Research Article

Evidence Based Physiotherapeutic Concepts and Approaches on Improving Functional Hand and Arm Activities for Stroke Patient

Shubham Sharma[1], Neha Gupta[2], Shubhi Kulshrestha[3]* and Sukriti Raj[4]

[1]Assistant Professor, Santosh Medical College, Ghaziabad, Uttar Pradesh, India

[2]Assistant Professor - lll, Amity Institute of Physiotherapy, Amity University, Noida, Uttar Pradesh, India

[3]Senior Physiotherapist, AID PLUS Physiotherapy and Rehabilitation Clinic, Delhi, India

[4]Physiotherapy Faculty, Impact Paramedical and Health Institute, New Delhi, India

*Corresponding Author: Shubhi Kulshrestha, Senior Physiotherapist, AID PLUS Physiotherapy and Rehabilitation Clinic, Delhi, India.

Abstract

Background: Stroke is a neurological disease. Half of the stroke patients are left with disability. Most of the stroke patients are able to walk independently but more than 50% of the patient will not recover their hand functions. Upper extremity functional recovery is slower than lower limb functional recovery.

Objective: There are several protocols which we are used to rehabilitate the upper limb after stroke, through this study we can find out the latest technique and the most effective technique at the present time.

Search Strategy: Various articles have been studied to create this literature review. The database was probed from various journal sites such as PubMed, Science Direct, Research Gate, Cochrane and Google Scholar. The articles were identified with keywords such upper limb rehabilitation for stroke, PNF for upper limb stroke rehabilitation and Bobath therapy.

Results: Total 10 studies were identified with different protocols to improve functional hand and arm activities for stroke patient. There are many concepts and approaches which are evolved during time and produce great output in the rehabilitation of upper limb. Concept used in postural control and integration of the task performance of the sensory information for the motor control and the perception will improve at the cortex level.

Conclusions: Through all the studies, every concept and approach gives significant improvement on each other. The latest technologies like electrical stimulator are more focused from last 5 years while CIMT shows better results in comparison with other studies for the rehabilitation of the upper limb recovery.

Keywords: Stroke; Neurological Disease; Limb

Introduction

Stroke is a neurological disease. The paresis of upper limb is caused by ischemic stroke that is the most common cause of permanent disability [1]. Ischemic stroke covers 80% of the stroke while the other 20% are hemorrhagic stroke. Ischemic stroke is caused by reduction of arterial perfusion. Hemorrhage stroke

occur due to weak blood vessel wall got bust and outflow of blood into brain tissue. Intracerebral and subarachnoid hemorrhages are two divisions of hemorrhagic stroke [6].

Half of the stroke patients are left with disability. Most of the stroke patients are able to walk independently but more than 50% of the patient will not recover their hand functions. Upper extremity functional recovery is slower than lower limb functional recovery. Up to 87% of the stroke patient survivors impaired with hand paralysis. 55 to 75% of the stroke patients have constant deficit in performing activities of daily living. Functional disability of the upper limb leads to loss of independence and affecting the quality of life and activities of daily living like washing, feeding, dressing and shopping etc. Only 5 to 20% of the post stroke patients have normal upper limb function after 3 months of period [9].

Stroke patients are relay on compensatory strategies by non-affected limbs. Simple movements like flexion and extension with repetitive training can improve hand function after stroke. Most of the stroke patient can regain to flex the fingers but extension is limited therefore inappropriate activity of the flexion interfere the extension movement however patient is unable to activate extensors because of impaired movement of flexion [2].

Brain develops by repetitive movements and regenerate to form new connections. This term is known as Neuroplasticity, through neuroplasticity we can form new pathways for motor relearning by repetitive training. Human hand is a very complex but important structure in reaction to an object [11].

After stroke movement dysfunction occur that can be improve by motor relearning with maximum repetition during rehabilitation program. There are many factors that have an impact on neuroplasticity after stroke like early implementation of treatment and rehabilitation, regularity, repeatability, intensity of performing exercise, etc.

Hand and ARM functional ability for stroke patient are measured by fugal Meyer assessment scale. FMA is 226-point scale which covers all details of the hand and ARM functions. Modified Ashworth scale is also used which is a six-point scale which calculate spasticity of the patient arm and hand. Some uses wolf motor function test and Barthel index and grip strength test.

