



Transcutaneous Electrical Neuromuscular Stimulation (TENS) Along with Traditional Dysphagia Therapy in Patients with Posterior Stroke: A Case Study

Anindita A. Banik¹ · Gayatri A. Hattiangadi¹

Received: 19 May 2019 / Accepted: 11 July 2019 / Published online: 19 August 2019
© Association of Otolaryngologists of India 2019

Abstract Swallowing is a complicated, multilevel and neuromuscular physiological function. Transcutaneous neuromuscular electrical stimulation is a relatively new therapeutic intervention for the treatment of swallowing disorders. The aim was to administer and focus on pre and post therapy effects of traditional dysphagia therapy and electrical stimulation (TENS) in 2 participants with posterior stroke. Electrical current along with traditional dysphagia therapy on regular intervals with adequate current levels post stroke. These cumulative therapeutic strategies helped in improving the swallowing mechanism. TENS is one of the new therapeutic technique that has greater advantage along with traditional dysphagia therapy, which promises a lot of scope in cases with acute cerebrovascular accidents.

Keywords Brainstem · TENS · Dysphagia · Traditional therapy · Stroke

Introduction

Swallowing is a complicated, multilevel and neuromuscular physiological function [1, 2]. For this reason, dysphagia is a significant health problem due to its dramatic outcomes such as malnutrition, increased morbidity and mortality, advanced disability, impaired quality of life, social

problems, and increased healthcare expenditures [3, 4]. Dysphagia is often a clinical consequence of aging (presbyphagia); congenital abnormalities; structural damage; and a variety of medical conditions, including those related to cerebrovascular accidents (stroke), head and neck cancer, neurodegenerative disorders, and traumatic brain injury [5, 6]. Dysphagia therapy includes rehabilitative and compensatory strategies as stated by Logemann.

Transcutaneous neuromuscular electrical stimulation (TENS) is a relatively new therapeutic intervention for the treatment of swallowing disorders and was first approved by the Food and Drug Administration in USA in 2001 as a treatment for dysphagia. TENS can be defined as “the external control of innervated but paretic or paralytic muscles by electrical stimulation of the corresponding intact peripheral nerves”. It is referred to in the literature by a potentially confusing variety of acronyms (NMES, TNMES, EMS, TES, TC and the trademarks VitalStim and AMP CARE™) [6]. TENS is a non-invasive technique, involving application of an electrical current to the targeted muscle groups via the skin using electrodes placed on the skin surface [7]. The hypothesis of TENS for the treatment of dysphagia is two-fold. Firstly, that by targeting the musculature of the oropharynx with electrical current, the muscles required for swallowing will be strengthened. It is postulated that by increasing the intensity of the electrical current, the electrical field penetrates deeper and depolarizes nerve endings in muscles to produce a muscle contraction. This process aims to strengthen the innervated muscles [1] and may protect striated muscles from atrophy [8]. Secondly, stimulation of the sensory pathways may promote reorganization of the motor cortex and enhance motor relearning. During volitional muscle contraction that occurs in traditional exercise, type I motor unit fibres are typically recruited first whereas in TENS, the fast twitch

✉ Anindita A. Banik
aninditabanik20@gmail.com;
aninditabanik1992@gmail.com

¹ Audiology and Speech Therapy Department, TNMC and
BYL Nair Ch Hospital, Dr. A. L Nair Road, Mumbai Central,
Mumbai, India

muscle fibres (type II motor unit fibres) are activated first and it is postulated that this pattern of recruitment will lead to enhanced muscle strengthening. This is considered to be a positive aspect of TENS in the treatment of dysphagia since a number of the muscles of swallowing are thought to have a higher proportion of type II motor unit fibres; for example the digastric muscle and middle pharyngeal constrictor muscles.

The first article about the use of TENS/NMES as a motor treatment in dysphagic patients was published by Freed [8] and it described treatment of a group of stroke patients with TENS/NMES. In that study, the supralaryngeal muscles were stimulated using transcutaneous electrostimulation. TENS is used frequently in physical medicine and rehabilitation facilities to support muscle strength development, including increasing muscle size, range of motion, and endurance; prevent or minimize muscle atrophy and fibrosis [9]; and enhance muscle reeducation, including increasing sensory awareness and volitional muscle control [10–13]. Although research has been made on the treatment of dysphagia, it is difficult to say that we are successful in effective treatment of every patient due to its complex physiopathology [14]. The conventional treatment of dysphagia today involves collective administration of diet modifications, thermal tactile stimulation, positional approaches, special techniques, airway protection maneuvers and oral-motor exercises [4, 15]. Swallowing compensation and feeding techniques have been recommended to over one half of the patients, but their effectiveness remains uncertain. The limited number of data we have on the issue makes it difficult for us to decide which treatment is more effective [3]. The different and sometimes insufficient outcomes of conventional treatments have led to researchers to look for new alternatives and after the FDA approval in 2001, the neuromuscular electrical stimulation, which is based on strengthening of the weak oropharyngeal muscles, started to be used for the treatment of dysphagia [16].

