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Efficacy of Constraint-Induced Movement on Improving Upper Functional Ability Motor Skills among Patients after Stroke

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Abstract: Stroke is a common cause of death and long-term disability. Neuro rehabilitation is a process to promote recovery and/or compensate for functional alterations especially if initiated early after stroke. Constraint induced movement therapy (CIMT) is deemed as an excellent therapy effectively applied on acute stroke stage for restoring motor function of upper extremities. Therefore, the ***aim* of the study** was to examine the efficacy of constraint induced movement (CIM) in improving upper functional ability motor skills among patients after stroke.
Method: Quasi-experimental research design was conducted in neurology department (stroke unit) at Mansoura University Hospital. A purposive sample of 100 adult patients of both sexes with cerebrovascular stroke, who corresponded to inclusion criteria were assigned randomly into two equal groups (study and control). ***Tools:*** Three tools were utilized to collect data pertinent to the study, namely; Biosociodemographic data, National Institute of Health Stroke Scale (NIHSS) and Barthel Index scale (BI). ***Results:*** The patients in study group showed significantly greater improvement in functional ability one month after baseline P< 0.05 & also as in control group. ***Conclusion*:** constraint induced movement therapy (CIMT) applied for patients early post stroke produced statistically significant improvements in functional ability /status. ***Recommendation:*** Applying constraint induced movement therapy (CIMT) in an outpatient rehabilitation setting for person with less motor recovery using a collaborative functional approach between team members, the stroke survivor, and the family

INTRODUCTION

Stroke is a vessel-related functional impairment of a specific region of the brain, resulting in unilateral paralysis followed by disorders of coordination, balance, and movements [(1)]. Due to dysfunctions of movements, self-care, cognition, behavior, and communication, some part of stroke patients remains disabled. They need assistance and care provided by other people, so, it is not only medical, but social issue [(2)].

Rehabilitation is a process of re-education of patients after stroke directed to independence training, to acquire a new skill or improve existing skills [(3)]. Previously it was thought that damage to the central nervous system was irreversible. Now, it is noted that the brain appears to be "primed" to recover early following stroke and at this point rehabilitation therapies will be the most effective and relearning can take place as soon as possible after injury when patients are medically stable [(4,5)]

Exercising the hemiparetic hand and wrist is essential part of a stroke rehabilitation program; Constraint-induced movement therapy (CIMT) is a highly standardized and intensive motor intervention that has been shown to substantially increase the amount of use and motor ability of an affected upper extremity after stroke, regardless of the level of motor disability, chronicity, hemiparetic side, or infarct location [(6,7)].

Constraint-induced movement therapy (CIMT) has received considerable attention as an intervention to enhance motor recovery and cortical reorganization after stroke, by producing "functional" changes in brain metabolism, blood flow, and electrical excitability, these plastic changes could improve motor function by compensating in part for the damage-induced motor deficit [(8,9)].

AIM OF STUDY

The aim of the study was to examine the efficacy of constraint induced movement (CIM) in improving upper functional ability motor skills among patients after stroke.

Research hypothesis:

Patients in the study group who received CIMT had a statistically significance post improvement in functional ability/ status than the patients in the control group.

METHOD

Study Design:

Quasi-experimental research designs were used in this study.

Setting:

The study was conducted in neurology department (stroke unit) at Mansoura University Hospital.

Subjects:

A purposive sample of 100 adult patients of both sexes with cerebral stroke admitted to neurology department (stroke unit) was included in the study. A representative sample size was calculated using epidemiological information (EPI info.) program version 6.02 after taking into consideration the total number of cerebral stroke patients admitted to neurology department in Mansoura University Hospital (alpha error 5% (= confidence level=95%) Beta error 20% (=study power= 80%).

The study included 100 patients at the early stage of rehabilitation, who were admitted to neurology department and randomly assigned to two equal groups, study group (received CIMT after one week) and control group (received routine nursing care), 50 each.

Inclusion criteria:

Sample of either sex, aged from 20 to 60 years old, medically stable, have the ability to learn, free of severe cognitive disorders and not at risk for falling, and newly admitted to stroke unit.

Exclusion criteria:

Patients with traumatic brain injury, chronic disabling pathologies ie, severe Parkinson's disease, polyneuropathy, and unconscious patients were excluded from the study.

Tools:

The following tools were utilized to collect data pertinent to the study

Tool I: "Biosociodemographic data"

To collect date about patient's socio-demographic characteristics, present and past health history

Tool II: National Institute of Health Stroke Scale (NIHSS) [(10)]:

NIHSS is a 15 item physical deficit rating instrument used to monitor neurological improvement or neurological worsening by assessing level of consciousness, gaze, visual fields, motor function of the face, upper extremity, and lower extremity, articulation, limb ataxia, sensory function, language, and the presence of neglect. The rating instrument shows excellent reproducibility and inters rater reliability (0.96).

