

# To Study The Effect Of Neuromuscular Electrical Stimulation And Rehabilitative Exercise Of Masseter And Buccinator In Oral Phase Of Neurogenic Dysphagia

**Manish kumar Jha**

MPT (Neurology) Shri Guru Ram Rai University,  
Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar Dehradun,  
Uttarakhand

**Nishu Sharma**

Assistant Professor, Shri Guru Ram Rai University,  
Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar Dehradun,  
Uttarakhand

**Niraj Kumar (Correspondence Author)**

HOD/Associate Professor Shri Guru Ram Rai University  
Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar Dehradun,  
Uttarakhand

[drnirajkumar25@gmail.com](mailto:drnirajkumar25@gmail.com),

**Niranjan Shah**

Assistant Professor  
SBS University, Balawala, Dehradun, Uttarakhand

**Devashree Shah**

Assistant Professor  
SBS University, Balawala, Dehradun, Uttarakhand

## **Abstract**

### **INTRODUCTION**

*Dysphagia is a derivative of Greek word "Dys", means "with difficulty or dysfunction" and "Phagia" means "to eat". Thus, it is defined as difficulty in swallowing or processing food from mouth to the stomach. 1*

### **AIM OF STUDY**

*To study the effectiveness of neuromuscular electrical stimulation (NMES) and rehabilitative exercise on masseter and buccinator group of muscle in oral phase of neurogenic dysphasia.*

### **METHODS:**

*30 patients with neurogenic dysphagia were selected according to the inclusion criteria. Dysphagia was evaluated with the help of FDS and NEDS respectively. The group A received NMES on buccinators and group B received NMES on masseter, both groups received exercise of their respective muscle. The treatment duration of both group was 5 days per week for 4 weeks. The post intervention data was compared with pre intervention data*

*and improvement in functional activity was thus measured. Main Outcome Measure FDS ( Functional dysphagia scale) and NEDS (Neurological examination dysphagia scale)*

**CONCLUSION :**

***NMES & rehabilitative exercise helps in improving neurogenic dysphagia.***

**Keywords :** NMES, Neurogenic Dysphagia, FDS, NEDS , Masseter , Buccinator.

## **INTRODUCTION**

Dysphagia is a derivative of Greek word "Dys" means "with difficulty or dysfunction" and "Phagia" means "to eat". Thus, it is defined as difficulty in swallowing or processing food from mouth to the stomach. <sup>1</sup>

Swallowing is defined as the semiautomatic motor action of the muscles of respiratory, oropharyngeal, and gastrointestinal tracts that propels the food from the oral cavity to the stomach and protects the airway from the unwanted entry of food, liquids, and other substances. <sup>2</sup>

Neurogenic dysphagia is seen in stroke, brain tumors, brain injury, bulbar and pseudobulbar paralysis, neurodegenerative diseases (amyotrophic lateral sclerosis, multiple sclerosis), tabes dorsalis, multisystem degenerations, Parkinson's disease, delayed dyskineses, Huntington's disease, myasthenia and myasthenic syndromes, myopathies and peripheral neuropathies. <sup>3</sup>

Facial muscles which include buccinator, orbicularis oris and risoris ,have a crucial function in oral phase of swallowing and also indulge in expression. Weak facial muscle can lead to dysfunction of oral phase which include reduced mastication and control of bolus, oral residue and drooling too. Facial muscle primarily affect the oral phase of swallowing. NMES is helpful in strengthening of muscle, it also prohibit muscle atrophy and also in neuro-muscular re-education <sup>4</sup>

During oral motor function buccinators perform a crucial role such as in regulation of salivary secretion from the parotid gland. The buccinator and orbicularis oris are active during oral phase and initiate a peristalsis like movement. <sup>5</sup>

In neurological disease impaired deglutition is very frequent and leads to overall morbidity. Patients who are not able to swallow normally are at risk for aspiration pneumonia which can be fatal. Patients with reduced oral intake are at risk of malnutrition which ultimately leads to overall frailty and disturb recovery. It further reduces the overall quality of patient's life.

