Assessment of Upper Extremity Motor Recovery in Post Stroke Hemiplegic Patients after Application of Constraint Induced Movement Rehabilitation Program

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ABSTRACT

Objectives: This prospective study was done to assess motor recovery of upper extremity function in post ischemic stroke patients after application of Constraint Induced Movement program in addition to traditional rehabilitation program and to compare between efficacy of this combination and efficacy of traditional rehabilitation program only in reducing upper limb impairment after stroke. Subjects and Methods: Forty patients with recent ischemic stroke were included in the study. According to type of rehabilitation program, patients were divided into two groups: 1) Constraint induced movement group: Twenty patients were subjected to constraint induced movement program in addition to traditional rehabilitation program. 2) Traditional rehabilitation program group: Twenty patients subjected to traditional rehabilitation program only. Both groups were subjected to follow-up protocol for 16 weeks. Motricity index, Fugel-Meyer Assessment scale, nine hole peg test and Barthel index were used as outcome measures and were used throughout the follow up period. Pre-test measures were performed within 1 week of onset of stroke. Follow up assessments were done at 2, 6, 10 and 14 weeks. Post test assessments were done after 16 weeks. Results: The results of Motricity index, Fugel-Meyer Assessment scale, nine hole peg test and Barthel index revealed that patients in constraint induced movement group performed better throughout the treatment period and showed more improvement in upper extremity functions than patients in traditional rehabilitation program group. Conclusion: Constraint induced movement program is essential to be added to traditional rehabilitation program to maximize improvement of upper extremity function in post stroke hemiplegic patients. (Egypt J. Neurol. Psychiat. Neurosurg., 2006, 43(1): 443-450)

INTRODUCTION

Post stroke hemiplegia is one of the most prevalent forms of motor disability.1 Motor function of post stroke patients may gradually return as a result of combination of spontaneous recovery and rehabilitation care. Approximately 80% of stroke patients who survive the acute phase regain their walking ability, while about 75% of survivors are no longer able to use the affected arm in performing activities of daily living (ADLs).2 This is because the recovery process of upper extremity (UE) function is often slower than that of lower extremity function.3

The functional recovery of the arm includes grasping, holding and manipulating objects. All these activities require recruitment and complex integration of activity of the muscles from shoulder to fingers.4 Moreover, secondary complications such as subluxation of the glenohumeral joint and painful shoulder frequently hinder rehabilitation of the hemiplegic arm.5 Another factor that might decrease probability of return of UE function is the lack of spontaneous stimulation during functional activities. Each transfer and each attempt to stand or to walk will require bilateral activity in the lower limbs. In performing UE activities, the patient may use the unaffected side exclusively.6

Constraint induced movement (CIM) rehabilitation program is defined as a functional program directing patient attention and effort toward the hemiplegic UE to exclude the use of unaffected limb during functional activities.7 It is based on the theory of “learned nonuse” first
described by Wolf et al., and later by Taub et al. Following neurological injury, a shock like phenomenon results in dramatically depressed condition of motor neuron function. During this period, the patient is unable to move the affected UE and learns to compensate with the unaffected limb leading to negative reinforcement of using the affected UE. As the shock resolves and function starts to improve, attempts to use the affected UE result in clumsy and ineffective movements that positively reinforce continued compensation. This behavior begins in the early post stroke period and typically continues the rest of their lives. Taub et al., reported that CIM therapy can effectively overcome this learned nonuse phenomenon to reuse the affected UE.

CIM program starts by restraining the unaffected UE during all waking hours, except for specific activities (e.g. bathing or toileting). Restraint mechanism of the uninvolved UE is either by a padded mitt or by a sling. The patient is encouraged to perform tasks almost exclusively with their paretic limb. The affected UE is taken through extensive massed therapy in the rehabilitation settings. The patient is also instructed to use the affected UE in his ADLs outside the rehabilitation settings.

