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Case Report

Preserved Cochlear Implant Function After Multiple Electroconvulsive Therapy Treatments

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This case report presents the successful use of multiple treatments of electroconvulsive therapy (ECT) in a patient with a cochlear implant (CI). A 60-year-old man with a left-sided CI and bipolar disorder presented with severe depression. A total of 9 separate sessions of unilateral ECT was administered to the contralateral side of the existing CI. We collected subjective, clinical, and audiological assessment of the patient and the CI prior, during, and after ECT therapy. The patient tolerated ECT well and there were no complications. Unilateral ECT was performed contralateral to the CI without any harm to the patient or implant.

Key Words: Cochlear implant, electroconvulsive therapy, impedances, cochlear implant user, depression, bipolar disorder.

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INTRODUCTION

Electroconvulsive therapy (ECT) is a well-known treatment for psychiatric disorders refractory to psychopharmaceutical management. Currently, cochlear implant (CI) manufacturers and the United States Food and Drug Administration caution against the use of ECT in CI users due to concern for thermal injury or device damage via electrical conduction. However, there is a paucity of data to assess the degree of caution required.[1]

A prior cadaveric study demonstrated preserved impedances after 12 sessions of ECT were delivered to five contralaterally placed CIs and five ipsilaterally placed CIs.[2] The effects of ECT on living patients with CIs have been previously discussed in a letter to the editor[3] and two case reports.[4,5] The published letter described a clinical scenario where ECT therapy was considered for a 35-year-old right-sided CI user with severe depression. That consultant otolaryngologist advised against the use of ECT, fearing current damage to the cochlea, and the patient was treated with two antidepressants. The authors noted, however, that there is no evidence to support that ECT may destroy the cochlea or CI.[3]

In a 2010 case report, Labadie et al.[4] reports the successful use of ECT in 17-year-old CI user for delirious mania. Notably, the patient only received a total of two treatments. This case study did not report any adverse effects; however, the treatment series was significantly shorter than what is commonly used in clinical practice. Although the CI was replaced 4 months later due to pain at the site of the external processor, the authors state that electrical integrity testing demonstrated no CI damage. A 2019 Danish case study[5] presented a 78-year-old CI user who underwent 13 contralateral ECT treatments for severe depression. The author reported no complications or CI damage with a current dose of 806mC to 1008mC, but it is unclear what device or audiologic measurements were used to verify preserved CI function after ECT. Here we report preserved CI function using clinical and audiologic measurements after ECT treatments for a CI user with severe depression.

CASE REPORT

The patient is a 60-year-old man with a history of Meniere's disease who had previously undergone an endolymphatic sac procedure with left-profound sensorineural hearing loss and tinnitus. In addition, he has a history of bipolar I disorder with severe depressive states requiring ECT. He completed seven outpatient treatments in 2014 without cognitive side effects. At the completion of his ECT therapy, the patient reported alleviation of his presenting symptoms and improved Patient Health Questionnaire-9 (PHQ-9) Depression scores.

Four years later, the patient presented to the otolaryngology service with left-sided severe sensorineural hearing loss, intact right-sided hearing, and left-sided debilitating. The tinnitus became so severe that the patient reported suicidal ideation. In October 2018, the patient underwent left-sided cochlear implantation with a Cochlear CI522 Slim Straight electrode array (Cochlear Americas, New South Wales, Australia). Post-operatively,