Need of the Study

Dysphagia management requires intensive therapy in severe cases of dysphagia post-CVA wherein, patients are expected to do oromotor strengthening exercises using very weak and non-compliant muscles. If there is an adjunct that promises greater efficacy, along with the traditional therapy, then the SLP needs to give such as therapy strategy a fair trial on a case by case basis and thus collect ongoing evidence base of a therapy regimen. This is especially important in the Indian context where there is a paucity of evidence based studies especially in presenting treatment efficacy.

Aims of the Study

To administer TENS with traditional dysphagia therapy and to compare the pre and post therapy effects of traditional dysphagia therapy and electrical stimulation (TENS) in 2 participants with posterior stroke.

Methodology

This retrospective study aimed to observe the effects of traditional dysphagia therapy along with TENS in 2 posterior stroke cases which was approved by the Ethics committee. It included 2 cases who were admitted in an acute care set up. i.e. Case 1 Mrs. B.P 48 years/F with Right sided cerebellar stroke and Case 2 Mr. S.N 47 years/M with Acute right medullary infarct; both with severe dysphagia and adequate speech, language comprehension and expression skills. A protocol was developed for medical evaluations and clearances; the subjects had been referred to otolaryngologist, cardiologist and neurologist; clearances were given after doing ECG/2Decho, blood electrolytes test and laryngoscopy.

The patients were assessed for bedside speech and language skills. Swallowing assessment to determine the severity was done using The Nair hospital bedside swallowing assessment (NHBSA) and Nair hospital swallowing ability scale (NHSAS) [17] and to assess the impact on physical, emotional, functional domains, Dysphagia Handicap Index was used. Severity was measured before and after therapy. FEES was done after completion of therapy in both cases and not before therapy owing to the severity and risk of aspiration. Informed consents were obtained before therapy. TENS was provided using the instrument Myomed with parameters of 80–100 Hz for pulse duration of 300 μ s and current from 1–14 mA as per tolerance of the patient. Traditional dysphagia therapy were based on swallowing maneuvers, head positions, thermal stimulation, rehabilitative exercises, Proprioceptive Neuromuscular Functioning exercises. Therapy plan included first few (4–5) sessions with only TENS current stimulation followed by trial feed. The patients were given TENS current along with traditional dysphagia therapy daily for 1 h. TENS was given for 5 min in 4 cycles i.e. total 20 min of current and 40 min of traditional therapy was given in between the rest periods of the electrical stimulation. Session wise reports were based on the case history, therapy goals, no. of sessions, effect of TENS on swallowing mechanism. The parameters assessed and compared were duration for swallows using Four Finger Test for swallowing, the ability to swallow/duration of swallow for different consistencies of food i.e. solids,

semisolids, thin liquid and dry swallow. Comparison were done before and after therapy based on swallowing skills.

Results and Discussion

Case Study 1: Mrs. B.P 48 years/F

History: h/o HTN, DM c/o CVA 1 episode. Was admitted in ward with Right sided cerebellar stroke, vertebral artery thrombosis. 2DEcho—Hypertensive heart disease Type I. HRCT chest with contrast—no significant abnormality. Blood electrolytes were within normal limits. Medical clearances were obtained based on above.

Swallowing examination before therapy At admission, Mrs. BP was put on Ryle's tube for mode of nutrition. On NHSAS and NHBSA, there was poor oral hygiene, inadequate respiratory laryngeal function, wet gurgly voice, weak cough reflex, prolonged pharyngeal phase, coughing on saliva swallow. No hyolaryngeal excursion was seen and she had thick copious secretions. She could not tolerate any food consistency. s/o severe pharyngeal dysphagia (Score 5 on NHSAS and NHBSA). Dysphagia Handicap Index showed severe impairment with score 63 in physical, emotional and functional domains.

Course of therapy It was based TENS with traditional dysphagia therapy using maneuvers, rehabilitative exercises; head positions, thermal stimulation, PNF exercises. No of sessions, current level and duration: A total of 9 sessions with current level 1–5 mA for a total duration of 20 min out of 60 min of therapy.

