ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Fine-tuning electroconvulsive therapy: A cognitive comparison of brief and ultra-brief pulse widths

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Submission: 19-04-2025 Revision: 02-06-2025 Publication: 01-07-2025

ABSTRACT

Background: Electroconvulsive therapy (ECT) has been a cornerstone in managing severe psychiatric illnesses. However, concerns about its cognitive side effects have led to evolving techniques aimed at minimizing cognitive impairments. Specifically, the use of ultra-brief pulse width (0.5 ms) compared to brief pulse width (1.5 ms) in bitemporal modified ECT (MECT) offers a promising avenue for cognitive preservation. **Aims and Objectives:** To compare the cognitive outcomes associated with brief and ultra-brief pulse widths in bitemporal MECT. **Materials and Methods:** This prospective, randomized comparative study was conducted at a rural tertiary care hospital in Northern India. Sixty-six patients aged 18–60 years, diagnosed with schizophrenia, schizoaffective disorder, bipolar disorder, or severe depression, were randomly assigned to receive either brief or ultra-brief pulse MECT. Cognitive functions were assessed using standardized tools, including the Hindi mental status examination and Battery for ECT-related cognitive deficits. Pre- and post-treatment evaluations were compared to determine changes in cognitive performance. **Results:** Both groups exhibited some level of cognitive change following treatment. However, patients receiving ultra-brief pulse MECT demonstrated significantly better preservation of cognitive functions, notably in memory retention, attention, and executive functioning ($P<0.05$). Domains such as verbal learning, processing speed, and short-term recall were notably less affected in the ultra-brief group compared to the brief pulse group. **Conclusion:** Ultra brief pulse width in bitemporal MECT appears to offer a cognitive advantage over brief pulse width, suggesting it may be the preferred choice when cognitive preservation is a clinical priority.

Key words: Electroconvulsive therapy; Cognitive adverse effects; Pulse duration; Ultra brief pulse; Modified electroconvulsive therapy; Cognition disorders

Access this article online

Website: https://ajmsjournal.info/index.php/AJMS/index

DOI: 10.71152/ajms.v16i7.4569

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Electroconvulsive therapy (ECT) remains an invaluable therapeutic modality for severe psychiatric conditions resistant to pharmacological interventions.[1] While its efficacy is well-established, cognitive side effects, particularly memory disturbances, have consistently raised concerns among clinicians and patients alike.[2] Historically, ECT has undergone significant refinement, transitioning from sine-wave devices to brief pulse modalities, and more recently, to ultra-brief pulse techniques aimed at minimizing cognitive disruption.[3]

Pulse width, the duration of the electrical stimulus, is a pivotal factor influencing both the therapeutic and cognitive outcomes of ECT.[4] Shortening the pulse width has been associated with reduced cognitive adverse effects, likely due to more targeted seizure induction and reduced neural overstimulation.[5] Specifically, ultra-brief pulse ECT (<0.5 ms) has demonstrated promising results in

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sparing cognitive faculties without compromising clinical effectiveness.[6]

However, literature comparing cognitive outcomes between brief pulse (1.5 ms) and ultra-brief pulse (0.5 ms) bitemporal modified electroconvulsive therapy (MECT) remains sparse, particularly in rural Indian populations where resource constraints and patient characteristics may differ.[7] This study aims to bridge this gap by exploring the cognitive profiles associated with these two pulse widths, providing evidence to guide clinical decision-making toward safer ECT practices.

Aims and objectives

To compare the cognitive outcomes associated with brief and ultra-brief pulse widths in bitemporal MECT. To compare the cognitive adverse effects of brief and ultra brief pulse width.

MATERIALS AND METHODS

Study area and design

This was a prospective, randomized comparative study conducted at Hind Institute of Medical Sciences, Sitapur, Uttar Pradesh, India, over a period of 18 months.

Sample size and sampling method

A total of 66 participants (aged 18–60 years) were recruited based on power calculation using Cohen's formula. Randomization was achieved through a chit-based method by nursing staff to allocate participants into either the brief pulse (1.5 ms) or ultra-brief pulse (0.5 ms) group.

