

Preliminary Results of Novel Noninvasive Cortical Modulation using Transcranial Rotating Permanent Magnet Stimulator in Improving Voiding Dysfunction in Female Multiple Sclerosis Patients

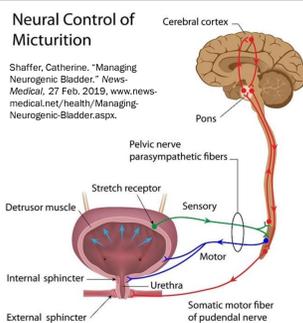
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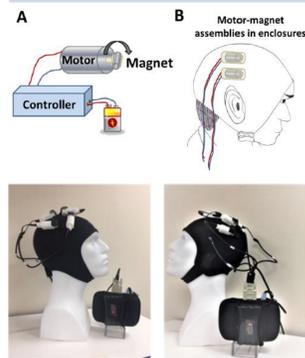
This pilot clinical trial investigates the therapeutic effects of Transcranial Rotating Permanent Magnet Stimulator (TRPMS) – a *noninvasive, multifocal, individualized* cortical stimulation device – in improving voiding dysfunction in female multiple sclerosis patients. Following two weeks of TRPMS treatment, patients showed more activation in brain regions involved in the micturition circuit, reflected in significant subjective and objective clinical improvement in voiding.

Background and Rationale

- Voiding dysfunction (VD)
 - Common in neurogenic patients such as multiple sclerosis (MS).
 - Only available therapies with modest effectiveness for VD is catheterization.
- Rationale: Shift treatment focus from the bladder to the brain.



Cortical regions	Task	Stimulated/Inhibited?
Right inferior frontal gyrus (IFG)	Voiding initiation	Stimulated (40 mins)
Left dorsolateral prefrontal cortex (dlPFC)	Depression mitigation	Stimulated (40 mins)
Bilateral supplementary motor area (SMA)	Pelvic floor contraction	Inhibited (10 mins)
Right middle frontal gyrus (MFG)	Pelvic floor contraction	Inhibited (10 mins)
Right dorsolateral prefrontal cortex (dlPFC)	Anxiety	Inhibited (10 mins)



Transcranial Rotating Permanent Magnet Stimulator (TRPMS)

- Simultaneously modulates (stimulates/inhibits) multiple cortical regions, using oscillating magnetic field.
- Noninvasive, multifocal, portable, individualizable, tablet/smartphone-controlled.

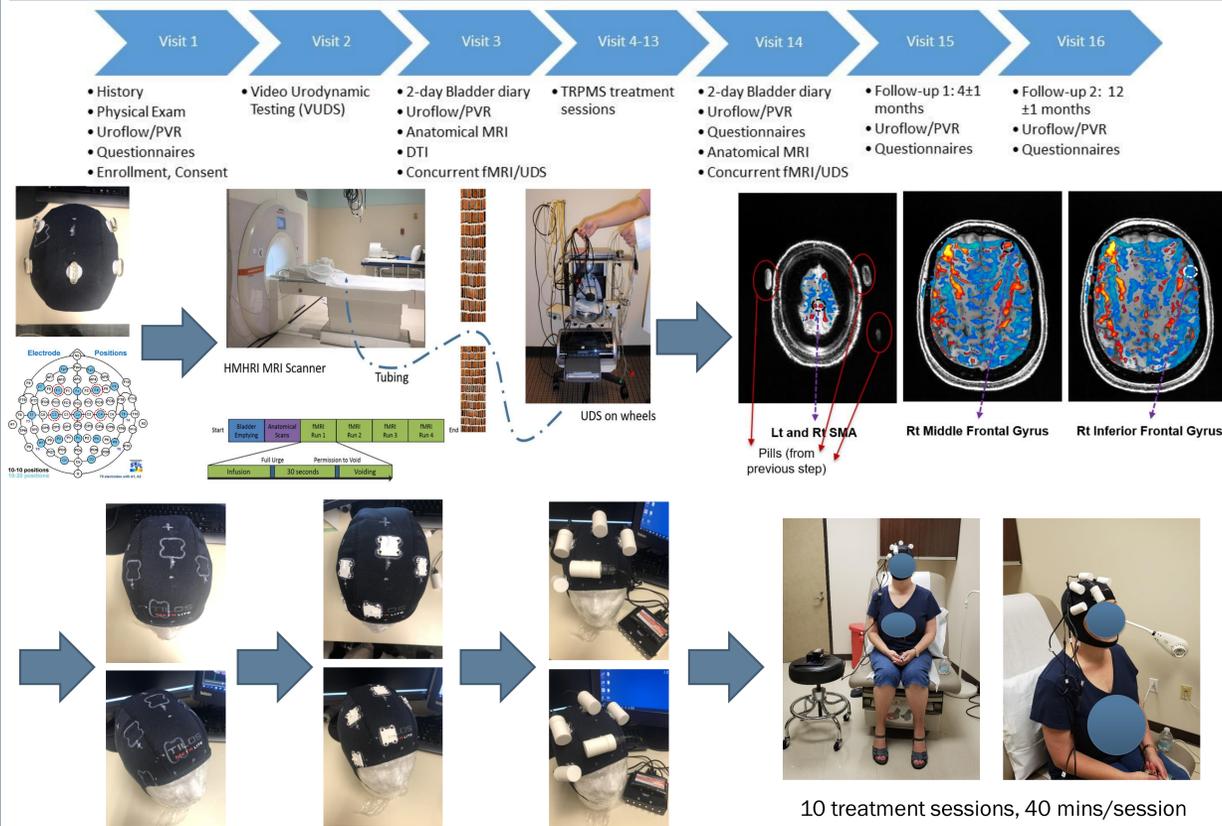
Objectives

- To assess blood-oxygen-level-dependent (BOLD) activation following TRPMS treatment in MS patients with VD.
- To evaluate subjective improvement (via urodynamic (UDS) and objective improvement (via validated questionnaires) in VD symptoms following TRPMS treatment.

