www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i5.216

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Effectiveness of Repetitive Bilateral Arm Training with Rhythmic Auditory Cueing in Hemiparetic Stroke

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Abstract
Background: *Stroke is the third leading cause of death in the United States and the leading cause of adult Disability.[1] Annually approximately 7,50,000 suffer a stroke[2] Although incidents rates have remained constant over the last 3 decades, mortality has declined, leaving an increased Stroke is the third leading cause of death in number of patients requiring rehabilitation.[3] Upper Extremity Hemiperesis is the most common post stroke disability and its recovery is often limited. Chronic Upper Extremity Weakness is the leading cause of functional disability after Stroke.*
Methods: *In this study we compare the effects of BATRAC [Bilateral arm training with rhythmic Auditory Cueing] with that of conservative unilateral training. In this study we determined the effects of 8 weeks of BATRAC on 15 patients with stroke. 30 minutes daily session 3 times per week was performed with the use of a custom – designed arm training machine.*
Results: *Patients showed significant increases in Fugl-Meyer Upper extremity Motor performance test and Wolf – Motor function test after training than compared to that of conservative unilateral upper extremity training[passive movements]. These benefits are sustained even after 6 weeks of training cessation.*
Conclusion: *8 weeks of BATRAC improved functional motor performance of paretic upper extremity as weii as improvements in Range of Motion and Isometric strength*
Keywords: *Auditory cueing, repetitive Bilateral arm training ,Motor function.*

INTRODUCTION

Stroke is the third leading cause of death in the United States and the leading cause of adult Disability.[1] Annually approximately 7,50,000 suffer a stroke[2] Although incidents rates have remained constant over the last 3 decades, mortality has declined, leaving an increased Stroke is the third leading cause of death in number of patients requiring rehabilitation.[3] Upper Extremity Hemiperesis is the most common post stroke disability and its recovery is often limited. However there is evidence that a specific rehabilitation intervention can improve Upper Extremity motor performance in Chronic Stroke Survivors.[4] Specifically dysfunction from upper extremity hemi paresis impairs performance of many daily activities such as feeding, dressing, bathing and self-care thus reducing functional independence. Infact only 5% of adults regain full arm function after stroke and 20% regain no functional use[5]. Hence, alternative strategies are needed to reduce the long term disability and functional impairment from upper extremity hemi paresis.

Traditionally methods of stroke rehabilitation have been focused on the first 3 months after stroke and consist largely of passive (non-specific) movement approaches[6] or compensatory training of non-paretic arm[7]. Most daily activities rely on bilateral arm use, thus unilateral upper extremity peresis affects the patient's ability to perform bimanual tasks. Therefore, bilateral retraining is necessary. Bilateral arm training which includes a number of different training techniques with the use of both upper extremities to complete a task has been used in treating stroke survivors at all levels of arm impairment with a positive over all outcome[8]. Bilateral arm training with rhythmic auditory cueing is based on motor learning principles including repetition, feedback and goal setting with the aim of overcoming learned non-use and relative inactivity[9, 10]. It includes the use of non-paretic upper extremity as a fundamental component of training, on the basis of interlimb coupling theory, where the two upper extremities act to form a neuro functional unit[11].In the present study we extend the forced-use paradigm in the form of repetitive Bilateral arm training with rhythmic auditory cueing protocol. The principles of forced-use and task specificity are retained, but the concept of constraining the non-paretic arm is not. Specifically we force the use of rhythmic reaching and retrieving actions using a metronome to cue the patients. We hypothesized that Bilateral arm training with rhythmic auditory cueing would resulting significant improvement in functional ability, sensory-motor impairments and daily use of paretic arm. Because of nature of training we also hypothesized that few significant changes would be found in strength or Range of motion outcome measures.

NEED FOR STUDY

There is need to develop effective treatment pattern to improve upper extremity function in hemiplegic patients. There is a need to develop an instrument, bilateral arm trainer to improve reach function (which is important for feeding) in stroke patient

Aims

- To investigate the efficacy of bilateral arm training with rhythmic auditory cueing.
- To compare the results of unilateral upper extremity conservative training with that of bilateral arm training with rhythmic auditory cueing.

Objectives

- To improve motor performance of paretic upper extremity. To improves the functional independence mainly, reaching.

