USE OF RHYTHMIC AUDITORY CUEING DURING BILATERAL TRAINING OF UPPER EXTREMITIES IN STROKE PATIENTS.

Reem H. Mohamed¹, Mohamed N. El Bahrawi², Enas ELSayed³, Ayman M. Abd Elnaby⁴, Nagwa Ibrahim Rehab⁵

¹Master student at the Department of Physical Therapy for Neuromuscular disorders and its Surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt
²,⁵Department of Physical Therapy for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt
³Department of Neurorehabilitation, Faculty of Physical Therapy, Galala University, Suez, Egypt
⁴Neurology Department, Faculty of Medicine, Mansoura University, Mansoura, Egypt
¹Email: charmed.reem@gmail.com

ABSTRACT

Background: Arm and hand movement problems are major contributors to disability in patients after stroke. Most interventions for upper-extremity paresis after stroke are unilateral. Adding rhythmic auditory cueing to bilateral practice is suggested to enhance upper extremity recovery.

Objective: This study was conducted to determine the effect of rhythmic auditory cueing with bilateral arm training (BATRAC) on arm motor impairment, upper extremity function and gross manual dexterity in stroke patients.

Methods: thirty patients with ischemic stroke participated in this study. Their age ranged from 45 to 60 years. All participants were evaluated for upper limb function by WMFT scale, arm impairment by Fugl-Myer scale, gross hand dexterity by Box & Block test and degree of spasticity by Modified Ashworth scale. They were randomly divided into two groups, study group and control group. The control group received standard Physical therapy program including conventional upper limb training and bilateral arm training. The study group received the same physical therapy program given to control group in addition to auditory cueing during bilateral arm training.

Results: At baseline there was no significant difference between the groups. There was a significant improvement in the upper limb function in both groups, but was significantly more in the study group (after the BATRAC program). The study patients showed more significant increase in the following: Fugl-Meyer Upper Extremity Motor Performance Test of impairment (P, 0.012), Wolf Motor Function Test (performance time measure, P, 0.035), (functional ability measure, P, 0.00001), Box & block test (P, 0.015).

Conclusion: Six weeks of BATRAC improves functional motor performance of the paretic upper extremity as well as changes in isometric strength in stroke patients more than bilateral arm training alone

Key words: ischemic stroke, bilateral training, auditory cueing

1. INTRODUCTION

Stroke is a neurological insufficiency due to an acute focal insult of the central nervous system. Most frequently, it causes restriction of motor activity, reducing mobility, although stroke may also lead to a variety of sensory and cognitive disabilities as well. Moreover, the ability to carry out the activities of daily living in an autonomous way and to be engaged in social and community participation is reduced (1)
Stroke is a leading cause of mortality and disability globally and can be classified into ischaemic and haemorrhagic stroke. Ischaemic stroke is defined as infarction of the brain or spinal cord and represents 80% of all strokes worldwide (2).

More than two-third of all stroke patients have impaired motor function of upper limb and have trouble in independently performing daily living activities. Approximately 50% of patients remain with a chronic reduction of arm function. Six months after stroke (3) this lack of functional recovery restricts daily living activities, decreases productivity, and impairs social re-integration, increasing the economic burden. Therefore, upper limb intervention is one of the challenging tasks of stroke rehabilitation (4).

Bilateral arm training (BAT) approach has led to positive outcomes in addressing upper limb paresis after stroke. It is defined as practice of spatiotemporally symmetrical activities or tasks performed bilaterally but with each limb individually (5). Bilateral practice may enhance upper limb recovery through increasing involvement of the affected motor cortex as concluded by Luft etal study (6) who found increased activation in the contralesional hemisphere (precentral gyri and post central gyri and ipsilesional cerebellum) after 6 weeks of bilateral arm training contrary to unilateral training.

Rhythmic auditory cueing has been shown to be effective in rehabilitation of motor learning (7). Auditory cueing is the process whereby movement is synchronized to sound. Auditory cues can guide movement through their temporal structure to which movement can be aligned (8). The use of functional music in training termed rhythmic auditory stimulation (RAS) has been demonstrated to be effective in stroke patients. Musical activity requires watching and planning, as well as remembering and anticipating musical event (2). In a fascinating analogy, it may be suggested that music written in the time code of rhythm, creating meaningful sound patterns in time simulates or resembles the oscillatory “rhythmic” synchronization codes of neural information processing in the brain, thus becoming a potent stimulus to deliver sensory and cognitive-perceptual information to the brain (9).