Subjects

- Ambulatory female MS patients with VD (n=6), defined as:
- Having post-void residual $\geq 40\%$ of bladder capacity; or
 - Falling below 10th percentile on Liverpool nomogram; or
 - Performing self-catheterization.

Methods



Results: Neuroimaging data

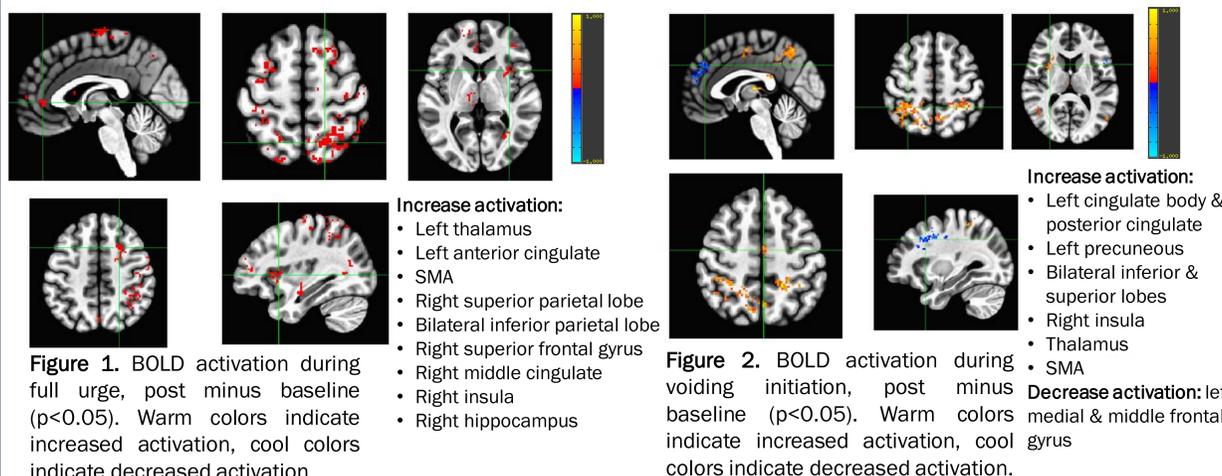


Figure 1. BOLD activation during full urge, post minus baseline ($p < 0.05$). Warm colors indicate increased activation, cool colors indicate decreased activation.

Figure 2. BOLD activation during voiding initiation, post minus baseline ($p < 0.05$). Warm colors indicate increased activation, cool colors indicate decreased activation.

Results: Clinical data

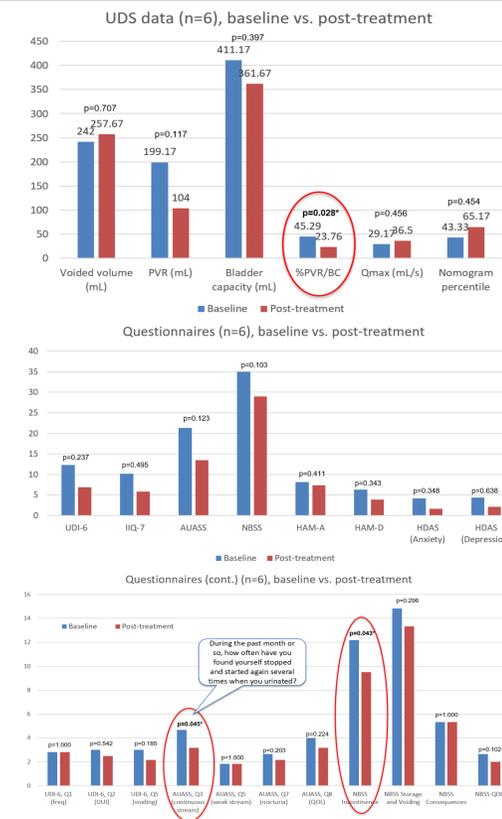


Figure 3. Paired t-tests ($\alpha < 0.05$) were performed to compare clinical data at baseline vs. post-treatment.

Top: UDS; Middle: validated questionnaires; Bottom: questions regarding voiding symptoms.

Asterisk indicates significant difference ($p < 0.05$), which is also circled in red.

Conclusions

- After treatment:
 - More activation in brain regions involved during full urge and voiding initiation, including deeper brain regions.
 - Significant clinical improvement in %PVR/BC (objective).
 - Significant clinical improvement in some questionnaires regarding voiding symptoms (subjective).
- Cortical modulation might have helped increase the strength of connectivity of the voiding network, hence produced significant changes in deeper regions involved in the micturition circuit, resulting in clinical improvement.

Acknowledgements

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