Procedure of therapy Initial 4 sessions included only current stimulation up to the level the patient could tolerate i.e. 1–2 mA and maximum upto 5 mA. Therapy was combined with oromotor exercises to improve motor functions, thermal stimulation using warm and cold water, proprioceptive neuromuscular exercises.

Indirect swallowing exercises on dry saliva swallow using Masako, Mendelsohn's, chin tuck position. After 4th session, there was hyolaryngeal excursion seen on dry saliva swallow. Trial feed with thin, thick liquids were initiated from 5th session, and patient was able to tolerate 1/4th to 1/2 teaspoon quantity. No aspiration, no multiple swallows were observed. On the 9th session, participant was able to tolerate thin liquid, semisolids and solid consistency with full spoon quantity. On Four Finger Test total oral transit time was 6–8 s.

FEES examination after therapy This showed true vocal cords mobile, no pooling of saliva, no aspiration, no motor or sensory deficits.

Post therapy There was an improvement in swallowing skills seen, the severity assessed on NHSAS and NHBSA revealed a score of level 0- normal swallow and no

handicap on functional, physical and emotional domains on Dysphagia Handicap Index. Later the patient was discharged from hospital on complete oral diet.

Case Study 2: Mr. S.N 47 years/Male

History: k/c/o Acute right medullary infarct seen on 3rd episode of CVA. Earlier MRI Scan revealed Chronic lacunar infarcts in B/L fronto-parietal with white matter. 2DEcho: Hypertensive heart disease Type I. Rest normal study, electrolyte balance were within normal limits. Medical clearances were obtained based on above.

Swallowing examination before therapy At admission, Mr. SN was put on Ryle's tube for mode of nutrition. On NHSAS and NHBSA, there was poor oral hygiene, inadequate respiratory laryngeal function, wet gurgly voice, weak cough reflex, prolonged pharyngeal phase, coughing on saliva swallow. No hyolaryngeal excursion was seen and he had thick copious secretions. He could not tolerate any food consistency. s/o severe pharyngeal dysphagia (Score 5 on NHSAS and NHBSA). Dysphagia Handicap Index showed severe impairment with score 68 in physical, emotional and functional domains.

Course of therapy It was based TENS with traditional dysphagia therapy using maneuvers, rehabilitative exercises; head positions, thermal stimulation, PNF exercises.

No of sessions, current level and duration: A total of 19 sessions with current level 1–13 mA for a total duration of 20 min out of 60 min of therapy.

Procedure of therapy Initial 7 sessions included only current stimulation up to the level the patient could tolerate i.e. 1–11.5 mA, because there no improvement seen in hyolaryngeal excursion. Therapy was combined with oromotor exercises to improve motor functions, thermal stimulation using warm and cold water, proprioceptive neuromuscular exercises.

Indirect swallowing exercises on dry saliva swallow using Masako, Mendelsohn's, chin tuck position and Shaker exercises were done.

After 7th session, there was hyolaryngeal excursion seen on dry saliva swallow. Trial feed with thin, thick liquids were initiated from 8th session, and patient was able to tolerate 1/4th to 1/2 teaspoon quantity. He could manage up to 7 spoons in session; however, there were delayed aspiration, could clear secretion by coughing. By the 16th session, he could swallow 1/2 teaspoon quantity, would manage 5 spoons with hyolaryngeal excursion. Total oral transit time for thick liquid-5–6 s.

Post therapy After the 16th session, On NHSAS and NHBSA it indicated level 3—Moderate Dysphagia indicating moderate difficulty in swallowing with audible aspiration, modification of consistency of food and use of maneuvers required. Can tolerate 3/5 consistencies. Mild

impairment (Score 10) on emotional domain and moderate impairment on physical and functional domains on Dysphagia Handicap Index.

FEES examination after therapy Bilateral vocal cords mobile, loss of sensation on pharynx, no participation of posterior pharyngeal wall in closure, trickling of food from left side, aspiration seen. The patient was discharged on RT feed and followed up after 1 month for therapy. Thus the objective evaluation corroborated what was observed clinically.

After 1 month Total 3 sessions of TENS with traditional therapy was done. On trial feed, he was able to tolerate thin, thick liquid, solid consistency with ½ spoon quantity. Could tolerate 4/5 spoons, no aspiration, complete hyolaryngeal excursion, swallow duration-6–8 s.

Patient was discharged on oral diet as advised by ENT.