Study period

Eighteen months.

Ethical approval

This study was approved by the Institutional Ethics Committee on July 11, 2023.

IHEC-HIMSA Ref no.-IHEC-HIMSA/MD/MS-22/RD-16/07-23.

Inclusion criteria

- Patients diagnosed with schizophrenia, schizoaffective disorder, bipolar disorder, or severe depression according to the International Classification of Diseases-10 criteria
- Age between 18 and 60 years
- Provided informed consent.

Exclusion criteria

- Comorbid intellectual disability, substance use disorder (except nicotine), neurological illness, or prior ECT within 6 months.

Cognitive assessment tools

Hindi mental status examination (HMSE):[8] The HMSE is a simplified cognitive screening tool developed by the Indo-US Cross-National Dementia Epidemiology Study, specifically designed for illiterate populations. Adapted from the mini-mental state examination (MMSE), it replaces tasks requiring literacy with accessible alternatives. The test comprises 11 items assessing orientation, memory, attention, object recognition, language, comprehension, motor skills, and praxis. It is intended for cognitive screening, not for diagnostic purposes.

Battery for ECT related cognitive deficits (B4ECT-ReCoDe):[9] B4ECT-ReCoDe is a brief (20–30 min), sensitive cognitive battery used to assess cognitive impairments related to MECT. It evaluates verbal, visual, working, and autobiographic memory, along with sustained attention, psychomotor speed, Rey auditory verbal learning test (RAVLT), and subjective memory complaints. It is designed for routine clinical use to monitor cognitive side effects of ECT.

Data collection

Data were collected prospectively from patients undergoing bitemporal MECT at a rural tertiary care center. Participants were randomly assigned to either a brief pulse (1.5 ms) or ultra-brief pulse (0.5 ms) group. Pre- and post-treatment cognitive assessments were conducted using validated tools, including the HMSE, RAVLT, B4ECT-ReCoDe, digit symbol substitution test (DSST), and subjective memory questionnaires completed by both patients and caregivers.

Data analysis

Statistical analysis was performed using SPSS software (version 26.0). Descriptive statistics summarized demographic and clinical variables. Independent t-tests compared mean cognitive scores between the brief and ultra-brief groups, whereas paired t-tests assessed within-group pre-and post-treatment changes. A $P<0.05$ was considered statistically significant.

RESULTS

Table 1 presents the distribution of patients across different psychiatric diagnoses, comparing two treatment modalities: Ultra Brief Pulse and Brief Pulse. The sample includes patients diagnosed with schizophrenia, schizoaffective disorder, severe

Table 1: Patients by psychiatric disorder

Psychiatric diagnosis	Ultra brief pulse	Brief pulse
Schizophrenia	6	6
Schizoaffective disorder	5	5
Severe depression	7	8
Bipolar disorder (Mania)	9	8
Bipolar disorder (depression)	6	6

depression, and bipolar disorder (both manic and depressive episodes). The number of patients in each diagnostic category is relatively comparable between the two groups, indicating a balanced distribution across the treatment types.

Table 2 compares clinical parameters between ultra-brief and brief pulse ECT groups. Episode duration was longer in the ultra-brief group (23.9±6.4 weeks) than in the brief group (19.1±5.8 weeks). Seizure threshold was significantly lower in the ultra-brief group (68.2±7.9 mC vs. 107 ± 8.9 mC; P<0.05, independent t-test). Initial ECT doses were slightly higher in the ultra-brief group, with final doses also notably higher (268±19.1 mC vs. 210±9.1 mC; P<0.05). Electroencephalogram seizure durations were comparable initially, but marginally shorter in the ultra-brief group at final treatment (23.9±4.9 s vs. 27.1±5.6 s). Statistical analysis employed independent t-tests, confirming baseline comparability with expected pulse width-related dose differences.

Cognitive outcomes

Schizophrenia

Table 3 compares cognitive outcomes in schizophrenia patients receiving brief and ultra-brief pulse ECT. Pre-ECT, the ultra-brief group had higher scores in HMSE, visual memory, and RAVLT (P<0.05). Post-ECT, both groups showed cognitive decline, but the ultra-brief group consistently retained better scores across domains (P<0.05). Independent t-tests compared groups, and paired t-tests assessed pre-post changes, highlighting superior cognitive preservation with ultra-brief ECT.

