ORIGINAL ARTICLE

Effect of Neuromuscular Electrical Stimulation on Swallowing Process in Stroke Patient with Neurogenic Dysphagia

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ABSTRACT

Objectivs: The aim of this study to determine the therapeutic effect of Neuromuscular Electrical Stimulation (NMES) on pharyngeal phase of swallowing for stroke patients with neurogenic dysphagia, and to see the effect of NMES in reducing the incidence of standing secretion, residue, penetration and aspiration.

Methods: It is a quasi-experimental study design. 10 stroke patients with neurogenic dysphagia in Cipto Mangunkusumo hospital, Jakarta, 40-80 years old with hemodynamically stable, cooperative and will be get NMES therapy for 4 weeks. Pre and post treatment assessments compared using a modified MASA test (The Mann Assessment of Swallowing Ability) and FEES examination (Flexible Endoscophic Evaluation of Swallowing). Analysis of change scores using Wilcoxon test.

Results: The obtained average age of patients 59.80+9.705 years. Significant difference seen in the pharyngeal phase of swallowing increased score of gag reflex, velum elevation, cough reflex, voluntary cough, voice quality, pharynx response, pharyngeal constrictor contraction and vocal cord adduction ($p < 0.005$). Also seen significant reduction in the incidence of standing secretion, residue and penetration ($p < 0.005$), but not significantly in the incidence of aspiration ($p = 0083$).

Conclusions: NMES increased the pharyngeal phase of swallowing, reduced the incidence of standing secretion, residue and penetration of stroke patients with neurogenic dysphagia, but have not able to reduced aspiration.

Keywords : *Neuromuscular Electrical Stimulation (NEMS), neurogenic dysphagia, MASA test (The Mann Assessment of Swallowing Ability), FEES examination (Flexible Endoscophic Evaluation of Swallowing), swallowing process.*

INTRODUCTION

The process of swallowing is a complex process, the role of each organ to work in an integrated and sustainable manner. Ingestion of this requires good cooperation of the cranial nerves, cervical nerves and the muscles of swallowing. In the process of swallowing, bolus removal will occur from the mouth into the stomach which involves structures in the mouth, pharynx, larynx and esofagus.[1,2] When there is interference with the nerves or muscles of swallowing it will happen dysphagia (swallowing disorders). Dysphagia often occurs

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due to nervous system disorders that can affect the central nervous system, peripheral or myoneural junction,[3,4,5] and often occur in acute cerebrovascular disorders (stroke), dysphagia due to nervous system disorder called neurogenic dysphagia. According to the WHO report in 2007, 15 million people worldwide suffered a stroke each year by 5 million people died and 5 million others suffered permanent disability, the prevalence of neurogenic dysphagia incidence of 22-65%.[6] Young EC, Durant JL (1990)[7] in its research found 28% of stroke patients who have neurogenic dysphagia, Wahyuni (1995)[8] in her research found the prevalence of neurogenic dysphagia in stroke patients at Cipto Mangunkusomo hospital, Jakarta is 23.3%, while Marpaung D (2008)[9] in his research found the prevalence of neurogenic dysphagia in stroke patients at Cipto Mangunkusumo hospital, Jakarta is 39.6% (highest stroke onset was 7 days). The prevalence of silent aspiration stroke patients were examined using FEES (Flexible Endoscophic Evaluation of Swallowing) is 29.2% and the prevalence of aspiration is 39.6%. Acute stroke patients who have neurogenic dysphagia have a poor prognosis, with an increased risk of lung infection (aspiration pneumonia), malnutrition, persistent disability, is being treated in hospital for longer, the risks are removed from the workplace and the mortality rate is high.[10] In some patients with poor coordination of swallowing, the food material into the airway often resulting in aspiration and this condition is sometimes no symptoms, called Silent Aspiration, Aspiration is the most frequent complications in stroke patients who have neurogenic dysphagia. The incidence of aspiration is high enough (found through examination videofluoroskopi) on research conducted by Schelp AO et al (2004)[11] which is about 76%

