

Pharyngeal neuromuscular electrical stimulation combined with surface electromyography biofeedback for dysphagia rehabilitation in Parkinson's disease: a case report

Estimulación eléctrica neuromuscular faríngea combinada con biorretroalimentación mediante electromiografía de superficie para la rehabilitación de la disfagia en la enfermedad de Parkinson: reporte de un caso clínico

Dincy Viniola^{1a}, Vanitha Jayaraj^{2a*}, Jeswitha Nandyala^{3a}, Vinodhkumar Ramalingam^{4a}, Harishraj A^{5a}, Manoj Kumar V^{6a}, S Mythili^{7a}, Monisha Kannan^{8a}, Dhanusia S^{9a}

SUMMARY

Introduction: Dysphagia is a common and clinically significant complication of Parkinson's disease, contributing to aspiration risk, malnutrition, dehydration, and reduced quality of life. Pharyngeal Neuromuscular Electrical Stimulation (NMES) and surface electromyography (sEMG) biofeedback are emerging rehabilitation approaches that target neuromuscular facilitation and motor relearning; however, evidence regarding their combined use in Parkinson's disease-associated dysphagia remains limited. **Objective:** To evaluate the effectiveness of

combined pharyngeal NMES and sEMG biofeedback on swallowing function, dysphagia severity, and swallowing-related quality of life in a patient with Parkinson's disease. **Design, setting, and patient:** Single-patient case report. A 62-year-old male with an eight-year history of Parkinson's disease (Hoehn and Yahr Stage III) presenting with progressive dysphagia, coughing during meals, drooling, and intermittent choking episodes. DOSS score at baseline was 3/7. Cognitive function was preserved (MMSE 27/30). **Main outcomes studied:** DOSS score, Swallowing Quality of Life Questionnaire (SWAL-QOL), and sEMG parameters (peak amplitude and swallowing duration). **Results:** DOSS score improved from 3/7 to 5/7. SWAL-QOL score increased from 48/100 to 82/100. sEMG peak amplitude increased from 42.5 μ V to 76.3 μ V, and swallowing duration decreased from 2.8 to 1.5 seconds. No adverse events were observed. **Conclusion:** Combined pharyngeal NMES and sEMG biofeedback were associated with improvements in swallowing function, muscle activation, and swallowing-related quality of life in a patient with Parkinson's disease-associated dysphagia. Further controlled studies are warranted to establish the clinical efficacy of this combined intervention.

ORCID:

¹ [0009-0008-2245-6777](https://orcid.org/0009-0008-2245-6777)

² [0000-0001-9049-3803](https://orcid.org/0000-0001-9049-3803)

³ [0009-0003-7806-1671](https://orcid.org/0009-0003-7806-1671)

⁴ [0000-0002-5269-0520](https://orcid.org/0000-0002-5269-0520)

⁵ [0009-0002-3605-7255](https://orcid.org/0009-0002-3605-7255)

⁶ [0009-0003-4649-2960](https://orcid.org/0009-0003-4649-2960)

⁷ [0009-0000-1443-6575](https://orcid.org/0009-0000-1443-6575)

⁸ [0009-0001-8970-4279](https://orcid.org/0009-0001-8970-4279)

⁹ [0000-0003-2164-078X](https://orcid.org/0000-0003-2164-078X)

***Corresponding author:** Vanitha Jayaraj, MPT. Lecturer & PhD Scholar, Department of Neurosciences, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India – 602105, E-mail: vanithajayaraj29@gmail.com

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a. Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India – 602105

