A new device to improve target localization for transcranial magnetic stimulation therapy

ABSTRACT

Background: Accurate identification of cranial midline structures is essential for many targeting techniques that use repetitive transcranial magnetic stimulation (rTMS), including the Beam F3 method used for depression treatment.

Objective: Evaluate whether a novel, laser-sighted device will assist with more accurate identification of the cranial midline relative to standard scalp-based measurement procedures.

Methods: Three trained TMS technicians performed repeated scalp-based measurements to identify the inion and vertex on five subjects (n = 54 measurements). Measurements were compared to points identified with the midline localizer device and the true midline as defined by MRI midline structures.

Results: Use of the midline localizer was more accurate for midline identification than technician measurement (p = 0.00025) and the ratio of localizing the midline within 5 mm was higher (78% versus 54%, p = 0.008).

Conclusion: Use of a laser-sighted midline localizer device can improve the accuracy of scalp measurements associated with target localization for rTMS treatment protocols.

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Dear editor:

Repetitive transcranial magnetic stimulation (TMS) is an FDA-approved treatment for major depressive disorder when targeted at the left prefrontal cortex [1]. However, the optimal cortical target within the left prefrontal cortex and the ideal method for identifying the target are unclear [2–4]. One of the most commonly used targeting methods, Beam F3, utilizes scalp landmarks to identify a left prefrontal brain region that corresponds with the F3 location of a 10–20 EEG measurement system [5]. The reliability of target identification with Beam F3 requires accurate identification of the cranial midline at the inion of the skull and the cranial vertex. To date, little research exists to examine the reliability and reproducibility of identification of these cranial midline targets, though the introduction of any error in these measurements would compromise successful target localization. Here we aim to test whether a novel laser-sighted device is capable of improving midline localization by quickly and efficiently minimizing measurement error relative to standard scalp-based measurement procedures.

We designed a horseshoe-shaped device, termed the “cranial midline localizer,” or more colloquially, the “wishbone.” It is adjustable to head size, with “calipers” that anchor in the bilateral external auditory canals with metallic spheres (Fig. 1A). A laser sight is located at the top of the device with a sighting mechanism to ensure the laser consistently illuminates the midpoint between the two metallic spheres. The device can swivel around its anchor point in the auditory canals, allowing identification of midline targets at any point along the mid-sagittal plane. For the purposes of this study, the device was used to plot points at the midline vertex and inion/occiput of the head (see supplementary online video).

Five young healthy subjects, four male, ages of 29–44 (mean 35.4) were recruited for the study. A second replication sample was obtained (measurements by 3 technicians across 7 subjects, four male, ages 20–44; mean 31.9). The study was approved by the University of Iowa Institutional Review Board and all subjects signed consent.

A T1-weighted structural MRI was obtained on a 7T GE MR950 scanner within 30 days of participation. Images were resampled to 1 mm isotropic voxels and the intensity range was truncated to standardize values from air-to-scalp-to-skin. The processed images were loaded into Brainsight neuronavigation equipment (Rogue Research, Montreal, Quebec) for measurement.

Three trained TMS technicians performed repeated scalp measurements on each of the 5 subjects at various time points over the course of one month (n = 54 measurements, 27 at each of two targets; 6 to 18 measurements per subject). Two targets were investigated: 1) the vertex compared to the falx cerebri midline on MRI, and 2) the inion/midline occiput compared to an MRI-defined midline occiput. This MRI occiput was identified by a posterior point in the mid-sagittal plane that bisected the falx cerebi, third ventricle, and cerebral aqueduct. A second sample including only vertex measurements was also analyzed (3 technicians x 3 time points = 9 measurements per subject x 7 subjects = 63 measurements - 1 lost data point = 62 measurements). Technicians used visual inspection, palpation of scalp landmarks, and tape

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The wishbone is a novel device designed to optimize target localization for transcranial magnetic stimulation (TMS) therapy. It improves the accuracy of identifying midline landmarks, which are crucial for targeting brain regions. The device consists of several components, including an external auditory canal sphere, a laser pointer, and various arms for different functions.

The wishbone was evaluated in a study where it was compared to technician-based measurements. The main findings were:

- The wishbone resulted in 78% accuracy within 5 mm of the actual midline compared to 54% for technician measurements (p = 0.008, chi-square).
- This was a significant improvement, with a 24% increase in accuracy compared to technician measurements.

The study also highlighted the importance of having a reliable identification of the midline, as it directly impacts the accuracy of TMS treatments. The wishbone, therefore, provides a valuable tool for improving the precision of TMS therapy.

Conflicts of Interest/Financial Disclosure

The University of Iowa has filed a provisional patent application for the Wishbone device. Drs. Zanaty, Holland, and Howard are listed as inventors. There are no other financial disclosures or conflicts of interest to report for any of the authors.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brs.2019.07.028.

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