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Original Research Article

EFFECT OF ENVIRONMENT AND MODIFICATION OF OBJECTS OF DAILY USE ON HAND RECOVERY IN STROKE PATIENTS

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Abstract

Background: Stroke is of growing concern to health care providers worldwide especially developing countries due to the numerous predominant risk factors. Stroke patients often have compromised hand dexterity of at least one side and the hand is an integral component to accomplishing routine activities. Exercises provided to stroke patients usually are not specific to improving hand dexterity and enhancing ADL execution. Various measures like the ARAT scale and MAL can be used to assess hand function post stroke. **Objective:** The objective of this study is to check the efficacy of modifications in the objects of daily use, how it enhances upper limb recovery in stroke patients. **Study design:** Pre test post test control design. **Method:** A total of 16 stroke patients who met the inclusion and exclusion criteria were considered for the study and allocated into groups. Group A = EX and MOT (n=8) and Group B = EX (n=8). Treatment was administered over a period of 3 weeks. Pre test and post test ARAT and MAL scores were recorded. **Results:** Both the groups showed improvement in hand function but there was no statistically significant difference between the groups on analysis. **Conclusion:** General rehabilitation and training with modified objects of daily used were both beneficial to the patients. Modifications to the objects of daily use however improved the individual's ability to perform the activity more than general exercises did.

Keywords: Stroke Rehabilitation; Hand Rehabilitation; Modified Object Training

Introduction

Stroke is clinically defined as 'the rapid development of signs and symptoms of a focal neurological disturbance lasting for more than twenty four hours or leading to death for no apparent cause other than vascular origin' as defined by WHO, 2005. Stroke is growing into the second major concern for health care providers globally, causing morbidity and mortality across the globe next to cancer. Developing countries share numerous predominant risk factors such as hypertension, impaired glucose metabolism, various cardiac pathologies, tobacco consumption, cigarette smoking, excessive alcohol intake, illicit drug abuse

and various lifestyle factors such as sedentary lifestyle, obesity, hyperlipidaemia etc. attribute to the cause [1]. In India stroke is one of the major factors for disability. The incidence rates are an estimated 84-262/100,000 in rural and an approximate 334-424/100,000 in the urban areas [2]. Stroke rehabilitation is not well developed in India due to lack of insight and personnel into it. It is required of us to assess individual patients' prioritizing their areas of concern and their routine activities which have been compromised due to the condition.

Stroke patients often have compromised hand dexterity of at least one side, experiencing delayed gripping, ability to release or have a coordinated hand function in respond to commands [3]. Good hand coordination in routine activities is an indispensable component in every individual's life, as a sound hand is necessary to accomplish daily tasks. Weakness in the hand or inability to manipulate fine objects makes the patient dependent and they tend to seek assistance for the same.

Exercise therapy is explained as the physical activity aimed at achieving certain health goals for an individual by improving his physical fitness or health. The specificity principle in exercise physiology strongly quotes that it is necessary to train functional activities in an individual if improvement in that functional activity is what we seek. Task specific exercises are essential considering a population of stroke patients where a majority of their routine activities have been compromised owing to disease. Recovering from stroke seems to be a daunting task, it requires for the brain that was damaged by stroke to relearn many skills which it otherwise did. Most of the time the stroke patients are dependent on the assistance of family members and friends to achieve the activity they desire to perform or for mobility in and around the community, this increases the necessity to evaluate the patient considering all the possible activities compromised and to identify the tasks that he wishes to accomplish independently, which he could have otherwise prior to the accident.