RESUMEN

Introducción: La disfagia es una complicación frecuente y clínicamente significativa de la enfermedad de Parkinson, que incrementa el riesgo de aspiración, desnutrición, deshidratación y reducción de la calidad de vida. La estimulación eléctrica neuromuscular faríngea y la biorretroalimentación mediante electromiografía de superficie (sEMG) son intervenciones rehabilitadoras emergentes dirigidas a la facilitación neuromuscular y el reaprendizaje motor; sin embargo, la evidencia sobre su uso combinado en la disfagia asociada a la enfermedad de Parkinson es limitada. **Objetivo:** Evaluar la efectividad de la estimulación eléctrica neuromuscular faríngea, combinada con biorretroalimentación sEMG, sobre la función deglutoria, la gravedad de la disfagia y la calidad de vida relacionada con la deglución en un paciente con enfermedad de Parkinson. **Diseño, lugar y paciente:** reporte de caso clínico individual. Varón de 62 años con ocho años de evolución de enfermedad de Parkinson (estadio III de Hoehn y Yahr) que presentó disfagia progresiva, tos durante las comidas, sialorrea y episodios intermitentes de atragantamiento. La puntuación basal en la Escala de Resultados y Gravedad de la Disfagia (DOSS) fue de 3/7. La función cognitiva estaba preservada (MMSE 27/30). **Resultados:** La puntuación DOSS mejoró de 3/7 a 5/7. La puntuación de SWAL-QOL aumentó de 48/100 a 82/100. La amplitud máxima del sEMG aumentó de 42,5 μ V a 76,3 μ V y la duración de la deglución disminuyó de 2,8 a 1,5 segundos. No se registraron eventos adversos. **Conclusión:** La estimulación eléctrica neuromuscular faríngea combinada con biorretroalimentación sEMG se asoció con mejoras en la función deglutoria, la activación muscular y la calidad de vida relacionada con la deglución en un paciente con disfagia asociada a la enfermedad de Parkinson. Se requieren estudios controlados adicionales para establecer la eficacia clínica de esta intervención combinada.

Palabras clave: Enfermedad de Parkinson, trastornos de la deglución, estimulación eléctrica neuromuscular, electromiografía, calidad de vida, Salud y bienestar

INTRODUCTION

Dysphagia, characterized by difficulty in swallowing, is a common and clinically significant complication in Parkinson's disease, affecting a substantial proportion of patients and contributing to malnutrition, dehydration, aspiration pneumonia, and reduced quality of life (1,2). Swallowing impairment in Parkinson's disease is multifactorial and is associated with bradykinesia,

rigidity, impaired coordination of swallowing musculature, delayed swallowing reflex, and reduced pharyngeal contraction, particularly during the pharyngeal phase of swallowing (2,3). These impairments compromise airway protection and increase the risk of aspiration.

Pharyngeal Neuromuscular Electrical Stimulation (NMES) is a rehabilitative intervention that delivers electrical current through surface electrodes placed over the submental and suprahyoid muscle groups to facilitate pharyngeal muscle activation and improve swallowing coordination (4). Previous studies in individuals with neurogenic dysphagia have demonstrated that pharyngeal NMES may improve swallowing performance by enhancing neuromuscular activation and promoting motor relearning of swallowing musculature (4,5). However, evidence regarding the effectiveness of pharyngeal NMES specifically in Parkinson's disease-associated dysphagia remains limited.

Surface electromyography (sEMG) biofeedback is another rehabilitation approach that provides real-time visual feedback regarding muscle activity during swallowing. By enhancing motor learning and voluntary control of the swallowing musculature, sEMG biofeedback has shown promising outcomes in improving swallowing biomechanics and oropharyngeal muscle activation in neurological populations, including those with Parkinson's disease (6,7).

Since pharyngeal NMES primarily targets neuromuscular activation of swallowing musculature, while sEMG biofeedback focuses on motor relearning and neuromuscular control, combining these interventions may produce synergistic therapeutic effects in dysphagia rehabilitation. Nevertheless, the literature on the combined use of pharyngeal NMES and sEMG biofeedback in patients with Parkinson's disease remains limited. Therefore, this case report was undertaken to evaluate the effectiveness of combined pharyngeal NMES and sEMG biofeedback on swallowing function, dysphagia severity, and swallowing-related quality of life in an individual with Parkinson's disease.

