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Effectiveness of Intense Sensory Motor Stimulation on Improving Functional Recovery in Post Stroke Individuals

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ABSTRACT

Introduction: Rehabilitation measures help to restore lost activities, improve quality of life and decrease the long term economic cost of stroke. Realistic goal setting, interdisciplinary team approach and the active participation of both patient and family members are important for the success of stroke rehabilitation. The primary objective of this study is to investigate the effects of intense sensory motor stimulation, given in the form of electrical stimulation, massage and re-education exercise programme, in augmenting recovery in stroke patients.
Methods: A prospective single group pre and post test study design was conducted with a total of 29 hemiparetic patients who provided informed consent. All the participants received the therapeutic measures of electrical stimulation, massage and re-education exercises including gait training and ADL retraining until discharge. The Neurological and Functional recovery were measured using Scandinavian Stroke Scale score (SSS) and Functional Independence Measure score (FIM) respectively.
Results: An Analysis of variance 'F' Value of 37.31 and 43.94 which are significant at 0.01 level shows that there is a significant difference between scores at admission, discharge and follow up in SSS and FIM scores respectively. The Pearson correlation coefficient 'r' value of 0.62, 0.81 and 0.97 at three time periods suggests that a moderate to strong negative correlation exists between SSS and FIM scores which are significant at 0.01 levels.
Conclusion: A significant level of neurological and functional recovery was obtained in the study group during the time of discharge and in the follow up period indicative of effectiveness of intense sensory motor stimulation in augmenting motor recovery in stroke patients.

Keywords: Sensory Motor Stimulation, Functional Recovery, Stroke Patients

INTRODUCTION

Stroke is the most disabling chronic condition. The prevalence rate for hemiplegia in South India was reported to be 56.9 per 10000. [1,2] WHO defined stroke as "rapidly developed clinical signs of focal or global disturbance of cerebral function; lasting more than 24 hours; leading to death with no apparent cause other than vascular origin". [3] The 24 hours threshold in the definition excludes transient ischemic attacks (TIA). Modern advances in stroke research aid better management of stroke patients. In the past, recovery from motor deficit after a stroke was a puzzling scientific question. Now it has been found out that, neuronal organization, dynamic changes in the somatotopia of primary motor cortex, recruitment of remote motor cortices, and participation of associative cortices are clearly part of rearrangement process. [4] It is likely that such mechanisms represent the basis of clinical recovery of stroke patients.

Rehabilitation measures help to restore lost activities, improve quality of life and decrease the long term economic cost of stroke. [5] Realistic goal setting,

interdisciplinary team approach and active participation of both patient and family members are important for the success of stroke rehabilitation. [6] It is desirable to start rehabilitation programmes to stroke patients once they are medically stable. [7] Various programmes of treatment, for patients with motor control problems, were developed in the past based on neurophysiological and developmental research of the time as well as careful observation of the responses made by patients when being handled.

Review of literature shows that there will be natural, spontaneous neurological recovery after stroke. The mechanism to explain recovery is neuroplasticity. Brain plasticity is the ability of the nervous system to modify its structural and functional organization. The two most plausible forms of plasticity are collateral sprouting of new synaptic connections and unmasking of previously latent functional pathways. [8] Experimental evidence indicates that plasticity can be altered by several external conditions, including pharmacological agents, electrical stimulation and environmental stimulation. [9]

A comprehensive critical review of medical literature reveals that rehabilitation interventions have variable relationships with functional outcome after stroke. 1) Increased functional skills on admission to rehabilitation, early initiation of rehabilitation services, and rehabilitation in an interdisciplinary setting after stroke appear to have strong relationship with improved functional outcome at hospital discharge and follow-up. 2) The use of specialized type of therapy services and greater intensity of therapy services appear to have a weak relationship with improved functional outcome at hospital discharge and follow-up. 3) The current literature is too limited to allow an assessment of the relationship of specific types of non-inpatient rehabilitation services after stroke and functional outcome. [10-12]

Current stroke rehabilitation practice throughout the world is based on a number of approaches that were developed independently by several pioneers in the 1950's. Prior to the 1950's the physical treatment of the patients following stroke focused on encouraging the patients to use the unaffected side of the body to compensate for the disabilities of the affected side. The affected limbs were not a prime focus for treatment.

