSE score was 27.66 (SD = 0.80).

All the cases had adequate seizure activity of optimum duration, and the minimum and maximum duration of seizures were 32 s and 43 s, respectively. The mean duration
of seizure was 37.24 s (SD = 2.76) and the mean dose of ECT was 252 mC (SD = 37.31). A, B, and C in all tables refer to baseline (A), after a course of six ECTs (B), and 4 weeks after the last ECT (C), respectively.

**Immediate memory**

The mean immediate memory scores (scaled) and their statistical analysis over the three time points are shown in Table 1.

Using an ANOVA with repeated measures, the mean immediate memory scores differed statistically significantly between time points ($F = 63.893, P < 0.0005$) as shown in Table 1. It showed a slight increase from the mean baseline score (30.98 ± 1.62) to the mean score after the course of six ECTs (31.14 ± 1.65), which was not statistically significant ($P = 0.592$). However, 4 weeks after the last ECT, the mean score had increased to 32.36 ± 1.90 which differed statistically significantly from mean score after the course of six ECTs and also from mean baseline score.

**General (delayed) memory**

The mean auditory delayed, visual delayed, auditory recognition, general memory scores, and their statistical analysis over the three time points are shown in Table 2.

Analysis of the mean general (delayed) memory score using ANOVA with repeated measures showed that it differed significantly between the time points ($F = 252.526, P < 0.0005$) as shown in Table 2. It showed a slight increase from the mean baseline score (26.02 ± 2.19) to the mean score after the course of six ECTs (26.34 ± 1.98), which was not statistically significant. However, 4 weeks after the last ECT, the mean score had increased to 36.12 ± 2.37. This score differed statistically significantly from mean score after the course of six ECTs and also from mean baseline score.

**Working memory**

The mean working memory scores and their statistical analysis over the three time points are shown in Table 3.

The mean working memory score also differed statistically significantly between time points ($F = 133.806, P < 0.0005$) as shown in Table 3. There was a marginal increase (0.86) from the mean working memory score at baseline (18.30 ± 1.31) to mean score after a course of six ECTs (19.16 ± 1.25) and was statistically significant.

There was also a marginal increase (0.46) from mean score after a course of six ECTs (19.16 ± 1.25) to the mean score 4 weeks after the last ECT (19.62 ± 1.40) and was statistically significant. Further, the increase from mean score at baseline (18.30 ± 1.31) to mean score 4 weeks after the last ECT (19.62 ± 1.40) was 1.320, which was also statistically significant.

**Becks Depression Inventory scores**

The mean BDI scores and their statistical analysis over the three time points are shown in Table 4.

Analysis revealed that there was a decrease in the mean BDI score over the three time points and it showed a steep fall (decrease) from baseline score (34.60 ± 2.57) to mean score after the course of six ECTs (0.82 ± 0.77) and a slight decrease to mean score 4 weeks past the last ECT (0.74 ± 0.75). Significant difference was noted between baseline score and the score after a course of six ECTs and between baseline score and the score 4 weeks after the last ECT.

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### Table 1: Immediate memory scores (scaled)

| Subtests        | Immediate memory scores - mean (SD) | A     | B     | C     |
|-----------------|-------------------------------------|-------|-------|-------|
| Auditory immediate | 13.48 (2.34)                     | 14.16 (2.89) | 15.06 (2.19) |
| Visual immediate  | 17.50 (2.75)                     | 16.98 (2.94) | 17.3 (2.73)  |
| Immediate memory  | 30.98 (1.62)                     | 31.14 (1.65) | 32.36 (1.90) |

| Comparison of mean immediate memory scores (ANOVA with repeated measures) |
|-----------------|-----------------|-----------------|
| Tests           | Significance of difference between | A and B | C and B | C and A |
| Auditory immediate | (F=25.122, P<0.0005) | 0.580 | 0.900 | 1.580 |
| (P=0.002)        | (P=0.007)        | (P<0.0005)      |
| Visual immediate  | (F=2.416, P=0.129) | -0.520 | 0.320 | -0.200 |
| (P=0.086)        | (P=0.856)        | (P=1.00)       |
| Immediate memory  | (F=83.93, P<0.0005) | 0.150 | 1.220 | 1.380 |
| (P=0.532)        | (P<0.0005)       | (P<0.0005)      |

**ANCOVA – Analysis of variance; SD – Standard deviation**

### Table 2: General (delayed) memory scores (scaled)

| Subtests        | General memory scores -mean (SD) | A     | B     | C     |
|-----------------|----------------------------------|-------|-------|-------|
| Auditory delayed | 8.02 (2.22)                      | 8.12 (2.19) | 17.60 (2.65) |
| Visual delayed   | 8.12 (1.06)                      | 8.38 (1.07) | 8.48 (0.94)  |
| Auditory recognition | 9.88 (1.32)                  | 9.84 (1.13) | 10.04 (1.14) |
| General memory    | 26.02 (2.19)                     | 26.34 (1.98) | 36.12 (2.37) |

| Comparison of mean general (delayed) memory scores (ANOVA with repeated measures) |
|-----------------|-----------------|-----------------|
| Tests           | Significance of difference between | A and B | C and B | C and A |
| Auditory delayed | (F=530.363, P<0.0005) | 0.100 | 9.480 | 9.580 |
| (P=1.000)        | (P<0.0005)        | (P<0.0005)      |
| Visual delayed   | (F=7.754, P=0.002) | 0.260 | 0.300 | 0.360 |
| (P=0.016)        | (P=0.099)        | (P=0.008)       |
| Auditory recognition | -0.040           | 0.200 | 0.160 |
| (P=0.000)        | (P=0.019)        | (P=0.555)       |
| General memory    | (F=25.122, P<0.0005) | 0.320 | 9.780 | 10.100 |
| (P=0.242)        | (P<0.0005)       | (P<0.0005)      |

**ANCOVA – Analysis of variance; SD – Standard deviation**

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When memory scores were compared between baseline and after the course of ECTs, there was a significant increase in the mean scores of auditory immediate, visual delayed, and working memory subtests. Similar results were found for immediate memory by Hihn et al. in 2006.[22,23] Semkovska et al., in their 2010 meta-analysis also had found that several cognitive functions including verbal memory, working memory, and executive function had improved in the long term (more than 15 days after the last ECT).

