Vagus Nerve Stimulation Combined with Minimally Supervised Home-based Exergame Training in a Person with Chronic Stroke, a Case Study

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INTRODUCTION

Vagus nerve stimulation (VNS) paired with rehabilitation is an approach to the neuroplasticity amelioration of upper extremity impairments experienced by persons with stroke. To date, the study of VNS supported by rehabilitation has focused on a 6-week period of intensive in-person therapy followed by a 90 day home based rehabilitation program following implantation of the stimulator (total rehab time = 1,368 minutes) [1]. The paired approach produced clinically meaningful improvements in measures of impairment and activity level upper extremity function that exceeded improvements demonstrated by subjects performing a control rehabilitation program of similar length and intensity [2]. Study participants tracked for a year after baseline testing demonstrated continued improvements in motor function, with a substantial amount of in person outpatient therapy (mean rehab time approximately 5,700 minutes [3]. This poster will describe the upper extremity rehabilitation history of a 68-year-old male with a 9-year history of stroke that completed a ten-month program of minimally supervised technology based exergame training using the R3THA system [4], paired with patient self-activated vagus nerve stimulation, which he began approximately 3 months after he completed a paired protocol of VNS and in-person therapy.

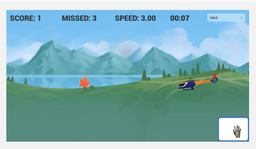
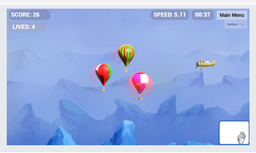
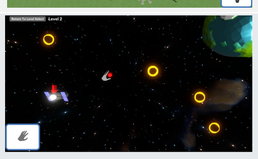
PARTICIPANT INFORMATION

DA is a 68-year-old ambidextrous gentleman with R hemiplegia due to a L CVA that occurred approximately 9 years prior to this intervention case. DA presented to therapy without visual / perceptual or cognitive impairments. DA ambulates in the community with significant gait deviations without an assistive device. He drives extensively using a steering wheel knob. He is self-employed as a property manager and describes himself as having basic computer skills.

INTERVENTION

A received initial one-hour training on how to use the system and directly supervised tele rehab 3 times a week for 2 weeks. After this, he continued to use the system independently with minimal supervision and as needed technical support. Over the ten-month training program DA utilized 10 different R3THA exergames that trained both proximal and distal upper extremity function (See table 1). AD typically trained 4 to 5 times per week for approximately 20 minutes per session over the 10-month training period. DA's training programs were modified at two in-person meetings with the study therapist, but he managed his day to day sessions on his own.

Table 1: 10 R3THA games DA played

Exergame	Gameplay	Training Goal
Brick Blaster		Elbow Extension/Flexion
Dog Dash		Wrist Radial/Ulnar Deviation
Cloud Cruiser		Wrist Extension/Flexion
Flight Frenzy		Wrist Extension/Flexion
Pinch Pop		Hand Open and Finger Pinch
Speed Bump Blitz		Gross Grasp
Fruit Farmer		Foream Pronation/Supination
Constellation Creator		Reach, Grasp, Release
Ruins Rider		Gross Grasp, Wrist Extension/Flexion, and Forearm Pronation/Supination

RESULTS

The clinical assessments FMA-UE, BBT, ARAT, WMFT, were performed by a licensed therapist at the beginning of the program and at 3 months six months and 9 months after beginning R3THA training, as well as kinematic data end points collected by the exergame system at the same dates. The patient, who had retained the gains made during the initial protocol of VNS and in-person rehabilitation, demonstrated continued improvements in distal and proximal upper extremity function in both clinical assessments and the kinematic data collected by the exergame system. Clinical outcomes after 9-month use of the exergame system showed increased scores in BBT (from 11 to 25 blocks), UEFMA (39 to 49 points), WMFT FAS (39 to 61 points) and ARAT score (29-35 points). R3THA system testing data showed increases in active pinch, hand opening aperture, wrist extension AROM and forearm pronation / supination AROM. as measured by the exergame system during training. In addition, the participant reported increased ability to use his paretic hand to manipulate small objects using a pincer grasp or three jaw chuck grasps.

Table 2: Clinical assessment improve continuously

Clinical Assessments	4/26/24	7/26/24	10/29/24	2/21/25
BBT	11	17	19	25
ARAT	29	29	29	35
UE-FMA	39	45	48	49
WMFT (FAS)	.52	.65	.71	.81

Table 3: Kinematic assessment improve continuously

R3THA Assessments	4/26/24	7/26/24	10/29/24	2/21/25
Pinch	81.48	97.89	99.64	94.61
Hand Open Range (in)	1.69	2.047	1.89	2.08
Wrist Extension Range (deg)	69.34	100.56	72.4	88.61
Pronation/Supination Range (deg)	46.18	96.41	105.81	112.18

Table 3: R3THA training time

Training Time	4/26/24 – 7/26/24	7/26/24 – 10/29/24	10/29/24 – 2/21/24
Total Minutes	799	1083	1828
Sessions Per Week	4	4	5.4
Minutes Per Session	16.6	21.7	21.0

DISCUSSION

DA demonstrated comparable improvements in motor function (+ 10 UEFMA points, + 14 blocks on the BBT, +.29 on the WMFT FAS) as compared to subjects in the one year follow - study by Francisco et al (+ 9.2 UEFMA points, + 3 blocks on the BBT, +.35 on the WMFT FAS) with essentially no upper extremity focused in-person treatment (Francisco 2023). His in-home training times were approximately one third less (3,711 total minutes) than the in-person therapy times (approximately 5,896 total minutes) logged by these subjects. Total repetitions per minute were likely closer due to the greater repetition efficiency of exergames training when compared to rehabilitation supervised by a therapist [5,6]. DA's outcomes which were particularly impressive considering his age (68) and the chronicity of his stroke (9 years post-CVA), were likely impacted by his consistent training habits.

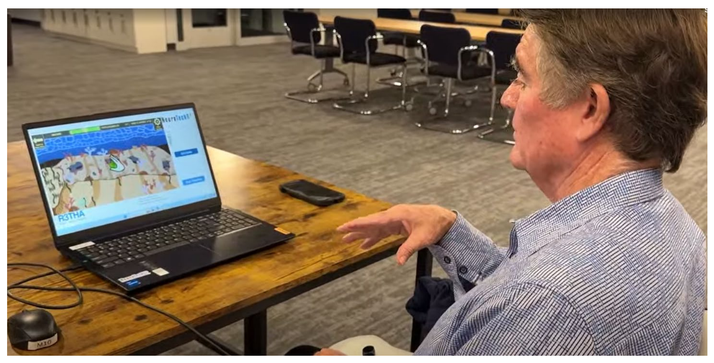


Figure 1: Photo of DA playing PinchPop game to train pinch movement

CONCLUSIONS

This patient case study suggests that a longer-term approach to rehabilitation catalyzed by VNS might be beneficial and that a home-based, minimally supervised, training program combined with VNS can be considered to improve functional outcomes.

REFERENCES

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