During the 1950's a number of new physiotherapy approaches emerged. These were developed by practitioners who were dissatisfied with the results of practice at the time and were interested in treating the paresis resulting from stroke. The work of many of these pioneers e.g. Bobath [1969], Brunnstrom[1961, 1970], Knott & Voss [1968] and Rood [1969] remains influential today. They developed their programmes primarily from observation and experience. Some of the approaches were associated with neuro physiological concepts current at that time; but others were developed observation alone and then a suitable theory was adapted to explain the effects.

Thus, several different physiotherapy approaches are used in the management of the patients who have suffered a stroke but these approaches are mutually exclusive and a rarely delivered in the uniform purist manner. The theoretical basis of the individual approaches remains unsubstantiated. All of the approaches aim to improve motor control and all of them demand that the therapist has a specialized training in the individual concept.

Many different electrical stimulation applications have been explored since the pioneering work of Liberson et al on foot drop. [13] So in this study electrical stimulation is used to augment motor recovery in patients being rehabilitated after acute stroke, in addition to olive oil massage, and re-education exercise programme.

The primary objective of the study is to investigate the effects of intense sensory motor stimulation, given in the form of electrical stimulation, massage and re-education exercise programme, in

augmenting recovery in stroke patients. The secondary objective of the study is to investigate the relationship between neurological and functional recovery in stroke patients.

METHODS

DESIGN

A prospective single group pre and post test study design. A total of 29 hemiparetic patients admitted to Government Institute of Rehabilitation Medicine, Chennai Medical college, Chennai were recruited. The participants received the intervention until they were discharged.

PARTICIPANTS

All stroke patients who were admitted to the Government Institute of Rehabilitation Medicine, Chennai Medical College, Chennai were screened and recruited on providing consent. No specific selection criteria with reference to age, side, and severity of paralysis, aphasia, neglect, incontinence and cognitive function were applied. But stroke cases of longer duration were not included in this study. On admission to the rehabilitation facility, age, and gender were documented for each patient as were the type and side of the cerebral lesion. The duration between stroke onset and rehabilitation were also recorded.

INTERVENTION

A) ELECTRICAL STIMULATION

The muscles stimulated in the upper limb are deltoid, supraspinatus, biceps, triceps, common flexors of forearm, common extensors of forearm, intrinsic muscle of hand. The muscles stimulated in the lower limb are Gluteus maximus, Quadriceps and Tibialis anterior. Each muscle is stimulated for 10 minutes. The active electrode is kept over the motor point of the muscle to be stimulated. The reference electrode is kept over the nearby bony point. An Electrical Stimulator which provides faradic current with a pulse width of 300 ms, intensity of 100 v and a frequency of 50Hz was used. The muscle contraction/relaxation time ratio is set at 5/10 sec. The patients received electrical stimulation daily for a duration of 1 ½ - 2 hours. [14-18]

B) MASSAGE AND RANGE OF MOTION EXERCISES

After electrical stimulation, olive oil massage was done to the affected upper and lower limbs. Effleurage or stroking massage involves lightly running the hand over the skin. This was performed with either superficial or deep pressure and provides different effects depending on the depth of treatment. Deep stroking involves mechanical effects and should be performed with continuous contact of the hands from distal to proximal on the extremities, the back, or the neck. Once the proximal extent is reached the hands can be drawn back to the distal position applying light contact or no contact at al. [19]

Then PROM exercises were done to the affected upper and lower extremities to prevent the occurrence of joint contracture. Once the patient developed volitional movement, strengthening programme was instituted with optimal movement pattern. ADL training to the upper limbs and gait training to the lower limbs were also administered.

OUTCOME MEASURES

After thorough neurological examination, CT brain was done to confirm the diagnosis. Then the neurological status was assessed using Scandinavian Stroke Scale score [20] and functional status was evaluated using Functional Independence Measure score. [21] Then the treatment programme was started. Outcomes were assessed in every two weeks. The patients were followed up to 6 months.