Case Presentation

A 62-year-old male with an eight-year history of Parkinson's disease presented with progressive swallowing difficulty, coughing during food intake, drooling of saliva, and occasional choking episodes for the past six months. The patient was on regular antiparkinsonian medications. The caregiver reported increased difficulty while consuming liquids and semi-solid foods, prolonged meal duration, reduced oral intake, and fatigue during swallowing. There was no history of recent aspiration pneumonia, seizures, psychiatric illness, substance abuse, or systemic comorbidities. Past medical and family histories were unremarkable.

On examination, the patient was conscious, cooperative, and medically stable. Neurological assessment revealed bradykinesia, facial masking, mild rigidity, hypophonia, and impaired voluntary swallowing coordination. Cognitive function was assessed using the Mini-Mental State Examination (MMSE), which yielded a score of 27/30, indicating preserved cognitive function adequate for active participation in rehabilitation.

Based on the Hoehn and Yahr staging system, the patient was classified as Stage III Parkinson's disease, indicating mild-to-moderate bilateral impairment with preserved postural reflexes and independent ambulation, consistent with capacity for active rehabilitation participation.

Clinical swallowing examination demonstrated delayed swallow initiation, reduced laryngeal elevation, wet vocal quality following swallowing, and intermittent coughing predominantly with thin liquids. Functional swallowing ability was assessed using the Dysphagia Outcome and Severity Scale (DOSS) (8), with the patient scoring 3/7, indicating moderate dysphagia requiring dietary modification and supervised feeding. He had not previously received any intervention for dysphagia.

Written informed consent was obtained from the patient for publication of this case report and accompanying clinical data. Ethical principles outlined in the Declaration of Helsinki were followed throughout the rehabilitation process.

Intervention Protocol

The patient underwent a combined swallowing rehabilitation program consisting of pharyngeal NMES and sEMG biofeedback training for four weeks. The intervention was delivered using the VitalStim® Plus (Chattanooga, DJO Global, Vista, CA, USA), an FDA-cleared device that integrates pharyngeal NMES and sEMG biofeedback on a single platform. Electrical stimulation was applied at a frequency of 80 Hz with a pulse duration of 300 microseconds and a biphasic waveform (4,5). Stimulation intensity was titrated to the patient's motor threshold, defined as the lowest current intensity sufficient to elicit a visible or palpable contraction of the targeted swallowing musculature, ranging from 3.5 to 7.5 mA across the treatment course. Self-adhesive, pre-gelled, dual-channel sEMG surface electrodes (2.0 cm diameter) were placed bilaterally over the submental and suprahyoid muscle groups in accordance with the manufacturer's recommended electrode placement protocol for dysphagia.

Each treatment session lasted 30 minutes and was delivered four sessions per week for a total duration of four weeks. During each session, sEMG biofeedback training was simultaneously incorporated to facilitate voluntary activation and coordination of swallowing musculature. Electrodes were positioned over the suprahyoid muscle group to monitor muscle activity during swallowing tasks. Real-time visual feedback from the sEMG display was provided to encourage appropriate muscle recruitment and improve swallowing efficiency (6,7).

The patient was instructed to perform approximately 10-15 swallowing repetitions per session with verbal cueing and visual biofeedback guidance, based on the patient's tolerance and fatigue level. Swallowing exercises were progressed gradually according to the patient's performance and clinical response. The stimulation threshold was re-established individually prior to each session.

Adverse events, including pain, discomfort, or unexpected reactions during or after stimulation,

were monitored and documented by the treating therapist at every session. Throughout the intervention period, the patient continued to receive routine medical management for Parkinson's disease.

Outcome Measures

Outcome measures were assessed at baseline (Week 0), during the second week (Week 2), and after completion of the fourth week of intervention (Week 4) to evaluate changes in swallowing function, dysphagia severity, and swallowing-related quality of life.

