Headache
© 2018 American Headache Society
ISSN 0017-8748
doi: 10.1111/head.13258
Published by Wiley Periodicals, Inc.

# Brief Communications

## Case Report of the Safety Assessment of Transcranial Magnetic Stimulation Use in a Patient With Cardiac Pacemaker: To Pulse or Not to Pulse?

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**Background.—Single-pulse transcranial magnetic stimulation (sTMS) is an emerging neuromodulation method reported to be useful in migraine. Despite a low propensity for side effects, some concern with its use in patients with cardiac pacemakers has been expressed.**

**Case.—We present a patient with chronic migraine with a cardiac pacemaker, who had tried unsuccessfully several migraine preventives with either poor efficacy or tolerability. With involvement of the cardiology team, we tested the effect of sTMS on her pacemaker and found it to be a safe and effective option for her.**

**Conclusion.—Having regard to the risk/benefit ratio of sTMS, its use in patients with disabling migraine in the presence of a cardiac pacemaker can be carefully evaluated and may represent a useful therapeutic option.**

**Key words: transcranial magnetic stimulator, pacemaker, migraine**

**Abbreviations: ECG electrocardiogram, PPM permanent pacemaker, sTMS single-pulsed transcranial magnetic stimulator**

(*Headache* 2018;58:295-297)

### CASE

We reviewed a 78-year-old woman with chronic migraine for over 25 years, which worsened gradually in severity in the preceding 5 years. She presented with daily and continuous biparietal and occipital throbbing pain that became a sharp shooting pain during worsenings. The baseline pain was 7/10 intensity with daily worsenings to 9/10 intensity. The headache was associated with phonophobia and localized cranial allodynia. During the worsenings, she had nausea. There was no photophobia, phonophobia, or osmophobia. There was no effect of movement sensitivity. There was no associated aura; she occasionally had bilateral lacrimation and aural discomfort with the headache worsenings.

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**Accepted for publication December 11, 2017.**

*Conflict of Interest*: D.Y. Wei, F.S. Greenwood, and F.D Murgatroyd have no disclosures. P.J. Goadsby reports personal fees from Allergan, Amgen, and Eli Lilly and Company; and personal fees from Akita Biomedical, Alder Biopharmaceuticals, Cipla Ltd, Dr. Reddy's Laboratories, eNeura, Electrocore LLC, Novartis, Pfizer Inc, Quest Diagnostics, Scion, Teva Pharmaceuticals, Trigemina Inc., Scion; and personal fees from MedicoLegal work, Journal Watch, Up-to-Date, Massachusetts Medical Society, Oxford University Press; and in addition, Dr. Goadsby has a patent Magnetic stimulation for headache assigned, without fee, to eNeura.

She had tried preventives in the past without any benefit and had side effects. She tried amitriptyline 10 mg, candesartan 16 mg, gabapentin 100 mg, and pizotifen 0.5 mg; all of them caused confusion and made her feel spaced out and therefore she was not able to tolerate titration of the drugs to therapeutic doses. She did not find lisinopril 20 mg and fluoxetine 20 mg helpful. Bilateral greater occipital nerve injections, not done by us, were not useful, and may have aggravated the headache.

She had a dual chamber rate responsive cardiac permanent pacemaker (PPM) (Symphony DR 2550, Sorin Biomedica, Gloucester, UK) inserted in 1997 for an otherwise undefined bradycardia. We confirmed the pacemaker was only pacing the ventricle 1% of the time and therefore she was not pacer dependent.

We had discussed onabotulinumA injections as a treatment option for her chronic migraine; however, she preferred a nonpharmacological option as she had tried several migraine preventives and could not tolerate the side effect profiles. Therefore, we discussed using the single-pulse transcranial magnetic stimulator (sTMS) as an alternative migraine management option. Given that she was not pacer dependent, any potential electrical interference from the sTMS would only be transient.

We admitted her to the cardiac lab, with the support of cardiology and cardiac pacing physiologists, and we interrogated the PPM and performed 12-lead ECG prior administering the sTMS pulses. She was continually monitored during the administration of two consecutive sTMS pulses. The sTMS pulses did not have any effect on her ECG or on her pacemaker. The subsequent 12-lead ECG did not show any change and she remained in an atrial paced rhythm.

She was advised to use two pulses in the morning and evening for a month. She did not have any side effects and she had a PPM interrogation after a month, which did not show any effects of the sTMS on the PPM.

The patient provided informed consent for this publication.

## DISCUSSION

Neuromodulation approaches to migraine prevention are increasing in use. Single-pulse transcranial magnetic stimulation (sTMS) is one such approach that may be preferable given its low side effect profile.[1] sTMS produces a magnetic field of 1.5 T to the surface of the scalp. The field penetrates the scalp and induces current in the subjacent cortex. As currently used, sTMS is believed to generate electrical fields in the cortex of up to 150 V/m and to reach cortical depths between 1.5 and 3 cm below the skull surface. This induced electric field causes depolarization or hyperpolarization.[2] The magnetic field emitted by the sTMS can induce large voltages in nearby wires and electronic devices,[3] and cardiac pacemakers have been considered a contraindication because of the potential for the sTMS to dislodge them or induce electrical currents.[4] However, according to the Safety of TMS Consensus Group, sTMS is considered safe in individuals with vagal nerve stimulatory systems, cardiac pacemakers, and spinal cord simulators as long as the TMS coil is not activated near the active components in the neck or chest.[3] Hizli Sayar and colleagues reported on the safety of using repetitive TMS in a depressive patient with a cardiac pacemaker, over the course of six sessions per week.[5]

It is considered that the only absolute contraindication to TMS is the presence of metallic hardware in close contact to the discharging coil[2] and history of seizures;[4] therefore, patients with PPMs can be considered for sTMS treatment for disabling migraine, with the appropriate cardiology input, continuous ECG monitoring during sTMS administration, and PPM interrogation before and after sTMS administration. It is important to continue regular PPM interrogation and have a low threshold to check for lead migration with use of chest x-ray with continued use for patient safety.

## STATEMENT OF AUTHORSHIP

### Category 1

**(a) Conception and Design**

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**(b) Acquisition of Data**

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**Category 3**

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## REFERENCES

1. Lipton RB, Dodick DW, Silberstein SD, et al. Single-pulse transcranial magnetic stimulation for acute treatment of migraine with aura: A randomised, double-blind, parallel-group, sham-controlled trial. *Lancet Neurol.* 2010;9:373-380.
2. Barker AT, Shields K. Transcranial magnetic stimulation: Basic principles and clinical applications in migraine. *Headache.* 2017;57:517-524.
3. Rossi S, Hallett M, Rossini PM, Pascual-Leone A; and The Safety of TMS Consensus Group. Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation in clinical practice and research. *Clin Neurophysiol.* 2009;120:2008-2039.
4. Dodick DW, Schembri CT, Helmuth M, Aurora SK. Transcranial magnetic stimulation for migraine: A safety review. *Headache.* 2010;50:1153-1163.
5. Hizli Sayar G, Şalçini C, Tarhan N. Transcranial magnetic stimulation in a depressive patient with cardiac pacemaker. *J ECT.* 2016;32:e22-e23.