STATISTICAL ANALYSIS

To analyze the data, two types of statistical techniques are used. They are descriptive statistics and inferential statistics. The averages of baseline characteristics were calculated using mean and standard deviation. One way ANOVA was used to analyse the differences in neurological recovery and functional recovery at three different time periods

(admission, discharge and follow up). Paired‘t’ test was used to identify the difference in the scores between admission, discharge and follow up. The relationship between functional recovery and neurological recovery at the time of admission, discharge and follow up were assessed using Pearson correlation coefficient ‘r’.

RESULTS

The descriptive statistics of the mean scores of Scandinavian Stroke Scale (SSS) and Functional Independence Measure (FIM) is represented in Table 1. In both measures, the scores on admission is found to be less when compared to those at discharge and follow up. The standard deviation also seems to be within the normal limits. It does not skew very much. So this distribution can be considered as normal distribution.

Table 1 The mean and standard deviation of Scandinavian Stroke Scale (SSS) scores and Functional Independence Measure (FIM) scores of stroke patients at different stages

S.no	Stages	No. of cases	SSS Mean ± SD	FIM Mean ± SD
1	On admission	29	32.82 ±9.16	75.79 ± 19.22
2	On discharge	29	47.9 ± 7.068	105.17 ± 12.75
3	On follow up	29	53.13 ± 6.85	115.37 ± 12.00

An Analysis of variance results to identify the difference in the SSS scores at admission, discharge and follow up, shows that the F value 37.31 found to be significant at 0.01 level indicates, that stroke level of different stages are significantly different from one another. The mean scores of SSS increased from 32.82 ±9.16 on admission to a score of 47.9 ± 7.06 at discharge and increased further on follow up to a score of 53.13 ± 6.85. Similarly ANOVA results of FIM scores shows that the F value of 43.94 which is significant at 0.01 level reveals that, there is significant difference in the functional independence levels among the three levels. The mean score ascends from 75.79 ± 19.22 at the time of admission to 105.17 ± 12.75 at the time of discharge and to a score of 115.37 ± 12.00 at follow-up. Both the scores show an improvement in the order of follow-up > discharge > admission.

Table 2 ANOVA results of Scandinavian Stroke Scale scores in different time periods of stroke patients is shown below

S. No	Source of variations	Sum of squares	DF	Mean square	F	Level of significance “p”
1.	Between groups	6269.63	2	3134.81		
2.	Within groups	5366.27	84	63.88	37.31	>0.01

Table 3 ANOVA results of Functional Independence Measure scores of stroke patients at different levels

S. No	Source of variations	Sum of squares	DF	Mean square	F	Level of significance “p”
1.	Between groups	24499.13	2	12249.56		
2.	Within groups	23415.73	84	278.75	43.94	>0.01

To identify whether there is any statistically important difference exists between the time of admission and discharge, discharge and follow up, student‘t’ test was used. Between admission and discharge, the SSS scores had ‘t’ value 6.79 which reveals that the difference is significant. Similarly the FIM scores had ‘t’ value 6.87 which is significant at 0.01 level indicates that the patients have significantly improved at discharge.

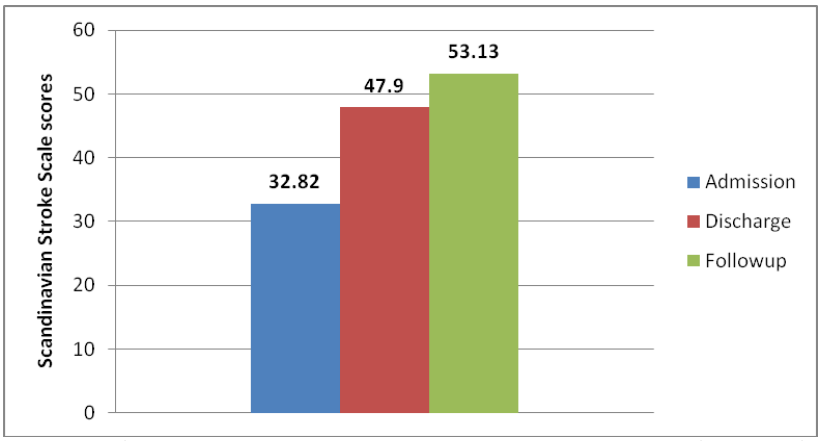
Table 4 The mean, standard deviation and ‘t’ value of Scandinavian Stroke Scale scores and Functional Independence Measure scores on admission and discharge

