EFFECTIVENESS OF SURGED FARADIC CURRENTS ON IMPROVING UPPER LIMB SPASTICITY AND MOTOR RECOVERY IN POST STROKE SUBJECTS

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Abstract-
Background and Objective: Spasticity is a common complication after stroke which can affects the motor recovery in rehabilitation and the quality of life. Neuromuscular electrical stimulation is one of the most used recent treatment technique for potentially benefit of motor enhancement. The objective of this study was to compare the effect of surged faradic currents combined with conventional physiotherapy versus conventional physiotherapy alone for improving upper limb spasticity and motor recovery in post stroke subjects.
Methods: Quasi experimental study design, in this study, there were 76 subjects with an average age of over 50 years, a clinical diagnosis of post stroke spasticity, and who were divided into two groups at randomly. The subjects in Group A (n = 38) received Surged Faradic Currents plus conventional physiotherapy and Group B (n =38) received conventional physiotherapy. Intervention was given to participants 5 days a week for 6 weeks. The MAS and FMA-UE were used to assess the intervention effectiveness.
Results: Independent 't' test was used to compare the mean significance difference between continuous variables. Paired 't' test was used to assess the statistical difference between pre and post test scores of FMA-UE. A Pearson's Chi-Square test was used to compare the pre and post-test scores and also compare the statistical difference between two independent groups for MAS. Statistical analysis of this data revealed that, both groups significantly improved in both parameters when compared within groups, but when compared between groups, the surged faradic currents plus conventional physiotherapy group improved better than the conventional physiotherapy alone group.
Conclusion: The present study concludes surged faradic currents plus conventional physiotherapy group and conventional physiotherapy group showed significant improvements in reduction of spasticity and motor recovery in subjects with stroke. However, surged faradic currents plus conventional physiotherapy group is more effective than conventional physiotherapy alone group. Therefore, it may be recommended from these findings that surged faradic currents that may be used as an adjunct to conventional physiotherapy for treatment of spasticity in the rehabilitation clinics.

Key words: **Post stroke spasticity, Spasticity, Surged Faradic Currents, Conventional Physiotherapy, MAS, FMA-UE.**

INTRODUCTION

Stroke is the second leading cause of mortality and disability globally and it continues to be significant contributor to depression and dementia. Every year, seventeen million individuals worldwide have a stroke, which means that a stroke happens somewhere in the world around every two seconds. Because of motor dysfunction and spasticity, most of the stroke victims are experiencing moderate to severe health related problems that may negatively affect activities of daily living. Therefore stroke patients relay on other human beings such as family and caretakers[1].
In stroke survivors, spasticity is a typical but not inevitable condition. In 1980, a scientist named Lance first identified

spasticity in upper motor neuron and also stated the character of spasticity is velocity-dependent, increased tone in muscle and exaggerated tendon jerks. Because of hyper- tonicity in the muscle lead to pain, soft tissue stiffness, and joint contracture. Subsequently, postural abnormalities in limbs and lowered quality of life are observed [2].

After cerebrovascular accident (CVA), the prevalence of spasticity ranging from 30% to 80%. The incidence of spasticity in paretic limb might various and the percentage of vary depends on the chronicity of the stroke. It is ranging from 1 month to 18 months after stroke. The percentage of spasticity seen in first month is 27%, after 3 months 28%, after 23 to 43% and at 18 month, it is 34%. Studies have shown that spasticity is observed remarkably between 1-3 months following stroke. The joint range is highly not possible to reverse after the stroke, especially after 3 to 6 weeks of CVA.

Limited literature is available regarding history, development of spasticity and contracture. A study was conducted in India on 88 subjects who had their first stroke and off 88 participants, 46% participants were reported with spasticity. Out of 46% of spastic survivors, one third of participants were reported with severe spasticity and 17 to 42% had more tone in upper limbs[3,4].

Few studies stated that spasticity is noticed more in upper limbs than lower limbs[5, 6]. Spasticity is more common in the flexor muscles of the upper limb (fingers, wrist, and elbow flexors) and extensor muscles of the lower limb (knee and ankle extensors). In upper limb, 58% spasticity is seen in shoulder, 79% in elbow and 66% in wrist musculature and in lower limb it is 66% after CVA[7].

The relationship between the neuroanatomical location and the spasticity is less clear, though. In a retrospective study by Picelli et al., it was discovered that severe post-stroke spasticity in the limbs was substantially correlated with lesions in the insula, thalamus, basal ganglia, and white matter tracts (internal capsule, corona radiata, external capsule, and superior longitudinal fasciculus)[8,9].

The potential mechanisms involved in spasticity are mainly two type's loss of supra-spinal control and muscle weakness and disuse immobilization. The spinal mechanisms induced spasticity are reduced "reciprocal inhibition", decreased presynaptic inhibition of Ia afferent terminals and decreased homosynaptic depression. The changes occur in the muscle properties are muscle fiber atrophy, deposition of excessive connective tissue in the muscle, increased stiffness of connective tissue and increase in spindle Ia afferent responses induce muscle over-activity and spasticity[10].

Patients with stroke typically exhibit impaired movement, which could be caused by a combination of upper motor neuron syndromes, such as spasticity, weakness, lack of coordination and dexterity and prolonged muscle contraction. Patients with spasticity are common to see abnormal postural patterns, which may be caused by hypertonia and an imbalance of agonist and antagonist strength. In the early stages of voluntary movement recovery in stroke patients, synergic patterns with mass muscle contraction are observed in the upper and lower limbs. The most frequent patterns in the upper limbs are adduction and internal rotation in the shoulder, flexion in the elbow, wrist and fingers, and pronation in the forearm[11].

Spasticity is often associated with pain in stroke patients, according to a prospective study by Wissel et al. According to the authors, reported that 72% of the patients with spasticity experienced pain, while only 1.5% of non-spastic patients had a pain syndrome. In addition it is also accompanied by reduced range of motion, stigmatizing postures, issues with dressing, mobility. Without treatment, it causes more severe muscle shortening, fibrosis, calcification, and permanent contractures in the upper limbs than the lower limbs[12, 13].

The most common method used in clinical measure of spasticity is Ashworth scale or its new version Modified Ashworth scale. It is a clinical assessment of resistance to passive stretch. Another scale that measures spasticity is Tardieu scale. This scale measures the angle of spasticity, which is the difference between the angle at the end of passive ROM at slow stretch and the angle of catch at fast stretch. It estimates the relative contribution of neural mechanisms (spasticity) and soft tissue changes due to mechanical restraints[14.]

Electrophysiological tests used to quantify the spasticity are H-reflex and H/M ratio. Servo- controlled motor-driven device is used for biomechanical measurements of spasticity and also can provide a more reliable measure of resistance to passive stretch[14].

While regaining voluntary control over skilled movements is the main objective of stroke patients still have considerable upper limb dysfunction following their stroke[15]. Several methods to control spasticity has been already investigated, including pharmacological and non-pharmacological interventions used in clinical practice for all aim to reduce complications and care burden, and to improve posture and ADL independence[16].

The pharmacological interventions can be administered orally or injectable forms can affect the CNS or peripheral muscles to reduce spasticity. The major oral drugs used are Baclofen, Tizanidine, Benzodiazapines, Dantrolene and Gabapentin. The injectable drugs are Phenol/Alcohol and Botulinum toxin. The surgical treatment of spasticity is mainly based on severity and functional impairments that can be caused by spasticity. The procedures involved in surgical correction are muscle-tendon lengthening and techniques for destroying nerves are neurectomy, rhizotomy and myelotomy are used to control of spasticity and these are typically used in most recalcitrant cases[17].

Physiotherapy is the best non-pharmacological method of application of physical modalities. This includes prolonged stretching, proprioceptive neuromuscular facilitation methods, cryotherapy, casting and splints, vibration, ultrasound, thermotherapy and joint mobilization, etc. are just a few of the standard treatment options available to treat spasticity[17].

Lately, numerous studies have discussed the effect of Neuromuscular electrical stimulation and it is one of the most used recent treatment technique for potentially benefit of motor enhancement. In neuromuscular electrical stimulation, Faradic muscle stimulation with restricted hand function in chronic stroke patients demonstrated enhanced awareness of the affected arm, hence it greatly improved hand muscle function and reduced spasticity. Studies have indicated that neuromuscular electrical stimulation can enhance long-lasting cortical plasticity & motor recovery in stroke patients[18, 19, 20].

The faradic current, which is a short-duration interrupted direct current with pulse duration of 0.1-1 ms and frequency between 50 Hz and 100 Hz, is the most often utilized electrical stimulation for motor activation in therapeutic rehabilitation. These currents' frequency ranges cause titanic muscular contractions because the tension built up during one twitch has no time to relax before the occurrence of the next. As a result, subsequent twitches accumulate, increasing muscle strength. Faradic current has demonstrated efficacy in both healthy and pathological states of muscles[21].