Stroke patients generally receive a gross treatment approach which covers for most of the patients shortcomings, what we neglect here are the finer more intrinsic activities which make a difference to the quality of the movements and hence the patients interaction with his immediate environment [4,5,6]. [The treatments normally received by a stroke patient include; Stretching, Functional exercises (constraint induced movement therapy based), Strengthening exercises, Functional electrical stimulation (to manage spasticity), Balance training, Transfers, mobility and gait training, Coordination exercises, Stair climbing (etc. are some of the many exercises given to the patient not directly focusing on his ADLs)]

James Gibson in 1966 first proposed the ecological theory which is now better known as the ecological approach to motor control. Motor control theory is defined as a complex neural, physical and behavioral organization to bring about a coordinated posture and movement [8]. It is the ability of the individual to regulate mechanisms essential for movement. This theory states that all movements or actions are influenced or constrained by the environment and that individual's actions are responsive of the kind of environment that he stays in. The theory emphasizes that the organization of movement is a result of interactions with the environment and goal directed actions [9]. Other studies explain it as an area of natural science exploring the purposeful and coordinated response by the central nervous system produced while interacting with the rest of the body and the environment [10]. Thus it is essential to incorporate the

enhance environment factor into the persons' rehabilitation set up to provoke the brain for an intentional or task oriented and better coordinated response. Following stroke a patient needs to combat various social and environmental barriers that he would possibly face either at home, in the hospital or at a clinic set up. The barriers he faces in the environment influence his participation and his estimated recovery period. It is hence vital to consider these factors in our rehabilitation program and chalk out customized mitigation measures to ensure the individuals' safety with respect to his environment and make it more accessible for him to promote participation and independency.

The abilities of an individual post stroke are significantly influenced by the environment around him. Environmental enrichment is the stimulation of the brain by enhancing the physical and social environment of the individual[11,12,13]. It involves modification of the individuals' immediate environment to assist him in his lifestyle and hence help develop his motor skills. It could be done by simplifying the environment for the person either in the hospital where he is admitted, his home once he gets discharged or even at the clinic set up where he comes for therapy sessions. In stroke patients where hemiagnosia or unilateral spatial neglect is a common feature exhibited by patients [14], participation and activity are of major concern. They tend to be reluctant to perform tasks with increased difficulty assuming fewer outcomes. However the difficulty could be reduced and the task simplified by modifying the object to adapt to their inefficient grip and reduced hand strength, promoting activity. Here we refer his immediate environment to be assisting his routine activities such as the size of the buttons and his ability to button up his shirt, the type of glass and his ability to hold it and drink water from it etc. These items could be enhanced to train the patient on an easy level initially and progressing to a less difficult and to more difficult levels eventually. Enriching his immediate environment to help train his routine activity helps motivate the patient and promotes participation. So these buttons, glasses, spoons, hooks etc. that the patient encounters on a daily basis which are a part of his routine activity can be modified to make it easier for the patient to accomplish these tasks, these improve his participation and motivate him to train to come back to a more normal state over time.

The ability to hold onto the object itself boosts his confidence and hence his willingness to perform the activity more often and later advance to a more difficult level. The difficulty can be altered by modifying the size, shape or thickness, weight and texture of these objects. Glasses, plates, spoons, bowls, buttons, pens, toothbrushes, hair brushes, etc. are generally used by individuals' on a daily basis. These objects could be modified with respect to the ability of the patient, making it easier or more difficult for him. The modifications initially done, adapt to the inefficient grip of the patient, helping him manipulate the newly modified object which boosts his confidence and drive to performing the activity.

Need for the Study

It is required of medical professionals to focus on the less evident but more problematic areas such as fine manipulations by the hand. We often ignore the ADLs impaired, which incoherently affect the patients' self esteem and confidence to a grievous extent.

Functional training by modification of objects, that the patient finds difficulty in handling which he could otherwise have in a normal state where, the objects are progressively modified increasing the difficulty level as the patient progresses, helping him reach a more normal state

through training, has limited research insight. Hence, making it arduous to standardize the percentage of change to be made in the object to help modify it to suit the dexterity of patients' hands. Thus this study aims at evaluating the efficacy of environmental enrichment (here the patients' immediate environment) for improving the hand function post stroke.

