

EFFECT OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION ON UNILATERAL NEGLECT FOLLOWING ACUTE STROKE: A RANDOMIZED CONTROLLED TRIAL (*TENS on Unilateral Neglect following Acute Stroke*)

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ABSTRACT: Little is known about the effectiveness of transcutaneous electrical nerve stimulation on unilateral neglect following acute stroke. The stimulatory effects of transcutaneous electrical nerve stimulation may be helpful in perceiving touch sensation in case of perceptual dysfunction like Unilateral neglect. Objective was to determine the effect of transcutaneous electrical nerve stimulation (TENS) on unilateral neglect over the standard care following acute stroke. Eighty stroke patients were screened for eligibility. Twenty four patients were randomized equally into intervention and control group. Both the groups received standard care treatment for twenty minutes once a day. Intervention group received transcutaneous electrical nerve stimulation for twenty minutes once a day for five days. The line bisection test, Catherine Bergego scale and Barthel index were measured on first and fifth day of treatment session. Between the groups differences in Line bisection test, Catherine Bergego scale and Barthel index for the intervention group were 2.49 ± 0.97 , 9.08 ± 1.56 , 21.25 ± 4.82 respectively and for the control group were 0.40 ± 0.17 , 3.33 ± 1.15 , 10.00 ± 4.76 . Between the group comparison of Line bisection test, Catherine Bergego scale and Barthel index were found to be statistically significant ($p < 0.001$). Transcutaneous electrical nerve stimulation coupled with the standard care shows improvement in reduction in presence and severity of unilateral neglect, and improvement in functional independence in acute stroke patients.

Key words: Transcutaneous electrical nerve stimulation, unilateral neglect, stroke, Line bisection test, Catherine Bergego scale, Barthel index

Introduction:

WHO defines Stroke as “rapidly developing clinical signs of focal or total disturbances of cerebral activity, with symptoms lasting twenty four hours or longer resulting in death with no apparent cause apart from of vascular origin”.¹ In India, the general age estimated rate for stroke was assessed to lie in between 84 – 262 for each 100000 in rural regions and for urban ranges it was evaluated to be from 334 – 424 for each 100000. The

yearly rate per 100000 of stroke was 124 in rural ranges and 145 in urban regions. The mean onset of stroke in India ranges from 63 – 65 for men and 57 – 68 for women.^{2, 3, 4}

UNILATERAL NEGLECT, conjointly called Hemineglect, hemispatialneglect or spatialneglect, is a disabling condition following brain injury during which patients fail to remember of things to at least one side of area. Neglect is most outstanding and durable once injury to the righthemisphere of the human brain, significantly following a stroke. Such peoples with right-sided brain injury usually fail to remember of objects to their left, demonstrating neglect of leftward things. Unilateral neglect (or “neglect”) may be a common behavioral syndrome in patients following stroke. The incidence of unilateral neglect varies wide from 10% to 82% following right-hemisphere stroke and from 15% to 65% following left-hemisphere stroke.⁵

Transcutaneous electrical nerve stimulation (TENS) is that the use of electric current created by a device to stimulate the nerves for therapeutic needs. TENS, by definition, covers the whole vary of transcutaneously applied currents used for nerve excitation though the term is usually used with a lot of restrictive intent, particularly to explain the types of pulses created by portable stimulators familiarized to treat pain. The unit is typically connected to the skin surface using two or more electrodes. A typical battery-operated TENS unit is in a position to modulate pulse width, frequency and intensity. During this study transcutaneous electrical nerve stimulation is applied at frequency of 100 Hz with intensity below motor contraction (sensory intensity).