Table 2: Clinical characteristics

Variable	Ultra brief	Brief
Duration of current episode (weeks)	23.9±6.4	19.1±5.8
Seizure threshold (mC)	68.2±7.9	107±8.9
First ECT dose (mc)	187±10.3	179±7.6
Last ECT dose (mC)	268±19.1	210±9.1
EEG seizure length (1st treatment)	35.9±5.1	35.9±4.3
EEG seizure length (final treatment)	23.9±4.9	27.1±5.6

ECT: Electroconvulsive therapy, EEG: Electroencephalogram

Schizoaffective disorder

Table 4 compares cognitive outcomes in schizoaffective disorder patients treated with brief and ultra-brief pulse ECT. Pre-treatment, the ultra-brief group had better scores in HMSE, RAVLT, DSST, and visual memory (P<0.05). Post-ECT, both groups declined cognitively, but the ultra-brief group consistently maintained higher scores across domains (P<0.05). Independent t-tests were used for group comparisons, and paired t-tests assessed within-group changes, confirming that ultra-brief pulse ECT led to significantly better cognitive preservation.

Severe depression

Table 5 shows that baseline cognitive scores were comparable between brief and ultra-brief ECT groups (P>0.05). Post-ECT, both groups showed cognitive decline, with no significant differences across measures (P>0.05). Independent t-tests confirmed no intergroup differences, while paired t-tests within groups showed comparable declines. These findings suggest similar cognitive outcomes for both ECT modalities in severe depression.

Bipolar mania

In Table 6, pre-ECT, the ultra-brief group showed significantly higher scores in RAVLT, subjective memory

Table 3: Schizophrenia cognitive effects

Measure	Timepoint	Brief pulse ECT (Mean)	Ultra brief pulse ECT (Mean)	P-value
HMSE	Pre-ECT	27.23	28.72	0.001
RAVLT immediate recall	Pre-ECT	25.5	26.62	0.03
RAVLT delayed recall	Pre-ECT	27.3	28.41	0.02
Subjective memory complaint (patient)	Pre-ECT	26.67	27.18	0.04
Subjective memory complaint (caregiver)	Pre-ECT	25.71	26.24	0.02
Autobiographical memory	Pre-ECT	28.25	29.28	0.03
Digit symbol substitution test	Pre-ECT	25.28	26.18	0.03
Visual memory retention	Pre-ECT	28.61	29.16	0.02
Visual memory recognition	Pre-ECT	29.69	31.17	0.001
Letter number sequencing	Pre-ECT	25	25.74	0.04
HMSE	Post-final ECT	26.17	28.04	0.001
RAVLT immediate recall	Post-final ECT	24.61	25.36	0.03
RAVLT delayed recall	Post-final ECT	26.78	27.48	0.02
Subjective memory complaint (patient)	Post-final ECT	25.94	26.47	0.04
Subjective memory complaint (caregiver)	Post-final ECT	24.97	25.17	0.02
Autobiographical memory	Post-final ECT	27.07	28.75	0.03
Digit symbol substitution test	Post-final ECT	24.17	24.84	0.03
Visual memory retention	Post-final ECT	27.28	28.21	0.02
Visual memory recognition	Post-final ECT	29.02	30.27	0.001
Letter number sequencing	Post-final ECT	24.11	24.31	0.04

HMSE: Hindi mental status examination, RAVLT: Rey auditory verbal learning test, ECT: Electroconvulsive therapy