Despite of all these dysphagia always remains underdiagnosed and less emphasizing is given in present neurological literature. In neurological disorder patients, dysphagia is common and usually affects the oropharyngeal phase of swallowing. <sup>6</sup>

Oropharyngeal dysphagia is generally related with neurological disorder and also other acute and chronic conditions. During study and assessment it was found that the incidence of oropharyngeal dysphagia is approx 70% in stroke patients, 97% in amyotrophic lateral sclerosis and almost between 55-82% in Parkinson disease. In various research we have seen and almost accepted by everyone that dysphagia leads to increase hospital stay , malnutrition, dehydration and ultimately death. Pneumonia is another serious complication which can develop who aspirate food and water into the airways. Studies have suggested that there are five cranial nerves which are involved in swallowing process. They are trigeminal nerve ( CN V ) , facial nerve (CNVII), glossopharyngeal nerve (CN IX) , vagus (CN X) and hypoglossal ( CN XII) <sup>7</sup>

Different condition have contrast ratio of neurogenic dysphagia in which traumatic brain injury is between 25 to 93%. After traumatic brain injury , dysphagia may lead to malnutrition , dehydration and aspiration pneumonia. So due to these complications , a proper planning is required to treat dysphagia in traumatic brain injury patients. the treatment protocol

which is used in stroke patient can be applied to TBI patients too. This suggest that regardless of the etiology , if there is dysphagia , treatment protocol could be same and it will give beneficial results too<sup>8</sup>

In ALS, dysphagia is very common, which ultimately affect approx 85% of patients. In older individual bulbar onset ALS is more common compared to older individual who were diagnosed with ALS.<sup>9</sup>

In patients with multiple sclerosis (MS) meta-analysis found approx 43% incidence of dysphagia. In multiple sclerosis the swallowing dysfunction may result from lesion in corticobulbar tracts, cranial nerve dysfunction, cerebellum and brainstem disorders, and can also be due to cognitive dysfunction.<sup>10</sup>

In spinocerebellar ataxia (SCA), the dysphagia which was reported varies from 6 to 74%. It depends on several factors such as underlying genetic mutations with less prevalence in pure cerebellar syndromes.<sup>11</sup>

In brainstem stroke (BSS) the incidence of dysphagia has been reported in 70-81% patients. Teasell et al. concluded an incidence of dysphagia in 47% of BSS patients. After brainstem stroke dysphagia is more severe as compared to hemispheric stroke and chance of recovery is less in brainstem stroke.<sup>12</sup>

The exercise which strengthen the buccinator muscle include, fill air inside the cheek and retain them, transfer air filled in cheek from one side to another, resistance exercise such as expansion of cheek against wooden spatula. All exercises to be done for 10 minutes or according to patient's tolerance level.<sup>13</sup>

The exercise for masseter include, the patient is asked to open mouth against mild resistance applied by therapist at patient's chin. The exercise can be performed for five minutes or according to patient tolerance.<sup>14</sup>

#### **AIM OF STUDY**

To study the effectiveness of neuromuscular electrical stimulation (NMES) and rehabilitative exercise on masseter and buccinator group of muscle in oral phase of neurogenic dysphasia.

#### **NEED OF STUDY**

Various studies has been done in oral phase in neurogenic dysphagia and the studies are based on different factors such as rehabilitation exercise , electrical stimulation, magnetic stimulation etc. but none of the study did comparison between two group of muscle with electrical stimulation. This was need to be as be precise in real clinic practice, so that patients can get most benefit in less time, as on study revealed that combined therapy gives better result than monotherapy.

#### **PURPOSE OF STUDY**

In neurological conditions, most of the research and also in practical life we focus most on upper and lower limb and dysphasia being under-rated due to which patients suffer most as their nutritional requirement is not fulfilled which ultimately results in malnutrition and deterioration of physical health. So this study will help in swallowing process and ultimately will improve quality of life.

#### **HYPOTHESIS**

1.9.1 EXPERIMENTAL HYPOTHESIS : NMES and rehabilitative exercise may be effective in oral phase of neurogenic dysphasia.

1.9.2 NULL HYPOTHESIS : NMES and rehabilitative exercise may or may not be effective in oral phase of neurogenic dysphasia.

#### **REVIEW OF LITERATURE**

The name of my study is to study the effect of neuromuscular electrical stimulation and rehabilitative exercise of masseter and buccinator in oral phase of neurogenic dysphagia and it was a four weeks study on 30 patients with dysphagia. In this study the dependent variables

were used such NMES and rehabilitative exercise in both buccinators and masseter muscle and the scales which used were FDS and NEDS to check pre and post evaluation.