Therefore this work was done to assess motor recovery of UE function in post ischemic stroke hemiplegic patients after application of CIM rehabilitation program in addition to traditional rehabilitation program and to compare between efficacy of this combination and efficacy of traditional rehabilitation program (TRP) only in reducing upper limb impairment after stroke.

SUBJECTS AND METHODS

Forty patients with recent ischemic stroke (within 1 week onset) admitted to the department of Neurology, Suez Canal University Hospital, were included in this prospective study. They were 17 men and 23 women. All of them had the first attack of right or left hemiplegia leading to impaired upper extremity function according to motor arm item of national institute of health stroke scale (NIHSS). The following patients were excluded from the study: patients with history of previous stroke, patients with severe comprehensive or language impairment, patients with impaired mental status due to dementia or psychological disease, patients with preexisting impairment or injury in the hemiplegic limb (fracture or deformity) and patients with contraindications for exercise training (uncompensated cardiac disease, end stage renal disease or hepatic failure).

After admission, all patients were subjected to full medical history, complete clinical examination, laboratory investigations and computed tomographic brain scan. All the patients received standard care including: general care for hemiplegic patients, antiplatelet drugs, anticoagulants for embolic stroke and for progressive stroke, antihypertensive drugs for hypertensive patients, hypoglycemic medications for diabetic patients, treatment of other risk factors and associated general medical conditions.

According to type of rehabilitation program, patients were divided into two groups:

1- Constraint Induced Movement (CIM) group: Patients subjected to CIM program in addition to traditional rehabilitation program. They were 20 patients, 9 (45%) males and 11 (55%) females. Their age ranging from 50 to 68 years (mean age 58.2±5.9 years). CIM program was achieved by application of a padded mitten into the unaffected UE. The rehabilitation was comprised of UE training with utilization of the affected UE as much as possible. Restraining the unaffected UE was done during all waking hours except for specific activities e.g. bathing or toileting for a minimum of 6 hours per day. The patients were encouraged to perform tasks almost exclusively with their paretic limb.

2- Traditional Rehabilitation Program (TRP) group: Twenty patients were subjected to TRP only. They were 8 (40%) males and 12 (60%) females. Their age ranging from 50 to 70 years (mean age 58.4±6.9 years). TRP
during flaccid stage included proper positioning, passive range of motion exercises, care of the skin and prevention of bed sores, deep venous thrombosis, bladder complications and bowel complications. TRP during spastic stage included intensive training program in the form of passive and active range of motion, stretching and strengthening, motor relearning, UE exercises, shoulder joint rehabilitation program, ambulation and gait retraining.

Both groups were subjected to follow up protocol for 16 weeks after stroke. Pre-test measures were performed within one week of onset. Follow up assessments were done at 2, 6, 10 and 14 weeks. Post test assessments were done after 16 weeks to assess effectiveness of the treatment and to determine impact on disability. The following scales were used throughout follow up period:

- Stroke specific motor function assessment scales:
  1. Motricity index.\(^{13}\) For assessment of motor function of both upper and lower extremities. The test evaluates pinch grip, elbow flexion and shoulder abduction of UEs and ankle dorsiflexion, knee extension and hip flexion of LEs. We used muscle testing manual according to Brunnstrom-Dennon grading method to grade muscle power strength on motricity index (from grade 0 to grade 5).\(^{14}\)
  2. Fugl-Meyer motor assessment scale (FMA).\(^{15}\) By using UE motor section of FMA. It consists of 33 items. Each item has 3 point scale (0= cannot perform, 1= can perform partially and 2= can perform fully). The result scores from 33 items were summed together.
  3. Nine Hole Peg test (9-HPT).\(^{16}\) For testing the fine motor function of UE. Both the dominant and non-dominant hands were tested twice. The total time to complete the task by each hand was recorded (in seconds). It should be less than 10 minutes (600 seconds). The total score was the average of the 4 trials (2 trials for each hand were averaged and then the score of the 2 hands were summed together). If the patient can’t do the test by the affected hand we added 600 seconds to his healthy hand score.