Faradic stimulation increases blood flow to the treated area due to vasodilatation of blood vessels; it also contracts the muscle like voluntary muscle contraction. The surged faradic current enables the muscle to relax after contraction to prevent exhaustion. The faradic current boosts metabolism, gets rid of waste, brings more blood and nutrients to muscles, increasing their need for oxygen and nutrition. Re-education of muscle action and minimize the extent of muscle atrophy can be achieved with the aid of electrical stimulation[22].

There were less number of studies in the literature to determine which method of stimulation is effective in reducing the spasticity and improving motor recovery after stroke. So, this study was aimed at determining the effect of surged faradic current neuromuscular electrical stimulation of antagonist muscles to reduce spasticity on upper limb which can be used as an adjunct to conventional treatment to improve the efficacy of rehabilitation.

REVIEW OF LITERATURE

Fatimah Ahmedy, Nooralisa Mohd Tuah and Natiara Mohamad Hashim et al., (2021) has their study titled, “Revisting spasticity after stroke: clustering clinical characteristics for identifying at risk individuals”. It is a cross-sectional study conducted at a single rehabilitation outpatient clinic, a total of 216 post-stroke participants were recruited. Recruited patients were divided into spasticity and No spasticity groups. The subjects include in this study are stroke duration of over four weeks, aged 18 years and above. Two-step clustering approach between groups for determining group of characteristics that collectively contributes to the risk of developing spasticity in the spasticity group. The duration of stroke ($p<0.001$) and the absence of hemisensory loss ($p=0.042$) were two significant factors in the spasticity group revealed by univariate analysis. They concluded that spasticity requires effective treatments for promoting neurological and functional recovery after stroke. Identifying individuals at risk allow better patient selection to prioritize treatment allocations.

Journal of multidisciplinary healthcare. 2021 Aug 31:2391-6.

Huangling Zeng, Jian Chen and Yang Guo et al.,(2021) have conducted a study on “Prevalence and Risk factors for Spasticity After Stroke: A Systematic Review and Meta-Analysis”. The authors included observational studies for incidence or risk factors for PSS and only cohort studies enrolled in meta-analysis. In this systematic review one thousand four hundred sixty-seven studies were retrieved and 23 were involved in meta-analysis. The results showed the pooled prevalence of spasticity after stroke was 25.3% and that after the first-ever stroke was 26.7% and the incidence of spasticity after the first ever stroke with paresis was 39.5%. The prevalence of disabiling or severe spasticity (MAS≥3) in stroke patients with paresis was 9.4% and severe spasticity was 10.3%. They concluded that incidence of PSS was significantly higher in stroke patients with paresis and moderate to severe paresis and sensory disorder should be closely followed up and a role of hemorrhagic stroke in predicting PSS remains to be explored.

Frontiers in neurology. 2021 Jan 20;11:616097.

Michal J. Schinwelski, Emilia J. Sitek and Piotr Waz et al., (2019) have conducted a study on “Prevalence and predictors of post-stroke spasticity and its impact on daily living and quality of life”. This study was aimed to assess the frequency of spasticity in a single centre cohort of stroke patients in a one-year follow-up. They take a total of 121 patients with hemiparesis (aged 73±11 years) out of 381 stroke patients on a period of one year. The results obtained in this study are 55 out of 121 (45%) patients after three months had developed spasticity (MAS ≥1), and in 19 of the 121 (15%) had severe spasticity. After one year 33/94 (35%) patients showed spasticity and in 19/94 (20%) it was severe. The authors measured baseline muscle weakness by National Institute of Health Stroke Scale (NIHSS) and greater disability by Barthel Index (BI), these are the significant predictors of persistent post-stroke spasticity. They concluded that spasticity affects a significant proportion of stroke survivors, was present in 35% of our patient at 12 months after stroke and also affects both ADL and HRQoL.

Neurologia i neurochirurgia polska. 2019;53(6):449-57.

Kyung Eun Nam, Seong Hoon Lim and Joon Sung Kim et al., (2019) have conducted a study on “When does

spasticity in the upper limb develop after a first stroke? A national wide observational study on 861 stroke patients". It is a retrospective study, the 861 individuals included with post-stroke spasticity in the upper limbs was defined as a MAS≥1. The authors stated that the median time to develop upper limb spasticity after stroke onset was 34 days, 12% of cases developed between 2 months and 3 months and 13% developed after 3 months from onset. At the time of diagnosis, most patients showed slight increase in muscle tone and most frequently in the elbow, followed by wrist and fingers and also young stroke survivors had severe spasticity and increased with time. They concluded that approximately half of the patients with post-stroke spasticity developed spasticity during the first month and can also develop more than 3 months after stroke onset-it is important to assess spasticity in chronic state.
Journal of Clinical Neuroscience. 2019 Aug 1;66:144-8.
F. LI, Y. W U and X. LI et al., (2014) have conducted a study on "Test-retest reliability and inter-rater reliability of the Modified Tardieu Scale and the Modified Ashworth Scale in hemiplegic patients with stroke". It is a cross-sectional study, 51 inpatients with hemiplegic stroke were included. The MTS and MAS data were collected from the affected elbow flexors and ankle plantar flexors by two raters who were blinded to the results of the other assessment and one rater one day apart. The results of this study showed the MAS measurement, the inter-rater and intra-rater kappa values were 0.66 and 0.69 for the elbow flexors, 0.48 and 0.48 for the plantar flexors. The angle measurement of the MTS, the inter-rater and intra-rater ICCs were between 0.58-0.89 for the R1 and R2 and between 0.62-0.70 for the R1-R2. They concluded that the agreement of MAS elbow flexors scores was higher than that of plantar flexor scores. The reliability of angle measurement in the MTS was insufficient.
Eur J Phys Rehabil Med. 2014 Feb 1;50(1):9-15.
Taciser Kaya, Altinay Goksel Karatepe et al., (2011) have conducted a study on Inter-rater reliability of the Modified ashworth scale and modified Modified ashworth scale in assessing poststroke elbow flexor spasticity. In this study sixty four patients with post stroke and 15.7 ± 10.2 weeks respectively. The patients were tested by two raters having equal experience in applying MAS and not subjected to any training for administering MMAS and the degree of agreement was analyzed using the weighted kappa statistic. Inter-rater agreements were very good for both MAS and MMAS. The highest agreements were observed for grade 0 in the MAS and lowest agreements were observed for grade 2 in MAS. According to our results, MAS and MMAS have very good inter-rater reliability for assessment of poststroke elbow flexor spasticity.
International Journal of Rehabilitation Research. 2011 Mar 1;34(1):59-64.

Nanako Hijikata, Michiyuki Kawakami et al., (2020) have conducted a study on Item difficulty of fugl-meyer assessment for upper extremity in persons with chronic stroke with moderate-to-severe upper limb impairment. This was a secondary analysis of data from previous randomized, controlled trials, or clinical trials. The participants were 101 persons with chronic stroke with moderate to severe hemiparesis (time after onset of stroke, 1375.3 ± 1157.9 days; the 33-item FMA-UE, 31.1 ± 12.8). Principal component analysis and infit statistics were used to evaluate dimensionality. Rasch analysis using a rating scale model was performed, and item difficulty was determined. The results showed that the 27-item FMA-UE was uni-dimensional. Rasch analysis showed that the movements performed within synergies were among the easiest items. Shoulder and elbow movements were among the easiest items, whereas forearm and wrist movements were among the moderatelyto most difficult items. Hand items spanned various difficulty levels. The authors concluded that the FMA-UE is a valid assessment tool of upper extremity motor function in persons with chronic stroke with moderate to severe deficits. The results showed that item difficulty was consistent with the stepwise recovery course proposed by Fugl-Meyer.
Frontiers in neurology. 2020 Nov 16;11:577855.