Neuromuscular Electrical Stimulation (NMES) is one of the modalities of rehabilitation is effective in improving muscle function. NMES at the present time is starting to be used also in the treatment of neurogenic dysphagia due to an effect on strength, endurance and coordination of muscles that function in the process of swallowing. Freed et al (2001)[12] reported the effectiveness of ES in 63 dysphagia patients caused by stroke, while a study conducted by Leelamanit et al (2002)[13] showed that 23 patients with pharyngeal dysphagia improved after therapy is given using the synchronized ES. In Indonesia, study of NMES therapy in stroke patients with neurogenic dysphagia has not been done, so that the required data whether NMES therapy had similar results with previous studies that have been committed abroad. Therefore, the purpose of this study aims to determine the therapeutic effect of Neuromuscular Electrical Stimulation (NMES) on pharyngeal phase of swallowing process in stroke patients with neurogenic dysphagia, with a look at the change score of gag reflex, velum elevation, cough reflex, voluntary cough, voice quality, pharynx response, pharyngeal constrictor contraction, vocal cord adduction and see the effect of NMES in reducing the incidence of standing secretion, residue, penetration and aspiration

METHODS

Is a quasi-experimental research design. From the selection of a consecutive sample, obtained 13 stroke patients with neurogenic dysphagia, inpatient and outpatient care at Cipto Mangunkusumo hospital, Jakarta who met the inclusion criteria are patients with both men and women, aged 40-80 years, good consciousness, stable hemodynamice, sub-acute and chronic phase of stroke and able to follow instructions (cooperative). The patients would be rejected if the patients had a disorder of the cardiovascular system (with or without using Peacemaker), an open wound in the neck, a tracheostomy is being installed, be intellectually impaired memory or cognitive impairment, had other neurological disorders can cause dysphagia and no history of suffering nasopharyngeal, esophageal and gastric malignancy. Patients who are willing to research samples and acceptance criteria will sign a letter of approval.

Then before being given treatment, carried out the initial assessment pharyngeal phase of swallowing using a modified MASA Test and FEES examination and then given therapy using NMES device brands Vitalstim model 5900, (Chattanooga Group, Hixson, TN). The tool uses dualchannel and four electrodes, with

power comes from two AA (1.5 volt) alkaline batteries, use a symmetrical biphasic rectangular wave. Each stimulation session is given with a fixed frequency of 80 Hz and amplitude of 700 μs. The first electrode is placed 1 mm to the right of the midline above the cartilage tiroideus, the second electrode is placed parallel to the first electrode, 1 mm to the left of the midline above the thyroid cartilage. The third electrode is placed 1 mm below the cartilage of tiroideus inferior from the first electrode and the fourth electrode placed in the inferior of the second electrode. Each therapy session is given for an hour accompanied by swallowing exercise using the Masako Maneuver technique and monitored of vital signs, O2 saturation and subjective complaints of patients every 15 minutes. Therapy will be discontinued if there is a subjective complaint of the patient (pain on therapeutic area/shortness of breath) or vital signs decreased (hypotension/bradycardia). NMES therapy was given 3 times per week for 4 weeks. after completion of therapy, reassessment of the pharyngeal phase of swallowing using a modified MASA Test and FEES examination.