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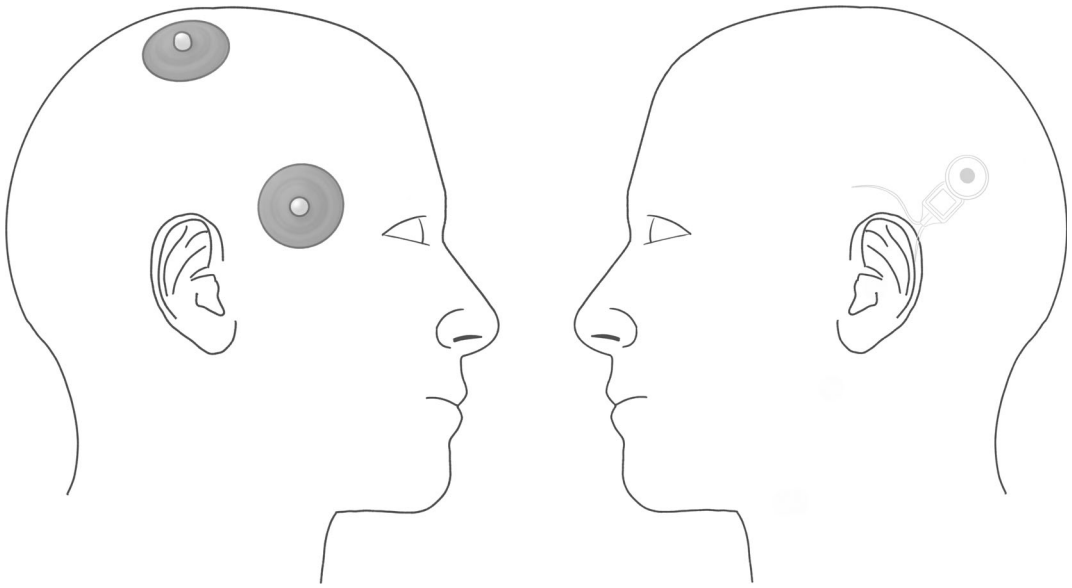

Fig. 1. Electrode placement for electroconvulsive therapy in a cochlear implant user. For right unilateral placement, one electrode is placed in the right frontal temporal position and the second electrode is placed to the right of the vertex. The cochlear implant internal processor (embedded beneath the scalp) is ideally on the contralateral side, as seen in this schematic illustration.