METHODOLOGY

Sample size of 30 subjects was enrolled in this study. Study population includes male and female post stroke Hemiplegic patients. Study design was Comparative study. Source of data Subjects were chosen from Narayana College of Physiotherapy out-patient department, Chinthareddypalem, Nellore, Andhra Pradesh. sampling method was Randomized Sampling Method.

VARIABLES: INDEPENDENT VARIABLE Bilateral Arm Trainer DEPENDANT VARIABLE: Upper Limb function.

GROUPS: 30 patients are randomly assigned into 2 groups of 15 each.15 are assigned to Interventional group and 15 are assigned to control group. The diagnosis, age, gender and number of months since onset of hemiplegia were obtained from patient interviews and medical charts. Training in bilateral arm trainer is given only to interventional group. And remaining was treated with only passive movements.8 weeks of treatment given with Bilateral Arm Trainer (three times per week) with each session lasting for 30 minutes.

OUT-COME MEASURES: Fugl-Meyer Upper Extremity function test and Wolf-motor Function Test.

INCLUSION CRITERIA: Unilateral involvement, ischemic stroke, Ability to follow 2 step commands (to follow simple instructions), No previous experience with Bilateral Arm Training with Rhythmic Auditory Cueing , Moderate Upper Extremity Impairment (Fugl-Meyer Upper Extremity Motor performance scores between 26 and 50) and Voluntary control of Non-Paretic arm and at least minimal antigravity movement in shoulder of paretic arm. (Voluntary Control Grading 4).

EXCLUSION CRITERIA: Excessive spasticity in the affected arm (modified Ashworth Scale >1+ in any upper extremity joints.), Patients with cerebellar involvement, Active Neoplastic disease, Cardiac failure or unstable Angina, Major Post-stroke depression Mental Illness. Aphasia with inability to follow 2 step commands.

MATERIALS USED: Chair, Table, Bilateral arm trainer and Timer.

Training consisted of 30 minutes of Bilateral Arm Training with Rhythmic Auditory cueing 3 times per week for 8 weeks (24 sessions). In each session patients were seated comfortably in a chair in front of a custom-designed Bilateral Arm Trainer. Bilateral Arm Trainer consists of 2 independent T-bar handles that can move, nearly friction free in transverse plane (perpendicular to the patient). The patient grasps the handles or the affected hand is strapped to the handle. By using scapular protraction, shoulder flexion and elbow extension, the patient pushes the handles away and then by using scapular retraction, shoulder extension, elbow flexion, pulls them towards the body. This action mimics the behaviour of reaching and bringing an object to oneself. In these, patients were encouraged to provide the active pushing and pulling. Training itself consists of 3 training sessions each 5 minutes interspersed with 3 rest periods of each 5 minutes, Daily session consists of 30 minutes of Bilateral Arm Training with Rhythmic Auditory cueing 3 times per week.

Data Analysis: Statistical techniques play an important role in planning of good study. In this study the analysis of effectiveness of Bilateral Arm Training with Rhythmic Auditory Cueing to improve reach function in Stroke patients is given only to Interventional group and only conservative treatment to control group was done using student t-test. All subjects are assessed before[pre-test] and after completion of Training [post-test] with Fugl- Meyer and Wolf-Motor scales. The observed differences were tested with the t-test at 95% level of significance.

I. Fugl-Meyer Scale:

- Comparison between interventional pre-test and control pre-test: There is no significance difference between Interventional pre-test group and control pre-test group (p=0.48). However, pre-test value of Interventional group (12.93±1.94) is higher than the pre-test value of control group (12.47±1.89).
- Comparison between post-test values of interventional and Control Group :There is high significant difference between post-test values of interventional group (26.4±2.38) and control group (18.2±2.40).

II. Wolf-Motor function Scale:

3. Comparison between pre-test values of both Interventional and Control Group: There is no significant difference between pre-test values of Interventional and control groups. However, Interventional pre-test value (3.73±1.16) is slight higher than control pre-test value (3.47±0.92).

4. Comparison between post-test values of both Interventional and Control Groups : There is a high significance difference between post-test values of Interventional and Control groups (p<0.0001). However, Interventional post-test value (10.13±1.25) is very higher than control post-test value (3.47±0.92).