The patients in this study have received the traditional treatment given to stroke patients however one group has also received training by enriching objects of their environment (with respect to the ADL compromised or where he seeks improvement) to help them reach a close to normal state.

Objective

The objective of this study is to check the efficacy of modifications in the objects of daily use, how it enhances upper limb recovery in stroke patients.

Methodology

The study considered a pre-test and post-test control design with Sequential sampling. The study included people dwelling in the community in and around areas of Mysore and Bangalore. A total of 16 subjects were considered. The study was conducted for a period of 3 weeks on both men and women of age 31-67 yrs diagnosed with stroke.

Selection Criteria:

Inclusion Criteria	Exclusion Criteria
• Age 32-67 years.	• Subjects with severe aphasia.
• Both males and females.	• Severe pain in any joint of the paretic extremity.
• Having at least 20^o wrist extension and 10^o active extension of metacarpophalengeal joints, interphalengeal joints of all digits, 10^o extension of the affected limb.	• Other co-morbidities affecting upper limb functional activity.
• MMSE score of 17 or above	• Intra-cerebral hemorrhage.
• Sit to stand balance without upper extremity support (for at least 2minutes)	• Previous stroke on same side.

Outcome measures

1. Action Research Arm Test (ARAT)
2. Motor Activity Log (MAL)

Procedure

Patients dwelling in the community in and around the areas of Mysore and Bangalore, diagnosed with stroke were considered for the study. A total of 21 stroke patients were screened and 16 patients fulfilling the inclusion criteria were included in the study. Informed consent was taken from the subjects. Subjects were allocated into 2 groups. Group 1 (n=8) received conventional stroke rehabilitation protocol respective to patient needs along with enriched environment training. Group 2 (n=8) received only conventional stroke rehabilitation protocol respective to patient needs.

Each subject was assessed for basic demographic data like Age (years), Gender, Respiratory rate (cycles per minute), Heart rate (beats per minute), Blood Pressure (mm Hg), Mini Mental State Examination score

and the values of baseline parameters like ARAT and MAL were recorded.

Assessment of ADLs compromised:

To train the ADL or to provide with modified objects to train or improve the activity, it is essential for us to first assess the patients ADL limitation. Since all compromised activities could not be treated for in the short span that we had for the study, we required to categorize activities based on the level of priority to the patient i.e. the activities he required to reform first. These were assessed by showing activity flash cards to the patient based on the ICF activity list. These included various activities that an individual would encounter on a routine basis. A maximum of 2 activities of utmost importance to the patients were noted. They were: Dressing up (n=5), Drinking from a glass of water (n=5), Eating (n=4)

Patients also had grievances of lesser gravity in the following:: Handling household work (n=2), Counting or handling money (n=1), Personal care (n=1), Fine hand use (n=1), Recreation and leisure activities like playing cards (n=1), Participating as a citizen in political affairs (n=1)

Modifications done:

Once the activity list from each patient in the experimental group was obtained, these activities were tested on the patients; to check their ability to manipulate the object. They were then provided with training pads of least difficulty and were made to practice a complete set under supervision for at least 5 times alongside conventional exercises designed for them.

Dressing up: Patients who faced difficulty dressing up were provided with practice kits (consisting of cardboard base attached with cloth pieces containing buttons and adjacent holes) with buttons of varying diameter and thickness to help train buttoning. In the first stage, the buttons with the most thickness and diameter were given to train, once the patient accomplished this activity we progressed to the next more difficult level which included buttons of a smaller diameter and thickness. Eventually we try to train and bring back the patient to using and manipulating with buttons of a normal size.

By the end of 3 weeks all 5 patients had progressed to a more difficult level however the study time period was too short to bring them to using buttons of a normal shape.

One of our male patients refrained from wearing formal pants as he was unable to hook up his pants also one of our female patients wanted to train to hook up her sari jacket, these patients were provided with training for hooking up.

Eating: Patients with difficulty using spoons were given increased diameter light weight spoons using foam and duck tape. They were trained to hold and take the spoons to their mouths and were advised to use the same while having meals. By the end of 3 weeks three of four patients learnt to handle normal spoons and take them to their mouths.