Another more recent technique is bilateral arm training with rhythmic auditory cueing (BATRAC) in which, bilateral reaching motions are practiced with metronome-cued timing. In several studies, patients with stroke had increased upper limb function with BATRAC. In this context, McCombe Waller etal (10) showed that bilateral arm training with auditory cueing (BATRAC) improves temporal and spatial aspects of bilateral reaching.

Meanwhile, Richards etal (11) mentioned that BATRAC facilitated increased use, but not the performance of the paretic arm. However, the sample sizes were small, and results have not been replicated. Our purpose was to determine the effect of rhythmic auditory cueing with bilateral arm training (BATRAC) on arm motor impairment, upper extremity function and gross manual dexterity in stroke patients.

II. MATERIALS AND METHODS

This pre-test - post-test randomized controlled study was conducted between September of 2020 and May of 2021. The details of study protocol was demonstrated for each patient before the participation in the study to ensure complete satisfaction and all patients signed an institutionally approved informed consent which was approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/ 002863). Thirty patients, diagnosed as having ischemic stroke (males and females), participated in the study. They were selected from the outpatient clinics of Mansoura university hospital and New generalhospital Ministry of health.

2.1. Study population

Patients were eligible to participate in this study if they had the following criteria: (3) (1) age went from 45 to 60 years (2) Duration of illness was from six months to eighteen months (3) spasticity went from 1 to 1+ evaluation as per the modified Ashworth scale; (4) Patients had moderate arm motor impairment (between 30 and 49 scores) according to Fugl-Meyer; (FM) arm section scale; (5) The affected upper extremity was the dominant side; (6) Patients had stroke for the first time; and (7) Patients was able to sit and maintain balance in sitting position. While, patients were excluded if they exhibited one of the following criteria: (1) Patients with auditory and visual impairments, (2) Musculoskeletal or neurological impairment of the unaffected upper extremity, (3) Aphasia or apraxia and (4) who had undergone surgeries in the upper extremities limiting range of motion.
2.2. Randomization

Enclosing assignment in sequentially numbered, opaque, sealed envelopes was used for the allocation concealment. An external independent person performed the envelopes’ opening process, who was unaware of the group allocation until data analyses were complete. Besides, he was not aware of the treatment technique and had no contact with the participants. A group of 36 with stroke were examined to be sure that the basic requirements were met. It was revealed that 6 patients out of the total number did not meet the consideration standards. The remaining 30 patients were divided randomly into two groups ($n = 15$ per group).

2.3. Outcome measures:

The patients were evaluated for (1) muscle tone assessment by using Modified Ashworth scale, (2) arm motor impairment using Fugl-Meyer arm section scale, (3) functional ability in a variety of upper limb activities using Wolf Motor Function Test and (4) gross manual dexterity was done by using Box and block test before and after the intervention.

Procedure

All tests were performed for both groups before and post treatment

1. Modified Ashworth Scale (MAS)

MAS is utilized to evaluate the degree of spasticity as resistance is experienced during passive range of motion. The assessment of muscle tone was done by grasping the affected upper limb by firm and constant manual contact from bony prominence. The rater should extend the patient’s limb from a position of maximal flexion to maximal extension until the first soft resistance is felt. Moving a patient’s limb through its full range of motion should be done passively manipulating it at a steady and rhythmic rate. Muscle tone was assessed from a comfortable supine lying position in a quiet room, head in neutral position (neither rotated nor bended) and no pillow under the head. Any nociceptive or exteroceptive stimuli were avoided (12)

It is 6 point numerical scale that graded spasticity from 0 to 4, where lower score represent normal muscle tone and higher score represents spasticity or increased resistance to passive movement (13).