Edgar D. HERNÁNDEZ, Claudia P. GALEANO and Nubia E. BARBOSA et al., (2019) have conducted a study on "Intra- and inter-rater reliability of fugl-meyer assessment of upper extremity in stroke". In this study the authors included sixty patients with stroke (mean age 65.9 years) admitted to Central Military Hospital of Colombia, Bogota and two physiotherapists scored FMA-UE independently on 2 consecutive days within 10 days post stroke. A rank-based statistical method for paired ordinal data was used to assess the level of agreement, systematic and random disagreements. The results showed in this study were item level intra- and inter-rater agreement was high (79–100%). The 70% agreement was also reached for the subscales and the total score when 1–3-point difference was accepted. They concluded that the FMA-UE is reliable both within and between raters in patients with stroke in the early subacute phase. A wider international use of FMA-UE will allow comparison of stroke recovery between regions and countries and thereby potentially improve the quality of care and rehabilitation in persons with stroke worldwide.
J Rehabil Med 2019; 51: 652–659.
Chin- Lin Kuo, Gwo-Chi Hu (2018) has reviewed an article on "Post-stroke spasticity: A Review of Epidemiology, Pathophysiology and Treatments". He stated that spasticity is a common condition in stroke survivors associated with pain and joint contracture leading to poor quality of life. It may be due to disruption of supra-spinal control from spinal cord, leading to a disinhibition of the stretch reflex. The treatment options mentioned in this study are physical

therapy; modality and pharmacological treatments, neurolysis with phenol and botulinum toxin and surgical treatments. He concluded that there are several approaches to control spasticity including non-pharmacological and pharmacological treatments are usually combined in clinical practice. The goal of spasticity management is to avoid complications and increase functional abilities and improve the functional quality of life.

Journal of Gerontology. 2018 Dec 1;12(4):280-4.

Amir H Bakhtiary and Elham Fatemy (2008) has done to study on “Does electrical stimulation reduce spasticity after stroke”, conducted a randomized controlled clinical trial to investigate the therapeutic effects of electrical stimulation on plantar flexor spasticity on 40 stroke patients. Fifteen minutes of inhibitory Bobath techniques were applied to one experimental group and a combination of 9 minutes of electrical stimulation on the dorsiflexor muscles and inhibitory Bobath techniques was applied to another group for 20 sessions daily. The outcome measures of this study are passive ankle joint dorsiflexion range of motion, dorsiflexion strength test, plantarflexor muscle tone by modified ashworth scale and soleus H-reflex. The mean change of passive ankle joint dorsiflexion in the combination therapy group is significantly higher (P=0.001) and plantar flexor muscle tonicity by the MAS (P=0.001) and higher dorsiflexion strength (P=0.04) were found in combination therapy group by comparison of mean changes from both groups.. He concluded that combination therapy with neuromuscular electrical stimulation and Bobath inhibitory technique may reduce spasticity in upper motor neuron lesions and may help to provide better functional performance.

Clinical rehabilitation. 2008 May;22(5):418-25.

Cinara Stein, Carolina Gassen Fritsch and Caroline Robinson et al.,(2015) have conducted a study on “Effects of Electrical Stimulation in Spastic Muscles after Stroke: Systematic Review and Meta-Analysis of Randomized Controlled Trials”. In this study was conducted to assess the effect of treatment with NMES with or without association to another therapy on spastic muscles after stroke compared with placebo or other intervention. In this study, two independent reviewers assessed the eligibility of studies based on predefined inclusion criteria and excluded studies with <3 days of intervention. The primary outcome extracted in this study was spasticity, assessed by the MAS, and the secondary outcome extracted was range of motion, assessed by goniometer. The results of this study were of the total of 5066 titles, 29 randomized clinical trials were included with 940 subjects. He stated that NMES provided reductions in spasticity and increase in range of motion when compared with control group after stroke. He concluded that NMES combined with other intervention modalities can be considered as a treatment option those improvements in spasticity and range of motion in patients after stroke.

Stroke. 2015 Aug;46(8):2197-205.

Manoj Kharka and Priyanka Singh (2021) have done “A study to compare effectiveness of mirror therapy and neuromuscular electrical stimulation on upper extremity motor recovery, motor function, and quality of life in subacute stroke subjects”. In this study 40 post stroke patients within 1 month of duration were assigned to the MT group (n=20) or the NMES group. Both the groups received same conventional rehabilitation programs and additionally had each of their own therapies for 30 min, 5 days a week for 3 weeks. The action research arm test (ARAT), Fugl-Meyer assessment (FMA), Modified Ashworth scale (MAS), and Modified Barthel index (MBI) were used as an outcome measure to assess upper limb motor recovery and motor function at pre and post intervention. Health-related quality of life was assessed by stroke specific quality of life (SS-QOL). The results of this study after 3 weeks intervention, patients of both groups showed statistically significant improvements in all the variables measured (<0.05). He concluded this study confirms that MT and NMES are both effective treatment techniques to improve upper extremity recovery, motor functioning and quality of life in subacute stroke patients except for improvement in spasticity.

Medical Journal of Dr. DY Patil University. 2021 May 1;14(3):318-26.

Belgin kara, Erbu Aytekin and Nil Sayiner Caglar et al.,(2021) has conducted a randomized controlled trial on “Neuromuscular electrical stimulation therapeutic effects on the functional and motor recovery of the upper extremity in patients after stroke”. In this study a total of 30 patients with hemiplegia were randomly distributed and conducted conventional rehabilitation program along with NMES and CRP alone in two groups. The results of this study shows statistically significant improvements in brunnstrom stages of UE and hands, FMA and VAS scores of study group at the end of therapy and after 2 months. The FMA overall score improved significantly in the control group at the end of treatment and after 2 months. MAS Scores were higher in control group follow-up but values did not significantly differ between groups. And finally he concluded that CRP plus passive NMES treatment applied to shoulder girdle muscles and wrist extensors seems to be no better than CRP alone but passive NMES therapy is suggested to be used as adjunct to neurological rehabilitation as it contributes to functional and motor recovery.

Istanbul Medical Journal. 2021 Aug 1;22(3).

Dr. Siddhima Hardikar and Dr. Sanjiv Kumar (2020) have conducted a randomized controlled trial on “Comparative study of Faradic muscle stimulation with myofascial release and Faradic muscle stimulation with passive stretching to improve hand muscle function in chronic stroke patients”. In this study, 30 subjects diagnosed with stroke were included and divided into 3 equal groups (Group A -Faradic muscle stimulation (FMS) with myofascial release, Group B –FMS with passive stretching and Group C –FMS with home exercise programme) by chit method. Pre and post outcome measure of MSHFT (Modified Sollerman Hand Function Test) was taken. The results obtained in this study were mean values of MSHFT for Group A was: 4.2 ± 0.15; Group B was: 3.8 ± 0.55; and Group C was: 2.2 ± 0.43. He concluded in this study it was found that Faradic muscle stimulation along with myofascial release and Faradic muscle stimulation along with passive stretching are more effective than conventional exercise protocol in management of stroke.

Int J Appl Res 2020:6(8):163-172.

G. Shankar Ganesh, Ranjita Kumari and Monalisa Pattnaik et al.,(2017) has done to study on "Effectiveness of Faradic and Russian currents on plantar flexor muscle spasticity, ankle motor recovery, and functional gait in stroke patients". The purpose of this study was to determine the effectiveness of Faradic and Russian currents in the reduction of ankle plantar-flexor spasticity and improving motor recovery in post stroke patients. In this study a total of 83 patients (29 females and 54 males; mean age of 57.12 years) were randomly assigned to group1 (task –oriented exercises), group 2 (Faradic current for 10 min and task oriented exercises), and group 3 (Russian current for 10 min and task oriented exercises) for a period of 5 sessions per week for 6 weeks. The outcome measurements in this study were soleus and gastrocnemius muscles spasticity measured by MAS, active and passive ROM measured by goniometer and functional ambulation measured by modified Emory Functional Ambulation Profile at the baseline and after 6 weeks. The results of the study of all the groups were effective in improving active ankle ROM, no group was found to be superior to another after treatment. He concluded that adding ES to exercises are associated with low to medium effect sizes (<0.5) in reducing spasticity and improving ankle ROM.

Physiotherapy Research International. 2018 Apr;23(2):e1705.

Suchetha P.S., Dhanesh Kumar K.U. and Mallikarjunaiah H.S. (2017) has conducted on study on "Antagonist versus agonist muscle neuromuscular electrical stimulation on spasticity in stroke patients". The objective of the study is to evaluate the efficacy of each technique and compare the two techniques of NMES to determine most effective. In this study 30 stroke patients were selected and they are randomly allocated into two groups. Group A received antagonist (triceps) muscle NMES and Group B received agonist (biceps brachii) muscle NMES for 2 weeks, one session per day for a duration of 30 minutes. There was a significant recovery after the treatment based on the MAS and deep tendon reflex grading scale within the groups and between the groups (p-value < 0.001). The antagonist muscle NMES showed better recovery with a mean difference of 1.8 and 1.2 on MAS and deep tendon reflex grading scale. She concluded that both the techniques resulted in reduction of spasticity and comparison it was found that antagonist NMES reduced spasticity more effectively than the agonist NMES.

International Journal of Physiotherapy. 2017 Dec 9:363-7.

