American Journal of Sciences and Engineering Research
E-ISSN -2348 – 703X, Volume 3, Issue 6, 2020

Efficacy of Neuromuscular Electrical Stimulation (NMES) With Traditional Dysphagia Therapy (TDT) In Acute Stroke Dysphagia Patients

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ABSTRACT:
Objective: *Is the combination of neuromuscular electrical stimulation and traditional dysphagia therapy approach effective in Stroke Dysphagia patients? Does the combination of neuromuscular electrical stimulation and traditional dysphagia therapy effective in all types and degree of dysphagia?*
Goal: *The goal of the literature review is to see the effectiveness of the combination of neuromuscular electrical stimulation and traditional dysphagia therapy in acute stroke dysphagia patients and assess whether the combination is effective in all degree of dysphagia.*
Material & Methods: *16 types of research were chosen for the literature review and data was extracted from Google, Pub med and research for life.*
Study Design: *The selected studies were randomized control trials, cohort and case-control studies.*
Results: *The analysis of the studies show that there is a significant improvement in acute stroke dysphagia patients when a comparison was done between neuromuscular electrical stimulation with traditional dysphagia therapy and traditional dysphagia therapy alone but caution should be made before the application of both treatment approaches together. As a very small sample of the population was included in the studies and severe to profound dysphagia patients were not included in most of the previous studies.*
Discussion: *The existing article confirms that few studies include the use of both therapeutic modalities with limited sample size also the duration and frequency of electrical stimulation is directly related to the patient's progress.*
Conclusion: *The traditional swallowing therapy adjunct with neuromuscular electrical stimulation provided for longer duration and frequency is an effective treatment approach for acute stroke patients with dysphagia.*

Keywords: *Dysphagia, Electrical stimulation, Swallowing therapy, Traditional swallowing therapy (TDT), Neuromuscular electrical stimulation (NMES)*

I. INTRODUCTION

Dysphagia is the lack of ability to swallow thin liquids and foods. The person with dysphagia will aspirate or silently aspirate depending upon different consistencies. Dysphagia can result in malnutrition, dehydration and at times aspiration pneumonia. It is most commonly seen in ischemic or haemorrhage strokes. About 8000,000 strokes occur every year in the USA and 45%-70% of cases are dysphagia patients. Dysphagia does not only affect nutrition, hydration but also affects patient psychologically. Quality of life and social activities are also affected as a result of dysphagia. A stroke is an event in which blood flow is insufficient to the brain that which ends the life of a cell in the brain. Based on its types, Stroke is divided into two groups, Ischemic stroke and Hemorrhage stroke. In ischemic stroke, there is not enough blood flow to the brain whereas in haemorrhage bleeding of an artery occurs and spreads in the surrounding area in the brain.

 Received- 06-11-2020, Accepted- 16-11-2020

The management of dysphagia usually includes traditional dysphagia therapy and along with traditional dysphagia therapy neuromuscular electrical stimulation is also been used as a therapeutic approach in stroke dysphagia patients. Traditional dysphagia therapy involves exercises of swallowing, modifications in the patient's diet, therapeutic postures and swallowing manoeuvres which enables the patient to eat and drink liquids and foods orally.

Neuromuscular electrical stimulation is a systematic approach of improving muscle strength in normal and paralyzed muscles group (Freed, Freed, Chatburn, & Christian, 2001) Freed was the first person who used transcutaneous NMES on submental and laryngeal muscles which provides stimulation to improve the function of swallowing muscles. NMES device sends impulses to the nerves that cause muscles of swallowing to contract. It improves the strength, range of motion of swallowing muscles also train and educate the disuse muscles of swallowing.

Combination of different therapeutic techniques to increase the probability of the efficacy of treatment has been the general trend in dysphagia management. It helps the clinician to bring the patient to a normal oral diet and improves the quality of life and human wellbeing.

II. Discussion

Several types of research have been done so far to check the effectiveness of combined NMES and TDT, and all researches have achieved significant results in their studies.