Drinking from a glass of water: Two of five patients here had difficulty holding onto a glass, one of five could hold onto an empty glass and two of five could barely hold onto a glass. Here patient specific modifications were made to the glasses. The patient who could not reach with the glass to the mouth was provided with a glass secured with a straw lid and a straw that helped her compass the distance to her mouth and she could drink from it. This motivated her to improvise and assured her with the efficacy of the treatment. The length of the straw was reduced as treatment progressed. It later progressed to a sipper glass (to prevent spillage of water) and then to a normal glass (without a lid).

Stroke Rehabilitation - general exercises:

All sixteen patients taken up for the study, were given these general exercises that they would otherwise in a physiotherapeutic

clinic, Physiotherapy Out Patient Department in Hospitals or in private home care. A general rehabilitation protocol specific to respective patient needs was tailored. A combination of the following exercises was administered to the patients over a period of 3 weeks under supervision.: Stretching (PNF patterns for affected upper and lower limbs 5 times daily), Functional exercises (constraint induced movement therapy based exercises emphasizing reach outs, gripping and placing objects from one point to another placed at least 25cms away), Strengthening exercises (for the affected upper limb with mild weights at least 30 repetitions and squatting to strengthen lower limb muscles at least 30 repetitions daily), Functional electrical stimulation (to manage spasticity), Balance training (Frenkles' exercises, tandem walking, walking along a figure of 8 pattern at least 5 times daily), Transfers, mobility and gait training (gait training with mirrors wherever available and verbal cues to correct abnormal deviations), Stair climbing (etc. are some of the many exercises given to the patient not focusing on his ADL)

Results

A total of 21 stroke patients dwelling in community areas in and around Mysore and Bangalore were screened and 16 of them were considered for the study as they fulfilled the inclusion and exclusion criteria. Subjects were placed into groups following sequential sampling. Group A received Exercises and Modified Object Training (n=8) while Group B received Exercises (n=8) for a period of 3 weeks.

Baseline data i.e. ARAT and MAL scores were documented on day 1 following which their patients underwent the respective treatment protocol. Data was again recorded in the end of the third week to compare the difference and check the efficacy of the treatment administered.

The baseline data of the subjects who participated in the study are given below :

Table: 1 Baseline data of groups

	Group A **(Mean ± SD) (n=8)**	Group B **(Mean ± SD) (n=8)**
Age (years)	49.5 ± 9.7	52.7 ± 12
ARAT	22.5 ± 11	29.1 ± 13
MAL AOU score	74 ± 14.8	77.8 ± 23.8
MAL QOM score	67.7 ± 19.3	68.4 ± 27.4

There was no significant subject age difference between the two groups. The numbers of males in the study were more than the numbers of females. There were a total of 16 males and 4 females. Each group however consisted of 2 female and 4 male subjects.