Author's study description

Sonja Suntrup-Krueger, Jens Minnerup, Paul Muhle et al. (2018) concluded that dysphagia screening in initial days and proper management which may include appropriate treatment can lead to reduced complications which further lead to positive outcome and early discharge from hospital. During 2008 to 2015, there was enhancement in dysphagia screening, which shows that dysphagia therapy is being widely used in clinical practice. By the end of six months, if high therapy was properly planned and implemented, the proportion of patients returned to normal dietary pattern was satisfactory. The other side of this is that, although there is visible advancement in dysphagia therapy in acute stroke patients, it falls over to make proper clinical

<sup>15</sup>

K. M. Lee, M. C. Joo, Y. M. Yu, et al (2018) states that various research has been done to make conclusion about the continuation and prognosis of swallowing dysfunction in stroke patients. Various factors are associated with neurogenic dysphagia, some of them are age, gender, previous history of stroke, site of lesion, cognitive function, severity of stroke. <sup>16</sup>

Cumhur Ertekin (2017) concludes that the co-ordinated contraction and relaxation of muscles situated around the tongue, larynx, pharynx and esophagus leads to swallowing which is a sensory – motor behavior. It is divided into three phases, the first being the oral phase, the second is pharyngeal phase and the last phase is oesophageal phase. The oral and pharyngeal phase is together known as oro – pharyngeal phase. Neurogenic dysphasia usually occurs in this phase. Neurogenic dysphagia can occur due to injury to neuromuscular pathway which can range from cerebral cortex to swallowing muscles. In approx 70% of patients swallowing difficulty is noted in neurological cases. The complications which are associated with neurogenic dysphagia are airway aspiration which leads to pneumonia, malnutrition and dehydration. These are very serious complications and more dangerous in patients with progressive symptoms. <sup>17</sup>

Andrews, M., & Pillay, M. (2017) concluded that the procedure which a professional uses and the resource which they utilize in clinical practices to manage neurogenic dysphagia may include assessment of clinical component of swallowing disorder. This knowledge gives rise to high quality practice which is evidence based practice too and this knowledge is gained from various research. Stroke dysphagia is a common symptom which leads to malnutrition or undernutrition, high mortality rate, dehydration, increased period of disability, poor quality of life. <sup>18</sup>

Yong Kyun Kim, Sung Sik Choi, Jung Hwa Choi et al (2015) states that in almost every patient of severe neurogenic dysphagia, they have to be dependent on tube feeding as they are unable to feed themselves due to altered consciousness or other factors. This results in limitation of use of oro – pharyngeal muscles i.e the muscles of oropharyngeal which help in swallowing cannot function properly which in turn limits the option to swallow food. Moreover the muscles which help in swallowing are paralyzed due to stroke. CVA also leads to reduction in motor skills as well as ability to co – ordinate is also degraded. These all factors are responsible for swallowing issues. <sup>19</sup>

Alison A. Howle, Ian J. Baguley, Louise Brown (2014) concluded that traumatic brain injury (TBI) and its complications leads to huge number of mortality and morbidity. TBI leads to dysphagia which is one of the most common complications and is present in 93% of patients, who are admitted in brain injury rehabilitation ward. Dysphagia after TBI can be due to many reasons but most commonly is due to impairment of one of the three phases. With dysphagia other common complications are behavior issue, cognitive and communication issues. Due to

this variability, the complexity of dysphagia increases. The severity of dysphagia can range from mild to severe depending on the site of injury and severity of injury too. Patients have to stay longer in hospital who have TBI & dysphasia compared to patients having TBI without dysphagia. This leads to increased risk of pneumonia, weight loss, dehydration, of these pneumonia can be dangerous and its incidence can be 12% after TBI. All these factors play an important role in its psychological and social relation which ultimately decrease patients quality of life.<sup>20</sup>

Aaron J. Hadley , Paul Thompson, Ilya Kolb et al. (2014) Patients who are at risk of developing aspiration are advised for rehabilitation exercise and modified diet. If these intervention fails then surgical recommendation is advised, but it can lead to non- satisfactory patient state, therefore an improved intervention is required.<sup>21</sup>