Scoring system:

Ratings for each item are scored with 3 to 5 grades with 0 as normal, 1-4 minor stroke, 5-15 moderate stroke, 16-20 moderate to severe Stroke and 21-42 severe stroke. Patients with a baseline NIHSS score of less than 5 generally have a favorable prognosis while those with scores more than 20 have a low likelihood of favorable outcomes. It strongly predicts outcomes and response to interventions, thus it has face validity (0.977).

Tool III: Barthel Index scale (BI) [(11)]:

Used in scoring improvement during rehabilitation of patients with chronic neuromuscular or musculoskeletal disorders, it measures functional disability by quantifying patient performance in 10 activities of daily life. These activities can be grouped according to self-care (feeding, grooming, bathing, dressing, bowel and bladder care, and toilet use) and mobility (ambulation, transfers, and stair climbing). Validity was found to be between 0.73 and 0.77, and demonstrated high inter-rater reliability (0.95) and test–retest reliability (0.89) as well as high correlations (0.74–0.8)

Scoring system:

Maximal score of 100 indicating that a patient is fully independent in physical functioning, and a lowest score of 0 representing a totally dependent bed-ridden state. Middle categories imply that the patient supplies over 50 per cent of the effort.

Frame work of the study:

- The frame work of the study was carried out in **four phases:**

Assessment phase:

- Patients who agreed to participate in the study and fulfilled the research criteria were included in the study, and divided into two groups study and control group

Study group: was consisted of 50 adult patients received CIMT after one week post stroke.

Control group: was consisted of 50 adult patients with stroke received routine hospital care

A. For both groups necessary data will be collected by using the study tools

For both groups:

- Assessment of the baseline data at the first admission day using Biosociodemographic data sheet (Tool 1).
- Neurological status was assessed using National Institute of Health stroke scale (NIHSS) (Tool II)) at the first admission day, reassessment done after 1st month
- Functional status was assessed using Barthel index scale (BI) (Tool III) at the first admission day and repeated every week for one month

Planning phase:

- Based on the finding of the assessment phase goals, priorities, and expected outcomes were formulated
- In this phase sessions were planned by researcher to provide the patient with:

a) Health education regarding nature of disease, its causes, risk factors, possible complications, recommended medication, importance of medication adherence, early possible complications, prevention, benefits of early stroke rehabilitation, rehabilitation plan, and importance of patient's role.

b) The researcher prepared needed equipments and materials to complete work.

Implementation phase:

Study group:

- Therapy involves inducing use of the more-affected limb by restraining the unaffected upper limb using a restricting position belt for 90% of waking hours, 7 days a week, for 2 weeks, to limit use of that limb in manipulation and allowing protective limb responses to unexpected loss of balance and simple support.
- Patients carryout adaptive task practice as arm training and engaging the affected limb in a range of everyday activities performed continuously for 15-20 minutes

Evaluation:

Patients in both study and control groups were evaluated and assessed as follows:

1. Neurological assessment were repeated after first month using ***Tool II***
2. Patient's functional assessment were done every week (6^{th} day) for one month using ***Tool II***

To test the effect of CIMT comparisons were done between studied groups regarding patient's neurological and functional outcome

Statistical analysis:

After data were collected it was revised, coded and fed to statistical software SPSS version 16, followed by tabulation and analysis. All statistical analysis was done using two tailed tests and alpha error of 0.05.

RESULTS

The findings of the present study presented in three parts which are:

- Socio-demographic characteristics of the studied groups
- Comparison between the studied groups according to their neurological status by the end of 1st month
- Comparison between the studied groups according to their functional status through the study period

Table 5.1: shows the distribution of studied subjects according to their demographic characteristics. A total of 100 patients were enrolled in the study. The age of the studied subjects ranged from 20 to 60 years, the majority of patients in study group (72.0%) were more than 50 years compared to 64.0% of control group. The mean age was 52.8± 8.1 and 52.3 ± 8.1 (t = 0.35 (P=0.731)) for early and late rehab groups respectively.