Surface Electromyography (sEMG)

Surface electromyography was used to assess the electrical activity and activation patterns of the swallowing musculature during deglutition (6). Electrodes were placed over the submental and suprahyoid muscle groups to record muscle activity associated with swallowing. sEMG provided an objective evaluation of muscle recruitment, timing, and coordination during swallowing tasks.

Dysphagia Outcome and Severity Scale (DOSS)

The Dysphagia Outcome and Severity Scale was used to assess dysphagia severity and

the patient's level of functional independence during feeding (8). Scores range from 1 (severe dysphagia requiring non-oral feeding) to 7 (normal swallowing function).

Swallowing Quality of Life Questionnaire (SWAL-QOL)

The Swallowing Quality of Life Questionnaire was used to assess the impact of dysphagia on the patient's physical, emotional, and social well-being, evaluating domains including eating duration, fear of choking, fatigue, communication, mental health, and social functioning (9).

RESULTS

The patient was assessed at baseline (Week 0), Week 2, and Week 4 of the combined pharyngeal NMES and sEMG biofeedback intervention. Progressive improvement was observed in swallowing muscle activation, dysphagia severity, and swallowing-related quality of life across the intervention period (Table 1).

At baseline, the patient demonstrated poor swallowing coordination with reduced suprahyoid muscle activation, prolonged swallowing duration, delayed swallow initiation, and frequent coughing during liquid intake. At Week 2,

Table 1. Outcome measures across the intervention period

Outcome Measure	Week 0 (Baseline)	Week 2	Week 4
DOSS Score (1–7)	3/7	4/7	5/7
SWAL-QOL Score (0–100)	48/100	66/100	82/100
sEMG Peak Amplitude (μ V)	42.5	58.7	76.3
sEMG Swallowing Duration (sec)	2.8	2.1	1.5

DOSS: Dysphagia Outcome and Severity Scale; SWAL-QOL: Swallowing Quality of Life Questionnaire; sEMG: surface electromyography

moderate improvement in muscle recruitment and swallowing coordination was observed, with a reduction in coughing episodes and improved tolerance to oral intake. By Week 4, clinically meaningful improvements were noted, including enhanced swallowing efficiency, improved muscle activation, safer oral intake, and better swallowing-related quality of life.

The DOSS score improved progressively from 3/7 at baseline to 5/7 at Week 4, indicating a transition from moderate dysphagia requiring supervised feeding to mild dysphagia with safer oral intake. Swallowing-related quality of life also improved substantially, with SWAL-QOL scores increasing from 48/100 to 82/100 following the full course of intervention.

Surface electromyography findings demonstrated enhanced neuromuscular activation of the swallowing musculature throughout the intervention period. Peak amplitude of swallowing muscle activity increased from 42.5 μ V at baseline to 76.3 μ V at Week 4, while swallowing duration decreased from 2.8 seconds to 1.5 seconds, indicating improved swallowing efficiency and neuromuscular coordination. No adverse effects, aspiration episodes, or therapy-related complications were observed during the rehabilitation period (Table 1).

DISCUSSION

This case report evaluated the effectiveness of combined pharyngeal NMES and sEMG biofeedback in the rehabilitation of dysphagia in a patient with Parkinson's disease. The findings demonstrated progressive improvement in swallowing muscle activation, swallowing efficiency, dysphagia severity, and swallowing-related quality of life following four weeks of intervention.

The improvement in sEMG peak amplitude, from 42.5 μ V at baseline to 76.3 μ V at Week 4, suggests enhanced recruitment and activation of the suprahyoid musculature involved in swallowing. Simultaneously, the reduction in

swallowing duration from 2.8 seconds to 1.5 seconds indicates improved swallowing efficiency and neuromuscular coordination. These findings support the concept that combined pharyngeal NMES and sEMG biofeedback may facilitate neuromuscular activation and motor relearning in swallowing rehabilitation.