- Global disability and activities of daily living (ADLs) assessment scales:
  1. Barthel index.\(^{17}\) For assessment of patient independence in ADLs. It consists of 10 items. The sum points for all items give total score of 0-100.
  2. Patient satisfaction questionnaire.\(^{18}\) For evaluation of the level of satisfaction with the rehabilitation programs at the end of the treatment period (16 weeks).

Data collected were coded, entered and analyzed using Microsoft Excel software, then imported into (SPSS 10,0) software for analysis. Paired t test was used to test differences for significance. P value was set at <0.05 for significant results.

## RESULTS

Tables (1, 2, 3 & 4) shows the changes of mean values of motricity index, Fugl-Meyer motor assessment scale, Nine Hole Peg test and Barthel index in both CIM and TRP groups over the 16 weeks follow up period. There is no statistical significant difference between both groups at the study entry in all scales. During follow up period there is improvement of motricity index, Fugl-Meyer motor assessment scale, Nine Hole Peg test and Barthel index in both groups. This improvement is significantly more marked in the CIM group than in TRP group.

Table (5) shows patient satisfaction with the rehabilitation programs in CIM and TRP groups at the end of the treatment period (16 weeks). The majority of the patients in the CIM and the TRP groups are satisfied with the rehabilitation programs. There is no patient in either group was dissatisfied with the rehabilitation program.
Table (1): Mean value changes of motoricity index of CIM and TRP groups over 16 weeks follow up period.

<table>
<thead>
<tr>
<th>Time in weeks</th>
<th>CIM Group (n=20)</th>
<th>TRP Group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29.2±10.9</td>
<td>27.8±7.7</td>
</tr>
<tr>
<td>2</td>
<td>39± 9.8*</td>
<td>32.8±6.9</td>
</tr>
<tr>
<td>6</td>
<td>44.8± 9.2</td>
<td>38.5±8.3</td>
</tr>
<tr>
<td>10</td>
<td>48.9± 8.7*</td>
<td>41.7±8.6</td>
</tr>
<tr>
<td>14</td>
<td>49.9± 9.1*</td>
<td>42.8±9.3</td>
</tr>
<tr>
<td>16</td>
<td>50.2± 9.2*</td>
<td>43.6±10</td>
</tr>
</tbody>
</table>

CIM: Constraint induced movement, TRP: Traditional rehabilitation program.
Paired t test, (*): Significant P< 0.05

Table 2. Mean value changes of Fugl-Meyer assessment scale of CIM and TRP groups over 16 weeks follow up period.

<table>
<thead>
<tr>
<th>Time in weeks</th>
<th>CIM Group (n=20)</th>
<th>TRP Group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.5±10.7</td>
<td>6.7±4.2</td>
</tr>
<tr>
<td>2</td>
<td>25.8±14.4*</td>
<td>9.6±1.9</td>
</tr>
<tr>
<td>6</td>
<td>38.1±19.6*</td>
<td>25.1±17.7</td>
</tr>
<tr>
<td>10</td>
<td>41.9±18.9*</td>
<td>28.2±19.9</td>
</tr>
<tr>
<td>14</td>
<td>43.9±20.1*</td>
<td>31.3±19.9</td>
</tr>
<tr>
<td>16</td>
<td>45.2±20.8*</td>
<td>32.3±20.9</td>
</tr>
</tbody>
</table>

CIM: Constraint induced movement, TRP: Traditional rehabilitation program.
Paired t test * Significant P< 0.05

Table 3. Mean value changes of Nine Hole Peg test of CIM and TRP groups over 16 weeks follow up period.