Figure 1. The Flow of Study

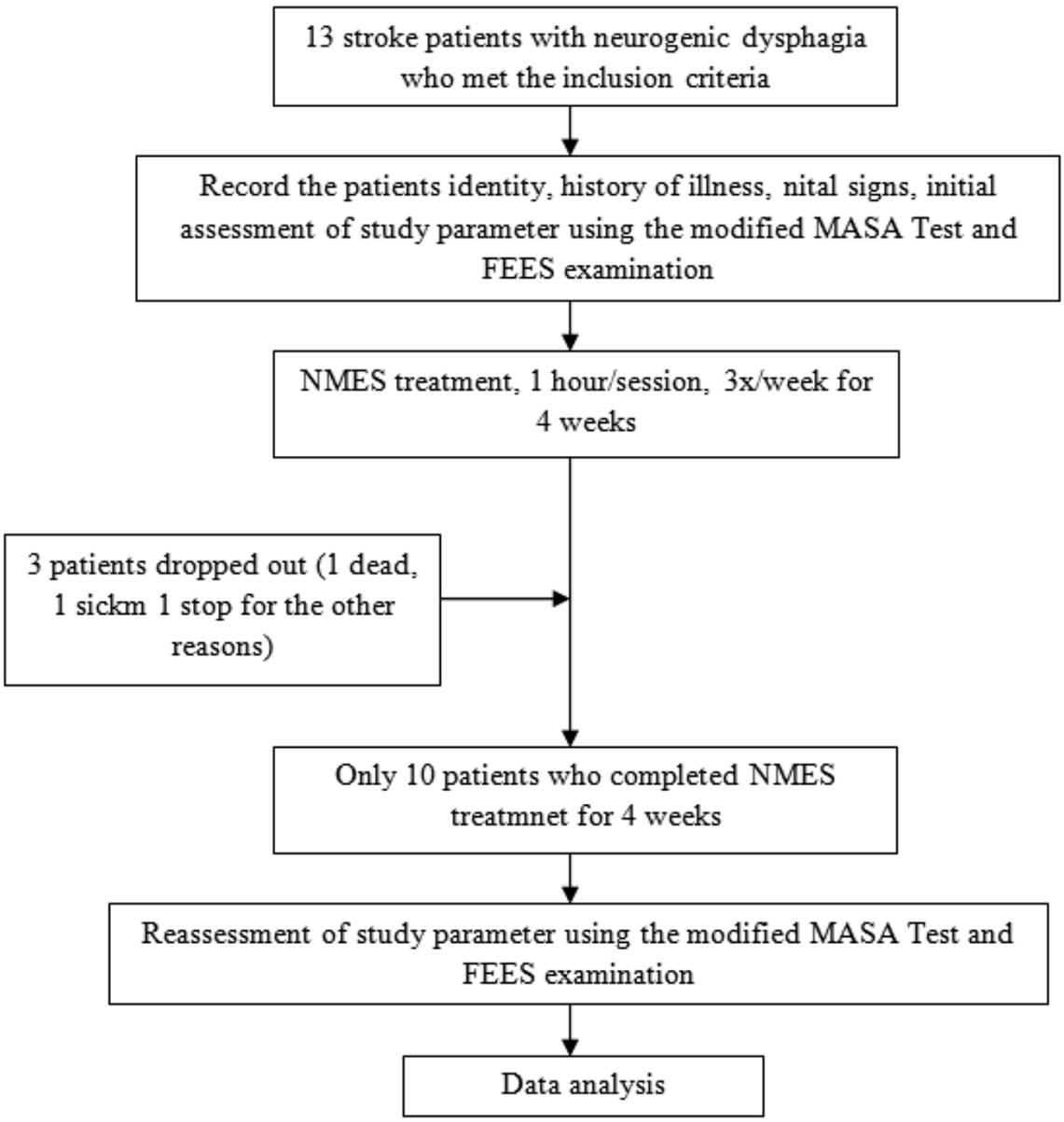


Table 1. FEES Examination

Standing secretion	4 = no abnormality detected 3 = standing secretion (+) on valecula/pyriform sinus 2 = standing secretion (+) on postcricoid/larynx vestibule, not settled 1 = standing secretion (+) on postcricoid / larynx vestibule, settled
Residue	4 = no abnormality detected 3 = residue (+) on valecula/pyriform sinus, removed with repeated swallowing/ maneuvering 2 = residue (+) on valecula and pyriform sinus, removed with repeated swallowing/maneuvering 1 = residue (+) on valecula and piriform sinus, is not removed with repeated swallowing/maneuvering
Pharyngeal constrictor contraction	3 = normal contraction 2 = weak contraction 1 = no contraction
Vocal cord adduction	3 = normal contraction 2 = weak contraction 1 = no contraction
Penetration	2 = penetration (-) 1 = penetration (+)
Aspiration	2 = aspiration (-) 1 = aspiration (+)

In this study the expected occurrence of a change score of gag reflex, velum elevation, cough reflex, voluntary cough, voice quality, pharynx response, pharyngeal constrictor contraction, vocal cord adduction and see the effect of NMES therapy on the incidence of standing secretion, residue, penetration and aspiration. Throughout the research data are recorded and analyzed using SPSS 17.0 program and because of normal data distribution requirements are not met, then the hypothesis test used is an alternative test that paired t test Wilcoxon test.

RESULTS

Of the 13 study subjects investigated, only 10 subjects were analyzed for the study had 3 people drop out (1 dead, 1 sick and 1 stop for other reasons). From the 10 study subjects, the age of majority is the age of 55-65 years amounted to 6 persons with an averaged age of 59.80 +9.705 years. Most of the study subjects suffered from ischemic stroke (80%) with the highest phase of stroke more than two weeks to six weeks (90%), of which 70% is the first stroke.