2. Fugl-Meyer Upper Extremity Motor Performance test (FM-UE)

It was used to assess arm motor impairment. This scale has been shown to be valid and reliable, and it correlates well with inter joint upper extremity coordination (3). This scale includes four motor sub-items relevant to the involved upper limb: (1) shoulder/elbow/forearm, (2) wrist, (3) hand and (4) speed/coordination. Each item was rated on a 3-point scale (0=cannot perform; 1=partially performs; 2=performs fully) for a 66-point maximum. The total score of 66 points indicated normal motor function, scores between 50 and 65 reflected mild impairments, those between 30 and 49 indicated moderate impairments and those below 30 reflected severe impairments (14).

3. Wolf Motor Function Test (WMFT)

It is used to assess upper extremity function. It consists of 17 functional tasks performed with the paretic arm and hand. 15 items involve timed functional tasks, items 7 and 12 are measures of strength. It was assessed by a 5-step ordinal scale.

Timed items assessed speed of performance, maximum Wolf time is 120 seconds for each item; moderate and severe impairment results in times above 80 and 120 seconds, respectively (15).

4. Box and Block Test

It is used to assess gross manual dexterity. It involves moving 1-inch cube blocks from a rectangular box container to another container, and the number of blocks moved by each hand in 60 seconds is determined using stop watch (16)

Intervention
The same physiotherapist was responsible for all training sessions. The control group received a traditional physical therapy program for upper limb and bilateral arm training (BAT) and a study group received the same physical therapy program combined with auditory cueing during bilateral arm training. Patients in both groups received exercises program for 20 minutes each session, three times per week for six successive weeks. None of the participants received less than 18 sessions (17). During the study period, participants received no physical therapy treatment rather than that scheduled in the study protocol.

**The control group received:**

A) The traditional physical therapy program described by whitall et al. (18) that in-corporates:

1. Stretching activities to keep up muscle elasticity of shoulder internal rotators, elbow and wrist flexors, pronators, and ulnar deviators;
2. Therapeutic positioning as weight bearing on the paretic arm;
3. Mechanical assisted (active and passive) exercises;
4. Scapular mobilization from side lying position;
5. Thoracic spine mobilization

B) Bilateral arm training: Patient was instructed to sit comfortably with both ankles in neutral dorsiflexion, knees and hips placed at 90°, shoulders in 0° flexion, elbows in 60° flexion, and wrists in neutral position of flexion/extension (3).

Patient was asked to do the following tasks described by Mansour et al. (19):

1. Grasping and folding a towel.
2. Holding a jar and unscrewing the lid, where the non-affected hand stabilizes the jar and the affected hand manipulates the cover.
3. Lifting two cups.
4. Holding a mug and stirring the coffee.
5. Catch thrown objects.
6. Climb a ladder.
7. Reaching forward or upward to move blocks
8. Alternative movements included exercises such as Alternative reaching forward or upward.

During BAT, patients should concentrated on simultaneous movement of the upper limbs in functional tasks in symmetric or alternating patterns that emphasize both upper limbs moving synchronously.

**The Study group received**

The previously mentioned physical therapy intervention in addition to bilateral arm training combined with auditory cueing, by using a metronome beat application (version was 3.13.2. Available beats per minute (BPM) range was 20–900) (20).

The Patients performed the same bilateral arm movement sequence in time with the metronome beat. The frequency of the rhythmic auditory stimulation was matched to the patient’s preferred movement speed assessed before the start of the trial, and patient typically started moving after they had heard the metronome beat two to three times.
Each patient was given sufficient practice trials to ensure full understanding before the actual recording of data with three minutes interval between trials. On the 3rd and 5th week, the rhythm frequency was increased by 5% (21).

Statistical analysis

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Preliminary assumption checking revealed that data was not normally distributed for all measured variables, as assessed by Shapiro-Wilk test (p < 0.05). There was homogeneity of variances (p > 0.05) and covariances (p > 0.05), as assessed by Levene's test of homogeneity of variances. Accordingly, non-parametric statistics were used. The Mann-Whitney U test was used to compare whether there is a difference in the dependent variable for the two independent groups. While, Wilcoxon test was used to compare whether there is a difference within the same group. Unpaired t-test was used to compare whether there is a difference pretreatment in the demographic characteristics for the two study groups. The alpha level was set at 0.05.

III. RESULTS

Demographic and clinical characteristics of participants:

The baseline characteristics of the participants showed that no statistically significant differences existed between both the groups (P>0.05), as shown in Table 1. There was also, no significant difference between both groups regarding gender, site of lesion, dominance, comorbidities and degree of spasticity the χ2 value was 1.36 (P>0.05).

