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Effectiveness of neuromuscular electrical stimulation along with swallow training versus Kinesio-taping along with swallow training on dysphagia among sub-acute stroke subjects

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Abstract

Background: Dysphagia is a condition in which an individual has had an interruption in either eating function or the maintenance of nutrition and hydration. Dysphagia is a swallowing difficulty- taking more time and effort to move the food or liquid from mouth to stomach. Dysphagia is a clinical symptoms commonly seen in conditions like stroke, head injury, dementia, and oesophageal cancer and gastro-oesophageal reflux diseases. The high incidence for dysphagia is consistent finding with stroke patients. Acute stroke was complicated by oropharyngeal dysphagia in 50% of patients. NMES stimulate the muscles of swallowing. Kinesio taping facilitates the muscles and suppresses the anterior movements of hyolaryngeal complex. Swallow training strengthens the muscles of swallowing and tongue.

Objectives: The study's objective was to compare the effectiveness of neuromuscular electrical stimulation with swallowing training versus kinesio taping with swallowing training on dysphagia in sub-acute stroke subjects.

Subjects and Methods: The study was a comparative study. Stroke patients with dysphagia were selected for this study. This study was conducted at Ashwin multispecialty hospital and outpatient department of PPG College of physiotherapy. 20 subjects were selected based on the selection Criteria. The selected adolescents were divided into two groups by using simple randomized trial by slot method. GROUP A consisted of 10 subjects and they received neuromuscular electrical stimulation and swallow training. GROUP B consisted of 10 subjects and they received Kinesio taping and swallowing training. Both the groups received the interventions for 5 days in a week for 8 weeks, 1 session per day and totally 40 sessions in 8 weeks. The period of study was 6 months. Before starting the session, the instructions were given to the adolescents. The Pretest score, score and post score values of swallowing were measured by using Dysphagia outcome severity scale and the values were recorded.

Results: The statistical analysis showed that the calculated t value using the paired "t" test for DOSS in group A and group B were 11.59 and 8.96 which was greater than the table value of 2.262 with $p < 0.05$. When comparing groups using unpaired "t" test, DOSS showed calculated "t" value of pre-comparison of 0.24 and post comparison of 2.67 which was greater than the table value of 2.101 with $p < 0.05$ level of significance. Thus, there is a significant difference in each group in pre and post intervention and significant difference in comparison between both groups.

Thus, the resultant of this study shows that there were improvements in both the groups eventually, but Group A (neuromuscular electrical stimulator and swallow training) showed more statistically significant improvement when compared to Group B (kinesio taping and swallow training).

Conclusion: The study concluded that, both the groups showed statistically significant improvement in swallowing after the application of Neuromuscular electrical stimulator with swallow training for group A and kinesio taping with swallow training for group B for a period of 8 weeks. But Group A (Neuromuscular electrical stimulator with swallow training) showed significant improvement in swallowing than Group B (kinesio taping with swallow training).

Clinical implications: Application of neuromuscular electrical stimulation and kinesio-taping is found to produce a significant effect when they combined with the swallowing training to manage the sub acute stroke subjects with dysphagia.

Keywords: Stroke, Dysphagia, Neuromuscular electrical stimulator, Kinesio -taping, Swallow training Dysphagia outcome severity scale

Introduction

Dysphagia is defined as a condition any disruption in swallowing process during bolus

transport from oral cavity to the stomach. Dysphagia is a swallowing difficulty- taking more time and effort to move the food or liquid from mouth to stomach ^[1].

Dysphagia can be divided into two types namely

- Oropharyngeal Dysphagia
- Esophageal Dysphagia ^[2]

Oropharyngeal dysphagia occurs when a person has difficulty moving food bolus from oral cavity to the cervical esophagus. It most common in neurological problems that has weakened the nerves and muscle. It is also called as high dysphagia.