Table 2. Distribution Characteristic of Study subjects

Subject of Study	n=10 (%)	Mean (SD)
Characteristics of age (year)		59.80+9.705
Gender :		
Male	5 (50)	
Female	5 (50)	
Work :		
Work	2 (20)	
Housewife	5 (50)	
Retaired	3 (30)	
Type of stroke :		
Ischemic stroke	8 (80)	
Hemorrhagic stroke	2 (20)	
Phase of stroke :		
Subacute	9 (90)	
Chorinc	1 (10)	
Stroke :		
First	7 (70)	
Relaps	3 (30)	

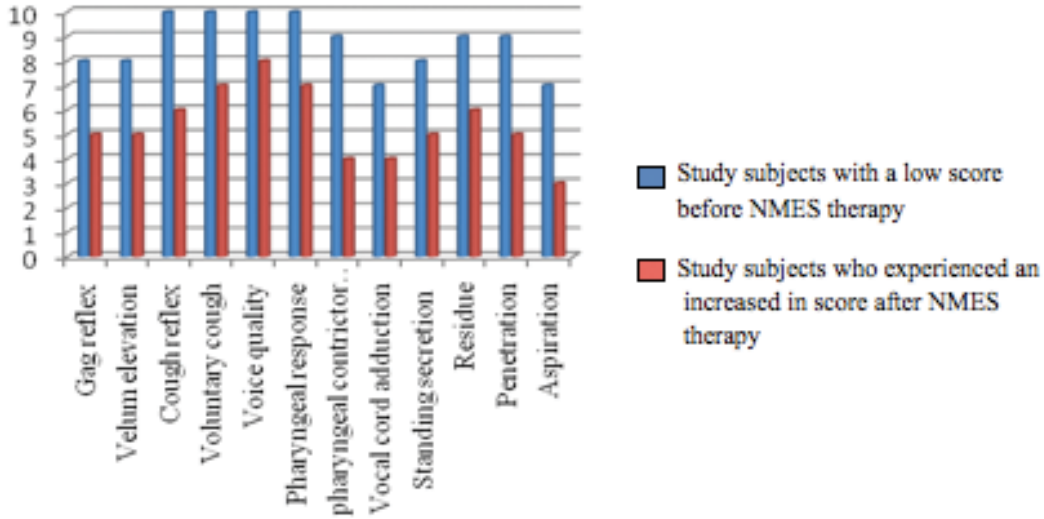
In this study shows that NMES therapy influenced the form of increased scores of gag reflex, velum elevation, cough reflex, voluntary cough, voice quality, response to the pharynx, pharyngeal constrictor contraction and vocal cord adduction after NMES treatment given and there are significant differences between before and after treated with NMES, with p values > 0.05. It also saw an increased in scores of standing secretion, residue, penetration and aspiration with p values > 0,05. This could mean also the incidence of standing secretion, residue, penetration and aspiration decreased after treatment with NMES, although the incidence of aspiration did not showed significant differences with p value of 0.083 (p> 0.05).

Table 3. Effect of NMES on Pharynx Phase of Swallowing Process

Examination	Mean	Median	SD	Maximum	Minimum	P* (p<0.05)
Modified MASA Test						
Gag reflex :						
Before	3.80	4	0.789	5	3	
After	4.60	5	0.669	5	3	0.038
Velum Elevation :						
Before	7.40	7	1.647	10	6	
After	8.80	10	1.932	10	6	0.038
Cough Reflex :						
Before	2.00	3	1.054	3	1	
After	3.60	3	1.350	5	1	0.011
Voluntary Cough :						
Before	5.00	5	2.000	5	5	
Fter	7.20	8	2.044	10	5	0.016
Voice Quality :						
Before	5.60	5	2.271	8	2	
After	7.80	8	2.201	10	4	0.009
Pharynx Response						
Before	5.60	5	1.265	5	1	
After	8.00	10	2.582	10	5	0.011
FEES Examination						
Standing Secretion						
Before	1.80	2	0.789	3	1	
After	2.30	2,5	0.823	3	1	0.025
Residue :						
Before	1.70	1,50	0.949	4	1	
After	2.80	3	1.033	4	1	0.015
Pharyngeal contrictor contraction :						
Before	2.10	2	0.316	3	2	
After	2.50	2.5	0.527	3	2	0.046
Vocal cord adduction:						
Before	2.30	2	0.483	3	2	
After	2.70	3	0.483	3	2	0.046
Penetration :						
Before	1.10	1	0.316	2	1	
After	1.60	2	0.316	2	1	0.025
Aspiration :						
Before	1.30	1	0.483	2	1	
After	1.6	2	0.51	2	1	0.083