So as observed, first case showed a quicker recovery than second, this can be attributed to the episodes and severity of strokes, age groups, therapy combined with electrical stimulation in acute stage in the recovery period. The results of these cases are similarly seen in a study [17] which stated good improvement in post CVA cases with TENS along with traditional dysphagia therapy. It can also be attributed to the different site of lesion in each case owing to the severity and improvement in swallowing mechanism. For case 1 Masako along with TENS whereas in case 2 Masako, Mendelsonn's along with TENS helped in improving the swallowing mechanism.

TENS is achieved through regulated administration of pulsed electrical currents to nerves or muscles. The current changes the ionic composition of the muscular cell membrane and triggers a motor unit action potential, to which a subsequent motor response follows. The action potential and synaptic transmission created by electrical stimulation is similar to the neural and chemical processes in a naturally-occurring excitation [18], hence the electrolyte balance of the body has to be within normal limits [19].

Compared Electrical Stimulation (ES) to traditional dysphagia therapy in acute/sub-acute ischemic stroke patients with moderate to severe dysphagia. More improvement (based on a symptom score) was noted at 3 and 6 weeks after ES. The authors concluded that early application of ES combined with traditional dysphagia therapy showed a positive effect in acute and subacute ischemic stroke patients with dysphagia; similarly it was seen in the present study. It was observed that using both techniques, it leads to improvement of hyolaryngeal excursion on dry swallow, which further helps in building the swallowing skill with different consistencies of food. It was observed that the level of current stimulation helped in improving sensory and motor functions. In case 1 with cerebellar lesion the current level was upto 5 mA and in case 2 with medullary lesion it was 13 mA current which

contributed to hyolaryngeal excursion. There was a gradual increase tolerance for current level as observed in both cases in sessions. There was a gradual improvement seen in cough reflex, control of secretions, decrease in gurgly voice, and lesser aspiration after trial feeds with different consistencies of food. Case 1 showed a better control of swallow with increase in food quantity per spoon while case 2 needed gradual improvement owing to the severity.

A study [20] conducted a retrospective review of 18 patients with dysphagia who received VitalStim therapy. The authors concluded that VitalStim therapy seems to help those with mild-to-moderate dysphagia. However, the patients with the most severe dysphagia did not gain independence from their feeding tubes. A study [21] concluded that ES combined with conventional treatment is superior to conventional treatment alone in patients with dysphagia following treatment for brain injury. So these findings would help in attributing the reason of improvement in the cases of the present study post-CVA.

The effectiveness using TENS with traditional dysphagia therapy seen in the present study can be similarly seen in other studies [22]. A study on RCT inclusive of 59 patients evaluated a neuromuscular electrical stimulator (VitalStim) in stroke patients with dysphagia. It showed that 42 patients improved while 17 did not improve with respect to residual solid, soft and liquid foods retained in the pharynx. The authors concluded that less pharyngeal residue before treatment serves as a factor for predicting greater improvement after VitalStim treatment. However, in the present study the pharyngeal residue would be due to the impact after stroke, site of lesion and the severity of stroke. As TENS recruits type II muscle fibres, combination therapy of TENS and exercise maneuvers results in early transition from tube feeding to the oral feeding [23]. Hence the use of TENS should be incorporated in the treatment protocol for Dysphagia particularly in the acute stage. Hence in this study the effectiveness of Transcutaneous Neuromuscular Electrical Stimulation combined with exercise were shown.

Summary and Conclusion

With the advent of new therapeutic techniques, there is a greater advantage in utilizing TENS along with traditional dysphagia therapy, especially in stroke cases and it is imperative to establish whether or not TENS has greater efficacy as compared with traditional swallowing therapy. Additionally, such research trials should assist in identification of specific patient populations that may have a greater response to TENS. The emergence of data from more rigorous and well designed clinical outcomes studies will surely advance our understanding of this technique and

contribute to collection of data towards evidence based therapy.