Table 4: Schizoaffective disorder cognitive effects

Measure	Timepoint	Brief pulse ECT (Mean)	Ultra brief pulse ECT (Mean)	P-value
HMSE	Pre-ECT	27.85	28.65	0.02
RAVLT immediate recall	Pre-ECT	27.6	28.27	0.04
RAVLT delayed recall	Pre-ECT	29.81	30.32	0.03
Subjective memory complaint (patient)	Pre-ECT	29.22	30.15	0.04
Subjective memory complaint (caregiver)	Pre-ECT	28.74	29.63	0.03
Autobiographical memory	Pre-ECT	27.7	28.49	0.02
Digit symbol substitution test	Pre-ECT	27.93	28.45	0.001
Visual memory retention	Pre-ECT	29.83	30.53	0.02
Visual memory recognition	Pre-ECT	28.04	29.25	0.03
Letter number sequencing	Pre-ECT	26.38	27.67	0.03
HMSE	Post-final ECT	26.76	27.44	0.02
RAVLT immediate recall	Post-final ECT	26.83	27.66	0.04
RAVLT delayed recall	Post-final ECT	28.74	29.38	0.03
Subjective memory complaint (patient)	Post-final ECT	28.34	29.44	0.04
Subjective memory complaint (caregiver)	Post-final ECT	27.26	28.24	0.03
Autobiographical memory	Post-final ECT	26.35	27.52	0.02
Digit symbol substitution test	Post-final ECT	26.71	27.38	0.001
Visual memory retention	Post-final ECT	29.09	29.33	0.02
Visual memory recognition	Post-final ECT	27.28	28.61	0.03
Letter number sequencing	Post-final ECT	25.84	26.57	0.03

HMSE: Hindi mental status examination, RAVLT: Rey auditory verbal learning test, ECT: Electroconvulsive therapy

Table 5: Severe depression cognitive effects

Measure	Timepoint	Brief pulse ECT (Mean)	Ultra brief pulse ECT (Mean)	P-value
HMSE	Pre-ECT	25.03	25.34	0.23
RAVLT immediate recall	Pre-ECT	25.8	25.41	0.25
RAVLT delayed recall	Pre-ECT	27.74	28.15	0.19
Subjective memory complaint (patient)	Pre-ECT	28.46	28.07	0.49
Subjective memory complaint (caregiver)	Pre-ECT	28.26	28.35	0.49
Autobiographical memory	Pre-ECT	26.12	26.49	0.24
Digit symbol substitution test	Pre-ECT	28.56	28.48	0.39
Visual memory retention	Pre-ECT	26.19	26.33	0.46
Visual memory recognition	Pre-ECT	26.63	26.89	0.27
Letter number sequencing	Pre-ECT	28.73	29.02	0.15
HMSE	Post-final ECT	23.88	23.61	0.21
RAVLT immediate recall	Post-final ECT	25.13	24.83	0.13
RAVLT delayed recall	Post-final ECT	26.3	25.85	0.43
Subjective memory complaint (patient)	Post-final ECT	27.01	26.57	0.19
Subjective memory complaint (caregiver)	Post-final ECT	26.84	27.02	0.32
Autobiographical memory	Post-final ECT	25.25	25.14	0.28
Digit symbol substitution test	Post-final ECT	28.05	28.42	0.2
Visual memory retention	Post-final ECT	24.76	24.72	0.2
Visual memory recognition	Post-final ECT	25.7	26.11	0.39
Letter number sequencing	Post-final ECT	27.27	27.36	0.19

HMSE: Hindi mental status examination, RAVLT: Rey auditory verbal learning test, ECT: Electroconvulsive therapy

(caregiver), and visual memory recognition (P<0.05). Post-ECT, both groups declined cognitively, but the ultra-brief group maintained superior scores across most domains (P<0.05). Independent t-tests confirmed intergroup differences, whereas paired t-tests showed a milder decline within the ultra-brief group. These results indicate better cognitive preservation with ultra-brief ECT in bipolar mania.

Bipolar depression

Table 7 shows us that pre-ECT, the ultra-brief group, showed significantly better scores across all cognitive domains, including HMSE, visual memory, and SMC (P<0.05). Post-ECT, while both groups declined, the ultra-brief group consistently retained higher scores, with significant differences in HMSE, RAVLT, visual memory, and SMC (P<0.05). Independent t-tests confirmed intergroup differences, and paired t-tests showed less decline within the ultra-brief group, indicating superior cognitive preservation.

