Introduction to the Portable Neuromodulation Stimulator (PoNS™) Device and Effects on Balance and Gait for Individuals with Traumatic Brain Injuries

Kati P. Liegl, Kathy L. Rust, Roger O. Smith, Ph.D., OTR, FAOTA, RESNA Fellow

Abstract

The Cranial Nerve Non-Invasive Neuromodulation (CN-NINM) intervention is a novel rehabilitation tool to improve functional gait and balance for people with traumatic brain injuries. The intervention has been tested on various disability groups and is being evaluated around the world. This review and case study highlights the need to document carry-over effects in addition to reporting benefits. During this A-B-A-B study, scores during the second withdrawal period are expected to stay slightly higher than the first withdrawal. This study adds to available research on the new intervention device and technique which may have significant effects on rehabilitation services.

Theoretical Background

Neurorehabilitation utilizes neuroplasticity of the brain to restructure and relearn information after a neurotrauma. A related field, neuromodulation, alters the nervous system with electrical and magnetic stimulation to provide information-free stimulation. This intervention was created Cranial Nerve Non-Invasive Neuromodulation (CN-NINM) and used the Portable Neuromodulation Stimulator (PoNS™) device. The PoNS™ was the first device to provide information-free stimulation.

BrainPort™ Balance Device

During sensory substitution studies, researchers and participants noted additional changes in function such as reduced pain, improved gait, and improved concentration. These changes led to another line of research for additional uses of the technology. The first device that came from this line of research, the BrainPort™ balance device, used electrical stimulation of the tongue to provide biofeedback for balance. Participants again reported additional functional changes in addition to improved balance, leading researchers to initiate another line of research that provided information-free stimulation. This intervention was called Cranial Nerve Non-Invasive Neuromodulation (CN-NINM) and used the Portable Neuromodulation Stimulator (PoNS™) device. The PoNS™ was the first device to provide information-free stimulation.

CN-NINM

CN-NINM, a neuromodulation intervention, was created at the University of Wisconsin-Madison in the Tactile Communications & Neuromodulation Laboratory (TCNL). The intervention has two primary components: 1) the use of the Portable Neuromodulation Stimulator (PoNS™) device to deliver small, doses of electric current to the tongue, and 2) targeted training activities that are personalized for each participant based on presenting symptoms and typically performed concurrently with the stimulation.

PoNS™ Device

The PoNS™ device has been optimized for usability and safety. The case is 86 mm wide by 45 mm thick by 15 mm thick and weighs 46 grams. The tab that provides the stimulation contains 145 electrodes and 80 on the anterior portion of the tongue, held tightly in place by the tips. The PoNS™ device uses the tongue in triplets of pulses at 5 ms intervals every 20 ms. The subject can control the pulse width (0.4-6.5 ms) by adjusting the intensity buttons on the device. The buttons on the device allow the stimulation to be turned on and off and increased or decreased in intensity. Each time the device is turned off, the intensity resets to the lowest level, requiring the subject to adjust it to a comfortable level each time.

TBI Case Study

An ongoing study at U1V-Wisconsin is testing the effect of CN-NINM on balance and gait for individuals with traumatic brain injuries. One participant has begun the study, with up to four total participants being recruited. The study is a 3-week A-B-A-A design to study benefits and carry-over effects of the CN-NINM intervention. Participants complete a daily gait assessment and weekly self-report measures about community integration and confidence with gait. The current participant had a brain injury more than 35 years ago. He uses an AF0 and occasionally a cane. The participant has currently completed 2 full weeks of the study. Noticeable changes have occurred in patient report and in gait quality. The participant also indicated an increased tolerance for exercise without pain in his lower extremity. Each of these components has significant application in rehabilitation.

Conclusions & Implications

Although many reports and several components of this study warrant additional studies and research. The participant indicated an almost immediate reduction in the tightness of his head and a reduced time required to stretch in the mornings even after not using the device overnight before stretching. The participant also indicated an increased tolerance for exercise without pain in his lower extremity. Each of these components has significant application in rehabilitation.

Acknowledgments

The case study and previous research support the use of the CN-NINM intervention as a rehabilitation tool to improve gait and possibly as a tool to reduce spasticity and tone. A drug-free and non-invasive pain reduction intervention would have significant implications and benefits in rehabilitation.

References