Pharyngeal NMES is believed to enhance neuromuscular activation of swallowing musculature and improve swallowing coordination by directly stimulating the submental and suprahyoid muscle groups through surface electrodes. Previous studies have reported that pharyngeal NMES can improve swallowing physiology, neuromuscular coordination, and functional swallowing outcomes in individuals with neurogenic dysphagia (4,5). The combined use of NMES with biofeedback may further amplify these effects by simultaneously facilitating peripheral neuromuscular activation and central motor relearning.

The incorporation of sEMG biofeedback may have contributed to improved voluntary control and motor relearning of swallowing musculature. Real-time visual feedback enables patients to understand muscle activation patterns and perform more coordinated swallowing efforts. Previous studies have demonstrated that biofeedback-based swallowing rehabilitation can improve swallowing biomechanics, neuromuscular coordination, and functional swallowing outcomes in individuals with neurological dysphagia (6,7).

Functional swallowing improvements were reflected in the DOSS, which improved from 3/7 at baseline to 5/7 following intervention. Clinically, the patient demonstrated fewer coughing episodes, improved laryngeal elevation, better tolerance to oral intake, and reduced need for supervision during feeding. These findings are clinically relevant because dysphagia in Parkinson's disease is associated with increased risk of aspiration pneumonia, malnutrition, dehydration, and reduced functional independence (1,2).

Swallowing-related quality of life improved considerably, with SWAL-QOL scores increasing from 48/100 to 82/100 after intervention.

The patient reported reduced fear of choking, shorter meal duration, and improved confidence during social eating. Dysphagia frequently affects emotional and social well-being in addition to physical swallowing function, and improvement in quality-of-life measures highlights the broader clinical significance of swallowing rehabilitation (1,2). Recent evidence highlights the growing role of objective biomarkers and neurophysiological monitoring in Parkinson's disease. Vocal biomarkers may assist in characterizing Parkinsonian dysfunction, while cerebellar dysfunction and emerging neuromodulatory therapies emphasize the importance of targeting impaired motor control. Additionally, electromyography has been shown to monitor functional recovery during rehabilitation. These findings support the combined use of pharyngeal NMES and sEMG biofeedback as a multimodal approach for facilitating and objectively monitoring swallowing-related neuromuscular recovery in Parkinson's disease (10, 11, 12).

This report has certain limitations. As a single-patient case report, findings cannot be generalized to the broader Parkinson's disease population. Instrumental swallowing assessments, such as the Videofluoroscopic Swallow Study or the Fiberoptic Endoscopic Evaluation of Swallowing, were not performed, which would have provided objective analysis of swallowing biomechanics and aspiration risk. Long-term follow-up was not conducted to assess retention of treatment effects.

Despite these limitations, the findings suggest that combined pharyngeal NMES and sEMG biofeedback may represent an effective and safe rehabilitation approach for dysphagia management in Parkinson's disease. Future randomized controlled trials with larger sample sizes and long-term follow-up are recommended to establish the clinical efficacy and durability of this combined intervention.

CONCLUSION

This case report demonstrated that the combined application of pharyngeal NMES and sEMG biofeedback produced positive clinical outcomes in a patient with Parkinson's disease-associated dysphagia. Following four weeks of intervention, improvements were observed in swallowing muscle activation, swallowing coordination, dysphagia severity, functional oral intake, and swallowing-related quality of life, without any adverse events during therapy. The findings suggest that combining neuromuscular facilitation via pharyngeal NMES with motor relearning using sEMG biofeedback may offer a safe, beneficial rehabilitation strategy for dysphagia management in Parkinson's disease. Further large-scale controlled studies are recommended to establish the long-term efficacy and clinical applicability of this combined intervention approach.

Academic Collaboration of the Authors

Dincy Viniola V: Conceptualization, Investigation, Data curation, Writing – original draft. Vanitha Jayaraj: Conceptualization, Methodology, Supervision, Writing – review and editing. Vinodhkumar Ramalingam: Writing – review and editing. Prathap Suganthirababu: Writing – review and editing. Dhanusia S: Writing – review and editing. Priyadharshini Kumar: Writing – review and editing.

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Conflict of Interest

The authors declare no conflicts of interest.

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