(Freed et al., 2001) Freed and colleagues were the first group who applied transcutaneous NMES to 63 patients and compared it to the group of 36 patients with whom TDT as thermal tactile stimulation was used. Both groups received therapy for 60 minutes per day for four consecutive days until a swallow function was achieved. The measuring outcome used during the study was swallow function score and the score was given to each patient at the start and end of the study. Gold standard assessment tool MBS was used at the beginning and end of the study. The results of the study were significantly different. Both groups showed improvements but the NMES group's swallowing function was improved and swallow function score was higher than thermal tactile stimulation group. 98% of the NMES group showed improved swallowing function. 27% of patients of the thermal tactile stimulation group were at the initial swallow score and 11% of the patients' score got worse at the end of the study. Although (Freed et al., 2001) Freed (2001) study showed significant results, it also had some limitations, Electrical stimulation can only be used with patients who speak less, clean shave is needed for bearded patients. The outcome measure was an objective assessment but it was based on interpreter perceptions so the scores could be biased. The number of participants was greater in the NMES group than the TTS group, so the higher score could be due to a larger number of participants in the NMES group. The results couldn't be generalized due to the small sample size.

(Humbert et al., 2006) Dr. Humbert suggested that hyolaryngeal elevation reduces when stimulation was given during swallowing. Significant laryngeal and hyoid depression were seen at rest when stimulated at rest. Results can't be generalized no experimental group was included in the study.

(Blumenfeld, Hahn, LePage, Leonard, & Belafsky, 2006) Liza and colleagues did a comparison between NMES+TDT and TDT alone. NMES with TDT was given to 40 patients group 1 and TDT was given to 40 patients group 2. All 80 patients were assessed at the time of admission in the study by multidisciplinary team and VFSS and FFES was done for swallowing diagnosis. The measuring outcome of the study was swallow severity score which was done at the initial stage and end of the study. Both groups received therapy for 30 minutes and the number of the session was decided based on the goal of the swallow care. At the end of the study, it was found that scores of NMES+TDT group were higher than TDT group 2. Few limitations were noted in this study the study was retrospective review study no randomized clinical trial study. The SLPs who conducted the assessments were also the ones who provided therapy. so the higher scores could be due to presumption of better scores and diagnosis bias for the NMES +TDT group. Participation bias was also present. The patients with poor prognosis NMES was not given to those participants. So the results of the NMES+TDT were biased. Stroke patients were only included in the study. Generalization of the results becomes questionable.

(Bülow, Speyer, Baijens, Woisard, & Ekberg, 2008) M. Bulow and colleagues concluded that NMES alone has similar therapy results as TDT would achieve. He proved his hypothesis by testing his hypothesis in RCT study. He selected 25 patients for the study. 12 participants in the NMES group and 13 participants in TDT group. Both groups received

therapy for 60 minutes 5 days' week for 3 weeks. Measuring outcome was the clinical assessment of swallowing, the visual analogue scale for patient's subjective self-evaluation of complaints and video graphic evaluation of swallowing was done for each patient. Both groups showed improved swallowing function at the end of the study but there was not any significant difference between NMES and TDT groups. The sample size was too small to generalize. no formal assessment of swallowing was done before and after the study. The NMES group had participants with severely impaired swallow function that is why no significant change in both groups was seen. No follow-up was done to check the status of progress.

Similar results were seen in a study of (Permsirivanich et al., 2009) W. Permsirivanich and coworkers in which he compared NMES therapy with swallow rehabilitation therapy. 23 patients were selected with persistent pharyngeal dysphagia. 11 patients were included in the NMES group and 12 were selected for the SRT group. Both groups received therapy for 60 minutes for 5 consecutive days for 4 weeks. The measuring outcome was functional oral intake scale (FOIS). All patients were assessed using VFSS before and after the study. The results of the study did not show a significant difference in FOIS score in both groups. However, both groups had improved swallowing function after the study. FOIS was higher for both groups. Small sample size will not help to generalize the results.