<table>
<thead>
<tr>
<th>Time in weeks</th>
<th>CIM Group (n=20)</th>
<th>TRP Group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>588.9±166.3</td>
<td>598.7±25.7</td>
</tr>
<tr>
<td>2</td>
<td>509.6±238.2*</td>
<td>581.1±156.1</td>
</tr>
<tr>
<td>6</td>
<td>390.5±285.9*</td>
<td>503.7±236.6</td>
</tr>
<tr>
<td>10</td>
<td>300.9±261.9*</td>
<td>476.4±244.5</td>
</tr>
<tr>
<td>14</td>
<td>288.3±265.9*</td>
<td>455.9±246.1</td>
</tr>
<tr>
<td>16</td>
<td>279.1±270.5*</td>
<td>441±263.5</td>
</tr>
</tbody>
</table>

CIM: Constraint induced movement, TRP: Traditional rehabilitation program.
Paired t test * Significant P< 0.05

Table (4): Mean value changes of Barthel index of CIM and TRP groups over 16 weeks follow up period.

<table>
<thead>
<tr>
<th>Time in weeks</th>
<th>CIM Group (n=20)</th>
<th>TRP Group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.5±17.6</td>
<td>5±8.9</td>
</tr>
<tr>
<td>2</td>
<td>42.5±27.6*</td>
<td>20.5±20.6</td>
</tr>
<tr>
<td>6</td>
<td>71±23.9*</td>
<td>47.1±25.6</td>
</tr>
<tr>
<td>10</td>
<td>80±22.1*</td>
<td>58.4±23.5</td>
</tr>
<tr>
<td>14</td>
<td>83±22.1*</td>
<td>62.4±24.2</td>
</tr>
<tr>
<td>16</td>
<td>85±21.8*</td>
<td>65±23.8</td>
</tr>
</tbody>
</table>

CIM: Constraint induced movement, TRP: Traditional rehabilitation program.
Paired t test * Significant P<0.05
**Table 5.** Patient satisfaction with the rehabilitation programs in CIM and TRP groups at the end of the treatment period (16 weeks).

<table>
<thead>
<tr>
<th>Satisfied with the CIM program</th>
<th>Very satisfied</th>
<th>Moderately satisfied</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfied with the CIM program</td>
<td>4 (20%)</td>
<td>14 (70%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>Satisfied with the TRP program</td>
<td>4 (20%)</td>
<td>13 (65%)</td>
<td>3 (15%)</td>
</tr>
</tbody>
</table>

CIM: Constraint induced movement, TRP: Traditional rehabilitation program.

**DISCUSSION**

Most rehabilitation programs for UE paralysis focus on compensatory strategies to promote independence in ADLs by any means. Thus, patients are taught to use the unaffected UE and various assistive devices. In contrast, CIM program encourages the use of the hemiplegic arm and its main goal is to maximize or restore motor function.\(^7\) Pilot data obtained by Page et al.\(^{19}\), demonstrated reduction in impairment and increase in arm use and function in patients with acute stroke who participated in a CIM rehabilitation program. Taub and Uswatte\(^{10}\) and Taub et al.\(^{20}\), claimed that CIM program is an appropriate method to improve motor recovery after stroke.

In the present study we used 4 assessment scales to evaluate motor recovery because the use of more than one rating scale is more valuable in predicting functional outcome in stroke patients and that the progress in ADLs had significant correlation with the motor gains of the patients.\(^{21,22}\)

Results of Motricity index showed improvement of in both CIM and TRP groups during the follow up period (16 weeks). This improvement is significantly more marked in the CIM group than in TRP group. Kunkel et al.\(^{21}\), agreed on the previous findings in their study. They investigated the effect of constraining the unaffected UE plus providing training for the affected limb. They found that the maximum effect had occurred when the CIM program was added to TRP. Page and colleagues\(^{24}\), found similar findings in their study. Wolf et al.\(^{22}\), reported that CIM program is an effective treatment even without adding other training programs.

