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Efficacy of self-monitoring virtual feedback exercises for upper motor neuron facial palsy. A double blinded randomized control study.

Authors

[1]**Vignesh Srinivasan** - vigneshphysio1989@gmail.com
[2]**Nithiyah Maruthey**-nithiyah.maruthey@newinti.edu.my
[3]**Prathap Suganthirababu** - emailprathap@gmail.com
[4]**Kumaresan A** - kresh49@gmail.com
[5]**Surya Vishnuram -** suryavishnuram@gmail.com
[6]**Aravind Ganesh -** aravindganesh96@gmail.com
[7]**Nivya Sebastian –** Post Graduate Student – niveasebastian@gmail.com

Authors Affliation

[*1]Assistant Professor, Saveetha College Of Physiotherapy, SIMATS, Chennai, Tamil Nadu, India.
[2]Lecturer, Faculty of Health and Life Sciences, INTI International University, Malaysia.
[3,4] Professor, Saveetha College Of Physiotherapy, SIMATS, Chennai, Tamil Nadu, India.
[5,6]Tutor, Saveetha College Of Physiotherapy, SIMATS, Chennai, Tamil Nadu, India.
[7]Post Graduate Student, Saveetha College Of Physiotherapy, SIMATS, Chennai, Tamil Nadu, India.

[*]***Corresponding Author:*** **Vignesh Srinivasan**
Email -vigneshphysio1989@gmail.com
Assistant Professor, Saveetha College of Physiotherapy, SIMATS, Chennai, Tamil Nadu, India.

ABSTRACT

Purpose:

Upper Motor Neuron Facial Palsy is common in those who have had a stroke. Electrical stimulation and other available therapeutic options for UMN facial palsy have been the subject of several research papers. The purpose of this study is to see how effective facial retraining exercise using self-monitoring virtual feedback via a mobile application for treating UMN facial palsy.

Materials and Method:

An experiment was carried out with the help of 82 volunteers. Based on the selection criteria, all of the participants were separated into experimental and control groupsThe experimental group was given electrical stimulation and face retraining exercises with self-monitoring virtual

ISSN: 2515-8260 Volume 09, Issue 08, 2022

feedback via an android application, whereas the control group was given electrical stimulation and conventional exercises. House-Brackmann facial grading score was measured pre and post to the intervention by a blinded assessor who was unaware about group allotment.

Results:

Comparison of the post-test values of both groups shows that the mann whitney U value =450 at p value of 0.0003 and median values between the two group (Experimental= 2.000) (Control= 3.000) is greater than the expected. As a result, the study reveals that the experimental group has made a statistically significant improvement.

Discussion and Conclusion:

This study concluded that electrical stimulation and facial retraining exercises with self-monitoring virtual feedback using android smart phone application showed substantial improvement in facial function, compared to electrical stimulation and conventional exercises with mirror feedback in the treatment of UMN facial palsy.

Keywords: Facial palsy, Facial retraining exercise, Virtual feedback, Smartphone Application, UMN palsy.

INTRODUCTION

Stroke is defined by the World Health Organization (WHO) as a condition marked by rapidly growing clinical symptoms of localized or extensive brain dysfunction with no obvious cause other than vascular origin. The neurological signs or symptoms may last from 24 hours or more than that and sometimes leads to death[1].With an estimated average mortality rate of 1.2%,the prevalence of stroke in Asian countries is 250 – 300 per 100,000 Person and its pervasiveness in the Indian population ranges from 105 to 152/100,000 persons per year[2,3].

Stroke is a clinical syndrome synonymous with impairment in the extremities such as motor, sensory and jeopardized higher center function, later progresses to even psychological impairment affecting the quality of lifeof the patient[4, 5]. 80-85 % of strokes have ischemic origin, often with Middle Central Artery involved[6, 7]. The involvement of precentral gyrus in the cortical lesions contributes to motor and sensory deficits on the lower half of the face in the contra-lesion side causing Oro-facial dysfunction and is termed as Upper Motor Neuron (UMN) Facial palsy[4, 8,9,10]. Post stroke sequale patients are affected with facial paralysis, leading to functional deficits and facial asymmetry culminating in an obliterated naso-labial fold, drooling of saliva, corners of the mouth are drooped, difficulty to chew foods, asymmetrical smile and impaired speech[11,12].

Recovery is facilitated by various neuro-restorative therapies such as cell therapy, gene therapy, EMG biofeedback, Mirror therapy, laser, electrical stimulation, massage, thermotherapy, and functional retraining which facilitates repair and restores the function during sub-acute or chronic phase[13,14,15,16]. Previous research suggests that mirror treatment for feedback after facial palsy

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can help prevent synkinesis, and other studies advocate including a computer assisted (laptop) webcam system for feedback in stroke rehabilitation. [17,18,19]. However, a few researchers claimed that if implemented through audio or visual prompts, virtual or visual feedback systems could influence automatic compensation detection, and that visual feedback systems could be a viable approach for UMN facial palsy patients performing rehabilitation exercises with or without the assistance of a physiotherapist. [20, 21].