(Park, Kim, Oh, & Lee, 2012)Park and colleagues did a combination of effortful swallow with NMES. He divided 20 patients into two groups and in one group infrahyoid motor NMES was applied with effortful swallow. In another group, effortful wallow was used with infrahyoid sensory NMES. NMES treatment was given for 20 minutes 5 days per week for 4 weeks. Blinded biochemical measurement was used for the hyolaryngeal excursion, the maximal width of UES. PAS was done before and after the study. It was found that in motor NMES group the vertical position of the larynx was increased significantly. The vertical placement of hyoid bone and UES was also increased but the difference was not significant in both groups. limitations include: Participants were assessed using PAS which shows penetration and aspiration but not their cause. For the application of this exercise, the patient must have a problem in laryngeal elevation. But if the patient has premature loss of bolus control, pharyngeal pooling then NMES with effortful swallow is not useful. The sample size was too small for the study. Patients with severe dysphagia were not included in the study. the study did not do follow-up for long term effects.

(Park et al., 2009) A group of researchers did the same study of which showed same results of the (Park et al., 2012) Park et al (2012) study NMES with effortful swallow had improved laryngeal elevation during swallowing with some limitations the study included the healthy volunteers. The small sample size was selected. The study only showed laryngeal movement but did not measure hyoid movement and cross-section of the submental muscles. The dysphagia participants were not included in the study.

(Lim, Lee, Lim, & Choi, 2009)Lim et al. (2009) also compared the combination of NMES and thermal tactile stimulation with thermal tactile stimulation alone. He chose 36 patient and divided into NMES and thermal tactile stimulation (experimental) and thermal tactile stimulation (control) group. Both groups received therapy for 4 weeks. Swallowing function score, PAS, pharyngeal transit time, discomfort score and satisfaction score was noted before and after the study. The results of the study showed significant differences in the experimental and control group. Swallowing function score, PAS, pharyngeal transit time, discomfort score and satisfaction scores were higher in NMES+TTS group. Small sample size and short follow-ups were the limitations of this study.

(Gallas, Marie, Leroi, & Verin, 2010) Gallas et al. (2010) used sensory transcutaneous NMES with 11 patients with oropharyngeal dysphagia. All patients received therapy for 60 minutes for 5 days for 1 week. All patients reported improved swallow function. VFSS showed reduced aspiration and pharyngeal residue, swallow reaction time also improved after one week of stimulation. The limitation of the study was a small sample size, no comparison group was included.

(Nam, Beom, Oh, & Han, 2013) Nam et al. (2013) used NMES on 50 patients which then further divided into two groups. In one group ES was provided only to suprahyoid muscles and in another group, ES was provided on infrahyoid and suprahyoid muscles. 10-15 sessions were given to both groups. VFSS was done before and after the study, a two-dimensional motion was used to analyze temporal and spatial parameters of hyoid excursion and laryngeal elevation. The suprahyoid muscle stimulation group showed increase front hyoid excursion with no difference in laryngeal elevation however supra and infrahyoid muscles stimulation showed a significant increase in maximal superior excursion distance and maximal absolute excursion distance of laryngeal elevation. But no increase in the hyoid

excursion. No significant difference was found in both groups. Limitation of this study is that it didn't include a control group. Two-dimension analyses were done for 2ml of swallowing.

(Lee et al., 2014) Lee et al. (2014) used NMES+TDT and TDT with 57 patients. Patients were enrolled in VFSS within 10 days of stroke. 31 in NMES+TDT group and 26 patients TDT group. Both groups received therapy for 30 for 15 days. Stimulation was given on both suprahyoid muscles. Swallowing function was assessed initially and at end of the study and follow-up after 12 weeks. FOIS score was given using VFSS. The results of the study showed that the FOIS score for NMES+TDT group was higher than the TDT group. Spontaneous recovery could major role in FOIS scores. Improvement was seen after the study and at 12 weeks. Small size is also a limitation to this study.

In a study conducted by (Kushner, Peters, Eroglu, Perless-Carroll, & Johnson-Greene, 2013) David et al. (2013) two groups were selected for the study; both groups had a total of 92 patients. One group had 65 patients who received NMES + TDT + Progressive resistance training(PRT) therapy for 18 days and another group received therapy of TDT+PRT for 18 days. Patients that were included in this study had severe dysphagia and they all aspirated on all consistencies at the time of assessment. FOIS was used as measuring outcome and scores were noted at the baseline at the end of the study. He found significant differences in scores of FOIS in NMES+TDT+PRT group and TDT+PRT group. NMES+TDT+PRT group had higher FOIS scores than TDT+PRT group. The results cannot be generalized because the patients were not equally divided so the results of the study were biased. Selection bias, no formal assessment was done before and after the study. The scores of the FOIC could be biased; the SLPs who scored the FOIS also provided therapy so better scores were predicted by the clinician at the end of the study.