Emiko Ogura , Miwa Matsuyama , Tazuko K. Goto et al. (2012) States that in peripheral and central nervous system, oral exercises have positive effect on the these. Some studies suggest that during lip movement, the activation of left hemisphere is visualized. Hesselmann et.al stated that left hemisphere was more activated during a lip pursing exercise in group, while in individual analysis it was found to be bilateral, when assessed on six right handed patient. Fukunga et.al conclude that left side was more activated than right side, when assessed on eight right handed subjects, but there was seen bilateral activation of sensorimotor area, when same exercise was performed. Both pre and post central gyrus were activated during lip protrusion and ball rolling exercise.<sup>22</sup>

Michael Vaiman ,and Ephraim Eviatar (2009) concluded that dysphagia or difficult swallowing can include nasopharyngeal regurgitation and also aspiration. The swallowing can be divided into three stages with oral phase being divided into oral initial and oral final stages. For solids is oral preparation stage. In case of drinking water , it takes place during oral initial stage . the oral final stage takes place when tongue push the liquid against hard palate . during this stage, the automatic reflexive gesture is initiated, but oral stage is still under total conscious control.<sup>23</sup>

Norine foley, robert teasell, katherine salter et al. (2008) concluded that during stroke recovery, dysphagia is notable and due to this patient may suffer from various complications, one of the serious one is pneumonia. When 15 studies were reviewed, some of the most common intervention was based on diet modification, dysphagia therapy and all of them are now used intensively in clinical practice. The conclusion is that dysphagia therapy program can lead to diminished risk of pneumonia in acute stage of stroke.<sup>24</sup>

## **METHODOLOGY**

### **SAMPLE DESIGN**

It is an experimental study design. 30 patients with neurogenic dysphasia who were willing to take treatment for four weeks session after a written consent were taken. Simple random sampling technique was applied and 30 patients were divided into two groups. 15 patients were selected randomly and was included in group first and 15 patients in group second. Shri Mahant Indresh Hospital, Patel nagar, Dehradun, UK. The duration of study was of Four weeks.

Study group was divided into two groups ( A&B). First group (A) consist of patients in which treatment was given on buccinator muscle and the second group(B) consist of patients in which treatment was given on masseter muscle. Both group received NMES on respective muscle. 15 subjects each in two groups were selected according to inclusion and exclusion criteria. Inclusion criteria Inclusion Criteria- Patient's of both gender who were above 18 years of age , were affected by neurological condition with complain of dysphagia, and also were conscious and responsive enough to answer the instrument which was used after explaining them about that particular instrument. Maximum age group : 78 ( Based on my 3 weeks survey in Shri Mahant Indresh hospital). exclusion criteria-Patient's were excluded who has undergone head and neck surgery or who were previously diagnosed with structural

oropharyngeal disorder ( laryngomalacia, tracheomalacia, stenosis of larynx and trachea ), less than score 10 in Glasgow Coma Scale and those who were clinically unstable. The following outcome measures were used : FDS ( Functional Dysphagia Scale), NEDS (Neurological Examination Dysphagia Score) Materials used Treatment couch, NMES machine & Data collection sheet

### **PROCEDURE**

30 patients between the age group of 18 – 78 years were included in study after taking a written consent from either the patient or their relatives. Patients were made aware of the research study & the procedure to be followed. Patients were divided into two groups randomly, each group consist of 15 patients of both male and female. Group A would receive NMES on buccinator muscle and group B would receive NMES on Masseter muscle. Both group will undergo rehabilitative exercise programme. The study was of 4 weeks, 5 days per week at department of neurology in Indresh hospital, during hospitalization of patient and in physiotherapy OPD when discharged. Education about safe food & liquid intake was provided to patient in both group and their caregivers/relatives. Examination included assessment which was performed on first and last day of treatment & data was recorded.



Fig 4.2: Applying NMES on masseter muscle.



Fig 4.3 : Applying NMES on buccinators muscle.



Fig 4.4 : Result after 4 week intervention.

#### DATA ANALYSIS

Outcome measures of all individual were analyzed on day one ,before the start of the therapy and at the end of four weeks.

Comparison between pre and post treatment of group A and Group B and also between groups was done using paired t- test. Graphpad prism (Version 8.3.4) software was used for data analysis.