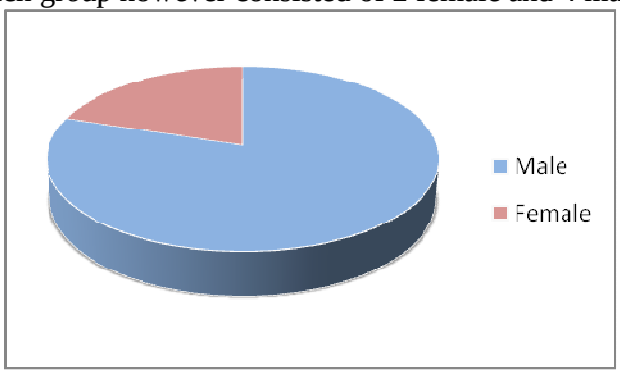

Figure – 3 Gender distribution of the study subjects

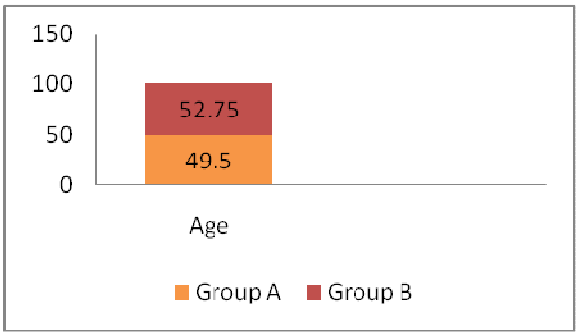

Figure - 4 Mean ages of the study subjects

Table – 2 Group A Experimental group (within group comparison)

Outcome measure	Pre test / Post test	Mean and SD (n=8)	t value (df = 7)	p value
ARAT	Pre test Post test	22.50 ± 11.04 35.00 ± 11.8	3.283	0.130
MAL AOU	Pre test Post test	74.06 ± 14.88 92.12 ± 8.64	3.520	0.010*
MAL QOM	Pre test Post test	67.75 ± 19.38 92.06 ± 9.88	4.417	0.003*

*p values for ARAT, MAL AOU and MAL QOM are < 0.05. Values <0.01 is considered to be highly significant. Hence there is significant difference between the pre and post test results of Group A. The null hypothesis is hence Rejected.

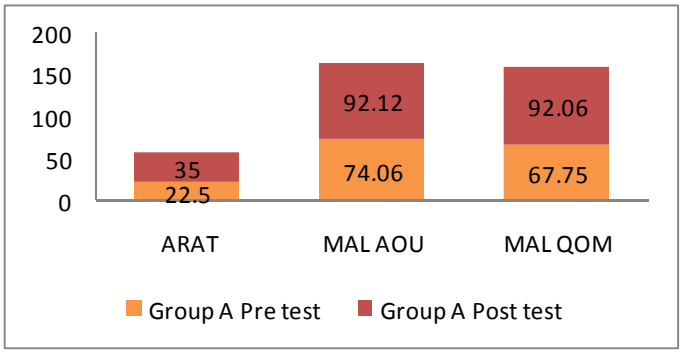

Figure - 5 Group A within group pre and post test analysis

Table – 3 Group B Control group (within group comparison)

Outcome measure	Pre test / Post test	Mean and SD (n=8)	t value df=7	p value
ARAT	Pre test Post test	29.12 ± 13.07 34.75 ± 12.34	4.596	0.002*
MAL AOU	Pre test Post test	77.81 ± 23.83 88.50 ± 22.10	4.071	0.005*
MAL QOM	Pre test Post test	68.43 ± 27.47 85.63 ± 25.9	4.183	0.004*

*p values for ARAT, MAL AOU and MAL QOM are < 0.05. The p value here is highly significant (<0.01) Hence there is significant difference between the pre and post test results of

Group B. The null hypothesis is hence rejected.

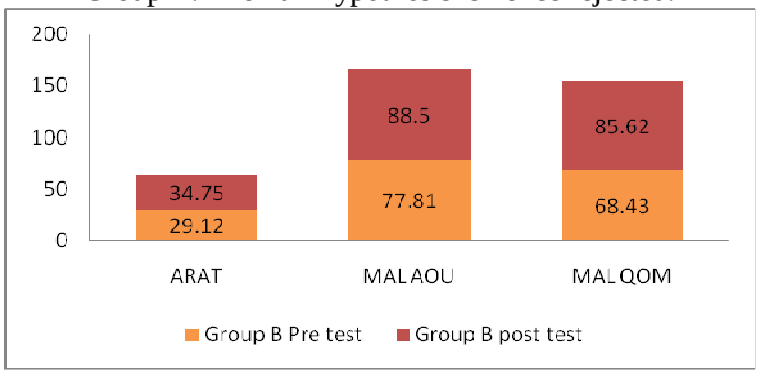

Figure – 6 Group B within group pre and post test analysis.