FUGL-MEYER SCALE: Paired Samples Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	INTERVENTIONAL PRE-TEST GROUP	12.93	15	1.944	.502
	INTERVENTIONAL POST-TEST GROUP	26.40	15	2.384	.616
Pair 2	CONTROL POST-TEST GROUP	12.47	15	1.885	.487
	CONTROL POST-TEST GROUP	18.20	15	2.396	.619
Pair 3	INTERVENTIONAL PRE-TEST GROUP	12.93	15	1.944	.502
	CONTROL PRE-TEST GROUP	12.47	15	1.885	.487
Pair 4	INTERVENTIONAL POST-TEST GROUP	26.40	15	2.384	.616
	CONTROL POST-TEST GROUP	18.20	15	2.396	.619

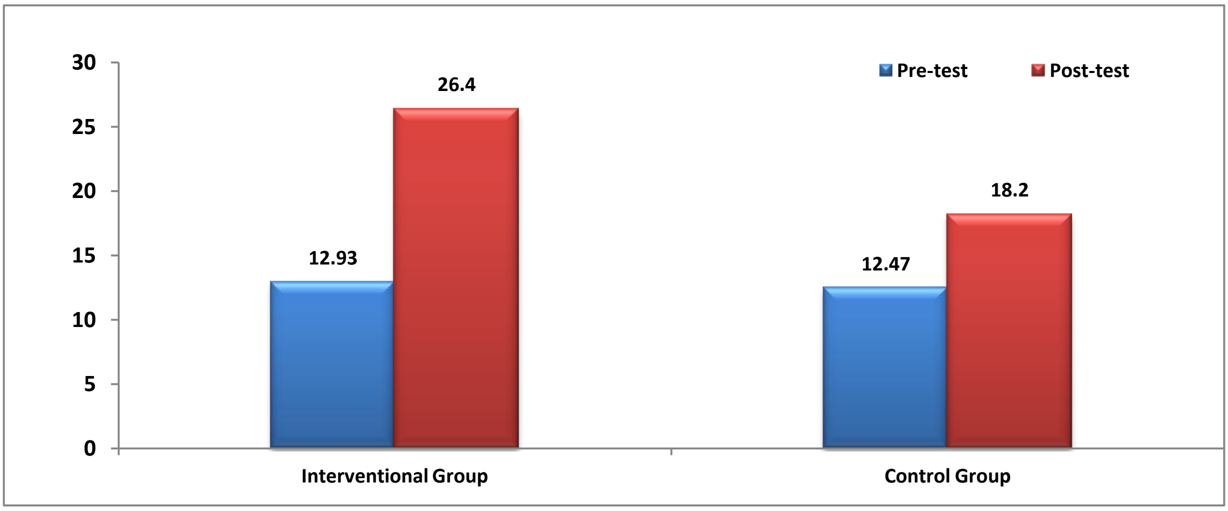
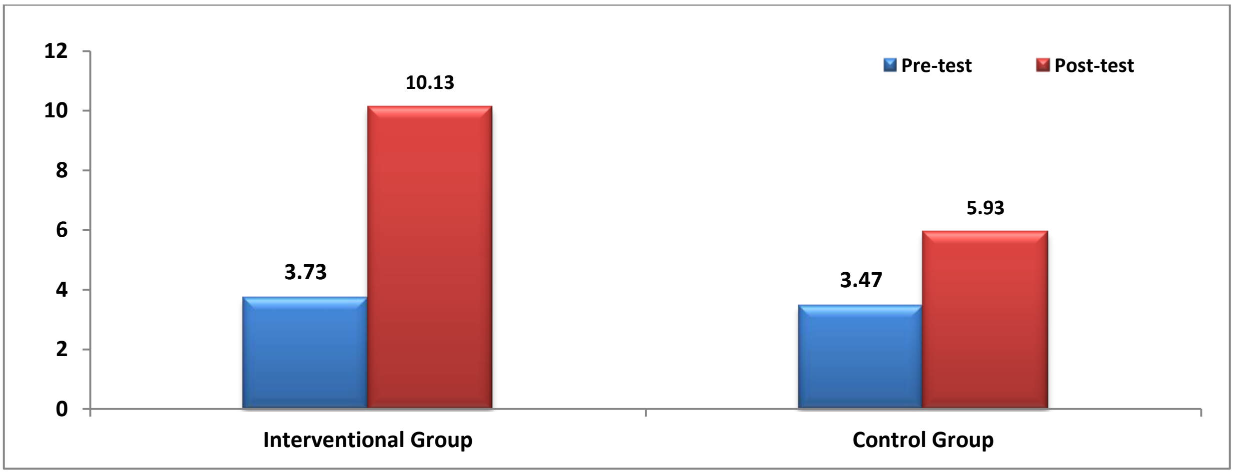