When depression scores were compared between baseline and after the course of ECTs, there was very significant decrease. There was no significant change in the depression scores subsequently between values after the course of ECTs and 4 weeks after the last ECT. When memory scores were correlated with BDI scores, significant correlation was found between the general memory subtest scores and BDI scores at baseline.

Thus, depression had decreased very significantly after the course of ECT and there was no significant change at 4 weeks following the last ECT. Memory scores increased after the course of ECTs and showed further improvement at 4 weeks after the last ECT. A probable explanation could be due to the effects of depression on memory as shown by Lohman et al. and Azuma et al., where it was found that as depression increases, memory decreases.[24,25] Probably, when depression was treated by ECT, its effect on memory diminished. Consequently, memory had improved. Initially, there was slight improvement followed by robust improvement later.

In the present study, it is likely that memory changes seen after ECT were mediated by depression, and ECT probably had no deleterious effects on memory. Similar findings were seen in a study by Semkovska et al. and it was interpreted that ECT while treating depression may improve cognitive performance.[1] Similar findings were also shown by Brodaty et al.,[26] who concluded that ECT, an effective treatment for depression, does not cause significant side effects or neuropsychological impairment, which are more likely to be depressive phenomena. Additionally, Bosboom and Deijen found that depression alleviation by ECT was mainly associated with improvement in cognitive domains such as memory.[17]

Findings of this study were in contrast to a 2006 systematic review by Rose et al., who found that ECT causes memory loss despite improvement in depression.[11] The data used in this systematic review were later found to be flawed by a recent review in 2012 by Bergsholm.[27]

**DISCUSSION**

When memory scores were compared between baseline and after the course of ECTs, there was a significant increase in the mean scores of immediate memory, general (delayed) memory and working memory. The only statistically significant correlation was between baseline BDI scores and baseline general memory scaled scores.

The correlation of mean BDI scores at baseline, after the course of six ECTs, and 4 weeks after the last ECT were analyzed with the corresponding scaled scores of immediate memory, auditory delayed, visual delayed, and working memory. Similar findings were also shown by Brodaty et al.,[26] who concluded that ECT, an effective treatment for depression, does not cause significant side effects or neuropsychological impairment, which are more likely to be depressive phenomena. Additionally, Bosboom and Deijen found that depression alleviation by ECT was mainly associated with improvement in cognitive domains such as memory.[17]

When memory scores were compared between baseline and after the course of ECTs, there was a significant increase in the mean scores of immediate memory, auditory immediate, general (delayed) memory, auditory delayed, visual delayed, and working memory scores. Similar results were noted by Hihn et al. (immediate memory) in 2006 and by Pisvejc et al. (general memory) in 1998.[22,23] Semkovska et al., in their 2010 meta-analysis also had found that several cognitive functions including verbal memory, working memory, and executive function had improved in the long term (more than 15 days after the last ECT).

**Table 3: Mean working memory scores (scaled)**

| Test              | Working memory scores ‑mean (SD) | A       | B       | C       |
|-------------------|----------------------------------|---------|---------|---------|
| Working memory    | 18.30 (2.31)                     | 19.16 (1.25) | 19.62 (1.40) |
| Comparison of mean working memory scores (repeated measures of ANOVA) |
| Tests             | Significance of difference between | B and A | C and B | C and A |
| Working memory    | 0.860 (0.77)                     | 1.320 (1.31) | 0.460 (0.75) |

ANOVA – Analysis of variance, SD – Standard deviation

**Table 4: Comparison of Becks Depression Inventory scores**

| BDI score‑mean (SD) | Significance of difference between |
|---------------------|-----------------------------------|
| A                   | B and A                           |
| 34.60 (2.57)        | 0.82 (0.77)                      | 0.74 (0.75) |

DISCUSSION

When memory scores were compared between baseline and after the course of ECTs, there was a significant increase in the mean scores of auditory immediate, visual delayed, and working memory subtests. Similar results were found for immediate memory by Hihn et al. in 2006.[22]

When memory scores were compared between values 4 weeks after the last ECT and soon after a course of ECTs, there was a significant increase in the mean scores of immediate memory, auditory immediate, general memory, auditory delayed, and working memory subtests. Similar results were found by Semkovska et al.,[22,23] who concluded that ECT, an effective treatment for depression, does not cause significant side effects or neuropsychological impairment, which are more likely to be depressive phenomena. Additionally, Bosboom and Deijen found that depression alleviation by ECT was mainly associated with improvement in cognitive domains such as memory.[17]

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**CONCLUSIONS**

Memory improved significantly after a course of six ECTs and further improved 4 weeks after the last ECT. Depression
scores also had reduced significantly when measured after completing the course of six ECTs. Significant correlation was found between baseline depression scores and baseline general (delayed) memory scores.

Thus, it is likely that after completing the course of six ECTs with which depression had drastically reduced, the reduced memory brought about by depression improved. The memory changes seen after ECT were likely to be mediated by changes in depression. Probably, ECT had no deleterious effects on memory or its negative effects were more than balanced by the changes due to improvement of depression.

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Conflicts of interest
There are no conflicts of interest.

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