Table – 4 Comparison of Group A and Group B (Comparison between groups)

Outcome measure	Groups	Mean and SD (n=16)	t value (df=14)	p value
ARAT	Group A Group B	35.00 ± 11.88 34.75 ± 12.34	0.041	0.968*
MAL AOU	Group A Group B	92.12 ± 8.64 88.5 ± 22.1	0.432	0.672*
MAL QOM	Group A Group B	92.06 ± 9.99 85.62 ± 25.9	0.656	0.523*

*p values for ARAT, MAL AOU and MAL QOM are not < 0.05. Hence there is no significant difference between the groups. The null hypothesis is hence Accepted.

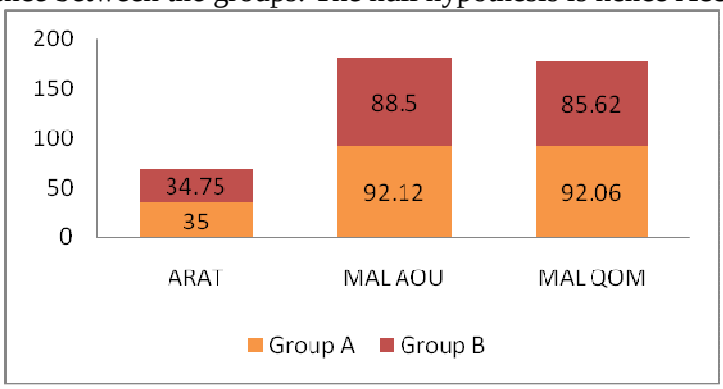

Figure – 7 Group A and Group B between groups analysis

Discussion

The objective of this study was to check the efficacy of modifications in the objects of daily use, how it enhances upper limb recovery in stroke patients. A number of studies have been done to suggest the importance of exercises for post- stroke rehabilitation, the importance of strengthening exercises to the hand muscles and activity specific or constraint induced therapy to improve hand function. Studies have also been done to suggest various modifications that could be made in the environment around him to promote mobility. However a lesser number has been conducted to show modifications in the patients' immediate environment, which promote patient participation and simultaneously make him independent.

The concept of this study however was to use these modifications to train the patient and with every progression made, the difficulty level was increased. The newly modified object suited the patients'

compromised hand and promoted participation. It motivated the patient into better execution of task as he visualized and experienced his improvement with progression. A similar study has not been attempted where modified objects pertaining to the ADLs compromised have been modified for patient training to bring them back to a state of normalcy.

Following pre test and post test evaluation of results, the p value of Action Research Arm Test was 0.968, Motor Activity Log Amount of Use was 0.672 and Motor Activity Log Quality of Movement was 0.523. Since these values are not ≤ 0.05 which was the considered value for significance, it suggests that there is no statistical and clinical difference between the two groups. This study hence supports the null hypothesis and rejects the experimental hypothesis.

Reason for acceptance of null hypothesis:

A similar study has not been conducted thus there was no standardization while increasing the difficulty level following progression. Thus the literature support to benefit the study was limited.

Sequential Sampling design was chosen for the study which could give scope for bias.

The outcome measures used for the study especially Motor Activity Log are much detailed and very time consuming especially when the patients most of the time do not consider the difference between the amount of use and quality of movement aspects, thus giving an approximated response with not much judgment to it.

The study duration was brief to have received significant results from each patient. The patients with these modifications did progress from not performing the activity at all (post stroke) to the more difficult level in a span of 3 weeks but the duration was not sufficient for all to reach a state of normalcy. Perhaps additional time would have helped yield significant results.

Strengths

- This study suggests that the use to modified objects for training hand function could help execute ADLs independently and efficiently post stroke.

Limitations

- The study duration was too short to yield significant results between the two groups.
- Sample size could have been more for a better analysis and significance.

Clinical Implication

- Modifications can be made to ADLs of concern and trained to improve ADL execution and promote patient independency and improved confidence. The same must be incorporated in rehabilitation set ups to provide with a holistic approach.