This study used MASA test to evaluated the clinical swallowing ability of research subjects. Researchers found 8 subjects decreased in gag reflex score and after treated 5 subjects have seen an increased in gag reflex score. 8 subjects decreased in velum elevation score and after treated 5 subjects have seen an increase in velum elevation score. In this study also shows that the voice quality and the voluntary cough score increased after a NMES treatment (the highest sound quality scores), where all study subjects (10 subjects) have problems in vocal cord adduction, could be due to the parese or edema. After treated 8 subjects have increased in voice quality score and 7 subjects have increased in voluntary cough score. Researchers found that of 10 subjects who have impaired cough reflex and pharynx response, 6 subjects have increased in cough reflex score and 7 subjects have increased in pharynx response score after NMES therapy. In this study also shows that after NMES therapy, 4 subjects have increased in pharyngeal constrictor contraction score, 5 subjects have increased in standing secretion score, 6 subjects have increased in residue score and 5 subjects experience an increased in penetration score, but only aspiration scores is increased in 3 subjects .

Figure 2. Effect of NMES Therapy on The Number of Study Subjects Who Experienced an Increased in Score of The Modified MASA Test and FEES Examination



During and after therapy, the researchers not found NMES complications such as bradycardia, laringospasme, pain or burning in the placement of the electrodes.

DISCUSSION

In this study subjects performed retrieval concecutive sampling of space inpatient and outpatient Cipto Mangunkusumo hospital, Jakarta. The number of samples obtained 13 subjects who meet the admission criteria of the study, but 3 of them drop out because of 1 dead, 1 sick and 1 stop for the other reasons. The 10 subjects found of male and female balanced that each of the 5 subjects, with the highest age ranged is 55-65 years of age amounted to 6 subjects. Even so although there was one subject aged 66-74 years and one subject aged between 75-85 years. This is consistent with the literature that says that the incidence of stroke with age, the world's prevalence stroke at age > 65 tahun.[14] This study obtained at a mean age of onset of 59.80 +9.705 years, this is different from the results of research Warnecke et al (2009)15 which have a mean age of 71.43

+11.81 years.

From this study found 50% of study subjects were housewives and only two subjects who are still actively working. Researchers also found that most strokes are ischemic strokes, amounting to 8 subjects with 7 of them are the subject of the first stroke, it is similar to the data on the prevalence of stroke Cipto Mangunkusumo hospital in 2008.

In this study, all study subjects given NMES therapy (Neuromuscular Electrical Stimulation) three times per week for four weeks. Each therapy session is given for an hour accompanied by swallowing exercise using the Masako Maneuver technique. Once research is completed and the data analyzed, and tested the normality of the data obtained that the distribution is not normal. Because the normal data distribution requirements are not met, then the hypothesis test used is an alternative test that paired t test Wilcoxon test.

Researchers found that scores between the modified MASA test and FEES examination before treatment is different, where the average throughout all items of the modified MASA test is greater than all items of FEES examination, is due to a difference in the scoring system. After NMES therapy is seen that all items of modified MASA test and FEES examination has increased. This suggests that NMES therapy affects to the pharyngeal phase of swallowing changes of stroke patients with neurogenic dysphagia, where swallowing ability of study subjects is improved. Only the score of the aspirations that showed clinical improvement, but no statistically significant difference between before and after NMES therapy. This could be due to a shorter treatment time. Effect of NMES to changes in the pharyngeal phase of swallowing is reinforced by an increased in total scores the modified MASA test, where the total score of prior therapy is 34.6 (+7834) and after NMES therapy increased to 48.4 (+10,554), and there were statistically significant differences before and after treated NMES with a p value > 0.005. Effect of NMES to changes in the pharyngeal phase of swallowing were also seen with an increased in the total score FEES examination, where the total score before treatment is 12.3 (+2003) and after treatment with NMES increased to 15.80 (+3293), and there were statistically significant differences before and after a NMES therapy with a p value 0017. The improvement results of the modified MASA test after a NMES therapy are similar to Giselle et al16 research in 2008 that conducts research on the effects of NMES therapy on patients with pharyngeal dysphagia using MASA test. Giselle get a total score before treatment is 160.5 (+17.4) and after therapy increased to 182.75 (+8.5). Difference scores in this study because Giselle assessed on all items of MASA test, while researchers assessed only on a few items MASA test are adapted to the purpose of research.