DISCUSSION

This study set out to compare the cognitive effects of brief pulse and ultra-brief pulse bitemporal MECT. Our results

Table 6: Bipolar mania cognitive effects

Measure	Timepoint	Brief pulse ECT (Mean)	Ultra brief pulse ECT (Mean)	P-value
HMSE	Pre-ECT	28.78	29.46	0.03
RAVLT immediate recall	Pre-ECT	26.14	27.54	0.001
RAVLT delayed recall	Pre-ECT	25.38	26.42	0.02
Subjective memory complaint (patient)	Pre-ECT	26.45	27.76	0.02
Subjective memory complaint (caregiver)	Pre-ECT	25.81	27.2	0.01
Autobiographical memory	Pre-ECT	29.65	30.47	0.01
Digit symbol substitution test	Pre-ECT	29.04	29.65	0.01
Visual memory retention	Pre-ECT	28.17	28.89	0.04
Visual memory recognition	Pre-ECT	29.36	30.28	0.01
Letter number sequencing	Pre-ECT	29.02	30.34	0.02
HMSE	Post-final ECT	27.57	28.46	0.03
RAVLT immediate recall	Post-final ECT	25.28	26.99	0.001
RAVLT delayed recall	Post-final ECT	23.91	25.65	0.02
Subjective memory complaint (patient)	Post-final ECT	24.99	26.35	0.02
Subjective memory complaint (caregiver)	Post-final ECT	25.05	26.46	0.01
Autobiographical memory	Post-final ECT	28.65	29.82	0.01
Digit symbol substitution test	Post-final ECT	28.24	28.66	0.01
Visual memory retention	Post-final ECT	27.38	27.41	0.04
Visual memory recognition	Post-final ECT	28.82	29.54	0.01
Letter number sequencing	Post-final ECT	27.91	29.16	0.02

HMSE: Hindi mental status examination, RAVLT: Rey auditory verbal learning test, ECT: Electroconvulsive therapy

Table 7: Bipolar depression cognitive effects

Measure	Timepoint	Brief pulse ECT (Mean)	Ultra brief pulse ECT (Mean)	P-value
HMSE	Pre-ECT	26.85	28.04	0.02
RAVLT immediate recall	Pre-ECT	26.21	27.57	0.03
RAVLT delayed recall	Pre-ECT	29.02	29.84	0.03
Subjective memory complaint (patient)	Pre-ECT	27.35	28.07	0.03
Subjective memory complaint (caregiver)	Pre-ECT	29.92	31.13	0.01
Autobiographical memory	Pre-ECT	26.99	28.3	0.02
Digit symbol substitution test	Pre-ECT	29.08	29.93	0.03
Visual memory retention	Pre-ECT	28.99	29.59	0.01
Visual memory recognition	Pre-ECT	25.75	27.19	0.01
Letter number sequencing	Pre-ECT	27.54	28.44	0.04
HMSE	Post-final ECT	25.83	26.69	0.02
RAVLT immediate recall	Post-final ECT	25.45	26.66	0.03
RAVLT delayed recall	Post-final ECT	27.52	28.45	0.03
Subjective memory complaint (patient)	Post-final ECT	25.89	26.72	0.03
Subjective memory complaint (caregiver)	Post-final ECT	28.86	29.69	0.01
Autobiographical memory	Post-final ECT	25.61	27.02	0.02
Digit symbol substitution test	Post-final ECT	28.39	28.76	0.03
Visual memory retention	Post-final ECT	28.21	28.51	0.01
Visual memory recognition	Post-final ECT	24.55	26.32	0.01
Letter number sequencing	Post-final ECT	26.19	27	0.04

HMSE: Hindi mental status examination, RAVLT: Rey auditory verbal learning test, ECT: Electroconvulsive therapy

clearly show that although some level of cognitive decline occurred in both groups, patients who received ultra-brief pulse ECT experienced significantly better preservation of cognitive functions, particularly in areas such as memory, attention, and executive skills.