NEED FOR THE STUDY

Unilateral neglect is one of the constraints in rehabilitating the patients with hemiplegia. Effective communication is the most integral part of any rehabilitation program to produce the best outcome. Unilateral neglect interferes with effective communication between the patient and the physical therapist at the time of rehabilitation. Treatment of unilateral neglect is essential for physical therapist to effectively implement the rehabilitation program for better recovery. The stimulatory effects of transcutaneous electrical nerve stimulation may helpful in perceiving touch sensation in case of perceptual dysfunction like Unilateral neglect. Preceding studies have used transcutaneous electrical nerve stimulation to improve muscle strength, proprioception, mobility and balance. The sensory stimulatory effect of transcutaneous electrical nerve stimulation and its mechanism in improving somatosensory perception is an area which is incomprehensible and equivocal. There is paucity of evidence to explain the interventional effect of high frequency transcutaneous electrical nerve stimulation in improving unilateral neglect. The present study will be focus on the effect of high frequency transcutaneous electrical nerve stimulation on unilateral neglect in acute stroke patients.

OBJECTIVE OF THE STUDY

To determine the effect of transcutaneous electrical nerve stimulation (TENS) on unilateral neglect over the standard care following acute stroke.

HYPOTHESIS

Experimental Hypothesis: Transcutaneous electrical nerve stimulation (TENS) may have effect on unilateral neglect over the standard care following acute stroke.

Null hypothesis: Transcutaneous electrical nerve stimulation (TENS) may not have effect on unilateral neglect over the standard care following acute stroke.

REVIEW OF LITERATURE

Pizzamiglio et al (2006) did a review on development of a rehabilitative program for unilateral neglect (N=13 chronic unilateral neglect patients) and stated that use of peripheral stimulations, at variance with other studies in the literature, did not add any advantage as compared to the improvements produced by the visuo-spatial training.⁶

Yang et al (2013) done a systematic review on rehabilitation interventions for unilateral neglect after stroke (12 RCTs covering 277 participants) and suggested that prism adaptation and repetitive Transcranial magnetic stimulation appeared to be the most effective intervention and burst stimulation appeared to be a new approach.⁷

Tyson et al (2013) done a randomized controlled cross over trial on the effects of transcutaneous electrical nerve stimulation on strength, Proprioception, balance and mobility in 29 chronic stroke survivors and stated that stimulation could have a negative impact on balance and improved impact on Proprioception was found.⁸

Perennou et al (2001) done an intervention study on transcutaneous electrical nerve stimulation reduces neglect related postural instability after stroke (N=22 stroke patients) and concluded that postural instability in the neglect patients was spectacularly and systematically reduced with transcutaneous electrical nerve stimulation.⁹

Schenkenberg et al (1980) examined the test-retest reliability of the line bisection test in patients with right hemispheric lesions, diffuse lesions, left hemispheric lesions and hospital controls, and found that it had excellent reliability ranging from $r=0.84$ to $r=0.93$.¹⁰

Azouvi et al (2003) done study of the psychometric properties of the Catherine Bergego Scale (CBS) and proved to be more sensitive than conventional paper and pencil tasks. Both conventional statistics and Rasch analysis suggest that the CBS is reliable and valid, and that the 10 items define a homogeneous construct.¹¹

Mahoney FI et al (1965) designed the Barthel Index, an ordinal scale used to measure performance in activities of daily living, uses variables describing ADL and Mobility. And found that Its Internal consistency Cronbach's alpha = 0.87 to 0.92. Test-retest of kappa score is 0.98.¹²

METHODOLOGY

SOURCE OF DATA: Subjects were selected from the stroke population group satisfying the inclusion criteria from the Department of Medicine, and Neurology, Justice K S Hegde Charitable Hospital, Mangalore.

STUDY DESIGN: Single blinded randomized controlled trial.

SAMPLE SIZE: 30 subjects (15 in each group)

SAMPLING METHOD: Convenience Sampling.

DURATION OF THE STUDY: 1 year 6 months.