Pretreatment comparison between both the groups

No statistically significant differences were noticed regarding the pretreatment between the two groups in all measured variables (P>0.05), as shown in Table 2.

Pretreatment and post-treatment comparison in each group

There was a significant improvement in all measured variables (P<0.05) in both groups, as shown in Table 2.

Post-treatment comparison between both the groups

There was statistically significant improvement in all measured variables between both groups (P>0.05) in favor to study group as shown in Table 2.

Table1. General characteristics of participants in both groups

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Study group</th>
<th>P- value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{x} \pm SD )</td>
<td>( \bar{x} \pm SD )</td>
<td></td>
</tr>
<tr>
<td>Age (Years)</td>
<td>51.86 ± 2.32</td>
<td>52.0 ± 2.0</td>
<td>0.868</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.2 ± 2.65</td>
<td>168.73 ± 1.33</td>
<td>0.492</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>79.4 ± 2.47</td>
<td>80.2 ± 2.62</td>
<td>0.397</td>
</tr>
<tr>
<td>BMI (kg/m^2)</td>
<td>28.0 ± 0.86</td>
<td>27.95 ± 0.84</td>
<td>0.866</td>
</tr>
<tr>
<td>Duration of illness</td>
<td>11.06 ± 4.35</td>
<td>10.66 ± 3.94</td>
<td>0.974</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8 (53.33 %)</td>
<td>10 (66.66 %)</td>
<td>0.456</td>
</tr>
<tr>
<td>Female</td>
<td>7 (46.66 %)</td>
<td>5 (33.33 %)</td>
<td></td>
</tr>
<tr>
<td>Site of lesion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capsular</td>
<td>7 (46.66 %)</td>
<td>8 (53.33 %)</td>
<td>0.701</td>
</tr>
<tr>
<td>Cortical</td>
<td>5 (33.33%)</td>
<td>3 (20%)</td>
<td></td>
</tr>
<tr>
<td>Pontine</td>
<td>3 (20%)</td>
<td>4 (26.66%)</td>
<td></td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTN</td>
<td>7 (46.66 %)</td>
<td>6 (40 %)</td>
<td>0.737</td>
</tr>
<tr>
<td>D.M</td>
<td>5 (33.33%)</td>
<td>7 (46.66%)</td>
<td></td>
</tr>
<tr>
<td>I.H.D</td>
<td>3 (20%)</td>
<td>2 (13.33%)</td>
<td></td>
</tr>
<tr>
<td>MAS</td>
<td>8 (53.33 %)</td>
<td>10 (66.66 %)</td>
<td>0.456</td>
</tr>
</tbody>
</table>
Table 2. Comparison between both groups in all measured variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>Control group Mean ± SD</th>
<th>Study group Mean ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>x ± SD</td>
<td>x ± SD</td>
<td></td>
</tr>
<tr>
<td>FUGL (score)</td>
<td>Before</td>
<td>41.86 ± 6.36</td>
<td>40.73 ± 5.88</td>
<td>0.574</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>48.86 ± 6.40</td>
<td>55.73 ± 5.90</td>
<td>0.012*</td>
</tr>
<tr>
<td></td>
<td>P Value</td>
<td>0.001*</td>
<td>0.000001*</td>
<td></td>
</tr>
<tr>
<td>WOLF (Time subscale) (seconds)</td>
<td>Before</td>
<td>9.5 ± 3.8</td>
<td>9.33 ± 3.05</td>
<td>0.869</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>2.42 ± 0.7</td>
<td>1.69 ± 0.9</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>P Value</td>
<td>0.0001*</td>
<td>0.00001</td>
<td></td>
</tr>
<tr>
<td>WOLF (Strength and quality subscale) (score)</td>
<td>Before</td>
<td>2.67 ± 0.32</td>
<td>2.62 ± 0.3</td>
<td>0.631</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>3.87 ± 0.33</td>
<td>4.62 ± 0.31</td>
<td>0.0001*</td>
</tr>
<tr>
<td></td>
<td>P Value</td>
<td>0.001*</td>
<td>0.000001*</td>
<td></td>
</tr>
<tr>
<td>Box &amp; block test (cube/min)</td>
<td>Before</td>
<td>17.33 ± 3.19</td>
<td>16.73 ± 5.82</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>26.33 ± 3.20</td>
<td>31.73 ± 5.85</td>
<td>0.015*</td>
</tr>
<tr>
<td></td>
<td>P Value</td>
<td>0.001*</td>
<td>0.000001*</td>
<td></td>
</tr>
</tbody>
</table>