References

- Clark H, Lazarus C, Arvedson J, Schooling T, Frymark T (2009) Evidence-based systematic review: effects of neuromuscular electrical stimulation on swallowing and neural activation. *Am J Speech Lang Pathol* 18:361–375
- Restivo DA, Casabona A, Centonze D, Marchese-Ragona R, Maimone D, Pavone A (2013) Pharyngeal electrical stimulation for dysphagia associated with multiple sclerosis: a pilot study. *Brain Stimul* 6:418–423
- Chen YW, Chang KH, Chen HC, Liang WM, Wang YH, Lin YN (2015) The effects of surface neuromuscular electrical stimulation on poststroke dysphagia: a systemic review and meta-analysis. *Clin Rehabil* 30(1):24–35
- Christiaanse ME, Mabe B, Russell G, Simeone TL, Fortunato J, Rubin B (2011) Neuromuscular electrical stimulation is no more effective than usual care for the treatment of primary dysphagia in children. *Pediatr Pulmonol* 46:559–565
- Ashford J, McCabe D, Wheeler-Hegland K, Frymark T, Mullen R, Musson N, Hammond CS (2009) Evidence based systematic review: oropharyngeal dysphagia behavioral treatments. Part III—impact of dysphagia treatments on populations with neurological disorders. *J Rehabil Res Dev* 46(2):195–204
- Huckabee ML, Doeltgen S (2007) Emerging modalities in dysphagia rehabilitation: neuromuscular electrical stimulation. *N Z Med J* 120:U2744
- Pownall S, Enderby P, Sproson L (2017) Electrical stimulation for the treatment of dysphagia. In: Majid A (ed) *Electroceuticals*. Springer, Cham, pp 137–153. https://doi.org/10.1007/978-3-319-28612-9_6
- Freed ML, Freed L, Chatburn RL, Christian M (2001) Electrical stimulation for swallowing disorders caused by stroke. *Respir Care* 46:466–474
- Gallas S, Marie JP, Leroi AM (2010) Sensory transcutaneous electrical stimulation improves post-stroke dysphagic patients. *Dysphagia* 25(4):291–297
- Bogaardt H (2002) Dysfunctie van de bovenste slokdarmsfincter bij slikstoornissen. *Logop Fonatrie* 3:84–87
- Alon G (1991) Principles of electrical stimulation. In: Nelson RM, Currier DP (eds) *Clinical electrotherapy*, 2nd edn. Appleton & Lange, Norwalk, CT, pp 25–101
- Campbell JM (n.d.) General considerations in the clinical application of electrical stimulation. Retrieved from http://www.ifess.org/cedu_generalconsiderations
- Carnaby-Mann GD, Crary MA (2007) Examining the evidence on neuromuscular electrical stimulation for swallowing: a meta-analysis. *Arch Otolaryngol Head Neck Surg* 133(6):564–571
- Crary MA, Carnaby-Mann GD, Faunce A (2007) Electrical stimulation therapy for dysphagia: descriptive results of two surveys. *Dysphagia* 22:165–173
- Freed M, Wijting Y (2007) *VitalStim therapy: training manual for the use of neuromuscular electrical stimulation in the treatment of dysphagia in the pediatric population*. Chattanooga Group, Hixson, TN
- Heijnen BJ, Speyer R, Baijens LW, Bogaardt HC (2012) Neuromuscular electrical stimulation versus traditional therapy in patients with Parkinson's disease and oropharyngeal dysphagia: effects on quality of life. *Dysphagia* 27:336–345
- Babani ND, Hattiangadi GA (2014) Bedside assessment protocol and grading scale for dysphagia in adults: a preliminary study. *J Indian Speech Lang Hear Assoc* 28(1):10
- Huckabee M-L, Doeltgen S (2007) Emerging modalities in dysphagia rehabilitation: neuromuscular electrical stimulation. *N Engl Med J* 120:1–9
- Lee K, Kim S, Lee J, Lee S, Ri J, Park J (2014) The effect of early neuromuscular electrical stimulation therapy in acute/subacute ischemic stroke patients with dysphagia. *Ann Rehabil Med* 38(2):153–159
- Shaw GY, Sechtem PR, Searl J, Keller K, Rawi TA, Dowdy E (2007) Transcutaneous neuromuscular electrical stimulation (VitalStim) curative therapy for severe dysphagia: myth or reality? *Ann Otol Rhinol Laryngol* 116:36–44
- Toyama K, Matsumoto S, Kurasawa M et al (2014) Novel neuromuscular electrical stimulation system for treatment of dysphagia after brain injury. *Neurol Med Chir (Tokyo)* 54(7):521–528
- Park J, Yong S, Kim J, Jung L et al (2014) Cutoff value of pharyngeal residue in prognosis prediction after neuromuscular electrical stimulation therapy for dysphagia in subacute stroke patients. *Ann Rehabil Med* 38(5):612–619
- Thakkar DR, Malarvizhi D (2016) Effectiveness of transcutaneous electrical neuromuscular stimulation along with exercises manoeuvre in dysphagia: case series. *Int J Pharm Bio Sci* 7(4):753–756. <https://doi.org/10.22376/ijpbs.2016.7.4.b753-756>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.