Males were more in the studied subjects they constituted 58.0% of study and 54.0% of control group. As regards marital status, 60.0% of study and 58.0% of late rehab group were married. Concerning level of education in this study, illiteracy was prevailing among 54.0% of study and 68.0% for control group

Table 5.1: Distribution of both groups (study & control) according to demographic characteristics (N=100)

Demographic Data	Groups				Test (P)
	Study (N = 50)		Control (N = 50)		
	No	%	No	%	
Age					X^2 = 2.2 (0.327*)
▪ **< 40**	5	10.0 %	3	6.0%	
▪ **40-50**	9	18.0 %	15	30.0%	
▪ **> 50**	36	72.0 %	32	64.0%	
Mean ± SD	52.8 ± 8.1		52.3 ± 8.1		t = 0.35 (0.731)
Sex					X^2 = 0.16 (0.687)
▪ **Male**	29	58.0%	27	54.0%	
▪ **Female**	21	42.0%	23	46.0%	
Marital status					X^2 = 6.0 (0.049*^)
▪ **Single**	5	10.0%	0	0.0%	
▪ **Married**	30	60.0%	29	58.0%	
▪ **Widow**	15	30.0%	21	42.0%	
Education					X^2 = 3.4 (0.338^)
▪ **Illiterate**	27	54.0%	34	68.0%	
▪ **Primary**	4	8.0%	5	10.0%	
▪ **Secondary**	9	18.0%	4	8.0%	
▪ **Highly educated**	10	20.0%	7	14.0%	

Table 5.2: shows the distribution of studied subjects according to their medical history. Concerning the past medical history, it was noted that about three fourth of study (76.0%) and control (74.0%) were not hospitalized. It was observed that 50.0% of study group and 36.0% of control group were smokers. The same table reveals that the majority of patients (46.0%) in study group were extremely active, while the majority of control group (48.0%) were moderately active.

The most common drugs consumed by the patients were anti-diabetic (46.0% of study group and 76.05 of control group) and antihypertensive drugs (58.0% of study group and 90.0% of control group). For both study and control groups it is clear that the minority of them 28.0% and 40% using cardiac drugs.

Regarding present medical history, it was observed that the majority of study and control groups (92.0% and 88.0% respectively) were ischemic stroke. The table also shows all studied subjects using Rt side as a dominant side, of them more than half in study and control group (58.0% and 60.0% respectively) are left side hemiplegia.

Table 5.2: Distribution of the both groups (study & control) according to their past medical history (N=100) (N=100)

Past Medical History	Group				Test (P)
	Study		Control		
	No	%	No	%	
Previous Hospitalization					X^2 = 0.05 (0.817)
▪ Yes	12	24.0	13	26.0	
▪ No	38	76.0	37	74.0	
Smoking					X^2 = 1.9 (0.157)
▪ Yes	25	50.0	18	36.0	
▪ No	25	50.0	32	64.0	
Pre Stroke Activity					X^2 = 11.1 (0.011*^)
▪ Sedentary	3	6.0	0	0.0	
▪ Moderately active	13	26.0	24	48.0	
▪ Vigorously Active	11	22.0	15	30.0	
▪ Extremely active	23	46.0	11	22.0	
Medication					X^2 = 9.5 (0.002*)
▪ No	18	36.0	5	10.0	
▪ Yes	32	64.0	45	90.0	
Antidiabetic					X^2 = 9.4 (0.002*)
▪ No	27	54.0	12	24.0	
▪ Yes	23	46.0	38	76.0	
Antihypertensive					X^2 = 10.2 (0.001*)
▪ No	21	42.0	5	10.0	
▪ Yes	29	58.0	45	90.0	
Cardiac Drugs					X^2 = 1.6 (0.205)
▪ No	36	72.0	30	60.0	
▪ Yes	14	28.0	20	40.0	
Chronic diseases					X^2 = 9.5 (0.002*)
▪ No	18	36.0	5	10.0	
▪ Yes	32	64.0	45	90.0	

Table 5.2: Distribution of both groups (study & control) according to their present medical history (N=100) "cont"

Present medical history	Group				Test (P)
	Study		Control		
	No	%	No	%	
Diagnosis					X^2 = 0.44 (0.505)
▪ Ischemic	46	92.0	44	88.0	
▪ Hemorrhagic	4	8.0	6	12.0	
Affected Side					X^2 = 0.04 (0.839)
▪ Rt	21	42.0	20	40.0	
▪ Lt	29	58.0	30	60.0	
Dominant Side					NA
▪ Rt	50	100.0	50	100.0	

Figure (5.1) and **(5.2):** Reflects a comparison between both groups (study & control) according to their neurological status by the end of 1th month. As regards neurological status among studied groups after one month, it can be observed from **figure (5.1)** that there was a high statistical significance difference between both groups (P=0.000).

