Upper Extremity Functional Outcomes With and Without Trunk Restraint in Stroke Patients

SALAH A. SAWAN, Ph.D.*; HUSSEIN A. SHAKER, Ph.D.*; EBTESAM M. FAHMY, M.D.** and NAGWA I. REHAB, M.Sc.*

The Department of Physical Therapy for Neuromuscular Disorder & Surgery*, Faculty of Physical Therapy, Cairo University and Neurology** Department, Faculty of Medicine, Cairo University

**Abstract**

**Background and Purpose:** Task-specific training improves functional outcomes after stroke. However, gains may be accompanied by increases in movements compensating for motor impairments. This study hypothesized that restriction of compensatory trunk movements may encourage recovery of premorbid movement patterns leading to better functional outcomes. The goal of this study was to determine whether task-specific training with trunk restraint produces greater improvements in upper extremity function than training without trunk restraint in post-stroke patients.

**Patients and Methods:** Thirty male chronic stroke patients with age ranged between 40-55 years were included in this study. Patients were divided into two equal groups (Group I and Group II). The first group (Group I) received reach to grasp and transfer blocks and pins using Box and Block Test (BBT) and Purdue Pegboard training during which compensatory movement of the trunk was prevented by trunk restraint. The second group (Group II) practiced the same task without trunk restraint. Motor function of the upper limb and gross manual dexterity were recorded using Upper Extremity Performance Test (TEMPA) and BBT respectively.

**Results:** There was a statistically very highly significant increase and highly significant increase of the mean value of the TEMPA score of the affected upper limb post treatment in both groups \((p=0.0001\) in GI and \(p=0.001\) in GI)). Also, there was a statistically very highly significant increase in BBT score post treatment in both groups \((p=0.0001\)). Trunk-restraint group had statistically non significant greater improvement in motor function as compared to group without trunk restraint \((p=0.057\) but trunk-restraint group had a statistically very highly significant improvement of gross manual dexterity as compared to group without trunk restraint \(p=0.0001\).

**Conclusion:** Task-specific training with trunk restraint can be suggested as an effective method in improving upper extremity function in patients with impaired arm and hand function post stroke.

**Key Words:** Stroke – Trunk restraint – Recovery of function – Purdue pegboard and box and block tests.

**Introduction**

**ARM** and hand movement problems are major contributors to disability in patients after stroke [1]. Loss of arm function has been shown to adversely affect quality of life and subjective well-being after stroke [2].

Motor function of the affected arm can explain up to 50% of the variance in functional autonomy in stroke patients. Furthermore, both arm impairment, that is, the ability to move the arm and its segments selectively, and arm disabilities, that is, the ability to handle everyday life objects successfully, are associated with handicap situations six months later. This explain the degree of difficulty and help needed in daily and instrumental activities, and in social roles [3].

According to Kwakkel et al., [4] 30% to 66% of all individuals with hemiparesis have poor arm function six months post-stroke whereas only 5% to 20% demonstrate complete functional recovery. Type and localization of stroke and initial severity of paresis of the upper limb are some of the best predictors for outcome at six months.

Post-stroke therapeutic interventions leading to functional improvement emphasize intensive task-specific practice to facilitate training-induced plasticity [5]. In patients with hemiparesis, the unrestricted and unguided repetition of a motor task may reinforce compensatory movements [6]. Trunk anterior displacement is a common motor compensation used by patients with hemiparesis for arm transport during reaching [7] and for hand orientation during grasping [8].
Although compensatory movements may improve performance of the paretic arm in the short term, these may be maladaptive by preventing recovery or reappearance of more efficient arm movement patterns in the long term [1].

Poor outcomes in the rehabilitation of the upper limb have been noted to be due to the false sense of independence gained by the use of compensatory techniques, so minimum use of compensatory strategies during functional recovery has been suggested [9].

Limiting trunk motion in patients after stroke has been shown to encourage greater decrease in arm impairment and improvement in arm function during task-related training of reaching and grasping, particularly for chronic patients with moderate-to-severe arm hemiparesis [10].

This study was designed to investigate the effect of trunk restraint on motor impairment and upper extremity functional outcomes in stroke patients.