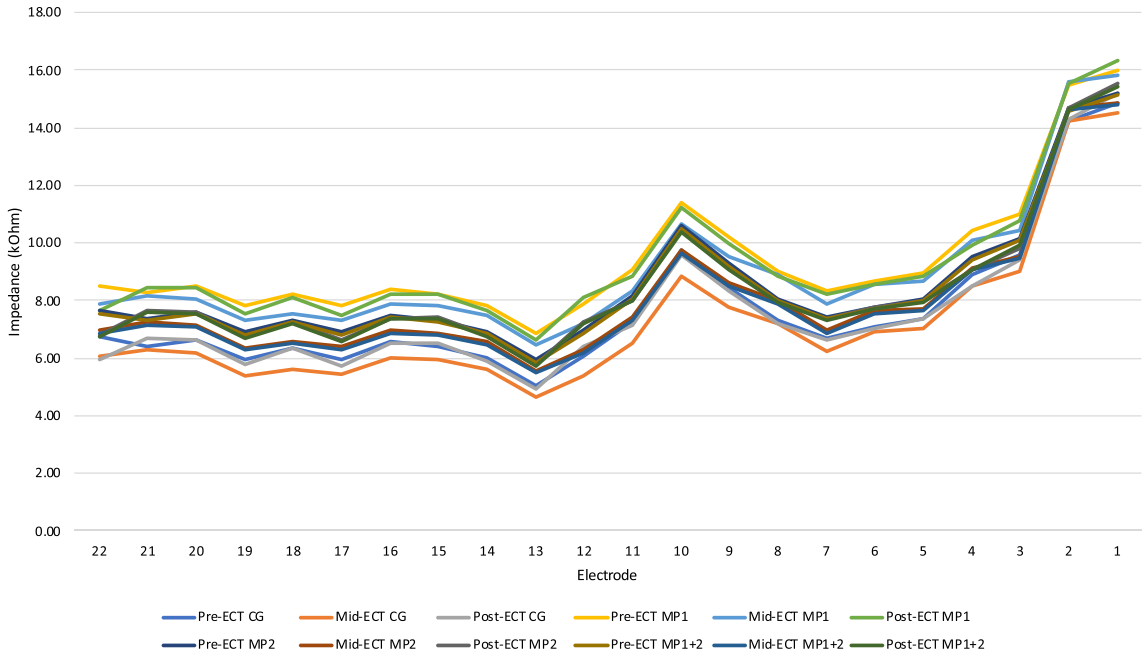

Fig. 2. Pre-, mid-, and post-electroconvulsive therapy impedance measurements. Impedance (a measure of resistance to current flow) measurements are used by audiologists to assess cochlear implant function. Shifts in impedance values may be due to resistivity in the electrode-tissue interface, the fluid-tissue medium, an/or the electrode contact and lead wires themselves. All four impedance modes were tested, which include: 1) Common-ground (CG); 2) Monopolar 1 (MP1); 3) Monopolar 2 (MP2); Monopolar 1 + 2 (MP1 + 2).

the patient reported satisfaction with his CI in terms of tinnitus suppression and sound perception.

In May 2020, the patient presented again with severe depression refractory to antidepressants, transcranial magnetic stimulation, and psilocybin trials. Given his prior success with ECT and the patient's severe depression, repeat ECT therapy was cautiously considered. Because of the severity of the patient's depression and the desire for rapid intervention, the decision was made to proceed with unilateral ECT with close monitoring but without CI removal (Fig. 1).

Pre-interventional impedances were obtained the week prior to ECT. Between July 15, 2020 to August 10, 2020, the patient underwent a total of nine outpatient

TABLE I.
Pre-, Mid-, and Post-Electroconvulsive Therapy Impedance Values.

Electrode	Pre-ECT CG	Mid-ECT CG	Post-ECT CG	Pre-ECT MP1	Mid-ECT MP1	Post-ECT MP1	Pre-ECT MP2	Mid-ECT MP2	Post-ECT MP2	Pre-ECT MP1 + 2	Mid-ECT MP1 + 2	Post-ECT MP1 + 2
22	6.72	6.06	5.96	8.53	7.89	7.66	7.63	6.96	6.80	7.55	6.89	6.76
21	6.43	6.27	6.70	8.29	8.18	8.47	7.37	7.24	7.64	7.30	7.16	7.59
20	6.63	6.16	6.64	8.53	8.07	8.44	7.61	7.15	7.60	7.53	7.07	7.55
19	5.94	5.38	5.78	7.83	7.30	7.57	6.92	6.37	6.74	6.83	6.29	6.68
18	6.34	5.63	6.34	8.24	7.53	8.12	7.33	6.60	7.27	7.25	6.52	7.23
17	5.96	5.44	5.71	7.81	7.33	7.46	6.90	6.38	6.63	6.81	6.30	6.55
16	6.58	6.03	6.50	8.42	7.89	8.23	7.50	6.96	7.39	7.41	6.88	7.35
15	6.43	5.96	6.54	8.24	7.81	8.25	7.33	6.87	7.41	7.26	6.80	7.38
14	6.03	5.63	5.92	7.85	7.48	7.66	6.94	6.55	6.82	6.87	6.48	6.76
13	5.02	4.65	4.91	6.84	6.48	6.62	5.93	5.55	5.77	5.86	5.48	5.72
12	6.05	5.37	6.39	7.87	7.20	8.10	6.95	6.27	7.26	6.87	6.20	7.23
11	7.26	6.50	7.16	9.07	8.34	8.86	8.16	7.41	8.01	8.07	7.33	7.97
10	9.73	8.85	9.59	11.41	10.66	11.25	10.58	9.74	10.42	10.50	9.66	10.39
9	8.46	7.79	8.35	10.20	9.55	9.98	9.28	8.63	9.13	9.20	8.53	9.09
8	7.29	7.18	7.22	9.00	8.90	8.82	8.08	7.97	7.96	8.00	7.89	7.92
7	6.68	6.22	6.65	8.35	7.89	8.21	7.45	6.96	7.37	7.37	6.89	7.33
6	7.07	6.92	7.05	8.69	8.56	8.57	7.77	7.63	7.75	7.70	7.56	7.70
5	7.40	7.05	7.36	8.97	8.65	8.82	8.06	7.72	8.00	7.99	7.63	7.94
4	8.90	8.52	8.49	10.43	10.07	9.94	9.53	9.15	9.09	9.44	9.07	9.07
3	9.56	9.00	9.44	10.99	10.43	10.78	10.18	9.55	9.84	10.10	9.48	9.91
2	14.23	14.24	14.29	15.48	15.61	15.54	14.67	14.71	14.72	14.60	14.64	14.64
1	14.84	14.51	15.20	16.00	15.80	16.36	15.21	14.89	15.52	15.12	14.81	15.44