Results of FMA revealed that patients in CIM group also displayed considerably larger improvements in the use and function of their affected arms than the TRP group. These results were in agree with the studies done by Garraway et al.\(^{26}\), in which significant differences, as tested by FMA scale, were seen after the CIM program. However, Miltner and his colleagues\(^{27}\) found no significant differences between the CIM and TRP groups indicating no treatment effect of CIM on FMA scale.

Assessment of 9-HPT in both groups showed that there were significant values of 9-HPT in the patients of CIM group than those of TRP group, denoting that CIM can improve fine grip more than TRP. These findings are in accordance with the results of the study done by Dettmers et al.\(^{28}\), as they reported significant improvement in the affected UE as assessed by 9-HPT. They concluded that CIM program is a promising intervention for improving motor function and quality of life in patients with stroke. Ploughman and Corbett\(^{29}\) and Page et al.\(^{24}\), reported also similar results.

The ultimate goal of rehabilitation is to maximize social participation and improve ADLs to cope with personal needs.\(^{30}\) Green et al.\(^{31}\), stated that functional prognosis represents one of the most important and meaningful aspect of disease outcome. Therefore, measurement of basic ADLs is reliable and important in post stroke evaluation.

The results of Barthel index at each interval period showed significant difference between CIM and TRP groups over follow up periods, denoting that the CIM program improves ADLs to maximal levels than TRP. This finding was recorded by
Wolf et al., who tested the effectiveness of CIM program in post stroke population in a clinical trial project called EXITE (Extremity Constraint Induced Movement Therapy Evaluation). They found that the intensive task practice of the affected UE in combination with restricted use of the unaffected UE had significantly increased using of the affected arm and hand in ADLs. However, Feys et al., reported no significant difference of the Barthel index between CIM group and TRP group.

As regarding the feasibility and satisfaction of CIM program the study revealed that most of the patients in CIM and TRP groups were satisfied with their rehabilitation programs. Interviews with the CIM patients revealed high satisfaction with the program and showed that they were actively attempting to use their affected UE during wearing the padded mitten to the healthy UE. The results of the studies carried by Dromerck et al., and Ploughman and Corbett recorded the same results. They concluded that the CIM mitten was safe and well tolerated.

In conclusion, the addition of this feasible and safe CIM rehabilitation program to the TRP is essential to maximize improvement of upper extremity function in post stroke hemiplegic patients.

**REFERENCES**

في المرضى المصابين بالذخول النصفي الحاد بعد السكتة المخية الإسهدادية
بعد تطبيق برنامج التقييد المستحسن للحركة

تم إجراء هذا البحث على 40 مريضاً بعوام من خلال نصفي حوالي خلال أسبوع من حدوث السكتة المخية الإسهدادية
الأولي وقد تم تقسيم المرضى إلى مجموعتين:

مجموعة البرنامج التقليدي للتأهيل: وتستم من 20 مريضاً والتي تم تطبيق البرنامج التقليدي للتأهيل فقط عليها.
مجموعة برنامج التقييد المستحسن للحركة: وتستم من 20 مريضاً والتي تم تطبيق برنامج التقييد المستحسن للحركة بجانب البرنامج التقليدي للتأهيل

وقد تم تقييم ومتاحا تحسن الأداء الحركي للطرف العلوي المريضي لمدة 16 أسبوع من تاريخ حدوث السكتة المخية وذلك باستخدام: التدفق الحركي، تقييم فيوجل ماير، اختبار الأوتاد والفتحات السع ودبل بارثيل. وتتم مقارنة الأداء الحركي للمجموعتين.

وقد أظهرت النتائج أن المرضى في مجموعة برنامج التقييد المستحسن للحركة أدوا بشكل أفضل من مجموعة البرنامج التقليدي للتأهيل في جميع الاختبارات خلال فترة المتابعة مما يؤكد على أهمية إضافة برنامج التقييد المستحسن للحركة بجانب البرنامج التقليدي للتأهيل وذلك لزيادة تحسن الأداء الحركي للطرف العلوي في المرضى المصابين بالذخول النصفي الحاد بعد السكتة المخية.