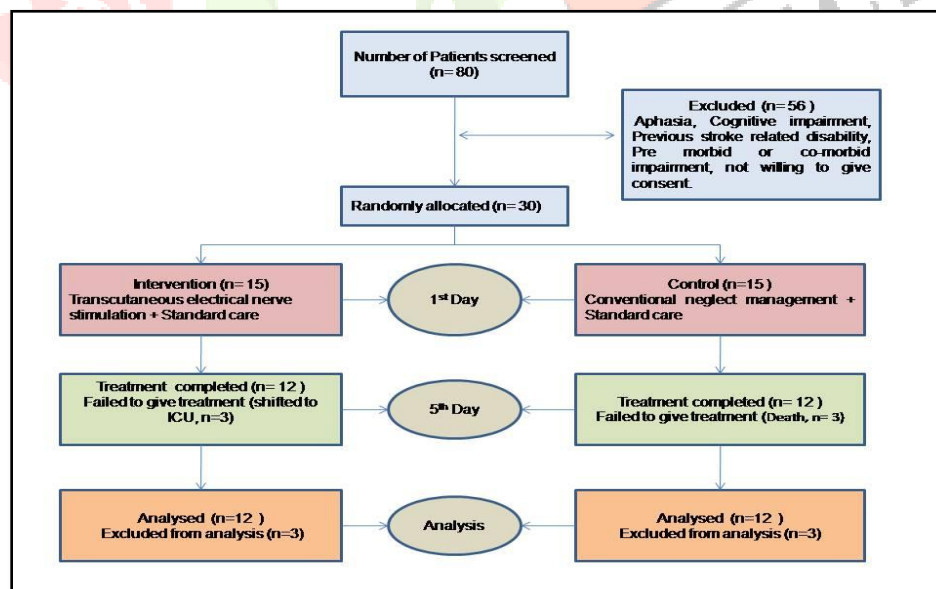


Figure 1: Participants sample flow chart

INCLUSION CRITERIA

- Age group: Above 45 years
- Gender: both Male and Female
- Type of stroke: Ischemic Stroke and Hemorrhagic stroke (MCA territory)
- Hemi neglect
- Acute unilateral stroke confirmed on computed tomography scan,
- Ability to participate in 40 minutes of physiotherapy sessions as the duration of treatment is 40 minutes (standard care of 20 minutes and transcutaneous electrical nerve stimulation for 20 minutes).

EXCLUSION CRITERIA

- Aphasia
- Cognitive impairment
- Previous stroke related disability
- Pre morbid or co-morbid impairment
- Not willing to give consent

MATERIALS USED

- Transcutaneous electrical nerve stimulator
 - 1a) MEDISANA® TENS unit, 41468 NEUSS, Germany.
 - 1b) Four battery operated system.
- Electrodes
- Treatment couch
- Line bisect test form
- Catherine Bergego scale form
- Barthel Index form.

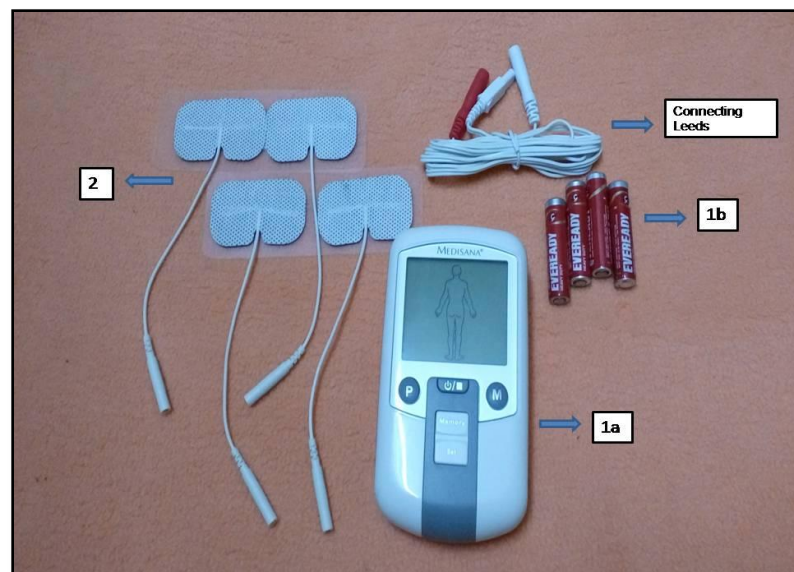


Figure 2: Equipment and accessories

TREATMENT

Group A: Intervention Group (Transcutaneous electrical nerve stimulation and Standard Care)