Research Implication

- Future research can be conducted to assess the effect of training by progressive object modification to assist ADL for a minimum of 3 month duration. A longer study duration could yield better patient outcome.

Conclusion

This study aimed at evaluating the efficacy of modifications in the objects of daily use, how it enhances upper limb recovery in stroke patients. From the results of the study we conclude that training by progressive object modification to assist ADL does improve the particular ADL execution in comparison to other exercises. However the study duration was too short to establish the extent to which improvements can be made to the individual.

Summary

Stroke is of growing concern to health care providers worldwide especially developing countries due to the numerous predominant risk factors. Exercises provided to stroke

patients usually are not specific to improving hand dexterity and enhancing ADL execution. Various measures like the ARAT scale and MAL can be used to assess hand function post stroke. A total of 16 stroke patients who met the inclusion and exclusion criteria were considered for the study and allocated into groups. Group A = EX and MOT (n=8) and Group B = EX (n=8). Treatment was administered over a period of 3 weeks. Pre test and post test ARAT and MAL scores were recorded.

Both the groups showed improvement in hand function but there was no statistically significant difference between the groups on analysis. We conclude by stating that general rehabilitation and training with modified objects of daily use were both beneficial to the patients. Modifications to the objects of daily use however contributed to a higher quality of improvement in the ability to perform the activity than general exercises did.

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Bibliography

1. Potential risk factors for stroke patients, National Stroke Association, Colorado, United States; American heart association. http://stroke.ahajournals.org/content/37/2/577
2. Jayaraj Durai Pandian and Paulin Sudhan, Paulin Sudhan; Stroke epidemiology and Stroke Care Services in India, Journal of Stroke 2013.
3. Marc Chase, Hand and Finger Exercises for Patients in Stroke Rehabilitation, August 2013. http://www.livestrong.com/article/314243-hand-and-finger-exercises-for-patients-in-stroke rehabilitation/
4. Nathan K. LeBrasseur, Jonathan F. Bean, Edward M Phillips, Walter R. Frontera, High intensity resistance training improves muscle strength, self-reported function and disability in long term stroke survivors, American Heart Association, April 2004;35:1404-1409
5. Marian Mullaney, Physiotherapy – Stroke care and prevention, MISCP, http://www.stroke.ie/media/pub/strokeie/marianmullaney.pdf
6. Louise Ada, Simone Dorsche and Colleen G Canning, Strengthening interventions increase strength and improve activity after stroke: a systematic review, Australian Journal of Physiotherapy 52: 241–248
7. Cormwell DA, Lawton MP, Paulos RG et al, Self Maintaining and Instrumental Activities of Daily Living, 1986; 9(3):179-186.
8. O' Sullivan, Schmitz TJ (2000) Physical Rehabilitation: Assessment and Treatment Philadelphia: FA Davis Company, 4th edition.
9. Lisa K.Kenyon, Mary T.Blackinton, Applying Motor-Control Theory to Physical Therapy Practice. Physiother Can. 2011 Summer; 63(3):345-354.
10. Steven L.Wolf, Carolee J.Winstein, Phillip Miller et al, Effect of constraint induced movement therapy on upper extremity function 3 to 9 months after stroke. Journal of American Medical Association, November 2006; 296(17)
11. Grey Bruce District Stroke Centre, Modifying the Home After Stroke. London, July 2005.
12. Lynn Legg, Avril Drummond, Jo Leonardi Bee et al 2009, Occupational Therapy for patients with problems in personal activities of daily living after