S. No	Outcome	On admission Mean ± SD	On discharge Mean ± SD	‘t’ value	‘p’ value
1.	SSS	32.82 ± 9.16	47.90 ± 7.68	6.79	>0.01
2.	FIM	75.79 ± 19.22	109.17± 12.75	6.87	>0.01

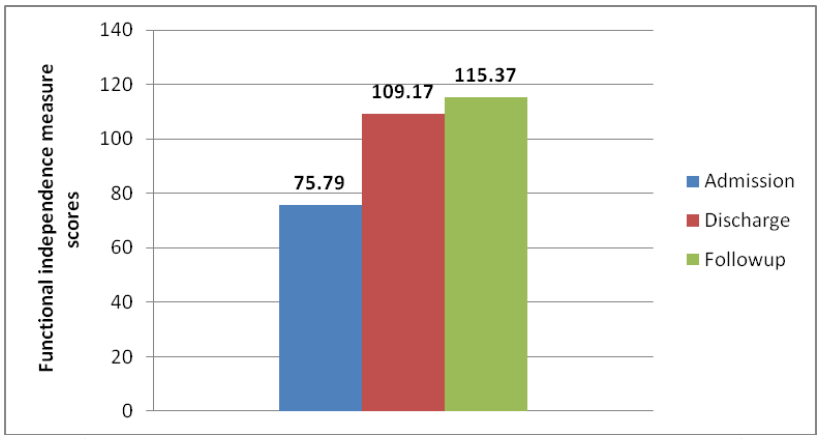
On comparison of scores between discharge and admission, both SSS and FIM scores were found to show a statistically significant difference among them with 't' values of 9.58 and 9.42 respectively. Hence the scores of SSS and FIM differed significantly between three time periods of evaluation.

Table 5 The mean, standard deviation and 't' value of Scandinavian Stroke Scale scores and Functional Independence Measure scores on admission and follow up

S. No	Outcome	On admission Mean ± SD	On follow up Mean ± SD	't' value	'p' value
1.	SSS	32.82 ± 9.16	53.13 ± 6.85	9.58	>0.01
2.	FIM	75.79 ± 19.22	115.37± 12.00	9.42	>0.01



Graph 1: Representation of Scandinavian stroke scale scores on admission, discharge and follow up of stroke patients



Graph 2: Representation of Functional Independence Measure scores on admission, discharge and follow up of stroke patients

Since the stroke level has got direct effects on the motor functions, the Pearson Correlation Coefficient was used to identify the relationship between the magnitude of the stroke and the level of functional independency at the time of admission, at the time of discharge and at the time of follow up.

Table 7 Correlation coefficient 'r' between Scandinavian Stroke Scale score and Functional Independence Measure score on admission, discharge and follow up

	On Admission	On Discharge	On Follow up
Correlation coefficient 'r' between SSS and FIM scores	0.62	0.81	0.97
Level of Significance	p>0.01	p>0.01	p>0.01

Based on the strength of correlation coefficient, the 'r' value of 0.62 between the scores at the time of admission and 'r' value of 0.81 at the time of discharge and 'r' value of 0.97 at the time of follow-up which are significant at 0.01 level indicate that a moderate to strong negative correlation exists between SSS and FIM scores. The above correlation

coefficient value suggests that, when the severity of stroke level increases, the functional independence level significantly decreases. Whereas, when there is improvement of the stroke status, the functional independence level will also increase significantly.
Since the total number of cases in certain conditions is found to be less, the non parametric tests were used to analyze the data. The percentage was calculated for each condition and the same was discussed.

Table 8 Shows the rate neurological recovery [SSS score] and functional recovery [FIM score] in cases of stroke at different levels of brain

S. No	Topography	On admission		On discharge		On follow up	
		SSS	FIM	SSS	FIM	SSS	FIM
1	Cortical level	57%	60%	85%	85%	93%	93%
2	Internal capsular level	53%	40%	85%	78%	85%	86%
3	Brainstem level	63%	72%	82%	92%	100%	99%

From the above table it is learnt that the neurological and functional recovery on discharge and follow-up are fair if the stroke is at the level of the internal capsule. The neurological and functional recovery on discharge and follow up are better if the stroke is at the levels of cortex or brainstem.