Patient was positioned in supine turning neck to right side. Cleaned the areas below occiput and postero-lateral part of spine. Then placed the 2 electrodes of Transcutaneous electrical nerve stimulation (TENS) below the occiput just lateral to the spine and posterior part of sternocleidomastoid muscle contralateral to the lesion. (This area is the emergence of superficial cervical plexus containing a subcutaneous network with high density of sensitive fibres¹³). Stimulation will last for 20 minutes per day other than the standard care, for 5 days. Transcutaneous electrical nerve stimulation Parameter used was;

- Frequency 100 Hz, Pulse Width 200 μ Sec
- Intensity: Based on the patients tolerance (> 30 mA), Current form: Rectangular Continuous

Group B: Control Group (Conventional Neglect Management and Standard Care)

Conventional Neglect management:

Cueing: Perceptual deficit rehabilitation may be performed via cueing. Scanning training attempts to encourage patient to direct their gaze to the neglected side and to scan their environment to the left with verbal cueing. Addressing the activities of daily living and may involve direct verbal, visual, or tactile cueing.

Environmental Modification: The patient's bedside environment may be oriented leftwards and hence make the patient perceive his or her left side.

Shifting of representation of space: It includes eye patching, trunk rotation and neck rotations to increase leftward orientation.¹⁴

Standard Care:

Positioning

Active and passive range of motion exercises

Bed mobility exercises: Rolling (Log roll, segmental rolling), Bridging, Supine to side lying, side lying to sit, sitting supported, weight shifting and weight bearing, PNF patterns(chopping movements, lifting patterns) on the affected side.¹⁵

Standard care were given for 20 minutes per day for 5 days.

OUTCOME MEASURES

Line Bisection Test: The line bisection test is a quick measure to detect the presence of unilateral neglect. A displacement of the bisection mark towards the side of the brain lesion is interpreted as a symptom of neglect. It would be an appropriate tool for evaluating unilateral neglect following stroke.¹⁶

Catherine Bergego Scale: The Catherine Bergego Scale is used to assess the presence and the extent of neglect on a sample of real everyday life activities. It was created because conventional tests of neglect were not good predictors of everyday difficulties.¹⁷

Barthel Index: The Barthel Index was developed to measure functional independence in personal care and mobility. It is an index of independence that scores the ability of a client with neuromuscular or musculoskeletal disorder to care for himself/herself.¹⁸

Outcome measures were collected at the first day and at the end of fifth day.

RESULTS

Statistical analysis

Statistical analysis was done using SPSS version 21.0.

The data was normally distributed so mean and standard deviation were used for descriptive statistics. Descriptive statistics including mean, standard deviation, were done for basic characteristics of the stroke population for age and gender.

Paired t test was used to compare within the group differences of the Control and intervention group on Line bisection test, Catherine Bergego scale and Wilcoxon sign rank test was used to the same for Barthel index.

The independent sample t test was used to compare between the group difference of control and intervention group before and after the treatment for Line bisection test, Catherine Bergego scale and Mann-Whitney U test was used to the same for Barthel index

Pearson correlation was used to find out the relation between Catherine Bergego scale and Barthel index.

P value less than 0.05% probability was considered as statistically significant

Table 1: Descriptive statistics of intervention and control group.

Demographics		Intervention (n=12)	Control (n=12)	Sig.
Age (Mean ± SD)		58.58 ± 9.72	62.58 ± 8.05	0.329 ^a
Sex	Male (%)	58	42	1.00 ^b
	Female (%)	58	42	
Side of hemiplegia		Left (12)	Left (12)	1.00 ^b
Unilateral neglect side		Left (12)	Left (12)	1.00 ^b
Type of stroke	Ischemic	75	75	1.00 ^b
	Hemorrhagic	25	25	
a= Independent t test, b= Chi-Square test				