stroke: Systematic review of randomized trials". British Medical Journal, 2009; 335(7626):922.
13. Mark L.Latash, Mindy F.Levin, John P.Scholz and Gregor Schoner, Motor Control Theories and Their Applications. Medicina (Kaunas). 2010; 46(6):382-392.
14. Rani Haley Lindberg, Stroke Rehabilitation. UAMS Department of Physical medicine and rehabilitation. Stroke 1999; 10(4):887-906.
15. Fiona C Taylor, Suresh Kumar K, Stroke in India Factsheet, 2012 South Asia Network for Chronic Disease, Public Health Foundation of India, IIPH Hyderabad
16. Nadir E. Barucha, Thomas Karuvilla, Epidemiology of stroke in India, Neurol J Southeast Asia 1998; 3: 5-8
17. Kiran Prakash P, Pilladi R.S. Thulasi et al, Effect of Modified Constraint Induced Therapy on Upper limb Functional Recovery in Young Stroke Subjects. Int J Physiother. October 2014; 1(4):220-226
18. Marluce Lopes Basilio, Faria-Fortini, Janaine Cunha, Aline A. Scianni, Christina D, Luci Fuscaldi, Handgrip strength deficits best explain limitations in performing bimanual activities after stroke, 2016, Journal of Physical Therapy Science, 28: 1161–1165
19. Ching Lin Hsieh, I Ping Hsueh, Fu Mei Chiang and Po Hsin Lin, Inter-rater reliability and validity of the Action Research Arm Test (ARAT) in stroke patients. Age and Ageing 1998; School of Occupational Therapy, College of Medicine, National Taiwan University, Republic of China.
20. Uswatte G, Taub E, Morris D, Light K., Thompson P.A., The Motor Activity Log-28 Assessing daily use of the hemiparetic arm after stroke, Neurology, 2006;67;1189-1194
21. Shyamal Kumar Das, Tapas Kumar Banerjee, Stroke – Indian scenario, Bangur Institute of Neurosciences and Psychiatry, 2008;118:2719-2724
22. Hiraoka, K. Rehabilitation effort to improve upper extremity function in post-stroke patients: A meta-analysis. Journal of Physical Therapy Science. 2001; 13(1):5-9.
23. Yen J.G., Wang R.Y, Effectiveness of modified constraint induced movement therapy on upper limb function in stroke subjects, Acta neurol Taiwan, March 2005; 14(1):16-20.
24. El-Helow M.R., Zamzam M.L et al, Eur J Phys Rehabil Med. Efficacy of modified constraint induced movement therapy in acute stroke. July 17 2014.
25. McIntyre A., Viana R., Janzen S. Systematic review and Meta-analysis of constraint induced movement therapy in hemiparetic upper extremity more than six months post stroke. Dec 2012; 19(6):499-513.
26. Priyanka Singh and Bijayeta Pradhan to assess the effectiveness of modified constraint induced movement therapy in stroke subjects: A randomized controlled trial. June 2013; 16(2):180-184.
27. Jennifer Ma Wai, Grace Fung Chi Yuen, Teresa Kim Kam Yu, et al, A study of constraint induced movement therapy in subacute stroke patients, Hong Kong, April 15 2007.
28. Taub E, Uswatte G, Mark VW, Morris D. The learned nonuse phenomenon: implications for rehabilitation. Eura Medicophys 2006; 42:241-255.
29. Stephen J. Page, Peter Levine, Sue Ann Sisto et al, Mental Practice combined with Physical practice for upper limb motot deficit in subacute stroke. Phys ther 2001; 81:1455-1462.
30. Yue X. Shi, Jin H.Tian, Ke H. Yang, Yue Zhao, Modified constraint-induced movement therapy versus traditional

rehabilitation in patients with upper extremity dysfunction after stroke- a systematic review and meta-analysis. Arch Phys Med Rehabil 2011; 92:972-82.

31. Chong Tae Kim, Department of physical medicine and rehabilitation, University of Pennsylvania, USA; explained on Stroke Rehabilitation. http://cdn.intechopen.com/pdfs-wm/37902.
32. Unsworth C.A. Cognitive and Perceptual Dysfunction. In S.B. O'Sullivan & T.J. Schmitz (Eds.), Physical Rehabilitation, 5th ed. Philadelphia 2007; 1180-1181.