Esophageal dysphagia occurs when food or liquid stops in the esophagus especially region between upper and lower Esophageal sphincter. It is also called as low dysphagia ⁽³⁾ Dysphagia is a clinical symptom commonly seen in conditions like stroke, head injury, dementia, and oesophageal cancer and gastro-oesophageal reflux diseases. The high incidence for dysphagia is consistent finding with stroke patients. Acute stroke is complicated by oropharyngeal dysphagia in 50% of patients. Oropharyngeal dysphagia is common symptom after stroke was reported in 8.1 – 80% of stroke patients. Worldwide prevalence of stroke was 33 million, with 16.9 million people having a first stroke. Stroke was the second leading global cause for death, accounting for 11.13% of total death due to oropharyngeal dysphagia ^[4].

The major muscles in the phases of swallowing starting in the oral cavity with tongue, genioglossus, hypoglossus and styloglossus are supplied by CN XII NERVE. In pharyngeal stage the supra hyoid muscles assist with elevating the hyoid bone during swallowing and include the digastric, stylohyoid, geniohyoid, and the mylohyoid. The infrahyoid muscles commonly referred to as the strap muscles, act to depress the hyoid bone during swallowing and includes the omohyoid, sternohyoid, sternothyroid, and thyrohyoid muscles. The longitudinal pharyngeal muscles function to condense and expand the pharynx as well as help elevate the pharynx and larynx during swallowing.

The normal swallow in humans was originally described with a three-stage sequential model. The swallowing process was classified into oral, pharyngeal, and esophageal stages according to the location of the bolus ^[5].

Dysphagia is difficulty in swallowing. It can be high or low dysphagia. But in stroke high dysphagia is commonly occurs. In brain the swallowing is controlled at two areas namely insula gyrus, prefrontal gyrus and somatosensory cortex of the cerebral cortex and brain stem. In stroke, it occurs due to necrosis of brain cells due to reduced or absence of blood supply which cause oxygen demand in the brain cells. Both the somatosensory cortex and insula gyrus were present in the temporal lobe which are supplied by the superior division of middle cerebral arteries. In bilateral hemisphere blocks of stroke, the superior division of middle cerebral arteries is blocked which results to the necrosis of insula gyrus which controls the swallowing. When there is no function of insula there is no impulse transmission from brain to the muscles of swallowing results to difficulty in swallowing. Lacunar stroke in the blood vessels of brainstem and bilateral hemispheres causes stroke with dysphagia. Cerebral, cerebellar, or brain stem strokes can impair swallowing physiology ^[6, 7]. There is a swallowing network in the Cerebral cortex that includes insula cingulate gyrus,

prefrontal gyrus, somatosensory cortex. If the superior division of middle cerebral arteries is blocked it causes oxygen demand on the insula gyrus which cause cerebral lesions can interrupt voluntary control of mastication and bolus transport during the oral phase. Cortical lesions involving the precentral gyrus may produce contralateral impairment in facial lip, and tongue motor control ^[8] Cerebellar lesions causing impairments in cognitive function. Such as concentration or selective attention may also impair control of swallowing ^[9] Brain stem lesion can affect sensation of the mouth, tongue, and cheek, timing in the trigger of the pharyngeal swallow, laryngeal elevation, glottic closure, and cricopharyngeal relaxation ^[10].

Neuromuscular electrical stimulator is most common method to treat the Dysphagic subjects after stroke. Kinesio taping is also an effective intervention which produces a significant improvement in treating the dysphagia stroke subjects. swallow training used to the strengthening of the swallowing muscles and tongue. There are limited studies only which compares the improvement in dysphagia by using neuromuscular electrical stimulator and kinesio taping. So, the study is to compare the effectiveness of neuromuscular electrical stimulation with swallowing training versus kinesio taping with swallowing training dysphagia in sub-acute stroke patients.

Methodology

Study design: A pre-test, post-test comparative study design was used with two different intervention groups to assess the effectiveness of neuromuscular electrical stimulator along with swallow training versus kinesio taping along with swallow training on dysphagia among sub acute stroke subjects.