**Patients and Methods**

Thirty male stroke patients aged from 45 to 55 years were enrolled in this study. Patients were selected from the out patient clinic of the Faculty of Physical Therapy, Cairo University in the period from October 2013 to March 2014. Patients were divided into two equal groups. The first group (Group I) received a program of reach to grasp and transfer blocks and pins using BBT and Purdue Pegboard training with trunk restraint and the second group (Group II) received the same program without trunk restraint.

The patients were diagnosed as having stroke in the domain of carotid system based on careful clinical assessment by a neurologist and radiological investigations including computed axial tomography or magnetic resonance imaging of the brain. Patients participated after signing a written consent forms approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University.

Inclusion criteria were duration of illness ranged from six months to one year. The muscle tone of affected upper limb ranged from 1 to 2 according to Modified Asworth Scale (MAS) [11] for muscle tone grading. Moderate arm motor impairment (between 30 and 49 scores) on the Fugl-Meyer (FM) arm section scale according to Michaelsen et al., [10] Ability to reach to targets within 80% of arm length without sliding hand along table. Normal vision and hearing.

Exclusion criteria include patients who had receptive aphasia, apraxia, unilateral spatial neglect, visual or auditory defects, recurrent stroke, other neurological disorders affecting the reaching to grasping ability such as ataxia, orthopaedic disorders affecting the reaching to grasping ability such as stiffness of arm and peripheral nerve injuries, shoulder pain, deep sensory loss, medically unstable and uncooperative patients.

**Instrumentation:**

- Modified Asworth Scale for assessment of muscle tone.
- The arm section of the FM Scale was used to evaluate upper extremity impairment as inclusion criteria. This scale includes 4 motor subitems. Each item was rated on a 3-Point scale (0=Cannot perform; 1=Partially performs; 2=Performs fully) for a 66-Point maximum.
- Upper Extremity Performance Test (TEMPA) for assessment of motor function. This test includes 4 unilateral activities of daily living tasks rated as 0 (successful) to –3 (unsuccessful) for score ranging from –12 to 0 (normal function). A high score indicates a poor performance [12].
- Box and Block Test for assessment of gross manual dexterity. This test was made up of a box with a partition directly in the centre creating two equal sides. Subjects would be instructed to move as many blocks as possible from one side of the container to the other for a period of one minute by using stop watch. It measures the number of cubes transported in 1 minute from one side of a box to another [13].
- Stop watch.

**A- Evaluation session:**

Assessment of arm motor impairment and function using the FM arm section scale and TEMPA respectively. Also, assessment of gross manual dexterity using BBT. These tests were done pre- and post treatment.

**B- Training Session:**

All patients in the study group (GI) received program of reach to grasp and transfer blocks and pins using BBT and Purdue Pegboard test for almost an hour three times per week for five successive weeks (total of 15 sessions) according to Michaelsen et al., [10]. Trunk movements were prevented by body and shoulder belts attached to the chair back. Intervention was based on motor learning concepts of type and scheduling of feedback and intensity according to recommendations suggested by evidence-based practice guidelines [14]. Rest periods
of one to two minutes were permitted when necessary to avoid fatigue. All patients in the second group (GII) received the same program without trunk restraint.

All patients in two groups received the selected physical therapy program (Postural control and balance activities, Bobath technique, upper extremity control, proprioceptive neuromuscular facilitation (PNF), weight bearing and weight shift exercises as modified plantigrade, lower limb control and gait training).

Statistical analysis:

Descriptive statistics were done in the form of mean and standard deviation for age, duration of illness, arm impairment, function and gross manual dexterity. Paired t-test was used to assess changes within groups and un-paired t-test used to assess the changes between the two groups. Analysis was done using SPSS version 18. The alpha point of 0.05 was used as a level of statistical significance (when \( p \leq 0.05 \) is usually classed as “significant”, \( p \leq 0.01 \) as “highly significant” and \( p \leq 0.001 \) as “very highly significant” [15].