Stéfanie Saccomam Freitas Guimarães, Carly de Faria Coelho and Luciana Barcala Carruba (2014) have conducted a study on "Effects of cryotherapy on tonic adequacy upper limb hemiparesis after stroke". This study aims to analyze the effect of cryotherapy before carrying out exercises kinesiotherapeuticss in hemiparetic patients and among the existing resources on physical therapy the adequacy of as spasticity, in the case of patients suffering from stroke, cryotherapy may reduce muscle atrophy, because it can tailor the tone for the move takes place. After assessment the results of this study all patients increased their level of functional independence, both the FuglMeyer assessement and Functional Independence Measure, with physical therapy associated with the use of ice. The authors conclude that new research may prove the efficacy of ice in reducing spasticity in post-stroke patients.

Manual Therapy, Posturology & Rehabilitation Journal. 2014 Mar 27:1-9.

Laura Gomez-Cuaresma, David Lucena-Anton and Gloria Gonzalez-Medina et al., (2021) have conducted a study on "Effectiveness of Stretching in Post-Stroke Spasticity and Range of Motion: Systematic Review and Meta-Analysis". The aim of this study was to evaluate the effectiveness of different types of stretching in reducing post-stroke spasticity. Research was carried out until March 2021. In this study, PEDro scale and the Cochrane collaboration tool were used to assess the methodological quality and risk of bias of the studies and eight articles were selected for qualitative analysis; six of them contributed information to the meta-analysis. The authors stated that no conclusive evidence was obtained on the effectiveness of stretching in terms of treating spasticity and range of motion in patients with stroke and recommended further research is necessary in order to determine the effectiveness of the use of stretching in this population, considering the different types of stretching (static and dynamic), the time of application, the measurement of the different components of spasticity, and the extrapolation of functional results.

Journal of personalized medicine. 2021 Oct 24;11(11):1074.

Ujwal Lakshman Yeole, Sakshi Pritam Arora and Gaurai Mangesh Gharote et al., (2017) have conducted a study on "Effectiveness of Proprioceptive Neuromuscular Facilitation on Spasticity in Hemiplegia: Randomised Controlled Trial", was done on 30 stroke patients with minimum Grade 1 spasticity and the subjects were randomly allotted for intervention period of 4 weeks into two groups with those receiving PNF technique and conventional physiotherapy. The spasticity and functional independency in this study was evaluated using Ashworth Scale and Barthel index. The results obtained in this study were the Ashworth Scale in PNF group showed significant improvement from 2.46±0.51 to 1.13±0.35 as compared to conventional group with 2.4±0.5 to 1.86±0.35. The Barthel index in PNF group showed significant improvement from 54.33±7.52 to 85±5 as compared to conventional group

with 53±2.53 to79±7.6. The ROM also had shown significant improvement in PNF group. He concluded that PNF technique is significantly effective over conventional physiotherapy for reducing spasticity and improving functional activities in hemiplegia.
J. Med. Sci. Clin. Res. 2017;5:15567-72.
Pallavi Sahay, Debashree Roy, Shriya Das et al., (2017) have conducted a study on "Effects of Intensive Coordination Training While Walking In Parallel Bars with Visual Feedback in a Case of Spinocerebellar Ataxia Type I: A Case Report". In this study, coordination training in the form of task oriented bimanual reaching activities for training of the upper extremities; along with gait training on parallel bars in front of a mirror was implemented thrice a week, for 3 months. The outcomes of this study were symptom evaluation using "International Cooperative for Ataxia Rating Scale" and assessment of mobility, derived from "Performance Oriented Mobility Assessment". Both outcomes measures showed significant improvement by the end of 3 months intervention. She concluded that "intensive coordination training for upper extremity reaching activities along with balance and gait training on parallel bars supplemented with mirror and verbal feedback" improved symptoms associated with spinocerebellar ataxia.
interventions. 2017;8:12.
Namrata Sant, Rinkle Hotwani and Yash Kulkarni et al.,(2021) have conducted a study on ''Effectiveness of surge faradic stimulation and proprioceptive neuromuscular facilitation for rehabilitation of hemiplegic hand in hemiplegic cerebral palsy: Case report'' He treated a case of 4-year old patient presented with right upper limb spasticity with difficulty in hand function. The patient was treated by various physical therapy approaches like passive stretching, task-oriented approach, and etc. was used but not shows satisfactory results. The purpose of this study incorporates proprioceptive neuromuscular facilitation (PNF)-irradiation along with surge faradic therapy, a combination of physical treatment that works on muscle spasticity and strength. The outcome measures in this study are Trunk control measure scale (TCMS) to assess control, MAS to assess spasticity and Quality of upper extremity skills test (QUEST) to assess hand function skills before and after intervention. He concluded that surge faradic stimulation and PNF irradiation given for wrist extensors has improved hand function skills, decreased spasticity and improved trunk control in hemiplegic cerebral palsy.
PAMJ-Clinical Medicine. 2022 Feb 10;8(32).

MATERIALS AND METHODS

STUDY DESIGN: Quasi-experimental study design.
ETHICAL CLEARANCE AND INFORMED CONSENT: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital (Annexure-I), the investigator explained the purpose of the study and given the patient information sheet. The participants were requested to provide their consent to participate in the study (Annexure-II). All the participants signed the informed consent and the rights of the included participants have been secured.
STUDY POPULATION: Subjects clinically diagnosed as Post stroke spasticity by a Neuro Physician.
STUDY SETTING: The study was conducted at Department of Physiotherapy, GSL general hospital, Rajamahendravaram, Andhra Pradesh, India.
STUDY DURATION: The study was conducted for a period of one year
INTERVENTION DURATION: 5 sessions per week for 6 weeks.
STUDY SAMPLING METHOD: Convenience sampling
SAMPLE SIZE: A total of 80 subjects were screened in that 76 subjects, both men and women with post stroke spasticity who are willing to participate in the study were included in this study, all the recruited participants were explained about the study. After obtaining informed consent form and meeting the criteria, total 76 subjects were allocated into two groups equally by convenience sampling method.

Group A – Surged faradic currents along with conventional physiotherapy (38 subjects)
Group B –Conventional physiotherapy (38 subjects)

GROUPS	NO.OF SUBJECTS	TREATMENT
GROUP A	38	SURGED FARADIC CURRENTS plus CONVENTIONAL PHYSIOTHERAPY

GROUP B	38	CONVENTIONAL PHYSIOTHERAPY

MATERIALS USED
- Electrical stimulator
- Stool
- Examination couch
- Data collection forms

CRITERIA FOR SAMPLE SELECTION

INCLUSION CRITERIA
- Subjects who have experienced first incidence of stroke clinically confirmed by computerized tomography or magnetic resonance imaging diagnosed by a Neurologist or General physician
- Subjects who have upper limb spasticity of grade II as per the modified Ashworth scale within 1-3 months after onset of stroke are included
- Subjects who have brunstrom stage ≥II

EXCLUSION CRITERIA
- Subjects carrying a cardiac pacemaker, defibrillator
- Subjects who have neuro-stimulator implant, electronic implant or metallic implant
- Subjects who have co-morbidities which contraindicate electro-therapeutic treatment includes high intensity electromagnetic stimulation
- Subjects who have respiratory failure, cardiac disease, cancer, fever, pregnancy

OUTCOME MEASURES

Modified Ashworth Scale (MAS)[24]:
The modified Ashworth scale is the most globally accepted clinical assessment tool used to measure the increase of muscular tone. Bohannon and smith in 1987, they modified the Ashworth scale by adding 1+ to the scale to increase sensitivity. Since its modification, the modified Ashworth scale (MAS) has been applied in clinical practice and research as a measure of spasticity. It is a 5-point ordinal scale and the score ranges from 0 to 4: 0 represents no increase in muscle tone and 4 represents limb rigid in flexion and extension.

Fugl-Meyer Assessment Upper Extremity (FMA-UE)[25]:
The Fugl-Meyer Assessment of upper extremity (FMA-UE) is a stroke-specific, performance based impairment index. It is designed to assess motor functioning, balance, sensation and joint functioning in patients with post-stroke hemiplegia. It is applied clinically and in research to determine disease severity, describe motor recovery, and to plan and assess treatment.
A 3-point ordinal scale is used to measure impairments of volitional movements with grades ranging from 0 to 2. 0 indicates item cannot be performed, 1 indicates performed partly & 2 indicate item can be fully performed. Specific descriptions for performance accompany individual test items. Subtests exist for upper extremity function. And subtest scores i.e., upper extremity maximum score is 66.