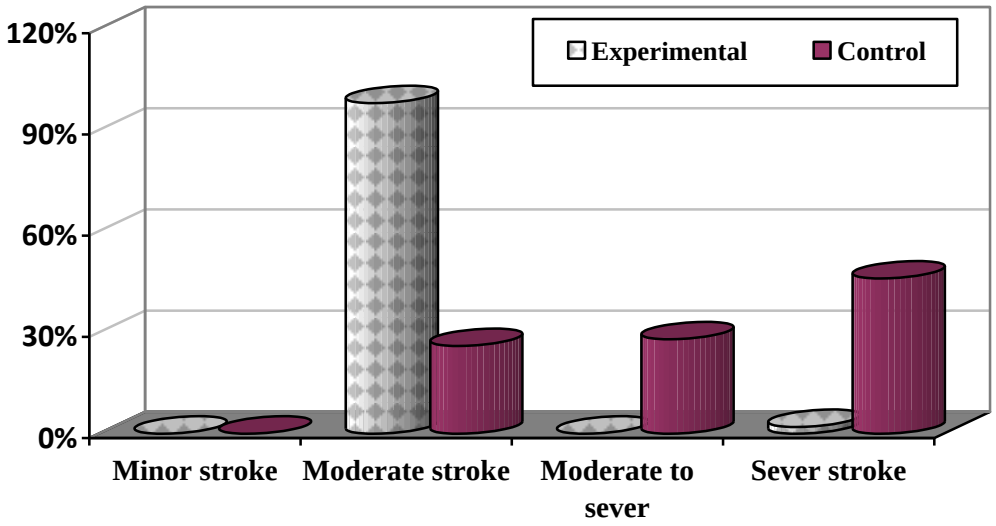

Figure (5.1): Neurological Status among both groups (study & control) after one month

Figure (5.2): reflect a comparison between both groups (study & control) according to their functional status through the study period. As regards the difference of BI score, there was a high significant difference between them through the study period (P=0.000) with apparent increase in mean BI score in study (33.7±18.3) than control group (17.4±15.0) by the end of first month (4th wk).

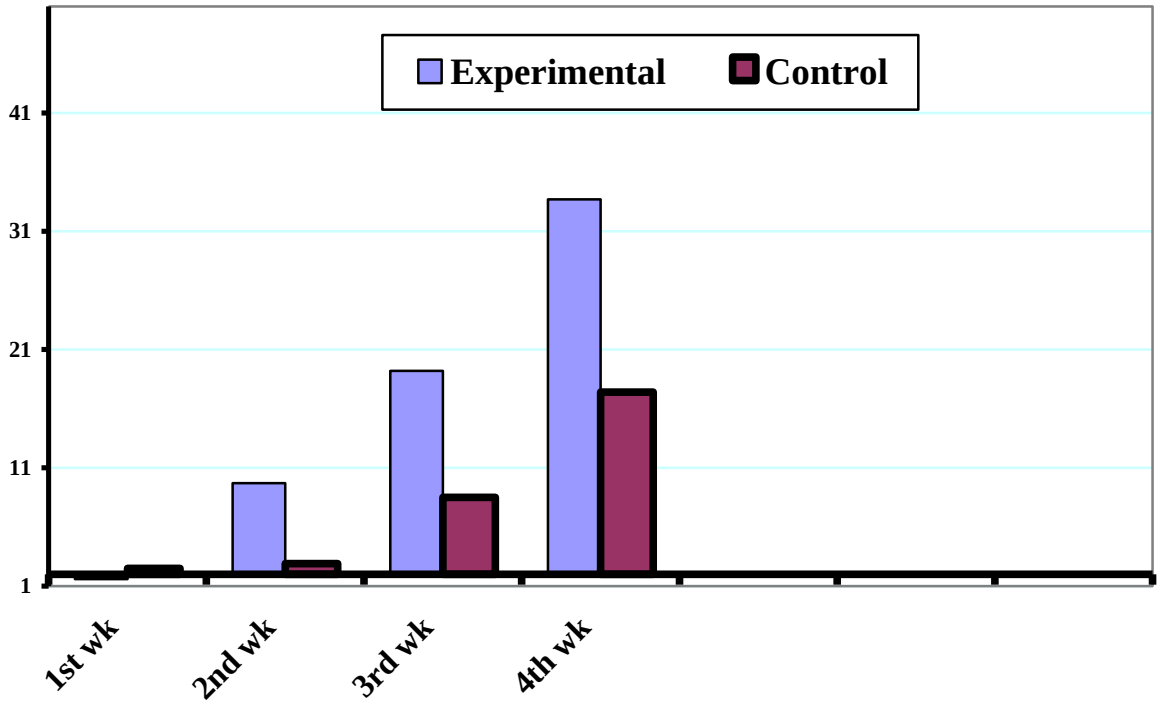

Figure (5.3): the mean difference of BI score among the both groups (study & control)

DISCUSSION

After stroke many patients will be left with persistent neurological deficits and various physical disabilities [(12)]. The term stroke rehabilitation refers to recovery efforts for any deficits resulting from a stroke. Fundamentally it is concerned with practicing activities, as this aids positive neuromuscular recovery [(13)]. Initiation of appropriate interventions in appropriate time can make the difference between patients regarding level of disability [(14)].