V: Mean; SD: Standard deviation P-value: probability value; *Significant at P<0.05

IV. DISCUSSION

Voluntary movement control is stereotypically impaired after a stroke, especially skilled movements of the upper extremities. These motor problems lead to difficulty in the performance of functional movements (e.g., picking up a glass, manipulating objects, etc.), and thus strongly decrease independence and everyday life function (2).

This study was conducted to determine the effect of rhythmic auditory cueing with bilateral arm training (BAT) on upper limb motor impairment and function and gross manual dexterity in stroke patients.

Thirty patients from both sexes suffered from ischemic stroke participated in this study. Patients were selected from outpatient clinics of Mansoura university hospital and New general hospital Ministry of health and were divided into two equal groups (control and study groups) according to the physical intervention. Control group received conventional upper limb training and BAT three days per week for six successive weeks (18 sessions). Study group received rhythmic auditory cueing during BAT in addition designed physical therapy program given to control group. Bilateral arm training session with rhythmic auditory cueing session lasted for 20 minutes three days per week for six successive weeks.

The patients were assessed for upper limb motor impairment and function using Fugl-Meyer Upper Extremity (FM-UE) scale and Wolf Motor Function Test (WMFT) respectively and for gross manual dexterity using Box and Block Test.

In the current study, the patient's age ranged from 45 to 60 years old as this age is the common age of ischemic stroke according to World Stroke Organization (22). Roy-O’Reilly and McCullough (23) reported that aging is the strongest non modifiable risk factor for ischemic stroke, and aged stroke patients ≥ 60 have higher mortality and morbidity and poorer functional recovery than their young counterparts. Also, Smajlović (24) mentioned that prevalence of stroke is lower in young adults under 45 years old.

Most of the patients in this study were male due to small number of available female patients during the period of practical application as stroke was more prevalent in men than women in Egypt (25). Also, Morr et al. (22) mentioned that 52% of new cases of ischemic stroke occur in men and 48% of new cases of ischemic stroke occur in women.

In this study, significant gains in arm impairment and function occurred in stroke patients. Although spontaneous arm motor improvement occurs most rapidly within the first months post-stroke, studies have shown that...
meaningful gains can occur even in chronic stroke if therapeutic interventions are done (26). For this reason, we choose patients after six months of stroke to ensure that improvement is attributed to physical therapy rather than spontaneous recovery.

Regarding the mean value of FM-UE scores, the results of this study showed that there was a statistically significant improvement in both study and control groups post treatment in favor to the study group. This result comes in agreement with the findings of Yu et al. (27) who compared BATRAC group (n=9) with dose matched therapeutic exercise group (DMTE) (n=12) and found more improvement in BATRAC group as reflected in Fugl-Meyer scores. However the difference was not statistically significant but the BATRAC group showed more brain activation assessed by fMRI (i.e., recruitment of premotor area and primary motor cortex. This statistical insignificance may be attributed to the small sample size.

Also, Luft et al. (28) reported that performing rhythmic auditory cueing during BAT training and traditional physical therapy exercise together following a single cortical or subcortical ischemic stroke was more effective than performing only traditional physical therapy in which significantly higher score was recorded in FMA items.

The results of this study was supported by Cauraugh et al. (29) who found that coupling bilateral arm training and auditory cueing protocols represent effective strategy in helping stroke patients make progress toward motor recovery, and should be included in a comprehensive program to minimize motor dysfunctions one year post stroke.

The results of this study revealed a statistically significant in the mean value of WMFT scores in both groups post treatment with more significant improvement in study group compared with control group for time and strength subscales. The improvement in the control group might be attributed to use of BAT. This explanation was supported by the findings of Latimer et al. (30) who reported that bilateral therapy enhance function in adults with chronic stroke. Also, Wu et al. (31) showed that BAT might be more effective than unilateral arm training (UAT) in enhancing upper limb recovery after stroke by activating the ipsilesional primary motor area (M1), primary sensory cortex (S1) and enhancing the intra-hemispheric and interhemispheric connectivity within the sensorimotor network.