Subjects: All those patients complaining of swallowing difficulty in stroke visiting the PPG college of physiotherapy and Ashwin multispecialty hospital formed the population for this study. Among them, those patients (N=20) whose having swallowing were recruited using randomized sampling approach. The criteria adopted to include the subjects with swallowing difficulty consist of: (i) both genders aged between 40 and 60 years; (ii) Patients with subacute post stroke (3 to 6 months); (iii) dysphagia outcome severity scale grading 3 and 4 (iv) active cooperation and independent sitting

Methods: After obtaining the informed consent, subjects were randomized into two groups of 10 each using a simple random technique before applying the planned therapeutic interventions. The demographic characteristics of the subjects are shown in table 1. All the subjects (N=20) were identical before the application of selected therapeutic interventions ($p > 0.05$) (Table 2). Subjects assigned to group-A were exposed to neuromuscular electrical stimulation and swallowing training, whereas those assigned to the group-B were given kinesio taping and swallowing training. Both the groups were advised to continue a common set of home advice that they have to adopt after applying the treatment. Subjects in both groups were not given any medications during the period of the study. All the therapeutic interventions were given for 8 weeks, excluding weekends. In order to study the effectiveness of the therapeutic interventions, Dysphagia outcome severity scale (DOSS) was chosen as outcome parameters.

Description of Interventions

Neuromuscular electrical stimulation

Total duration of muscle stimulator is 30 minutes and first 15 minutes of the treatment suprahyoid muscles are stimulated and last 15 minutes of the treatment infrahyoid muscles are stimulated.

A) Nmes for suprahyoid muscles

- Patient position: Supine Lying
- Therapist position: Walk Standing beside the patients.
- Type of current: Galvanic current
- Frequency: 80 Hz
- Duration: 300 ms
- Muscle innervated: Digastric, stylohyoid, geniohyoid, mylohyoid
- Procedure: Both the active and inactive electrodes are placed horizontally just above the submental region in the suprahyoid muscles for 15 mins.

B) Nmes for infrahyoid muscles

- Patient position: Supine Lying
- Therapist position: Walk standing beside the patients.
- Type of current: Galvanic current
- Frequency: 80 Hz
- Duration: 300 ms
- Muscles innervated: omohyoid, sternohyoid, sternothyroid, thyrohyoid
- Procedure: Both the active and inactive electrodes are placed horizontally just above the submental region in the suprahyoid muscles for 15 mins.

Kinesio-taping

Patient position: supine lying

Therapist position: walk standing beside the patient

Procedure: Cut the k-tape into 4 pieces with the length of 3 to 5 cm. Apply the k-tape on pulling downwards (vertical)direction over the hyoid bone (submental region). Apply another pieces of k-tape on the digastric and geniohyoid muscle in vertical direction. Apply the last piece of k-tape on the horizontal direction over the hyoid bone to cover the suprahyoid muscles.

Swallow training

There several exercise in swallow training and some of them are

- Effortful swallowing
- Hyoid lift Maneuver
- Supraglottic swallowing

Effortful swallowing

While dry swallowing, squeeze all of the muscles associated with swallowing as hard as possible. Gather the small amount water in your mouth in the middle of your tongue. Keep your teeth pressed together. Swallow all the water.

Hyoid lift Maneuver

Gather materials—a drinking straw, pieces of paper towel, and a cup. You can start with 3 to 5 pieces of paper and work up to 10 as your strength increases. Place the straw in your mouth. Suck on the straw, picking up a piece of the paper with the suction that forms. Keep the suction strong enough to carry each piece of paper over to a cup. Stop sucking and let the paper fall into the cup. Repeat until all pieces of paper are in the cup.

Supraglottic Maneuver

Collect a bit of saliva in your mouth. Take a deep breath and hold it. Swallow while holding your breath. Immediately after swallowing, cough. Once you have this down with saliva, you can try with food or drink.

At end of each sessions subjects in both groups are given with these swallowing training exercises for 10 to 15 mins

Statistical analysis

Related ‘t’ test (i.e., paired t-test) was used to compare each group’s pre and post-test scores separately. Unrelated ‘t’ test (i.e., unpaired t-test) was utilized to compare the outcome measures (i.e., pre-test scores and post-test scores) between the two experimental groups. A p-value <0.05 was considered ‘significant’.