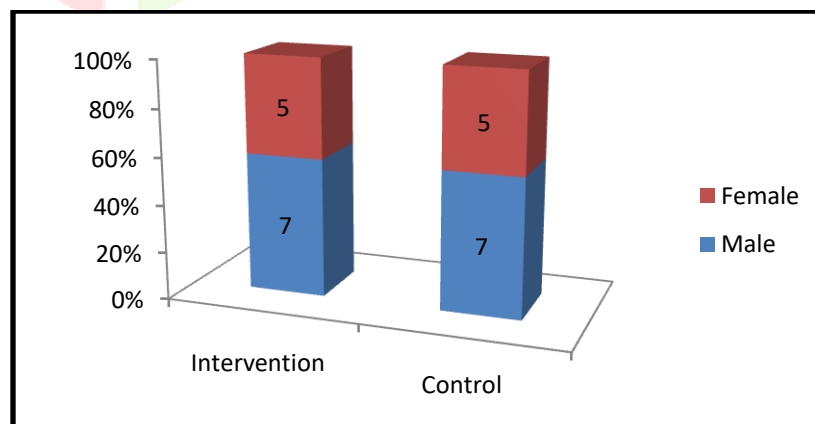


Figure 3: Sex distribution in intervention and control group

Table 2: Differences in pre and post values of line bisection test in intervention and control group.

Variable	Intervention (n=12)				Control (n=12)				P value
	Mean ± SD	95% CI		t value	Mean ± SD	95% CI		t value	
		Lower	Upper			Lower	Upper		
LBT Pre	3.31 ± 1.16	-	-	-	3.45 ± 0.96	-	-	-	-
LBT Post	0.82 ± 0.49	-	-	-	3.05 ± 0.05	-	-	-	-
LBT Difference (Pre – Post)	2.49 ± 0.97	1.87	3.10	8.87	0.40 ± 0.17	0.50	8.12	8.12	0.001
LBT = Line Bisection Test, CI = Confidence Interval									

Table 3: Differences in pre and post values of Catherine Bergego scale in intervention and control group.

Variable	Intervention (n=12)				Control (n=12)				P value
	Mean ± SD	95% CI		t value	Mean ± SD	95% CI		t value	
		Lower	Upper			Lower	Upper		
CBS Pre	20.25 ± 4.67	-	-	-	20.41 ± 2.23	-	-	-	-
CBS Post	11.16 ± 4.64	-	-	-	17.08 ± 2.15	-	-	-	-
CBS Difference (Pre – Post)	9.08 ± 1.56	8.08	10.07	20.11	3.33 ± 1.15	2.59	4.05	10.00	0.001
CBS = Catherine Bergego Scale, CI = Confidence Interval									

Table 4: Differences in pre and post values of Barthel index in intervention and control group.

Group	Descriptive Statistics		BI Pre	BI Post	BI Difference
Intervention (n=12)	Mean ± SD		18.75 ± 10.8	40.00 ± 10.66	21.25 ± 4.82
	Median		20.00	37.50	20.00
	Quartiles	25	10.00	35.00	16.25
		50	20.00	37.50	20.00
75		28.75	45.00	25.00	
Control (n=12)	Mean ± SD		17.08 ± 12.33	27.08 ± 15.58	10.00 ± 4.76
	Median		15.00	20.00	10.00
	Quartiles	25	5.00	15.00	5.00
		50	20.00	37.50	20.00
75		28.75	45.00	25.00	

Table 5: Independent t test value of LBT and CBS between the groups.

Variables	Levene's Test for Equality of Variances		t – Test for Equality of Means				
	F Value	Sig.	95% Confidence Interval of the Difference		Mean Difference	t Value	Sig. (2 tailed)
			Lower	Upper			
LBT Difference	15.85	0.001	1.46	2.71	2.09	7.33	0.001
CBS Difference	1.59	0.220	4.58	6.91	5.75	10.24	0.001

LBT = Line Bisection Test, CBS = Catherine Bergego Scale

Table 6: Mann Whitney U test of Barthel index between the groups

Variable	Group	Mean Rank	Sig.
BI Difference	Intervention	17.83	U = 0.001
	Control	7.17	

Table 7: Pearson correlation between Catherine Bergego scale and Barthel index.