In today's digital era, every one of us is having smart phones in our hand. It will be even easier for the people living in rural areas to make use of the technology and achieve the desired medical assistance whenever needed. Hence this study promotes effective participation of the patient to perform facial retraining exercises with greater precision, enhanced by the qualitative self-monitoring visual feedback using a smart phone android application and the goal of the study was to see if virtual feedback exercises may help patients with upper motor neuron facial palsy improve their facial function.

METHODS

A total of 108 volunteers willing to engage in the study were recruited from a teaching hospital in Chennai, India, using an experimental study design. 26 individuals were eliminated and 82 participants were chosen based on the selection criteria. The participants were informed about the study's goal, and the therapy procedures were addressed with them before they gave their informed consent. The study received approval from the institutional review board.

Post-stroke subjects with UMN facial palsy, both genders, ranging in age from 22 to 55 years, were included in the study. Patients with LMN facial palsy, head injuries, or those who were disoriented were excluded from the study. Participants were randomly randomized to the experimental and control groups using the sealed envelope method, with 41 individuals in each group..

Randomization and Blinding

The participants were given the option of using the "Facial paralysis free android app" or doing conventional exercises with electrical stimulation. Throughout the study, both groups were balanced with an identical sample size, and none of the subjects were aware of their group assignment or what they would receive. A trained physiotherapist who was blinded to group allotment collected pre- and post-test scores.

Procedure

Both groups commonly received Interrupted Direct Galvanic Current (IDC) with pulse duration of 100ms, to the Buccinators, Zygomaticus, Rhisorius, Orbicularis oris, Angulioris (levators and depressors), and Mentalis muscles of face with 9 contractions per session on the affected side

ISSN: 2515-8260 Volume 09, Issue 08, 2022

once daily for 12 weeks. Followed by electrical stimulation, participants in experimental group were taught facial retraining exercises with the aid of the "Facial paralysis free android application" downloaded from Google Play store and advised to do the exercises under the supervision of physiotherapist at the outpatient department of Saveetha Medical College Hospital and at home they were encouraged to do the same exercise self-monitored by the virtual feedback using the android application .The application has two prime options a) Play video- It has a pre-recorded virtual demonstration with audio and video cues of a particular facial expression, specifically involving lower half of facial muscle and b) Start exercise-The application flips on the Smart phone's secondary (Front) Camera, so the patient can visualize his/her face and execute the same facial action that was learned by them previously in the virtual demonstration . By using this application, the patient knows how pertinently the action has to be performed and how to execute the action of the facial muscle in a synchronous manner. This application enables a digital counter in the right corner of the Smartphone screen that counts for every precise facial muscle action the patient makes. Therefore the patient must repeat the exercise with same degree of precision until end of the exercise session. The digital counter will not move for the next count until the patient executes the muscle action exactly.

Control group participants were treated with the same parameters of electrical stimulation described above and taught conventional exercises with normal mirror feedback, such as blowing the air with a straw, vowels verbal training, trying to squeeze the lips with each other, pursing the lips to whistle, smiling with mouth open and mouth closed. Both groups were told to do 5 to 10 repetitions of each exercise three times a day (once in the clinic and twice at home), six days a week, for 12 weeks[15.]

Outcome Measure

To determine the degrees of function of the mid face and mouth, the House Brackmann facial grading score[22] was utilised as an outcome evaluation. Pre-treatment (first day) and Post-treatment (12th week) data for both groups were recorded and tabulated by one of the coauthors who was blinded to the group allocation.

RESULTS

There were 82 participants in the study, 49 of whom were men and 33 of them were women. Each group's data was tallied separately, with pre- and post-test values tabulated separately. The median value for pre-treatment = 5.000 and for post-treatment = 2.000 when comparing pre- and post-test results within the experimental group. The data was analyzed, and the value of W was zero, indicating that the distribution is essentially normal. The p-value is.00001 and the value of z is -5.786. At p.05., the outcome is considerable. (As seen in Table 1). Prior to therapy, the median was 25% = 4.000 and 75% = 6.000. After therapy, the median was 25% = 1.000 and 75% = 2.000.

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The statistical analysis of the Control group's pre- and post-tests revealed that the Median Value for Pre-test = 4.000 and Post-test = 3.000. W equals 0, suggesting that the distribution is about normal. The p-value is 00001, and the value of z is -5.1594. At p.05., the outcome is considerable. For the pre-test, 25% equals 4.000 and 75% equals 6.000. For the post-test, 25% equals 3.000 and 75% equals 4.000. (Illustrated in table 1).

When the differences between the post-test values of both groups are compared, the post-test experimental group's median value is =2.000, whereas the post-test control group's median value is =3.000. The Mann-Whitney U statistic has a p value of (p=0.0003), revealing that the post values of the experimental and control groups differ significantly. (Illustrated in table 2).

This study findings indicates that the group received Electrical stimulation and facial retraining exercises with self-monitoring virtual feedback using the android smart phone application have demonstrated substantial progress compared than the other group, who received electrical stimulation and conventional facial functional exercises using mirror feedback.