Results

The demographic presentation of subjects is shown in Table1.

Table 1: Demographic characteristics of the subjects

Variables	Group A	Group B
Age	40-50 years: 4	40-50 years: 3
	50-60 years: 6	50-60 years: 7
Gender	Males: 8	Males: 7
	Females: 2	Females :3
Duration	6 months	6 months

The outcome measures' pre-treatment scores were subjected to statistical treatment using an unrelated t-test, and the obtained t value is less than the required t table value at 0.05 levels [Table 2]. Hence it is inferred that the mean scores of all the dependent variables identical at the Pre-intervention stage before being subjected to the selected therapeutic interventions.

Table 2: Comparison of swallowing difficulty in stroke subjects in both group A and group B during the preintervention stage

Outcome Parameter	Groups	Mean	SD	T-value*
Dysphagia outcome severity scale	Group-A	3.5	0.42	0.24
	Group-B	3.4	0.23	

*Non-significant at 0.05 levels (p>0.05)

Further, a significant difference is observed between the two groups while analysing the effect of 8 weeks of therapeutic. Group-A is better than the Group-B.

Table 3: Comparison of swallowing difficulty in stroke subjects in both group A and group B during the post-intervention stage

Outcome Parameter	Groups	Mean	SD	T-value*
Dysphagia outcome severity scale	Group-A	6.5	0.42	2.67
	Group-B	5.5	0.42	

From table 4, it is inferred that the Group A, which was exposed to the treatment combinations of neuromuscular electrical stimulation and swallowing training showed a better reduction in swallowing difficulty (Mean difference 6.5) than the group-B, that was exposed to the treatment combinations of kinesio taping and swallowing training at 0.05 levels of significance.

Table 4: Comparison of swallowing difficulty on stroke subjects among the both groups between pre and post-intervention stage

Dependent Variable	Groups	Pre-intervention Stage		Post intervention Stage (At the end of 8weeks)		T-value
		Mean	SD	Mean	SD	
Dysphagia outcome severity scale	Group-A	3.5	0.42	6.5	0.42	11.59*
	Group-B	3.4	0.23	5.5	0.42	8.96*

Discussion

Dysphagia is a swallowing difficulty- taking more time and effort to move the food or liquid from your mouth to your stomach. It mostly affects individuals between 40 to 60 years. Acute stroke is complicated by oropharyngeal dysphagia in 50% of patients. It affects the cerebral region and causes dysphagia. Many studies have been shown that neuromuscular electrical stimulator, kinesiotaping and swallow training have a significance on treating dysphagia in stroke subjects.

In 2020 Isabel Dieguez-Perez *et al.*, conducted the study that shows dysphagia causes severe complications among people with a stroke Physiotherapy allows the cure of this pathology, and among the tools it offers is neuromuscular electrical stimulation. However, this is a technique that has not been protocolized. Therefore, it was considered necessary to carry out a systematic review on the efficacy of the various parameters of application of the neuromuscular electrical stimulation in dysphagia generated after a stroke. A systematic search for publications was conducted in March 2020 in the PubMed, Cinahl, Medline, Web of Science and Scopus databases, using as search terms: Electric stimulation therapy, Deglutition disorders and Stroke. 21 articles were obtained in which the application of neuromuscular electrical stimulation was applied in isolation (n = 7) or in combination with other techniques such as strengthening exercises and manual therapy techniques (n = 14), with this second modality of treatment having greater benefits for patients. The greatest efficacy of this technique is reached when applied at 60-80 Hz, 700 µs of pulse duration, at the motor intensity threshold and in sessions of 20–30 min.