Correlations			
		CBS	BI
CBS	Pearson Correlation	1	.802**
	Sig. (2-tailed)		.000
BI	Pearson Correlation	.802**	1
	Sig. (2-tailed)	.000	
**. Correlation is significant at the 0.01 level (2-tailed).			
CBS = Catherine Bergego Scale, BI = Barthel Index			

DISCUSSION

The objective of the study was to determine the effect of transcutaneous electrical nerve stimulation on unilateral neglect following acute stroke. In this study, results show that there is significance difference between the intervention group and the control group for line bisection test ($p = 0.001$), Catherine Bergego scale ($p = 0.001$) and Barthel index ($p = 0.001$). Reduction in the presence of unilateral neglect of the intervention group suggests improvement in severity of neglect and functional independence in the activity of daily living.

As per our results, we reject the null hypothesis and accept the experimental hypothesis which suggests that transcutaneous electrical nerve stimulation may have an effect on unilateral neglect over the standard care following acute stroke. Perennou et al(2001) concluded that postural instability in the neglect patients was spectacularly and systematically reduced with transcutaneous electrical nerve stimulation and provides clinical evidence supporting the postural body scheme concept. However in this study effects on postural stability was not assessed but improvement in the outcome measures indirectly states an improvement in the postural stability.

Pizzamiglio et al(2006) conducted a study and inferred that use of peripheral stimulation did not add any advantage as compared to improvements produced by visuo-spatial training. However this study showed

considerable improvements on outcome measures with transcutaneous electrical nerve stimulation and standard rehabilitation care. Previous studies with burst and transcranial magnetic stimulation have been undertaken however effect of continuous mode of transcutaneous electrical nerve stimulation lacks literature.

As per the literature search no research has determined the correlation between Catherine Bergego scale and Barthel index. This study is the first to do so with a result of positive correlation existing between CBS and BI (Pearson Correlation 0.802 and $p < 0.001$).

STRENGTH OF THE STUDY

- Single blinded parallel group randomized controlled trial
- First study to attempt effect of transcutaneous electrical nerve stimulation on unilateral neglect following stroke in India.
- First study to correlate the relationship between the Catherine Bergego scale and the Barthel index.
- The homogeneity of variance was achieved for sex, age and site of the lesion.
- Although we had less number of subjects in the study ,we could able to achieve statistical significance difference between the groups
- Minimal bias
- No side effects reported during the study

LIMITATIONS OF THE STUDY

- Small sample size
- Sample size calculated in not scientific manner because of the low incidence rate of unilateral neglect.
- Only left side hemiplegia patients were included
- No follow up was observed

FUTURE SUGGESTIONS

- ❑ Similar study need to be done with a large sample size, either left or right sided neglect cases, neglect related issues after brain surgery and long term follow up to study the effectiveness of transcutaneous electrical nerve stimulation on unilateral neglect following acute stroke.

CONCLUSIONS

The current single blinded randomized controlled trial results suggests that transcutaneous electrical nerve stimulation coupled with standard care is beneficial in reduction of presence and severity of unilateral neglect

following acute stroke. Reduction in unilateral neglect leads to improvement in the activity of daily living following acute stroke by the use of transcutaneous electrical nerve stimulation over the conventional neglect management.

There exists a positive correlation between Catherine Bergego Scale and Barthel Index for measuring functional independence in activity of daily living in acute stroke patients.

Transcutaneous electrical nerve stimulation is observed as safe, feasible, cheaper and no side effect while giving treatment.

ETHICAL COMMITTEE APPROVAL STATUS: Central Ethics Committee, Nitte University, Ref: NU/CEC/P.G.-06(NIPT)/2015.

CLINICAL TRIAL REGISTRY OF INDIA (CTRI): CTRI/2016/04/006845 [Registered on: 19/04/2016] – Trial Registered Retrospectively.

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