DISCUSSION

The above results indicate that the condition of stroke has significantly improved at the time of discharge and follow up when compared to the condition at the time of admission. It is possible to say that the different forms of "intense sensory motor stimulation" would have contributed much for the recovery of the stroke patients. Similarly even after the discharge, the improved condition was maintained significantly. This has proven the efficiency of the intense sensory motor stimulation in stroke rehabilitation. In the follow up it was found that most patients were able to maintain their functions and to make further improvements. Also their psychological well-being was also quite good.

The benefits of this recovery were maintained for a longtime, perhaps because all patients continued to do exercise. Some patients continued with their assigned exercise programme at the hospital and others continued exercise programme at home.

The above findings prove that the functional independence of stroke patients have improved very much at the time of discharge and follow up. The possible reason could be due to the attack of stroke, the movements of the extremities were lost. That could be the possible reason for their low level of functional independency. Since the stroke level is highly related with the motor function, it would have retarded the physical function. [22] Once the severity of the stroke level is decreased, the functional independency will also improve significantly. Another possibility could be the beneficial effects of exercise therapy for the upper limbs and motor training for the lower limbs, which could have improved the functional independency of the stroke patients during discharge and follow up. These results are in accordance with the intensive task specific training to improve lower limb function and gait in acute stroke individuals. [23, 24]

The management of stroke, so long a "Cinderella condition", is changing rapidly as new developments appear for acute treatment, rehabilitation and secondary prevention. Stroke is no longer an untreatable or unpredictable condition and it is vital that hospitals design appropriate systems to manage patients in an interdisciplinary environment. [25]

Though this study size was relatively small, a large treatment effect was demonstrated. In our study, the maximum improvement in the motor recovery was observed at 3 months. These results improved again slightly and remained constant up to the follow up period. Significant improvement in motor recovery in the stroke patients indicates that "intense

sensory motor stimulation" is an effective method of stroke rehabilitation to augment motor recovery. Electrical stimulation is a relatively low cost intervention. Concerns that subjects would find the treatment uncomfortable or inconvenient were unfounded. All subjects reported that the sensation of the muscle contraction following electrical stimulation and the resultant movement of the limb were encouraging. No stimulation induced complications requiring medical attention such as burns, falls or fractures occurred for any patient. A few subjects showed minor skin irritation transiently. Thus intense sensory motor stimulation programme could achieve a better functional outcome in stroke patients and could shorten the hospital stay for rehabilitation.

CONCLUSION

The following conclusions are drawn from the above study:

1. There was a significant level of neurological and functional recovery in the study group during the time of discharge and in the follow up period, when compared to their neurological and functional status at the time of admission. This shows the effectiveness of intense sensory motor stimulation in augmenting motor recovery in stroke patients.
2. The improvements in the neurological and functional status observed at the time of discharge were maintained during the follow-up period. Stroke cases with severe neurological damage and severe functional impairment as evidenced by low scores in the Scandinavian Stroke Scale score and FIM score on admission, required longer duration of treatment.
3. In the hemorrhagic stroke cases, the neurological and functional recovery at the time of discharge and follow up are less, when compared to thrombotic and embolic stroke cases. The neurological and functional recovery on discharge and follow up are better if the lesion is at the level of the cortical than at the capsular level.