This study used a modified MASA test to evaluated the clinical swallowing ability of the study subjects. As we know, in many cases of stroke, we often encounter a disturbance in the gag reflex. The loss of gag reflex does not always indicate the presence of swallowing disorders, since 38.6% gag reflex in patients with dysphagia disappeared and the normal person can not have gag reflex.[17,18] Investigators wanted to point out that although the examination is less sensitive gag reflex, but specific enough for can described the response of tactile receptors and pathways afferent impulses n.IX and X, and how the contraction of the pharyngeal constrictor muscles. After a NMES therapy, there is an increased in gag reflex score, this indicated that the response of tactile receptors and contraction of the muscles of the pharynx included pharyngeal constrictor began to experience improvement.

Velum elevation is a series of complex pharyngeal phase of swallowing. Velum contributes to the closure of the posterior oral cavity during the process of swallowing occurs, velum will be move to suppress the nasopharyngeal, so the food will not enter into the nasal cavity. With the improvement of velum elevation after NMES therapy, the risk of nasal regurgitation can be reduced. Unfortunately the researchers were unable to assess the coordination between the movement of the closing of the velum elevation and velofaringeal port because the movement can only be seen by videofluoroscopy.

Stroke patients with neurogenic dysphagia

often have paralysis of vocal cord, this condition interfered with the movement of vocal cord adduction who also plays a role in preventing aspiration. In this study also showed that the voice quality and the voluntary cough score increased after a NMES therapy (the highest sound quality score). This suggests that the strength of the movement of the muscles to adduction of vocal cord increased because the sound quality and the voluntary cough assessment can be used to assess the condition of vocal cord. While based on FEES examination, found only a slight increased in vocal cord adduction score. There was a different, this can be attributed to differences in scoring system between the modified MASA test with FEES examination. From the modified MASA test scores improved, but a voice quality of study subject is still not back to normal, only improved from a weak voice becomes more powerful but husky voice. Adduction of vocal cord improvement less than the maximum could be due to a shorter treatment time and may be due to the location of the intrinsic muscles of the larynx are very deep, so that NMES with electrodes attached to the neck area are less able to stimulate the muscles. This is similar to research conducted by Humbert et al (2008)[19] which also showed that administration of NMES only able to make a vocal cord adduction increased slightly due to the location of the muscles that are too deep.

Researchers found that the cough reflex and pharyngeal response scores increased after a NMES therapy. Cough reflex is a defense both to removed the bolus in the surrounding area or the area underneath vocal cord. Like a lot of literature that described the larynx and trachea contains many sensitive receptors that delivered information via the superior laringeus nerve and reccurent branch n.X. Stimulation of this receptor as a bolus will lead to the occurrence of cough reflex to removed the bolus. Addington et al (1999)[20], Hammond et al (2001)[21], and Carol H et al (2006)[22] in their researches found an association between reduced / loss of cough reflex with an increased incidence of aspiration pneumonia in stroke patients. Decreased cough reflex, the greater the risk of aspiration.

Researchers found that the results obtained from clinical examination using the modified MASA test is not as accurate as results obtained from the FEES examination, clinical examination is nevertheless still can be used to identified the risk of penetration or aspiration. After getting the NMES therapy, seen a significant increased in cough reflex score and pharyngeal response score, it indicated an increased receptor sensitivity in the larynx area.

After getting the NMES therapy, the pharyngeal constrictor contraction, standing secretion, residue, and penetration scores increased. Unfortunately, very little increased in aspiration score, this could be due to the time of treatment just four weeks, so that muscle strength is not maximized. As already described in the literature[23,24] that the electrical therapy can changed of type II muscle fibers into type I, but changed in alpha and beta tropomyosin of fast-type muscle to completed a new type of slow going at 8 weeks. Pharyngeal constrictor muscle which has not recovered to the maximum condition, the bolus has reached the vocal cord area or who have entered into the trachea can not be the most excluded, although the cough reflex has begun to increased.

CONCLUSIONS

NMES therapy may improved the pharyngeal phase of swallowing in stroke patients with neurogenic dysphagia is increased in scores from all items of modified MASA test and FEES examination, which included an increased in score of gag reflex, velum elevation, cough reflex, voluntary cough, voice quality, pharynx response, pharyngeal constrictor contraction and vocal cord adduction. NMES therapy may decreased the incidence of standing secretion, residue and penetration in stroke patients with neurogenic dysphagia is increased in scores above the third examination, but not significantly in the incidence of aspiration.

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