#### RESULT

- This chapter deals with the result of the data analysis of the two outcome measures - FDS and NEDS, between group A and group B and within group A and group B. The scores were analyzed and interpreted to determine whether “ NMES and exercise help in improving neurogenic dysphagia “ or not.
- Paired t – test was used to analyze and compare scores within group A and Group B and unpaired t – test was used to analyze and compare between group A & B. Significant level of 0.05 was used for data analysis.
- Analyzing FDS revealed slight significant difference in group A post treatment, Mean and Standard error of mean ( $7.53 \pm 0.850$ ) when compared with group A pre treatment, Mean and standard error of mean ( $14 \pm 1.331$ ).
- Analyzing FDS revealed significant difference in group B post treatment, Mean and Standard error of mean ( $7.33 \pm 0.8808$ ) when compared with group B pre treatment, Mean and standard error of mean ( $13.67 \pm 1.376$ ).
- Analyzing FDS in both group A & B , there was significant difference in both groups but group B shows slightly more significance in result.
- Analyzing post data of FDS of both group A & B ,group A Mean and SEM ( $7.53 \pm 0.850$ ), group B Mean & SEM ( $7.33 \pm 0.8808$ ), there was no significant difference i.e both the muscles shows improvement by applying NMES and rehabilitative exercise.
- Analyzing NEDS revealed slight significant difference in group A post treatment, Mean and Standard error of mean ( $2.733 \pm 0.3446$ ) when compared with group A pre treatment, Mean and standard error of mean ( $4.667 \pm 0.2702$ ).
- Analyzing NEDS revealed significant difference in group B post treatment, Mean and Standard error of mean ( $2.60 \pm 0.3352$ ) when compared with group B pre treatment, Mean and standard error of mean ( $4.607 \pm 0.2667$ ).
- Analyzing NEDS in both group A & B , there was significant difference in both groups and group B shows slightly more significance in result.
- Analyzing post data of NEDS of both group A & B ,group A Mean & SEM ( $2.733 \pm 0.3446$ ) , group Mean & SEM ( $2.60 \pm 0.3352$ ) there was no significant difference i.e both the muscles shows improvement by applying NMES and rehabilitative exercise.

- Analyzing both group data, although both groups shows significant difference but group B (masseter muscle) shows slightly more improvement and analyzing both the outcome measures i.e FDS and NEDS, NEDS shows significant improvement.

Therefore, results suggest that after four weeks of NMES and exercise, it will help in improving dysphagia and there will be improvement in NEDS

OUTCOME MEASURE	PRE ( MEAN ± SEM)	POST (MEAN ± SEM)	P VALUE
FDS	14 ± 1.331	7.53 ± 0.8500	P < 0.001
NEDS	4.667 ± 0.2702	2.733 ± 0.3446	P<0.001

Table 6.1: Within group comparison of outcome measure in Buccinator muscle in group A

OUTCOME MEASURE	PRE ( MEAN ± SEM)	POST (MEAN ± SEM)	P VALUE
FDS	13.67 ± 1.376	7.33 ± 0.8808	P<0.0001
NEDS	4.607 ± 0.2667	2.60 ± 0.3352	P<0.0001

Table 6.2 : Within group comparison of outcome measure in Masseter muscle in group B.

OUTCOME MEASURE	BUCCINATOR GROUP(A) POST DATA ( MEAN ± SEM)	MASSETERE GROUP(B) POST DATA (MEAN ± SEM)	P VALUE
FDS	7.53 ± 0.8500	7.33 ± 0.8808	0.8714
NEDS	2.733 ± 0.3446	2.60 ± 0.3352	0.7835

Table 6.3: Within group comparison of outcome measure in Buccinator and Masseter group

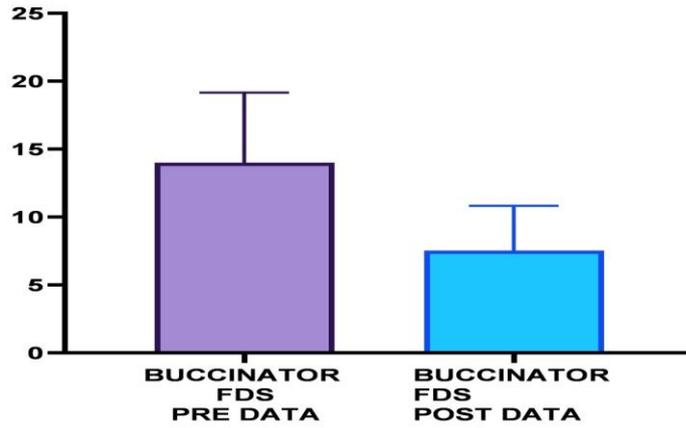


fig 6.1 : Comparison of FDS pre and post treatment of group A ( Mean & SD)