When we look at similar research from India, our findings are quite consistent. Ramesh et al. (2023) carried out a study in Bengaluru and reported that ultra-brief pulse ECT resulted in fewer cognitive deficits compared to brief pulse ECT, particularly improving memory and attention scores assessed by the MMSE and Digit Span tests.[10] Likewise, Sharma et al. (2022) at AIIMS Rishikesh found that patients undergoing ultra-brief pulse ECT, especially those with bipolar disorder, had better cognitive outcomes in verbal memory and autobiographical recall than those treated with brief pulses.[11] These Indian studies support the conclusion that ultra-brief pulse stimulation helps in better preserving cognitive function in the Indian psychiatric population.

International research also mirrors these findings. In a randomized controlled trial by Heath et al. (2021), it was demonstrated that ultra-brief pulse bitemporal ECT led to significantly less cognitive impairment without sacrificing

clinical efficacy in treating depression.[12] Similarly, a review by Verwijk et al. (2012) noted that ultra-brief pulse ECT, especially when applied unilaterally, consistently showed reduced cognitive side effects compared to brief pulse ECT.[13] Together, these international studies validate the benefits of using ultra-brief pulse widths, especially for maintaining cognitive health alongside therapeutic improvement.

In this study, the patient distribution across psychiatric diagnoses was well-balanced (Table 1), minimizing any bias that could have skewed cognitive results. Schizophrenia, bipolar mania, and bipolar depression groups particularly benefited from the ultra-brief approach in terms of cognitive preservation, aligning with existing literature. Interestingly, among patients with severe depression, both brief and ultra-brief groups showed similar cognitive outcomes. This could be due to the fact that severe depressive episodes inherently cause cognitive impairments that are less influenced by ECT parameters.[14]

Another noteworthy finding was the lower seizure threshold seen in the ultra-brief group, a trend that has been recognized in earlier work.[10] Despite needing slightly higher total stimulation over multiple sessions, the ultra-brief group still showed superior cognitive outcomes. This emphasizes that it is the pulse width – rather than just total dose – that plays a crucial role in cognitive side effects.

Detailed cognitive testing showed that areas such as autobiographical memory, visual memory retention, attention (as assessed by the DSST), and working memory were better preserved in the ultra-brief group. This is consistent with the understanding that ultra-brief stimulation causes less disruption in frontotemporal brain regions critical for cognitive functioning.[13]

The strengths of this study include its randomized design, the use of validated Indian cognitive tools (HMSE and B4ECT-ReCoDe), and its focus on a rural population, offering insights where research is usually scarce.

In short, our study reinforces the growing preference for ultra-brief pulse ECT, both nationally and internationally. This approach seems to achieve a better balance between therapeutic benefits and cognitive safety, making it a highly viable option for clinicians aiming to minimize cognitive side effects while still delivering effective treatment.

Limitations of the study

This study has a few limitations that are important to keep in mind. First, the number of participants was relatively small, which means the results might not apply to all patient groups or settings. Since the study was done in a single rural hospital, the findings may not fully reflect outcomes in more urban or varied healthcare environments. Also, the follow-up period was short, so we couldn't explore how cognitive effects might evolve over time. While culturally adapted tools were used for assessment, individual differences in language and understanding might still have influenced some responses.

CONCLUSION

This study highlights that ultra-brief pulse ECT offers superior cognitive preservation compared to brief pulse ECT, particularly in schizophrenia, schizoaffective disorder, bipolar mania, and bipolar depression. While cognitive decline was observed in both groups, ultra brief stimulation consistently resulted in less impairment across memory, attention, and executive functions. In severe depression, however, cognitive outcomes were similar between groups, suggesting illness severity may influence results. These findings support the adoption of ultra-brief pulse ECT when minimizing cognitive side effects is a priority. Future research should explore longer-term cognitive trajectories and identify neurobiological predictors to guide more personalized ECT protocols.

ACKNOWLEDGMENT

A special thanks to the Head of Department, esteemed faculty members, senior residents, and postgraduate residents of the Department of Psychiatry, Hind Institute of Medical Sciences, Sitapur, for their constant support, guidance, and encouragement throughout the course of this study. Their valuable insights and collaborative spirit made this work possible.

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Source of Funding: None, **Conflicts of Interest:** None.