All four impedance modes were tested, which include: 1) Common-ground (CG); 2) Monopolar 1 (MP1); 3) Monopolar 2 (MP2); Monopolar 1 + 2 (MP1 + 2). Impedance units were measured in kOhm. Electrode 22 is the most apical electrode contact. Electrode 1 is the most basal electrode contact.

ECT = electroconvulsive therapy.

ECT treatments with the Thymatron System IV machine (Somatics, LLC, Venice, Florida) and right unilateral lead placement. The settings were 10% energy (~10 J) with pulse-width of 0.25 ms for the initial treatment, and 60% energy (~60 J) for subsequent treatments. At the end of nine ECT treatments, the patient reported complete clinical improvement and appeared to be euthymic with a PHQ-9 score of 12. CI impedance testing were rechecked 2 weeks into ECT (after seven treatments) and at the conclusion of ECT treatment (after nine treatments), which was within normal limits among all electrodes and stable compared to his pre-ECT treatment baseline (Fig. 2; Table I). At both audiology appointments, the patient reported no changes in hearing status or the sound quality of his CI. His intermittent tinnitus was unchanged. There were no reported symptoms of pain or vertigo.

DISCUSSION

Due to current guidelines and clinical practices, patients that are offered ECT have often exhausted pharmacological and psychotherapy trials. This perception may change with increasing literature supporting earlier use of ECT for bipolar disorder or severe depression. Furthermore, more instances will occur where ECT is considered in a CI user as the incidence of cochlear implantation continues to rise.

One way to reduce the electrical energy risks is through ECT positioning. Within the psychiatric community, right unilateral and bifrontal placement are preferred to reduce side effects. Bilateral placement is reserved for patients whom the latter positions have been inadequate or if the patient has prominent symptoms of catatonia or psychosis. Although prior studies revealed no difference in efficacy between left versus right and unilateral versus bilateral electrode placement, unilateral right-sided placement is associated with less cognitive side effects. Patients who received left unilateral ECT were more likely to experience verbal memory impairment; however, they were less likely to experience visual and nonverbal memory impairment than patients undergoing right unilateral and bilateral ECT.

While this case of right unilateral ECT in a patient with a left CI was successful, this is a single case report and a case series would be more supportive of the safety of ECT in CI users. As described above, patients with right-sided CIs could be treated with left unilateral ECT with minimal diminution of efficacy. It remains unclear if bilateral ECT would have any adverse effect on CIs.

CONCLUSION

This case report demonstrated preserved CI functionality, unchanged sound quality, and no patient harm after multiple ECT sessions for severe depression. More studies are needed to evaluate the indications and current guidelines of using ECT in CI users.

CONFLICT OF INTEREST

C.J.L. serves as a member of the Advanced Bionics Medical Advisory Board. He has served as Scientific Chair of the Music Advisory Board for MED-EL Corporation. He also serves as Chief Medical Officer and consultant for Spiral Therapeutics. He receives research funding and support from Advanced Bionics Corporation, Oticon Medical, and MED-EL Corporation.

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