Neuromodulatory intervention using non-invasive brain stimulation (NIBS) can target areas of the brain such as the motor cortex for recovery following stroke and may be paired with rehabilitation.1,3 Although results show promise, understanding how NIBS impacts other systems such as the autonomic nervous system (ANS) is not known. One form of NIBS, transcranial magnetic stimulation (TMS), may be used as a test or repetitively as an intervention (rTMS) to influence cortical excitability. Combining ANS and TMS assessment may provide unique insight into responses to NIBS.

TMS—One form of NIBS

• TMS involves using a magnetic coil to provide a cortical stimulus to the central nervous system in a targeted location such as the primary motor cortex (M1) (Figure 1a-b).
• Muscular responses to TMS are measured using surface electromyography (EMG).
• Stimulating a child’s brain using NIBS, may elicit individual responses (e.g. anxiety, stress, subtle side effects) and carries the risk of adverse events (e.g. seizure or vasovagal response).
• TMS has demonstrated an effect on blood pressure (BP) with the activation of the sympathetic nervous system.4
• Evidence suggests that when used as an intervention, rTMS can modulate sympathetic activity and thereby alter the ANS.4,5
• Therefore, by monitoring the ANS during TMS testing, we aim to 1) determine the feasibility and tolerance of measuring the ANS 2) gain a comprehensive assessment of ANS responses and 2) measure of safety and tolerance for intervention in children.

Methodology

Rationale for TMS/ANS Study

• Analyze the physiological effects of NIBS using ANS monitoring
• Potentially prevent an adverse event from occurring through early identification
• Contribute to a greater understanding of the role of the ANS impacting functional change following NIBS interventions.

Table 1. Feasibility considerations for concurrent ANS and EMG monitoring in children.

<table>
<thead>
<tr>
<th>Feasibility Considerations</th>
<th>Strategy</th>
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<tbody>
<tr>
<td>Signal interference from ANS equipment can occur when using concurrent EMG recording.</td>
<td>Repositioning the ANS equipment and intermittent use of the finger cuff for monitoring during different components of the testing protocol can reduce signal noise present in EMG data.</td>
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<tr>
<td>Periods of quiet rest are needed to record baseline activity.</td>
<td>Behavioral strategies that create procedural predictability aid in supporting the child’s tolerance and achievement of the quiet rest periods.</td>
</tr>
<tr>
<td>Monitoring equipment may influence child’s tolerance for completing TMS testing.</td>
<td>Developmentally appropriate explanations and behavioral strategies such as visual schedules or visual timers may ease anticipatory anxiety.</td>
</tr>
</tbody>
</table>

Figure 4. Pilot ANS data. Red trace: ECG recording, Blue trace: Raw blood pressure signal, Purple trace: TMS stimulus. Horizontal axis: time in minutes. The large purple vertical line denotes TMS stimulus tracking.

Figure 5. Sample concurrent monitoring set-up. EMG leads are on the thumb side of the hand with red and black EMG wires. Non-invasive blood pressure monitoring is the cuff on the ring finger.

Significance

• Our pilot data suggests that ANS techniques can be well-tolerated by children with the use of environmental and behavioral strategies.
• ANS monitoring during NIBS may provide valuable information regarding alterations in BP and HR that may be directly or indirectly caused by NIBS.
• ANS monitoring may be helpful for early identification of BP and HR changes that may lead to syncope or other rare adverse events.
• ANS assessment may contribute to understanding how children respond to NIBS.

References


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