In 2022 Young Jinjung *et al.*, they conducted study that suprahyoid muscle exercise using kinesiology taping (KT) increases the activation of the suprahyoid muscle in healthy adults, suggesting a potential therapeutic clinical exercise for dysphagia rehabilitation. This study investigated the effect of dysphagia rehabilitation using KT in stroke patients with dysphagia. Methods: Thirty subjects in South Korea were enrolled in this prospective placebo-controlled double-blind study. Participants were randomly assigned to the experimental and sham groups. In the experimental group, the tape was attached to the hyolaryngeal complex, pulled downward with approximately 70% tension, and then attached to the sternum and the clavicle bilaterally. In the sham group, the tape was applied similarly but without the tension. Both groups performed voluntary swallowing 50 times (10 times swallowing per set, times 5 sets) a day for 4 weeks with KT applied. Outcome measures were assessed using portable ultrasound equipment. The parameter measured was the change in thickness of the tongue muscle, mylohyoid muscle, and the anterior belly of the digastric muscle. Results: The experimental group showed statistically significant changes in the thickness of the tongue muscle, mylohyoid muscle, and anterior belly of the digastric muscle than the sham group (p = 0.007, 0.002, and 0.001). Dysphagia rehabilitation using KT is a technique that may promote oropharyngeal muscle thickness in

patients with dysphagia after stroke.

In 2020 Hathaya Jongprasitkul *et al.*, they conducted that shows dysphagia is a common problem in acute stroke patient. Aspiration pneumonia increases in this group. Swallowing therapy is immediately conducted in a stable stroke patient. An effectiveness of our program has not been determined. To determine an effectiveness of conventional swallowing therapy in acute stroke patients with dysphagia. We retrospectively reviewed data from medical records of acute stroke patients with dysphagia who participated a swallowing therapy from January 2017 to June 2017. Fifty-seven acute stroke patients with dysphagia (26 males and 31 females) were participating in a conventional swallowing therapy (50 minutes a day for 3 days per week). A functional oral intake scale (FOIS) and swallow function scoring system (SFSS) were used to determine an effectiveness of the swallowing therapy. FOIS and SFSS scores before the first therapy session and after the last therapy session were compared using a paired -test. Results. The mean age of the patient was 69.5+15.35 years. The period from stroke onset to the first swallowing therapy session was 7.5 +6.69 days. The number of therapy was 5.6 +2.83 sessions. Participants showed a significant improvement of the FOIS (mean score increased from 1.74 to 3.30 points, p=0.001) and SFSS (Mean score increased from 2.51 to 3.68 points, p=0.001). Forty-two percent of patients with tube dependent change to total oral intake. Conventional swallowing therapy is an effective treatment in acute stroke with dysphagia.

This present study shows that neuromuscular electrical stimulation along with swallowing training (group A) has more significant improvement than the kinesio-taping along with swallowing training in treating the subjects with dysphagic stroke. This resultant study has shown that significant improvement because of this following mechanism

Swallowing training is used as the strengthening protocol to the deep infrahyoid muscles. It can increase the strength mobility of the muscles. Effortful swallowing, Hyoid lift Maneuver, Supraglottic swallowing are the strengthening exercise and training of swallowing to muscles involved in swallowing. Neuromuscular electrical stimulation [NMES] is a proposed treatment for dysphagia that involves electrical stimulation of swallowing muscles to improve muscle strength, coordination and swallowing function .Electrode placed on the skin over the anterior neck muscles and small amounts of electrical current are delivered in order to stimulate and innervates the muscle responsible for swallowing. But Kinesiotaping is used to only facilitate the suprahyoid and infrahyoid muscles and inhibits the upward movement of epiglottis and maintains the larynx elevated position. Thus NMES along with swallowing training gives more improvement in swallowing when compared with kinesiotaping along with swallowing training and this study hence supports the alternative hypothesis.

Limitations

- The study was limited to particular age group.

- The study includes only subjects with dysphagia due to stroke
- The study was conducted in short duration.
- The study did not include a control group.

Suggestions

- Further studies can be done with different age groups.
- Other conditions which having dysphagia can be included.
- Long term benefits can be employed to make the results more reliable
- Having a control group is desirable

Conclusion

The study concluded that, both the groups showed statistically significant improvement in swallowing after the application of Neuromuscular electrical stimulator with swallow training for group A and kinesio taping with swallow training for group B for a period of 2 months. But Group A (Neuromuscular electrical stimulator with swallow training) showed significant improvement in swallowing than Group B (kinesio taping with swallow training).

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