Therefore, the current study concentrated on the efficacy of CIMT in improve on functional status ability among patients with stroke, applied early after one week. Potential differences between studied groups were examined in terms of neurological and functional improvement.

The demographic background of the present study showed that, the mean age of study group was 52.8 ± 8.1 years,

while the mean age of the control group was 52.3 ± 8.1 years. Males were more prevalent in the studied sample. The majority of patient in the study and control groups were married. Illiteracy prevailed among the majority of the study and control group. The majority of study and control groups diagnosed as ischemic stroke. More than one half of the study and control group present with left side hemiplegia. Among studied groups, the right side is a dominant side for all patients.

Regarding to age, stroke was found to be more common among those more than 50 years of age, in this respect ***El-shamaa et al. (2011)***, found that the majority of stroke subjects were among the age group of fifty to sixty years old [(15)]. The present study revealed that ischemic stroke is the most commonly founded diagnosis. These findings are in agreement with the findings of ***Alan et al, (2013) and Khedr et al (2013)*** who stated that, of all strokes, 87% are ischemic and 10% are intracerebral hemorrhagic strokes [(16, 17)].

The findings of the current study demonstrate that, neurological improvement increased significantly in study group. This may attributed to compensatory mechanism in the brain initiated early after a stroke as a reflection of CIMT.

This finding goes well together with ***Roach et al, (2010)*** who reported that, spontaneous recovery aiding in neurological recovery early in the post-stroke period, and if accompanied by effective stroke rehabilitation it results in optimal patient recovery ***[(18)]***. ***Gosney et al, 2012*** reported that neurological recovery occurs rapidly in the first 2 weeks as a result of increased activation in primary motor cortex, primary sensory cortex, and premotor cortex of the affected hemisphere [(19)], This suggests that CIMT induces brain reorganization that results in a more distributed motor representation for upper-extremity muscles [(20)]

Noggle et al (2013) and Matsui et al (2010) emphasize that cortical reorganization occurs with experience and training, rehabilitation started 5 to 14 days post-stroke displayed increased dendritic branching of cortical neurons [(21, 22)]. Contrary to the results of the current study ***Umphred et al (2013***) expressed caution about training in the early post-stroke period, speculating that abnormal cardiovascular responses to exercise may impede perfusion of ischemic brain tissue during the period when cerebral auto-regulation is most often impaired [(23)]

This study found that early CIMT improving functional status and ability to perform ADL. This may attributed to recruitment of new motor areas and repeated training increase the area of motor cortex that controls the used muscles. ***Carey (2012)*** proposed that, if rehabilitative intervention is delayed for several weeks after a stroke, activation of mechanisms underlying brain plasticity, brain reorganization, and recovery are severely reduced [(24)].

These findings are in agreement with the findings of ***Matsui et al (2010, Roach et al, (2010))and Gosney et al (2012)*** they reported that training initiated early between the first week to the first month after onset of injury influences functional reorganization in the brain, improving motor function and enhancing dendritic growth in addition it prevent neglegance to paralyzed limb known as learned non use phenomenon [(18,19,22)]. ***Lescher (2011) and Brauer et al (2013)*** demonstrated that CIMT applied on acute stage post stroke within 14 days after onset effectively improving upper extremity motor function even those with severe hemiparesis without exacerbation of pain or fatigue [(26, 27)]. ***Oujamaa et al (2009) and Page et al (2008)*** emphasize that starting CIMT before the 10th day post stroke resulting in more significant improvements in basic and extended functional abilities of upper extremities compared to classic rehabilitation training with the same amount of total training hours [(28, 9)]

CONCLUSION

The present study shows strong evidence that applying CIMT including intensive and varied exercises early in acute stage post stroke (after one week) improving functional ability/ status among patients with stroke.

RECOMMENDATION

Strongly recommend that

- Starting CIMT for patients in acute stage early post stroke.
- Applying constraint induced movement therapy (CIMT) in an outpatient rehabilitation setting for person with less motor recovery using a collaborative functional approach between team members, the stroke survivor, and the family.
- Further study is needed to study the effect of education programs to nursing staff related to CIMT on the outcome of patients with stroke.

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