INTERVENTION
This is a 6-week study which includes surged faradic currents for Group – A and conventional physical therapy for Group -B. The outcomes were measured by the Modified Ashworth scale for muscle tension and the Fugl-Meyer Assessment Upper Extremity for upper limb and hand function. All the subjects who were eligible for the criteria were randomly allocated into Group A and Group B.

GROUP – A

SURGED FARADIC CURRENTS[26, 27, 28]:
The subjects in the group A were follow the neurological rehabilitation program (PNF, prolonged stretching, cryotherapy, neuromuscular electrical stimulation, activity-based exercises etc.) to the affected upper limb and lower limb in the rehabilitation unit. Additionally subjects in the group A was received neuromuscular electrical stimulation (Surged faradic currents) of the upper limb of paretic side. The surged faradic electrical stimulation was given to the

muscles of upper limb which included are posterior deltoid, triceps & wrist extensors.

ELBOW EXTENSORS:

Patient position in triceps stimulation: side lying on the normal side, head was slightly flexed and positioned over a thin pillow, trunk was straight with a pillow to support from the back, the affected side shoulder was protracted, flexed with the arm forward over a pillow in a relaxed supported position, elbow was slightly flexed, forearm pronated and wrist and fingers in neutral position. The affected lower limb positioned on a pillow with hip and knee in slight flexion.

Electrode placement of triceps: Inactive electrode was placed at the site of origin of triceps i.e., upper part of the posterior humerus and active electrode was kept on the motor point of the triceps muscle.

Patient position in deltoid stimulation: sitting on a chair with arms on arm rest and trunk was straight with the support of back rest and head and shoulders was in neutral position and foot touches the ground.

Electrode placement of posterior deltoid: Active electrode was placed two-finger width down to the posterior edge of the acromion process and inactive electrode was placed on the cervical spine of C7.

WRIST EXTENSORS:

Patient position in wrist extensors stimulation: Patient was positioned in supine lying position with the neck in a neutral position on a thin pillow, and the trunk was positioned straight in line with the neck. The affected side shoulder was protracted on a pillow with the arm and fore- arm pronated by the side with the elbow and wrist in neutral position, properly supported and relaxed. A small pillow was placed under the hip to prevent retraction of the pelvis and lateral rotation of lower limb.

Electrode placement of wrist extensors: Active electrode was located just above the wrist crease for the wrist extensors and the inactive electrode was fixed to an area near the lateral epicondyle.

Faradic Current was delivered to the muscles as per the following parameters: 100Hz pulse (pulse duration = 0.1 ms, pulse interval = 0.9 ms) in surge mode (surge duration = 4s and rest between surge = 6s). The stimulated part to be exposed, so that the therapist could observe the muscle contraction.

Treatment duration was 20 min/session for 5 days a week for 6 weeks.

Fig no:1 Surged Faradic currents stimulation of Triceps muscle

Fig no:2 Surged Faradic currents stimulation of Posterior deltoid muscle

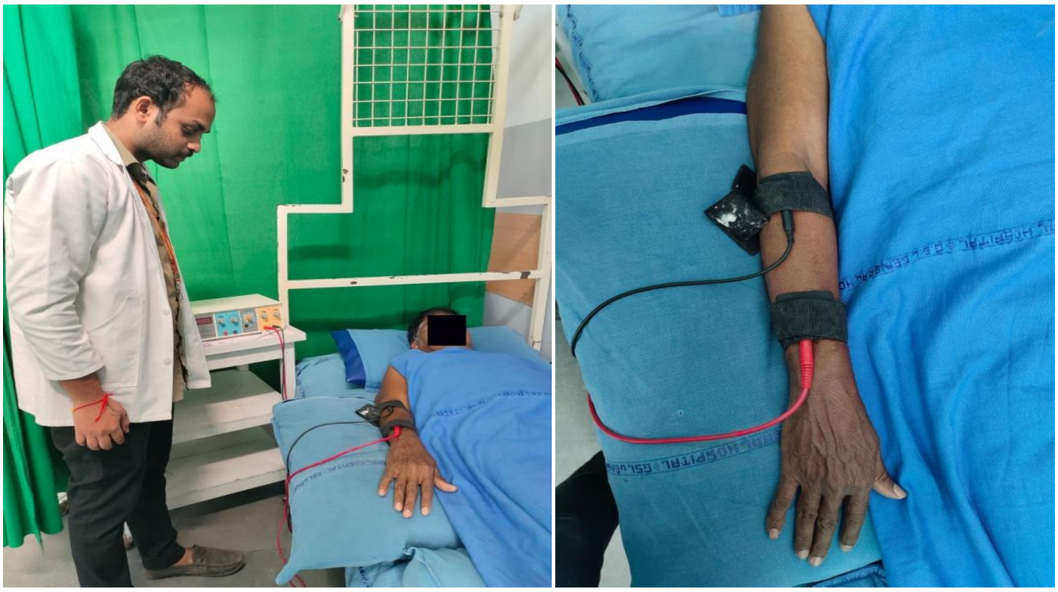


Fig no:3 Surged Faradic currents stimulation of Wrist extensor muscles

GROUP B
CONVENTIONAL PHYSIOTHERAPY[29]:

The treatment techniques in conventional physiotherapy to treat spasticity of upper limb which includes, prolonged stretching, proprioceptive neuromuscular techniques and cryotherapy, neuromuscular stimulation to the paretic side of the patient.

• **Cryotherapy**[30] in the treatment of spasticity has as primarily objective to reduce visco-elastic mioarticular tension and facilitate neuromuscular function. Cryotherapy was performed for 25 minutes on the ventral surface of the spastic upper limb and lower limb using a plastic bag containing ice and a wet towel around it.

• **Stretching**[31] of the involved muscle is the commonly used physical modality for the management of spasticity. Prolonged and regular stretching was given to upper limb and lower limb muscles with three repetitions each with 30 seconds hold can reduce sarcomere shortening, and help increase or preserve the length of the muscles and other musculoskeletal structures.

• **PNF techniques**[32] rely mainly on stimulation of the proprioceptors for increasing the demand made on the neuromuscular mechanism to obtain and facilitate its response. It uses proprioceptive, cutaneous, auditory input to produce functional improvement in motor output and in the rehabilitation of many injuries. The techniques of PNF are composed of both rotational and diagonal exercise patterns. The patterns of facilitation i.e. D1 and D2 flexion extension for both upper limb and lower limb with stretch stimulus and stretch reflex.

The D1 flexion for upper limb included flexion abduction with lateral rotation and D1 extension included extension-adduction with medial rotation. The D2 flexion included flexion- adduction with lateral rotation and D2 extension included extension-abduction with medial rotation.

Similarly, for lower limb, D1 flexion included flexion-abduction with medial rotation and D1 extension included extension-adduction with lateral rotation. The D2 flexion included flexion-adduction with lateral rotation and D2 extension included extension-abduction with medial rotation.

• **Neuromuscular electrical stimulation**[33] was given to the affected side of the patient with stroke. The stimulation was given to upper and lower limb muscles at a frequency adjusted in between 20 and 50 Hz and amplitude was adjusted to a suitable amount for the patient (0-100 mA).

• **Gait training**[34, 35] was performed manually on parallel bars. This training mainly focused on shifting of weight properly, step length uniformity, control of gait speed, and maintaining correct alignment of trunk and pelvis during gait. The training was given 10 to 12 sessions of ambulation for 10 meters. Auditory and visual feedback was provided in the form of physiotherapists command and mirror image respectively.