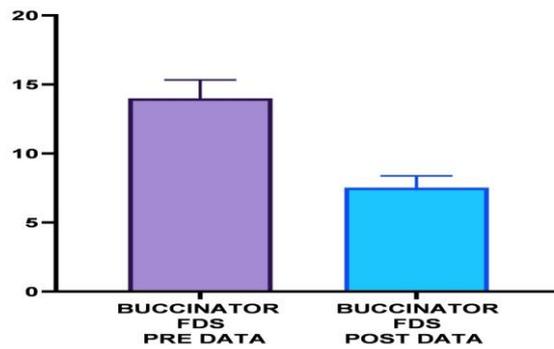


fig 6.2: Comparison of FDS pre and post treatment of group A ( Mean & SEM)

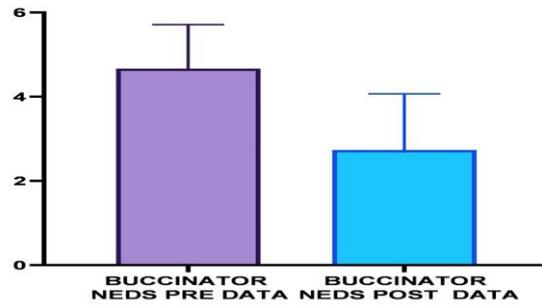


fig 6.3 : Comparison of NEDS pre and post treatment of group A ( Mean & SD)

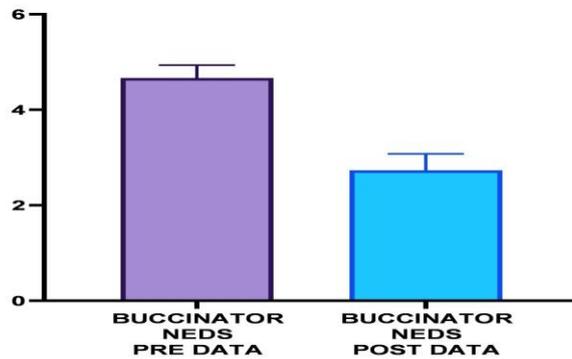


fig 6.4 : Comparison of NEDS pre and post treatment of group A ( Mean & SEM)

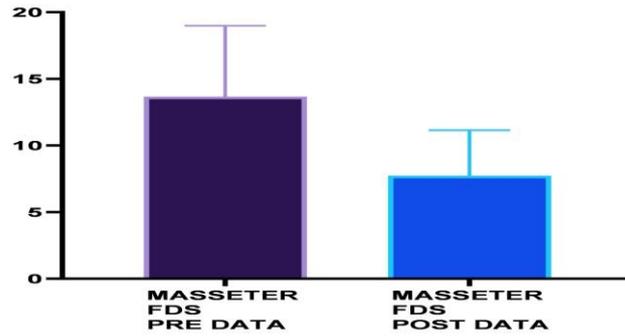


fig 6.5 : Comparison of FDS pre and post treatment of group B ( Mean & SD)

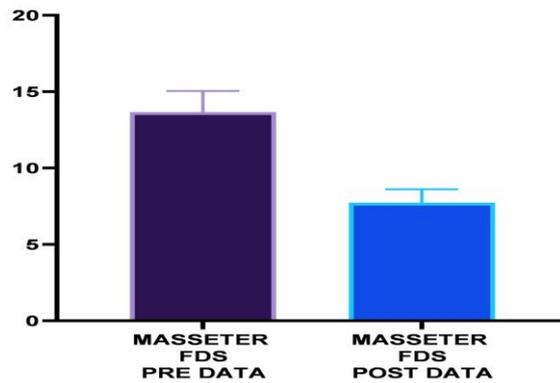


fig 6.6: Comparison of FDS pre and post treatment of group B ( Mean & SEM)