Figure 1: Comparison of Pre-test and Post-test values in Fugl-Myeyer Scale for Interventional and Control Group

WOLF MOTOR FUNCTION SCALE

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	INTERVENTIONAL PRE-TEST GROUP	3.73	15	1.163	.300
	INTERVENTIONAL POST-TEST GROUP	10.13	15	1.246	.322
Pair 2	CONTROL POST-TEST GROUP	3.47	15	.915	.236
	CONTROL POST-TEST GROUP	5.93	15	.961	.248
Pair 3	INTERVENTIONAL PRE-TEST GROUP	3.73	15	1.163	.300
	CONTROL PRE-TEST GROUP	3.47	15	.915	.236
Pair 4	INTERVENTIONAL POST-TEST GROUP	10.13	15	1.246	.322
	CONTROL POST-TEST GROUP	5.93	15	.961	.248



Comparison of pre test and post test values in wolf motor function scale for interventional and control group

RESULTS

In this study, pre-test values of both Interventional and control groups are not significant. For Interventional group there was very high significance compared to control group, i.e., after training that is post-test. For Interventional group, that is treatment with Bilateral Arm Trainer there is improved Upper limb function after 8 weeks. For patients in Interventional group both mean and t-test values are higher than control group values. (P-value is <0.0001). All p-values <0.005 are considered as statistically significant.

DISCUSSION

In this study, we find that 8 weeks of Bilateral arm training with rhythmic auditory cueing improve sensory-motor impairments, functional ability and functional use in patients with stroke. These improvements were checked after 6 weeks after patients stopped training, suggesting that motor improvements were stable. In patients in which direct comparison can be made with the Wolf-Motor function test for performance, our results are more comparable for some studies[12,13] but less comparable for other[14].Active bilateral upper extremity training in the study is effective can be found in the motor behavior. Practicing bilateral movements in synchrony may result in facilitation effect from the non-paretic arm to the paretic arm. For example, when bilateral movements are initiated, the arms acts as a unit that improves individual arm action[15,16] suggesting that both arms are strongly linked as a co-ordinated unit in the brain. Further more studies have shown that learning a motor skill with one arm will result in a subsequent bilateral transfer of skill to the other arm[17]. These experiments suggested a strong neuro physiological link in the brain that explains how bilateral movements may benefit motor learning. Another important concept of bilateral arm training with rhythmic auditory cueing is rhythmic repetition of action through auditory cueing. Repetition is a well known motor learning principle[18], and recent studies have demonstrated that forced use involving a repetitive motor task rather than forced use alone may promote central neural plasticity[19]. Rhythmic Auditory cueing has three advantages: first, by keeping frequency constant, same movement is actually repeated , Second, trying to match the sound with full extension or flexion provides an attentional goal for the patient. Goal setting is known to promote motor learning[21]. Third, feedback is the important factor for motor learning[22]. In this study sensory information from the audio cues and from visual and somato sensory sources, provided intrinsic feed back to the patient regarding the movement goal[23].Our findings suggest that even patients with severe upper extremity hemiparesis can improve with bilateral arm training with rhythmic auditory cueing program. Constraint induced protocols require subjects to have a fair degree of voluntary movement. In this study stroke patients achieved greater improvement in Fugl-Meyer upper extremity score following of Bilateral arm training with rhythmic auditory cueing than following unilateral training.

Our findings suggest that after 8 weeks of Bilateral arm training with rhythmic auditory cueing patient had significant improvements in shoulder flexion and elbow extension, which are integral part of reaching. Bilateral arm training with Rhythmic auditory cueing based on motor learning principles leads to significant and potentially durable functional gains in the paretic upper extremity of stroke patients. In this study we speculate that bilateral training may be more useful than unilateral training. Bilateral arm training with Rhythmic auditory cueing is effective in improving motor performance in stroke patients with moderate upper extremity motor impairment. Bilateral arm training with Rhythmic auditory cueing can induce re-organization in motor cortex. These findings recommend using Bilateral arm training with Rhythmic auditory cueing in stroke patients.

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