Fig no:4 Cryotherapy applied to patient

Fig no:5 Stretching of upper limb muscles

Fig no:6 Stretching of lower limb muscles

Fig no:7 PNF patterns of upper limb

Fig no:8 PNF patterns of lower limb

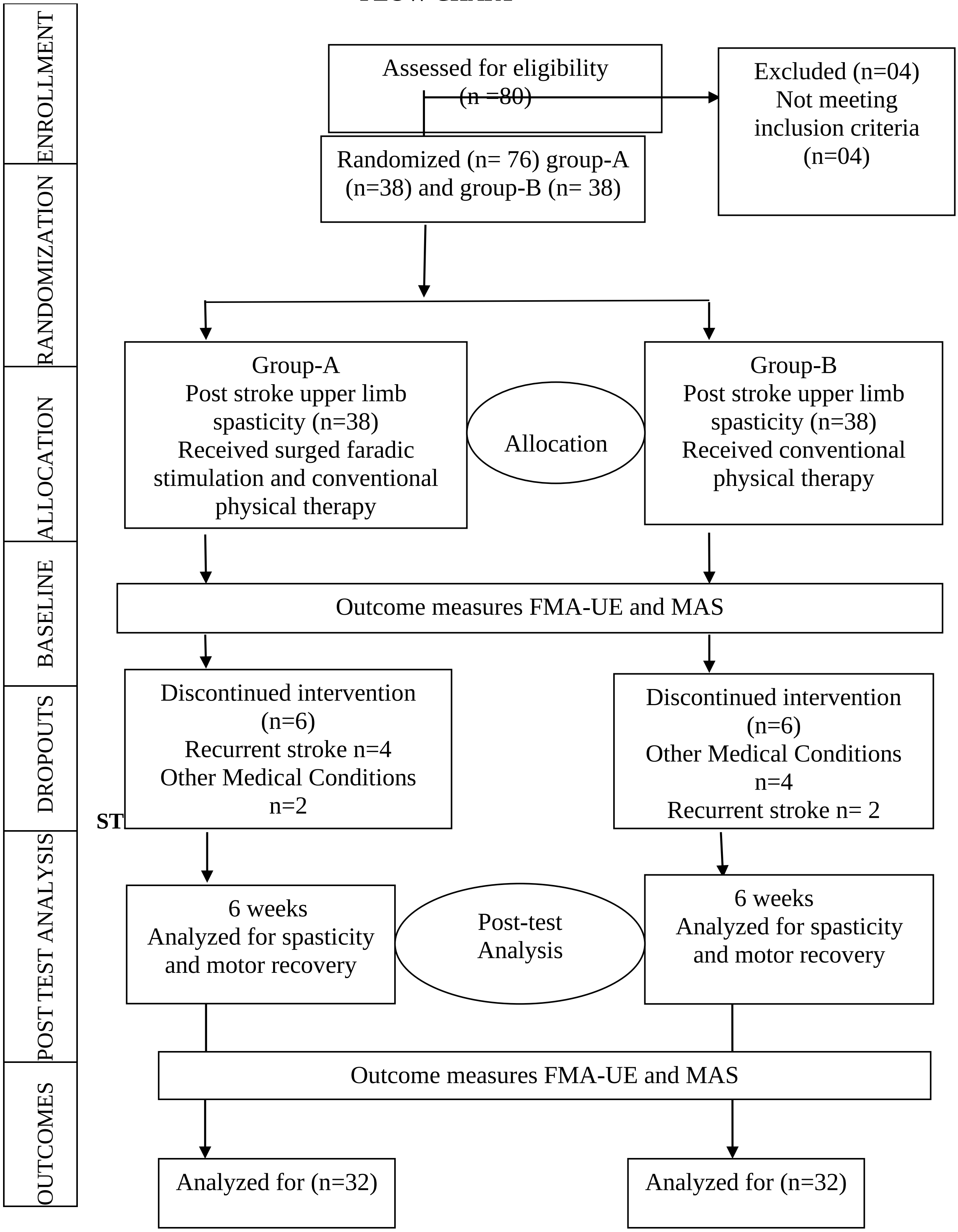
Fig no:9 Application of Neuromuscular electrical stimulation for affected side upper limb muscles

Fig no:10 Application of Neuromuscular electrical stimulation for affected side lower limb muscles

Fig no:11 Gait training

FLOW CHART

FLOW CHART



All statistical analysis was done by using SPSS software version 20.0 and Ms excel 2007.
Descriptive data was presented as mean +/- standard deviation and percentages.
Data was tabulated and graphically represented. Data was analyzed by using both descriptive and inferential statistics.
Within the group: Paired T-test was used to compare the levels of pre and post-test scores (non-parametric or parametric accordingly). It was used to assess the statistical difference within the FMA-UE group.
Between the group: Unpaired't-test' was used to compare the statistical difference between the mean of two independent groups for FMA-UE.

A Pearson's Chi-Square test was used to compare the pre and post-test scores and also compare the statistical difference between two independent groups for MAS

RESULT

The results of the study were analysed by FMA -UE & MAS to see the improvement in upper limb spasticity and motor recovery.

The consort flow chart of the study showed the study organization in terms of Subjects Screening, Random allocation and Analysis following the intervention.

A total of 80 screened for eligibility, among 76 subjects were included in the study trail. All the 76 subjects undergone baseline assessment and subjects who met the inclusion criteria were randomized into two groups consisting 38 and 38 subjects.

In this study 32 subjects completed training in Group -A and 32 subjects completed training in Group – B with dropouts of 6 and 6 in respective groups, results showed that there is a statistical difference in two groups.

GROUP- A MAS PRE-TEST AND POST-TEST

GROUP A			**MAS POST TEST**			**TOTAL**	**P – VALUE**	**INFERENCE**
			GRADE 0	GRADE 1	GRADE 1+			
MAS PRE TEST	GRADE 2	Count	18	5	0	23	0.001	HIGHLY SIGNIFICANT
		% within MAS Pre test	78.27%	21.73%	0.0%	100.0%		
	GRADE 3	Count	1	6	2	9		
		% within MAS Pre test	11.11%	66.67%	22.22%	100.0%		
TOTAL		Count	19	11	2	32		
		% within MAS Pre test	59.37%	34.38%	6.25%	100.0%		

TABLE-1

RESULTS: The above table depicts that categorical data of MAS changes from pretest to posttest values within Group-A were found to be more statistically significant (P < 0.005).

GROUP- B MAS PRE-TEST AND POST-TEST

GROUP B			MAS POST TEST				TOTAL	P-VALUE	INFERENCE
			GRADE 1	GRADE 1+	GRADE 2	GRADE 3			
MAS PRE TEST	GRADE 2	Count	3	17	1	0	21	0.01	SIGNIFICANT
		% within MAS Pre test	14.28 %	80.95 %	4.77 %	0.0%	100 %		
	GRADE 3	Count	1	4	5	1	11		
		% within MAS Pre test	9.09%	36.37 %	45.45 %	9.09 %	100 %		
TOTAL		Count	4	21	6	1	32		
		% within MAS Pre test	12.5%	65.625%	18.75 %	3.125 %	100 %		

TABLE-2

RESULTS: The above table depicts that categorical data of MAS changes from pretest to posttest values within Group-B were found to be statistically significant ($P < 0.05$).

MAS PRE TEST OF GROUP A & B

			GROUP		TOTAL	P VALUE	INFERENCE
			A	B			
MAS PRE TEST	GRADE 2	Count	23	21	44	0.791	INSIGNIFICANT
		% within group	71.88%	65.63%	68.75%		
	GRADE 3	Count	9	11	20		
		% within group	28.13%	34.38%	31.25%		
TOTAL		Count	32	32	64		
		% within group	100.0%	100.0%	100.0%		

TABLE – 3

RESULTS: The above table depicts that baseline measurement of MAS in Group-A & Group-B were found to be statistically insignificant ($P > 0.05$).

MAS POST-TEST OF GROUP A&B

			GROUP		TOTAL	P VALUE	INFERENCE
			A	B			
MAS POST TEST	GRADE 0	Count	19	0	19	0.0001	HIGHLY SIGNIFICANT
		% within group	59.38%	0.0%	29.69%		
	GRADE 1	Count	11	4	15		
		% within group	34.38%	12.5%	23.44%		
	GRADE 1+	Count	2	21	23		
		% within group	6.25%	65.63%	35.94%		
	GRADE 2	Count	0	6	6		
		% within group	0.0%	18.75%	9.38%		
	GRADE 3	Count	0	1	1		
		% within group	0.0%	3.12%	1.56%		
TOTAL		Count	32	32	64		
		% within group	100%	100%	100%		

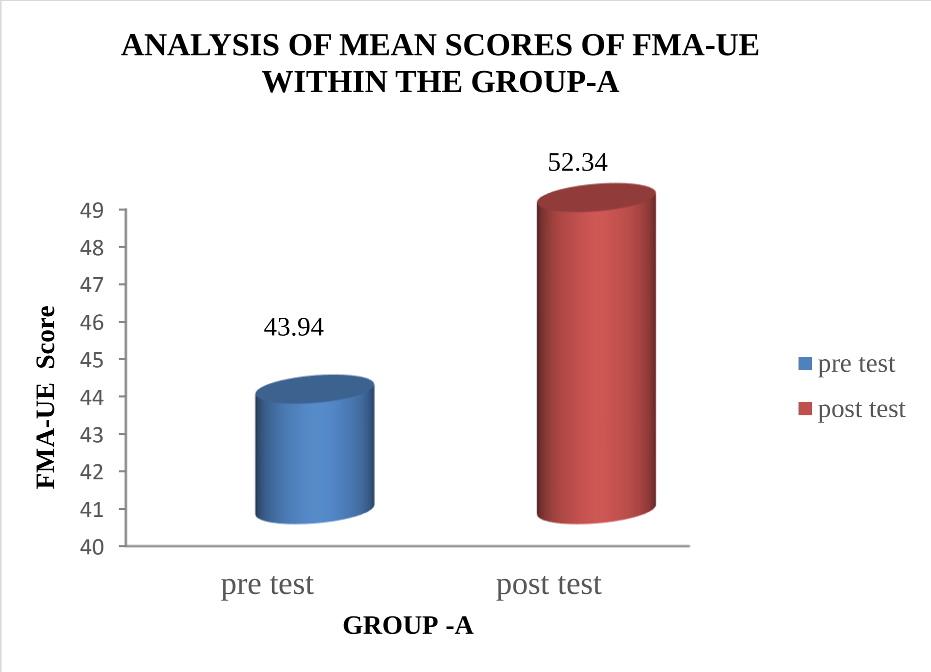
TABLE-4

RESULTS: The above table depicts that Posttest measurement of MAS in Group-I & Group-II were found to be more statistically significant (P < 0.005).