DISCUSSION

The primary objective of the study was to achieve active repetitive qualitative facial exercises that were performed more precisely with a visual feedback. The exercises were carried out both in OPD as well as at home by using an android smart phone application.

Compared to the group who received electrical stimulation and conventional facial exercises using mirror feedback, it is evident that, the group who received electrical stimulation and facial retraining exercises with self-monitoring virtual feedback using android smart phone application has shown significant improvement in facial function retrieval. In addition, the above statement is further supported by various studies.

A study was undertaken by Shayanelinet al. (2019) to investigate the effectiveness and acceptability of a visual feedback system for stroke recovery exercises at home. Three input models were employed in the research: The author concluded that the visual feedback system can be used as a useful method for stroke patients performing rehabilitation exercises without the assistance of a therapist (a) No feedback, b) Visualfeedback, and c) Avatar feedback, and that the visual feedback system can be used as a useful method for stroke patients performing rehabilitation exercises without the assistance of a therapist (a) No feedback, b) Visualfeedback, and c) Avatar feedback.[23] Jung-A Kang et al. (2017) investigated 21 stroke patients, with the test group (n=10) receiving mirror therapy while exercising on a tablet PC and the control group (n=11) receiving no such treatment. In the mirror group, there was a noticeable improvement in facial movement. He found that employing a Tablet PC to deliver mirror feedback therapy has proven to be an effective way for treating facial paresis following a stroke.[24] In a study, Ashubashin et al. (2012) looked at 20 chronic stroke patients and 10 healthy controls. Clinical disease severity scores, functional magnetic resonance imaging (fMRI), and diffuse tensor imaging (DTI) were all performed at baseline, 8 weeks, and 24 weeks. The individuals were given mirror therapy using a laptop device with a web camera that mirrored the unaffected hand's

ISSN: 2515-8260 Volume 09, Issue 08, 2022

motions. The programme was followed for eight weeks, five days a week for 60-90 minutes. According to the author, mirror therapy duplicated the activity, with the observed hypothesis suggesting healing in patients with chronic stroke cortical rearrangement detected after intervention.[25].

Jong-Bae Choi et. al.(2016) investigated the significance of electrical stimulation in stroke patients. A research with nine dysphagic stroke patients was undertaken. Each patient received 30 minutes of electrical stimulation for facial muscles five days a week for four weeks. There was a considerable improvement in cheek and lip strength, as well as improved oral function, at the end of the trial. According to the author, electrical stimulation improves face muscle strength and oromotor performance. However, due to the limited sample size, the author's study had limitations.[26] Similarly, Kumaresan A et al. (2019) investigated the effectiveness of electrical stimulation combined with the Mendelsohn manoeuvre for swallowing and cognitive function in post-stroke dysphagia. The study's findings demonstrated a considerable improvement in post-stroke dysphagia swallowing muscle function as well as cognitive performance.[27].

Therefore, the brain's ability to alter its own structure and function is accomplished by activating neural plasticity, using an effective feedback method enabling the brain to get adapted to new conditions after any trauma. This study concludes that. There has been significant improvement seen in the facial function via the android application to attain the quality virtual feedback.

The present study has its own benefits and constraints. The positives of the study are that, repeated précised facial muscle actions are facilitated by virtual feedback .A Patient can perform the exercise precisely with or without physiotherapist supervision with this android application, hence it can be used as one of the best self-monitoring follow up home based exercises with an appropriate visual feedback. Above all the application is free of cost for public use in the Google play store for public use. It is easy to access for a person who is having an android phone. The study's downsides are that, it included only the UMN facial palsy due to only because of stroke and not because of any space occupying lesions, as the study focused to find the efficacy of a quality in visual feedback, in order to identify the improvement of neuroplasticity due to the active participation of the patient in doing self-monitoring exercises with appropriate virtual feedback to the brain .Even though there are few studies, which has involved many advanced testing and treatment tool for the feedback, but this study focused to use a simple, easy, free of cost, approachable and effective self-monitoring tool to be used even in the rural place of the country.

CONCLUSIONS

This study concludes that electrical stimulation and self-monitoring facial retraining exercises with virtual feedback using android smart phone application showed substantial improvement in facial function, compared to electrical stimulation and conventional exercises with mirror feedback in the treatment of UMN facial palsy.

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ISSN: 2515-8260 Volume 09, Issue 08, 2022

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Tables

Table 1: Within group analysis of both groups before and after intervention by Wilcoxon Signed Rank Test.

Group	N	Median	25%	75%	z value	p value
Experimental- Pre Test	41	5.000	4.000	6.000	-5.5786	< .00001
Experimental- Post Test	41	2.000	1.000	2.000		
Control- Pre Test	41	4.000	4.000	6.000	-5.1594	< .00001
Control- Post Test	41	3.000	3.000	4.000		

Table 2: Between group analysis of post-test values by Mann-Whitney U test

Group	N	Median	25%	75%	u value	p value
Experimental	41	2.000	1.000	2.000	450	< .0003
Control	41	3.000	3.000	4.000		