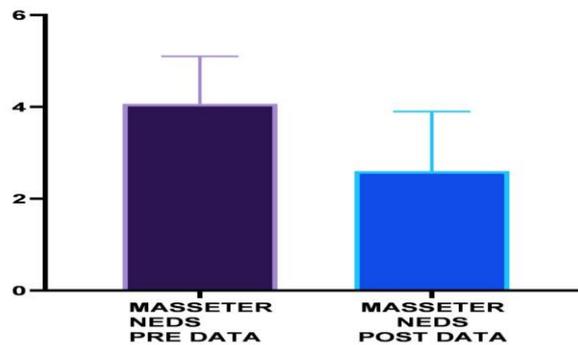


fig 6.7: Comparison of NEDS pre and post treatment in group B ( Mean & SD)

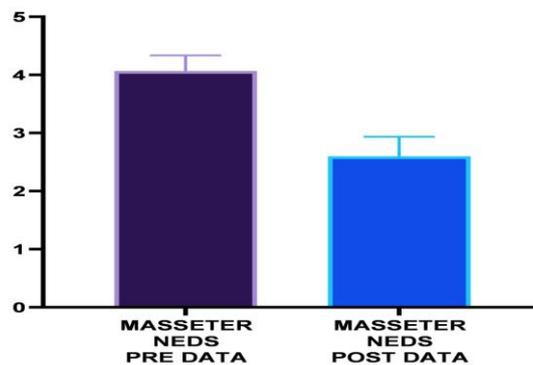


fig 6.8: comparison of NEDS pre and post treatment in group B ( Mean & SEM)

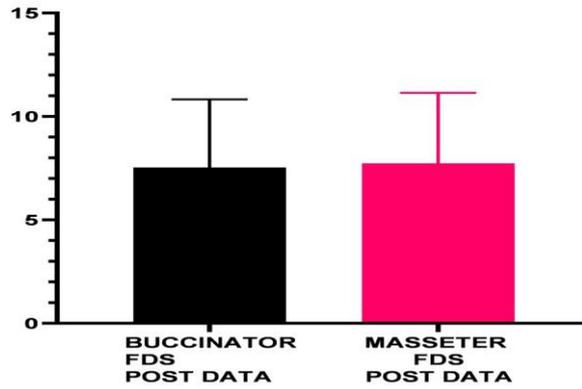


fig 6.9 : Comparison of FDS post treatment of group A & group B ( Mean & SD)

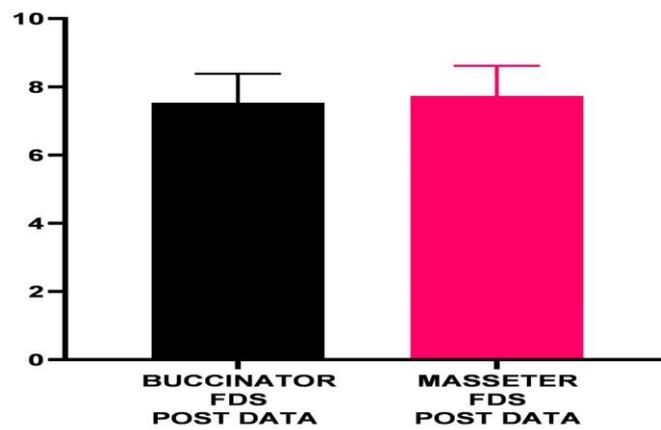


fig 6.10 : Comparison of FDS post treatment of group A & group B ( Mean & SEM)

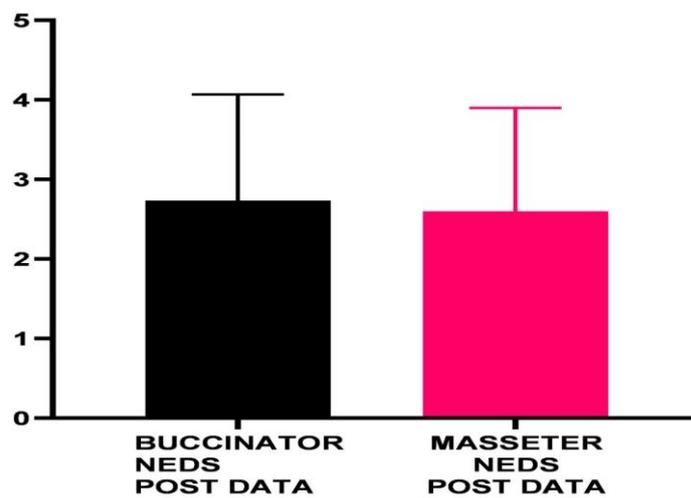


Fig 6.11 : Comparison Of NEDS Post Treatment Of Group A & Group B( Mean & SD)