Results

Demographic and clinical characteristics of the patients in both groups:

No statistically significant difference between both groups regarding mean age, duration of illness and motor impairment (\( p=0.436, p=0.1295 \) and \( p=0.1821 \) respectively) (Table 1). In GI, nine patients had left sided hemiparesis and six patients had Rt sided hemiparesis while in GII, Six patients had left sided hemiparesis and nine patients had right sided hemiparesis.

### Table (1): Demographic and clinical characteristics of the patients in both groups (GI & GII).

<table>
<thead>
<tr>
<th>Variables</th>
<th>GI Mean ± SD</th>
<th>GII Mean ± SD</th>
<th>t-value</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>47 ± 5.490</td>
<td>48.33 ± 3.559</td>
<td>0.7892</td>
<td>0.4366</td>
<td>NS</td>
</tr>
<tr>
<td>Duration of illness (months)</td>
<td>9.67 ± 1.543</td>
<td>10.47 ± 1.246</td>
<td>1.562</td>
<td>0.1295</td>
<td>NS</td>
</tr>
<tr>
<td>FM score</td>
<td>39.33 ± 3.519</td>
<td>37.33 ± 4.435</td>
<td>1.368</td>
<td>0.1821</td>
<td>NS</td>
</tr>
</tbody>
</table>


**I- Comparison of TEMPA and hand function scores within groups:**

**Group (I):**

There was a statistically very highly significant increase in TEMPA score post treatment in GI (\( p=0.0001 \)). The mean value of TEMPA score was \(-6.333\) points pre treatment and \(-3.400\) points post treatment. Also, there was a statistically very highly significant increase in BBT score post treatment in GI (\( p=0.0001 \)). The mean value of BBT score was 12.80 blocks pre treatment and 24.80 blocks post treatment (Table 2, Figs. 1,2).

**Group (II):**

There was a statistically very highly significant increase in TEMPA score post treatment in GII (\( p=0.001 \)). The mean value of TEMPA score was \(-5.800\) points pre treatment and \(-4.600\) points post treatment. Also, there was a statistically very highly significant increase in BBT score post treatment in GII (\( p=0.0001 \)). The mean value of BBT score was 12.80 blocks pre treatment and 24.80 blocks post treatment (Table 2, Figs. 1,2).

### Table (2): Comparison between pre and post treatment mean values of TEMPA and hand function scores in both groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-treatment Mean±SD</th>
<th>Post-treatment Mean±SD</th>
<th>Mean difference</th>
<th>t-value</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPA score:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI</td>
<td>(-6.333±1.718)</td>
<td>(-3.400±1.404)</td>
<td>2.933</td>
<td>9.769</td>
<td>0.0001***</td>
<td>VHS</td>
</tr>
<tr>
<td>GII</td>
<td>(-5.800±1.781)</td>
<td>(-4.600±1.88)</td>
<td>1.200</td>
<td>4.054</td>
<td>0.001***</td>
<td>VHS</td>
</tr>
<tr>
<td>BBT score:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI</td>
<td>12.80±3.509</td>
<td>24.80±5.213</td>
<td>12</td>
<td>14.10</td>
<td>0.0001***</td>
<td>VHS</td>
</tr>
<tr>
<td>GII</td>
<td>11.87±3.314</td>
<td>15.00±3.684</td>
<td>3.133</td>
<td>8.622</td>
<td>0.0001***</td>
<td>VHS</td>
</tr>
</tbody>
</table>

TEMPA : Upper extremity performance test.  BBT : Box and block test.  SD : Standard deviation.  VHS : Very highly significant at \( p \leq 0.001 \).
II- Comparison between both groups as regards TEMPA and hand function scores pre & post treatment:

There was a non significant difference in the mean value of TEMPA score between GI and GII pre and post treatment ($p=0.4109$ and $p=0.0577$ respectively). There was a non significant difference in the mean value of BBT score between GI and GII pre treatment ($p=0.04601$) while, there was a very highly significant difference in BBT score post treatment ($p=0.0001$) (Table 3, Figs. 3, 4).

Table (3): Comparison of the mean values of TEMPA and hand function scores between both groups pre and post treatment.