Analysis of mean scores of FMA-UE within the Group – A

Groups		Mean	Standard Deviation	P-value	Inference
Group – A	FMA-UE Pre test	43.94	5.570	0.001	Highly significant
	FMA-UE Post test	52.34	5.539		

TABLE -5



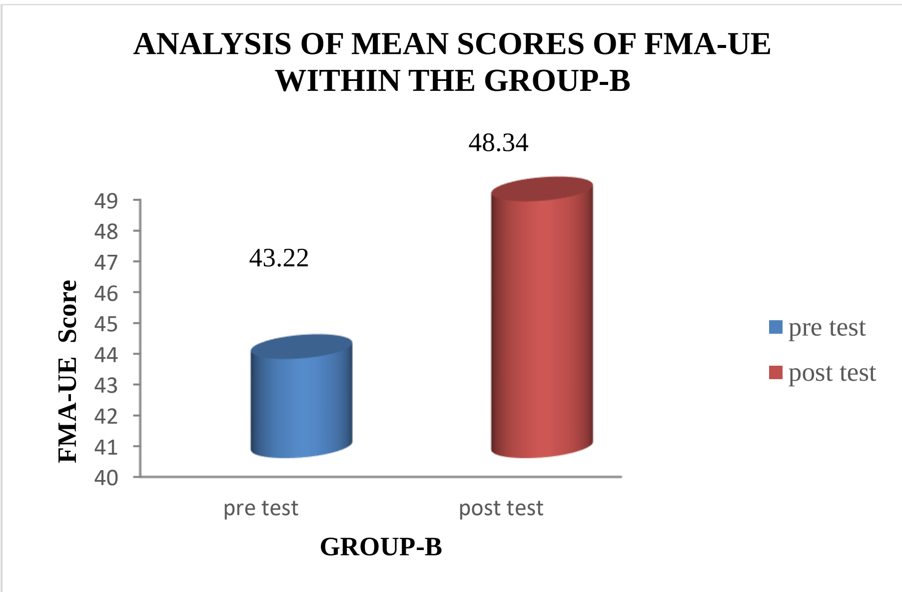
GRAPH – 1

RESULTS: The above table and graph depicts the mean score of FMA-UE changes from pretest to posttest values within Group-A were found to be statistically significant (P < 0.005).

Analysis of mean scores of FMA-UE within the Group – B

Groups		Mean	Standard Deviation	P-Value	Inference
Group -B	FMA-UE Pre-test	43.22	5.857	0.001	Highly significant
	FMA -UE Post-test	48.34	5.672		

TABLE-6



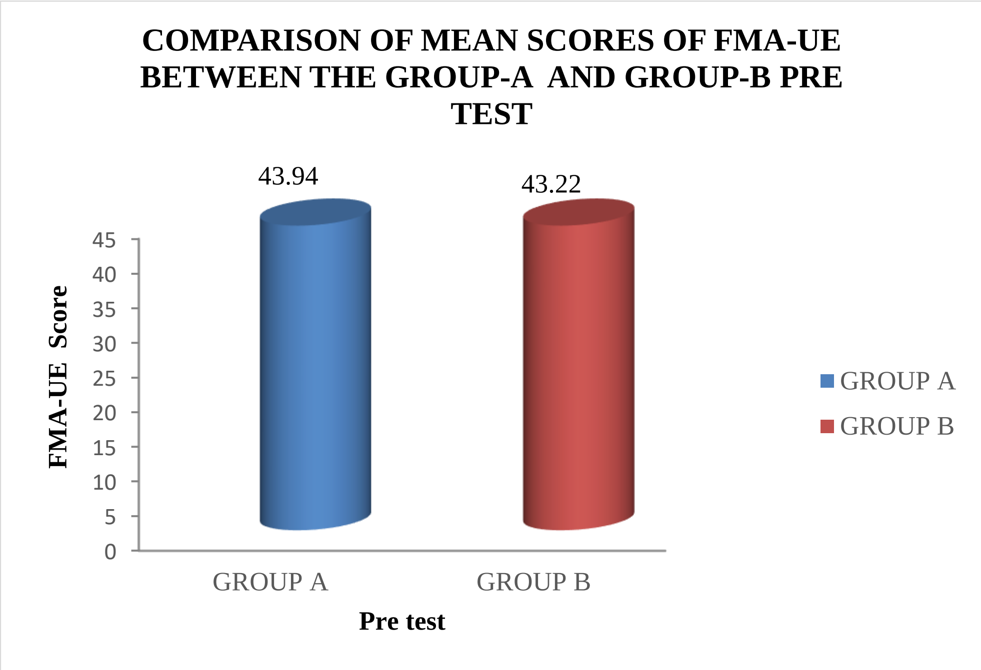
GRAPH-2

RESULTS: The above table and graph depicts the mean score of FMA-UE changes from pretest to posttest values within Group-B were found to be statistically significant (P < 0.005).

Comparison of mean scores of FMA -UE between the groups Group A & B (Pre- Test)

Groups		Mean	Standard Deviation	P-Value	Inference
FMA-UE Pre-test	Group - A	43.94	5.570	0.616733	Insignificant
	Group - B	43.22	5.857		

TABLE-7



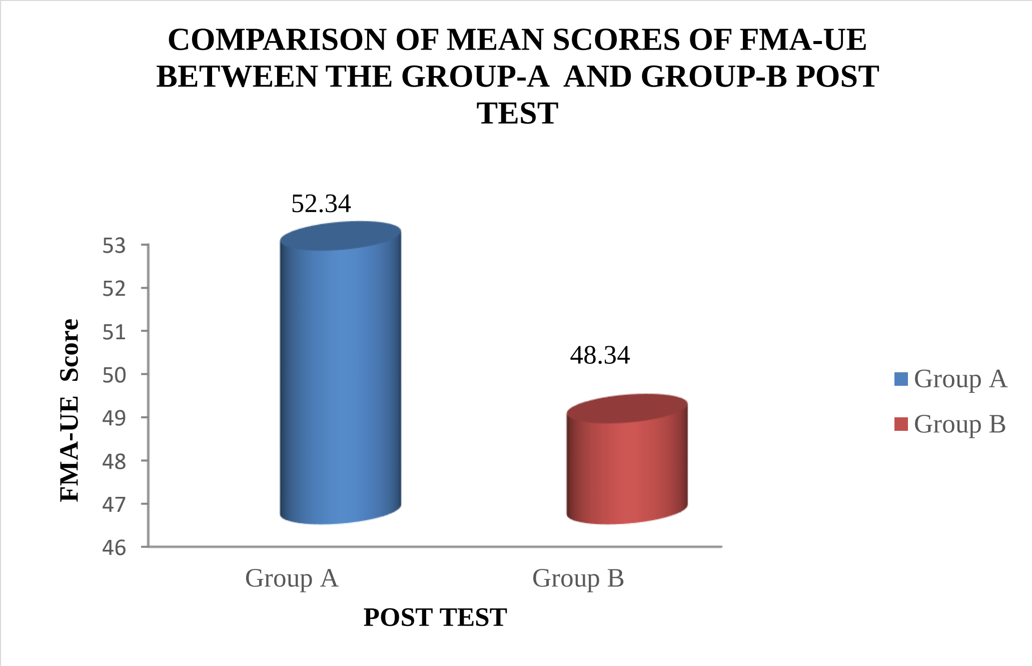
GRAPH-3

RESULTS: The above table and graph depicts the baseline measurement of FMA-UE inGroup – A (43.94) and Group – B (43.22) were found to be statistically insignificant.