REFERENCES

1. Bonita R. Epidemiology of stroke. *Lancet*. 1992; 339(8789):342-344.
2. Dalal P, Bhattacharjee M, Vairale J, Bhat P. UN millennium development goals: Can we halt the stroke epidemic in India?. Ann Indian Acad Neurol 2007;10:130-6
3. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. *Bull World Health Organ*. 1980; 58(1):113-130.
4. Chollet F, Loubinoux I, Carel C, et al. Mechanisms of motor recovery after cerebrovascular accident. Revue Neurologique. 1999; 155(9):718-724.
5. Bohannon RW, Andrews AW, Smith MB. Rehabilitation goals of patients with hemiplegia. Int J Rehabil Res 1988; 11:181-3.
6. Kotila M, Waltimo O, Niemi ML, Laaksonen R, Lempinen M. The profile of recovery from stroke and factors influencing outcome. *Stroke*. 1984;15(6):1039-1044.
7. Watson LD, Quinn DA. Stages of stroke: a model for stroke rehabilitation. *Br J Nurs*. 1998;7(11):631-640.
8. Bach y Rita P. Central nervous system lesions: sprouting and unmasking in rehabilitation. *Arch Phys Med Rehabil*. 1981; 62(9):413-417.
9. Bach-y-Rita P. Brain plasticity as a basis of the development of rehabilitation procedures for hemiplegia. *Scand J Rehabil Med*. 1981; 13(2-3):73-83.
10. Heinemann AW, Roth EJ, Cichowski K, Betts HB. Multivariate analysis of improvement and outcome following stroke rehabilitation. *Arch Neurol*. 1987;44(11):1167-1172.
11. Ottenbacher KJ, Jannell S. The results of clinical trials in stroke rehabilitation research. *Arch Neurol*. 1993; 50(1):37-44.
12. Trialists'Collaboration SU. How do stroke units improve patient outcomes? A collaborative systematic review of the randomized trials. Stroke. 1997 Nov;28(11): 2139-44.
13. Liberson WT, Holmquest HJ, Scot D, Dow M. Functional electrotherapy: stimulation of the peroneal nerve synchronized with the

swing phase of the gait of hemiplegic patients. *Arch Phys Med Rehabil*. 1961; 42:101-105.
14. Faghri PD, Rodgers MM, Glaser RM, Bors JG, Ho C, Akuthota P. The effects of functional electrical stimulation on shoulder subluxation, arm function recovery, and shoulder pain in hemiplegic stroke patients. *Arch Phys Med Rehabil*. 1994; 75(1):73-79.
15. Peckham PH, Creasey GH. Neural prostheses: clinical applications of functional electrical stimulation in spinal cord injury. *Paraplegia*. 1992; 30(2): 96-101.
16. Rushton DN. Functional electrical stimulation. *Physiol Meas*. 1997; 18(4): 241-275.
17. Low and reed electrotherapy explained principles and practice: edition 2. Electrical stimulation of nerve and muscle. P.63.
18. Weingarden HP, Kizony R, Nathan R, Ohry A, Levy H. Upper limb functional electrical stimulation for walker ambulation in hemiplegia: a case report. *Am J Phys Med Rehabil*. 1997; 76(1):63-67.
19. Hofkosh JM (1985) Classical massage. In Basmajian JV (ed) Manipulation, Traction and Massage. Williams & Wilkins, Baltimore, pp 263–269.
20. Lindenstrøm E, Boysen G, Waage Christiansen L, à Rogvi Hansen B, Würtzen Nielsen P: Reliability of Scandinavian Neurological Stroke Scale. Cerebrovasc Dis 1991;1:103-107.
21. Franchignoni F, Tesio L, Martino MT, Benevolo E, Castagna M. Length of stay of stroke rehabilitation inpatients: prediction through the functional independence measure. *Ann Ist Super Sanita*. 1998; 34(4): 463-467.
22. Oczkowski W, Barreca S. Neural network modeling accurately predicts the functional outcome of stroke survivors with moderate disabilities. Arch Phys Med Rehabil 1997; 78:340-5.
23. Richards CL, Malouin F, Wood-Dauphinee S, Williams JI, Bouchard JP, Brunet D. Task-specific physical therapy for optimization of gait recovery in acute stroke patients. *Arch Phys Med Rehabil*. 1993;74(6):612-620.
24. Kwakkel G, Wagenaar RC, Koelman TW, Lankhorst GJ, Koetsier JC. Effects of intensity of rehabilitation after stroke. A research synthesis. *Stroke*. 1997; 28(8): 1550-1556.
25. Appelros P, Nydevik I. [For whom is training after stroke most beneficial? Selection method exists and should be used]. *Lakartidningen*. 1999; 96(19): 2343-2347.

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