<table>
<thead>
<tr>
<th>Un paired t-test</th>
<th>TEMPA score</th>
<th>BBT score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>GI</td>
<td>-6.333</td>
<td>-5.800</td>
</tr>
<tr>
<td>GII</td>
<td>-3.400</td>
<td>-4.600</td>
</tr>
<tr>
<td>GI</td>
<td>-4.600</td>
<td>-2.000</td>
</tr>
<tr>
<td>GII</td>
<td>-1.200</td>
<td>-1.200</td>
</tr>
</tbody>
</table>

Mean difference

| GI              | -0.533       | -1.200     | 0.93         | 9.8           |
| GII             | 1.404        | 1.882      | 3.509        | 3.314         |
| GI              | 0.93         | 0.93       | 3.509        | 3.684         |
| GII             | 9.8          | 9.8        | 3.509        | 3.684         |

$\text{t}$-value

| GI              | 0.8347       | 0.7489     | 0.4601       | 0.0001***     |
| GII             | 1.781        | 1.979      | 0.0577       | 0.0001***     |
| GI              | 1.781        | 1.979      | 0.0577       | 0.0001***     |
| GII             | 1.781        | 1.979      | 0.0577       | 0.0001***     |

$p$-value

| GI              | 0.4109       | 0.7489     | 0.4601       | 0.0001***     |
| GII             | NS           | NS         | NS           | NS            |
| GI              | NS           | NS         | NS           | NS            |
| GII             | NS           | NS         | NS           | NS            |

SD : Standard deviation. VHS : Very highly significant at $p \leq 0.001$. TEMPA : Upper extremity performance test. P : Probability. BBT : Box and block test. NS : Non-significant.
Discussion

In the present study, there was a statistically significant increase in the mean value of the TEMPA score post treatment in both groups, but there was no significant difference between groups. Results of this study come in agreement with Michaelsen et al., who reported that moderate trunk restraint group tended to increase TEMPA score more than task specific training without restraint but this increase did not reach significance. This increase in TEMPA score post treatment in GI may be attributed to increased active ROM of elbow extension and shoulder flexion but in GII may be attributed to increased trunk displacement. This explanation agreed with Michaelsen and Levin who mentioned that although compensatory movements may improve performance of the paretic arm in the short term, these may be maladaptive by preventing recovery or reappearance of more efficient arm movement patterns in the long term. The results of this study agreed with Cirstea et al., who mentioned that improvement of function in patients with moderate to severe clinical syndromes may be associated with increased trunk displacement when unrestrained pointing movements are practiced. On the contrary, French et al., reported that there was no significant difference for hand/arm functional activity, after repetitive task training in stroke patients. The contradiction between results may be attributed to different methodology and training methods used.

In this study, there was a statistically significant increase of the mean value of the BBT score post treatment in both groups. This may be explained in view that the excitability of the representation of the paretic hand in ipsilesional motor cortex is affected by the efficacy of motor training of a paretic hand. This explanation was also postulated by Carey et al., who found that intensively trained stroke patients improved hand grasp and release function and these motor gains were associated with a shift in the laterality of activation in sensorimotor cortex (primary motor cortex, primary somatosensory cortex, premotor cortex) from largely contralesional to largely ipsilesional, detected by using functional magnetic resonance image (FMRI) during paretic index finger tracking. Moreover, Muellbacher et al., suggested that motor gains produced by task-specific rehabilitation in chronic stroke patients are associated with normalization of sensorimotor cortex laterality. Carey et al., also found that intensively trained stroke patients improved hand grasp.

On the contrary, Michaelsen et al., found that there was a non significant increase in the BBT score post treatment but in this study, both trunk restraint and without restraint groups significantly increase the BBT score with trunk restraint group improved the BBT score significantly compared to group without trunk restraint. Higges et al., also indicated that a task-oriented intervention did not improve gross manual dexterity of the affected arm in people with chronic stroke in which only two blocks increased post treatment. The contradiction between results may be attributed to different methodology and training methods used as in this study, BBT was used not only as assessment method but also as a training method.

Conclusion:

The present study showed that program of reach to grasp training combined with trunk restraint improved upper extremity function in stroke patients with moderate arm impairment especially arm function and gross manual dexterity.

References