(Sun et al., 2013) Shu F.S et al. (2013) combined FEES+NMES+TDT and provided therapy to 32 patients who had moderate to severe dysphagia and stroke of <3 weeks. All patient received therapy of 12 sessions of NMES therapy and 12 sessions of TDT. Each session was of 50 minutes of TDT and NMES therapy for 3 days per week for 4 weeks. FOIS was the measuring outcome of the study and other measures were also used as the clinical degree of dysphagia, the patient's self-perception of swallowing and global satisfaction with therapy. All patients were assessed at the beginning and end of the therapy and follow up was done at 2 years. The results were remarkable as the significant improvement was seen in scores of primary and secondary measures. Out of 32, 29 were back to a normal diet. but there were few limitations as the study didn't have the control group. Effortful swallowing was also used during TDT which can alter the overall scores of primary and secondary measures. The scores were high due to effortful swallowing or due to NMES is not clear in this study so further research is recommended with effortful swallow alone.

Anna et al., (Guillén-Solà et al., 2017) hypothesized and tested her hypothesis that if inspiratory and expiratory muscle training is coupled with NMES the swallowing ability of the patient will be improved. She recruited 62 patients for the study and divided them into two groups. One group received standard swallow therapy for 3 weeks and other group received NMES with standard swallow therapy for 3 weeks. PAS scores and respiratory muscle strength were checked at the start and end of the therapy, after 3 weeks of therapy she found out that the group who received NMES + SST had significantly higher scores of PAS and respiratory muscle strength than SST group. Use of IEMT with NMES improves patient swallowing ability and improves pharyngeal protection signs. This study did not any instrumental assessment before and after the study. Only stroke patients were included. Patients had no history of swallowing and respiratory problems.

(Sproson, Pownall, Enderby, & Freeman, 2018) Lise et al. also received the same results when combined NMES with strengthening exercises. It included 30 patients and divided into 2 groups' one swallow care group and other was effective swallow protocol. both groups received therapy for 4 weeks 5 days per week. Measuring outcomes were PAS, SWAL-QOL and FOIS. After 4 weeks of therapy, the group who received NMES with strengthening exercises scored higher and showed improved swallow function in PAS, FOIS and SWAL-QOL. The sample size was too small to generalize the results. Due to treatment complexity, it was not clear that therapy outcome was due to intensive therapy sessions or due to NMES or due to exercises. Follow up was also not done after the study.

(Meng et al., 2018) Pingping et al. also concluded the same results as it was seen in (Sproson et al., 2018) Lise et al (2017) study 30 participants were divided into 3 groups. One was the control group which received TDT and two other groups NMES+TDT but the location of electrodes was different in both groups. VFSS was done at the start and end of the therapy. Measuring outcomes were the water swallow test, dysphagia outcome and swallow scale and repetitive saliva swallow test. A significant difference in scores was found when compared to control. Stimulating suprahyoid

muscles or stimulating supra and infrahyoid muscles had no significant differences. Suprahyoid muscles could move hyoid anteriorly. The only limitation with the study was no follow up was done. Treatment was provided for a shorter duration. The small sample size was selected for the study.

III. CONCLUSIONS

Combination of NMES and TDT can achieve promising results in dysphagia and can return the patient with Dysphagia, especially caused by stroke patients, to a normal diet, depending upon the type and severity of dysphagia. Dysphagia therapy is recommended within one or two weeks after stroke as it will robust the treatment results. When NMES is used with TDT as a combination it will increase the chances that the patient will be returned to a safe oral diet. For severely-profound dysphagia patients, more research is recommended as most of the researches have achieved good results in mild to severe dysphagia. However further research is recommended to fill the gaps of previous researches, as most of the studies were conducted on small sample size, the intervention period was too short, follow-ups were not done in most of the studies, accurate measurement tools should be used, proper assessment tools should be used before and after the study, the larger sample size should be included, extended observation should be done to see the effects of the treatment.

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