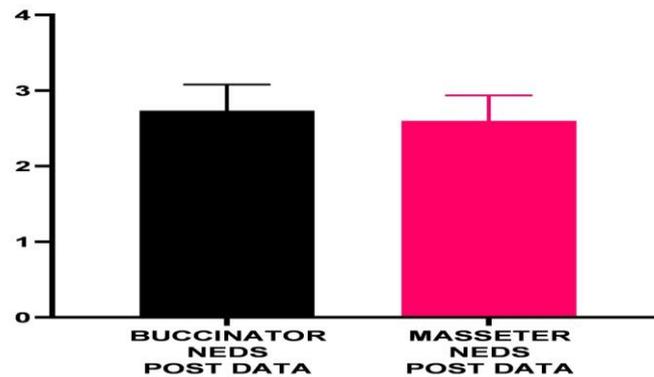


fig 6.12 : Comparison of NEDS post treatment of group A & group B ( Mean & SEM)

### Chapter – 7 : DISCUSSION

The purpose of study was to study the effect of neuromuscular electrical stimulation and rehabilitative exercise of masseter and buccinators in oral phase of neurogenic dysphagia. In this study 30 subjects were included with 15 in each group of the age group 18 year to 78 years.

Improvement of dysphagia in neurological condition is one of the most important aim of treatment in neurogenic dysphagia. This will lead to prevent aspiration pneumonia and reduced hospital stay which will ultimately benefit the patients. Mainly the aim of NMES and rehabilitative exercise is to improve swallowing so that patient can continue feeding through mouth rather than artificial feeding. In this study two outcome measures were used in which patients responded well in both group when measured by FDS & NEDS, but in NEDS there was more significant improvement. According to the study, group B reveal more marked improvement .

In a research by Rocco Salvatore reported that NMES enhance swallowing function. Another research by NORINE FOLEY suggested that dysphagia therapy program can lead to diminished risk of pneumonia. One study by Linda E. Mackay revealed that awareness has been increased and there is positive result of initial rehabilitation. Aaron J. Hadley suggested that Patients who are at risk of developing aspiration are advised for rehabilitation exercise. To date few studied have investigated the effect of NMES and rehabilitative exercise together in neurogenic dysphagia. Through this study the group B responded well enough to NMES and rehabilitative exercise. In this study comparison of two muscles and also pre and post treatment scores of both group showed a significant improvement in group B.

### LIMITATION OF STUDY

First, except from masseter and buccinators muscle , there are different muscles of oral phase where electrical stimulation can be given. Electrophysiological evaluation of the masseter and buccinator muscle was not done. Secondly, stimulation on infrahyoid and suprahyoid was not given, by using this there may be chances of getting more efficacy. Thirdly it was unable to evaluate cortical structures by using MRI. Lastly a large scale study is needed so that conclusive data can be collected to validate the above study.

### FUTURE RESEARCH:

The future research can be proceed on study of cortical structures evaluation, i.e which area of brain is more activated when giving the electrical stimulation. Further research can be done on stimulating not only oral phase muscle but also to evaluate all the phase in a larger group. Moreover exercise can be given on a group of muscles in different phases of swallowing so that an appropriate therapy can be achieved and this is necessary too as because we have seen in our study that dysphagia leads to many serious complication and is one of the important factor in mortality of patients having dysphagia, it ultimately affect the life quality of patients.

So if we can get an appropriate therapy, it can help patients to maintain their quality of life with integrity.

### CONCLUSION

This study concluded that although both groups, (group A and group B) showed significant improvement in FDS and NEDS, but group B showed more improvement in NEDS when compared with FDS. Thus it is better to consider that NMES and rehabilitative exercise in masseter muscle should be started as early as possible to improve the swallowing function. Thus the alternate hypothesis that NMES and rehabilitative exercise helps in neurogenic dysphagia is accepted.

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