More significant improvement in the mean value of WMFT scores in study group compared with control group post treatment might be attributed to improvement of movement speed using BAT. This explanation was supported by Thaut et al. (32) who mentioned that the use of rhythmic cueing with BAT led to increase in speed of movement and smoothing the movement trajectory that often accompany arm movements in persons with stroke.

Also, this explanation was confirmed with the findings of Senesac et al. (33) who stated that rhythmic auditory cueing during BAT regimen based on motor learning principles leads to significant and potentially durable functional gains in the paretic upper extremity of chronic hemiparetic patients.

Concerning motor function of the affected upper extremity as measured by WMFT, there was more significant improvement in study group compared with control group. This result comes in agreement with the findings of Schaffert et al. (34) who found significant improvement in functional motor performance of the paretic arm after 6 weeks of rhythmic auditory cueing during BAT stroke patients and also at an 8-week follow-up assessment.

This significant improvement in motor function of the affected upper extremity in study group received rhythmic auditory cueing during BAT may be explained on neural basis due to increase in the activated ipsilesional precentral gyrus, the ipsilesional cerebellum, ipsilesional medial precentral gyrus, and contralesional medial precentral gyrus for paretic arm movement as proved by studies done by Whitall et al. (35) and Yu et al. (27) who compared rhythmic auditory cueing during BAT with dose matched therapeutic exercise (DMTE) group using functional magnetic resonance imaging (fMRI).

Additionally, this effect may be due to changes that occur quickly after practice which probably represent an "unmasking" of dormant neuromuscular pathways rather than neural reorganization or plasticity. Besides, reconditioning of the neuromuscular system by reversing disuse atrophy may contribute to functional gain (3).
Another important aspect of the rhythmic auditory cueing during BAT is the rhythmic repetition of an action via auditory cueing. Repetition, or “time on task,” is a well-known motor learning principle (36).

Rhythmic auditory cueing has 3 advantages. First, by holding frequency constant during training it ensures that the same movement is actually repeated, this may entrain the motor system to the auditory cueing beat. Second, to match the sound with full extension or flexion provides an attentional goal for the patient. Goal setting is also known to promote motor learning. Third, receiving feedback has been shown to be fundamental to motor learning (37).

The results of this study regarding arm motor impairment and arm motor function come in contradiction with the findings of Richards et al. (11) who argued that rhythmic auditory cueing during BAT facilitated increased use of the paretic arm, but it did not increase motor performance significantly as measured by FM-UE or WMFT. The exploration of this contrast between two results may be attributed to different methodology used in which Richards et al. (11) conducted study on small sample size; only 14 patients with chronic stroke but this study was conducted on thirty patients with moderate arm impairment.

Regarding Box and Block Test scores, there was a statistically significant difference between both groups post-treatment in favor to the study group. The current findings are consistent with the findings of Cauraugh et al. (29) who conduct Meta-analysis which included 12 studies. 9 of them used Box and Block Test for assessment. They recorded that supplementing bilateral arm movements with rhythmically paced motion significantly improved motor recovery in stroke patients with mild to moderate severity.

The present study has some limitations. The main one was the lack of follow-up to determine the long term effects of rhythmic auditory cueing during BAT on upper extremity motor impairment and function and gross manual dexterity in stroke patients. In addition, the study investigated only stroke patients with moderate arm motor impairment and not considered stroke patients with mild or severe arm motor impairment.

V. CONCLUSION

It was concluded that adding rhythmic auditory cueing to bilateral arm training has good impact on arm motor impairment and function and gross manual dexterity in stroke patients. So, use of rhythmic auditory cueing during bilateral arm training should be an essential strategy in rehabilitation of stroke patients with moderate arm impairment.

Conflict of interest

The authors declare that there is no any conflict of interests regarding the publication of this paper.

REFERENCE


MANSOUR WT, FAHMY EM, EL BALAWY YM. Efficacy of Constrained Induced Movement Therapy Versus Bilateral Arm Training on Upper Extremity Functional Outcomes in Stroke Patients. 2015;83(2):79–85.