Comparison of mean scores of FMA-UE between the groups Group A & B (Post- Test)

Groups		Mean	Standard Deviation	P-Value	Inference
FMA-UE Post-test	Group - A	52.34	5.539	0.00586	Highly significant
	Group – B	48.34	5.672		

TABLE-8



GRAPH-4

RESULTS: The above table and graph depicts the post-test measurement of mean score of FMA-UE changes between the Group-A (52.34) and Group-B (48.34) were found to be statistically significant (P <0.005).

DISCUSSION

The aim of the study was to assess the effectiveness of surged faradic currents combined with conventional physical therapy for improving upper limb spasticity and motor recovery in post stroke subjects. NMES is one of the most used recent treatment techniques and it is a potentially beneficial treatment choice for motor enhancement. It is widely used in the recovery of patients who had sustained neurological injuries such as stroke, spinal cord injuries, or other neurological disorders. Numerous studies have confirmed that NMES has a prominent effect on limb rehabilitation in stroke patients, but there were limited studies on exploring the effect of surged faradic currents on improving upper limb spasticity and motor recovery in post stroke subjects.

Subjects were assessed for spasticity and upper limb motor function at baseline and at end of intervention using MAS for spasticity and FMA-UE for motor function. There were six drop-outs in Group-A (Surged Faradic Currents + Conventional Physiotherapy), four due to recurrent stroke & two due to other medical conditions and in Group-B (Conventional Physiotherapy), there were six dropouts two due to recurrent stroke and four dropouts due to other medical conditions.

In Group-A there is statistically more significant improvement in MAS (P=0.001) and also improvements seen in FMA-UE (P=0.001). According to Siddhima Hardikar[28] et al., Faradic Muscle Stimulation increases blood flow to treated area. Because of vasodilatation, the area becomes red and soft. Moreover, FMS attributes muscle contraction and relaxation to a specific muscle by stimulating a specific motor point to prevent fatigability in the muscle. The faradic current facilitates metabolism process, removing of waste products, and improvising muscle function to improve performance. The main therapeutic advantage of electrical stimulation is to prevent muscle atrophy.

G. Shankar Ganesh[26] et al., compared the effectiveness of the two types of electrical stimulation on ROM, Spasticity and Gait in people with stroke. In this study, the faradic and Russian s currents group had significant improvements on ankle ROM than exercise group alone. Study conductor sated that the reciprocal inhibition is only the possib;le mechanism behind the improvements.

Suchetha P.S.[27] et al., has conducted a study on antagonist versus agonist neuromuscular electrical stimulation on spasticity in stroke patients. After the study complication, the researcher has noticed significant improvements on modified ashworth scale as well as on deep tendon grading scale. Therefore, the researcher concluded that antagonist muscle neuromuscular electrical stimulation reduces spasticity more effectively when compared to agonist neuromuscular electrical stimulation. Because of reciprocal inhibition, the stiffness in the muscle may reduce and encourage the motor function. Reciprocal inhibition is happening in the muscle when the nerve gets stimulated. After neuromuscular electrical stimulation application, the large diameter Ia muscle spindle afferent fibers get excited and carry afferent information to the spinal cord. In the spinal cord the afferent information reaches to interneurons. The efferent information reaches to antagonist muscle from the spinal cord via interneuron’s in order to improve the tone in the weakened muscle and inhibit the tone in the spastic muscle group.

Hitoshi Ohnishi[36] et al., conducted a study on stroke population in which the author allocated severe paretic upper limb patients. The participants of this study were treated with NMES, repetitive facilitative exercises, conventional physiotherapy and NMES plus RFE. NMES plus RFE group participants had significant motor recovery on FMA. NMES alone produces plastic changes in motor cortex and pyramidal tract. NMES with voluntary movement exercises are enhanced motor cortex excitability. Passive movements plus NMES also attributed for cortical plasticity by motor learning.

Current study NMES plus Conventional physiotherapy group is having positive correlation with previous studies mechanisms because the improvements in motor recovery are measured on FMA and reduction in spasticity is measured on MAS.

Group-B (conventional physiotherapy) of current study had significant improvements on MAS score (P=0.01) and FMA-UE (P=0.001). The protocol of conventional physiotherapy of this study was taken from previous study. In our current study, participants were taken proprioceptive neuromuscular facilitation, passive muscle stretching, cryotherapy, gait training and NMES.

Monaghan K[29], et al., stated that proprioceptive neuromuscular facilitation training, stretching, cryotherapy and NMES were aimed at improving the functional activities of hemiplegic patients such as muscular tone, strength and flexibility and the mechanism behind the improvements is reciprocal inhibition and Golgi tendon activation and inhibition of excitability of alpha motor neurons leads to an increase in the extensibility of soft tissues. Cryotherapy[30] in the treatment of spasticity has as primarily objective to reduce visco-elastic mioarticular tension and facilitate neuromuscular function. The physiological effect of ice is reduction of muscle spindle, neuromuscular junction and peripheral nerve activity.

Pallavi Sahay[34, 35] et al., stated that gait training in parallel bars has greater improvements in the functional outcomes, as the parallel bars provided support and decreased the fear of fall providing stable background to practice gait. Therefore strategies for decreasing movement speed through mechanical constraints resulting from holding on to the parallel bars and visual feedback from the mirror helping the patient to slow down the speed of movement may outweigh the negative consequences of increased inertia.

The study findings indicating that after 6 weeks of interventions surged faradic currents along with conventional physical therapy was more effective than conventional physical therapy alone in reducing spasticity and improving upper limb function. Thus this study concludes that Surged Faradic Currents is a useful adjunct in Post Stroke Spasticity along with Rehabilitation.

LIMITATIONS

1. Small sample size.
2. No blinding of evaluators.
3. No follow-up.

RECOMMENDATIONS OF FURTHER RESEARCH

1. Studies with larger duration could be taken with follow-up period to assess the long-term benefits of this intervention.
2. Larger sample size could be taken into consideration.

CONCLUSION

The present study concludes surged faradic currents plus conventional physiotherapy group and conventional physiotherapy group showed significant improvements in reduction of spasticity and motor recovery in subjects with stroke. However, surged faradic currents plus conventional physiotherapy group was more effective than conventional physiotherapy alone group. Therefore, it may be recommended from these findings that surged faradic currents that may be used as an adjunct to conventional physiotherapy for treatment of spasticity in the rehabilitation clinics.

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ANNEXURE-I

CHAIRMAN
Mr. Naveen
Social Activist

INSTITUTIONAL ETHICS COMMITTEE
GSL MEDICAL COLLEGE & GENERAL HOSPITAL,
NH-16, RAJAHMUNDRY [ANDHRAPRADESH] – 533296

GSLMC/ RC:947-EC/947-09/2022 *Date: 20.09.2022*

Communication of Decision of the Institutional Ethics Committee [IEC] - Institutional Review Board [IRB]

To: **Mr. NANDINA VENKATESH, 1st year MPT (NEUROLOGY), SWATANTRA INSTITUTE OF PHYSIOTHERAPY & REHABILITATION, Rajahmundry**

IEC/IRB Ref No: 947-EC/947-09/22

Protocol Title: "EFFECTIVENESS OF SURGED FARADIC CURRENTS ON IMPROVING UPPER LIMB SPASTICITY AND MOTOR RECOVERY IN POST STROKE SUBJECTS"					
Principal Investigator: : Mr. NANDINA VENKATESH					
Name & Address of Institution: SWATANTRA INSTITUTE OF PHYSIOTHERAPY & REHABILITATION, Rajahmundry					
New review	√	**Revised Review**		**Expedited review**	
Date of review [D/M/Y]	2 0 / 0 9 / 2 0 2 2				
Date of previous review (if revised application)					
Documents reviewed:					
Current CV of the investigator	√	Trial protocol	√	Investigator's Brochure	√
Proposed methods	√	Informed consent form	√	Agreement with the Sponsor	
Compensation protocol	√	Investigators undertaking	√	Case Report Form	√
Any other/ additional documents (Specify)					
Decision of the IEC / IRB:					
Recommended √	Recommended with suggestions	Revision	Deferred	Rejected	
Suggestion/Reasons/Remarks: APPROVED √					
Recommended for a period of :					
One Year		Three Years	√	Five Years	

Please note:

- Inform IEC/ IRB immediately in case of any Advance events and Serious adverse events
- Inform IEC/IRB in case of any change of study procedure, site and investigator.
- This permission is only for period mentioned above. Annual report to be submitted to IEC/IRB.
- Members of IEC/IRB have right to monitor the trial with prior intimation.

Signature of **MEMBER SECRETARY**
IEC/IRB

MEMBER SECRETARY
INSTITUTIONAL ETHICAL COMMITTEE
GSL Medical College & General Hospital
NH-5, Rajahmundry 533 296

GSL Medical College
NH-5, Lakshmipuram,
Rajahmundry - 533 296