WMFT is a quantitative scale includes 15 functional based tasks and 2 strength-based tasks and has a maximum score of 75. Barthel index include information from patient itself or one of the patient relatives. It includes 10 activities of daily living like feeding, transfer, personal hygiene, getting on and off to the toilet, bathing, walking, ascending and descending wheelchair, dressing, controlling bowel and bladder. Grip strength is measured by force tester by maximum isometric strength of the hands and forearm muscles [1].

There is various method used to rehabilitate the patient after stroke by repetitive task training (RTT), Constraint induced movement therapy (CIMT), strength training aerobic training, noninvasive brain stimulation, computer based virtual reality training, neuromuscular electrical stimulation and robotic assisted rehabilitation [8].

Task specific training is a progressive training approach which helps the patient to do daily living activities. Bobath state that the Integration of the posture control and quality of task performance, selective movement and the role of sensory information to promote the movement pattern [9]. Transcranial magnetic stimulation and functional magnetic resonance imaging improve the motor function of upper limb with functional and structural reorganization of the cortex [10]. Aerobic exercises enhance neuroplasticity after stroke. Actually, treadmill training of one session can enhance the upper limb motor function of the chronic stroke patient [10]. Bilateral upper limb training task uses both upper limbs to complete task the non-affected limb is used as a reference limb to guide the affected limb to enhance the organized movement [5]. PNF is effective though minimize impairment and improve function of limb and trunk. PNF improves joint movement and facilitate the muscle to activate in a particular sequence [1]. Mirror Therapy is a technique in which the reflection of the intact arm was used to stimulated as the amputated limb was present [9].

Need of the study

There are several protocols which we are used to rehabilitate the upper limb after stroke like proprioceptive neuromuscular facilitation, Robotic assisted therapy, Bobath technique, Constraint Induced Movement Therapy, Virtual Reality Training, Functional Electrical Stimulation and Repetitive Task Training etc. Though this we can study about the various approaches and techniques for upper limb rehabilitation.

Aim of the study

Through this study we can find out the latest technique and the most effective technique at the present time.

Methodology

Search strategy

Various articles have been studied to create this literature review. The database was probed from various journal sites such as PubMed, Science Direct, Research Gate, Cochrane and Google Scholar. The inclusion criteria were articles including post stroke patients, about functional task of upper limb for stroke patients, had no significant cognitive disorder MMSC > 20, Displayed weakness in the affected upper extremity and literature available in English language.

Articles having subjects with any previous injuries, post-surgery stroke patients, no sitting balance and any other co-morbid neurological disease or condition such as Multiple sclerosis, Parkinson's, Spinal Cord Injury, Traumatic brain injury, Brain tumor, Epilepsy or Dementia and Hemi neglect phenomenon were excluded from the study.

The articles were identified with keywords such upper limb rehabilitation for stroke, PNF for upper limb stroke rehabilitation and Bobath therapy.

Data extraction

In stroke patient upper limb activities play an important role in performing ADL like eating, dressing, going washroom, bathing etc.

There are several studies which improves the motor ability of the upper limb activities after stroke. Tanchanak., *et al*. in 2019 studies moderate to severe deficits in upper limb and hand function for chronic stroke by Bobath therapy [11]. J.H.lee., *et al*. in 2019 conduct the effect of PNF in upper limb for stroke patient [7]. Eascow., *et al*. in 2019 find out the effect of bilateral upper extremity task training on post-stroke patients [5]. Alya Abba., *et al*. in 2019 compare the CIMT and PNF effect on the function of upper limb in stroke survivors [1]. Chinnanan., *et al*. in 2020 studies the Mirror Therapy effect on hemiplegic patients' upper limb [3]. Burcu., *et al*. in 2012 study the comparison between CIMT and Bobath concept functional recovery on upper limb in stroke patient [2]. Fahimeh., *et al*. in 2019 conduct a research by combining the Task-Oriented Training with bobath program [6]. E.Lang., *et al*. in 2009 studied the thumb and finger extension recovery in relation to grip performance [4]. Sarah.R., *et al*. in 2019 find the recovery by aerobic exercise and task specific training together for hand and arm [10]. Marko., *et al*. in 2009 finds functional electrical stimulation with bilateral arm training in chronic stroke [8]. Pervene., *et al*. in 2016 studied the use of mirror therapy in complex regional pain syndrome in stroke patients [9].

Results

We include 50 articles for our review for the upper limb rehabilitation by the help of Prisma flow chart only 10 articles are included in our criteria while the others were excluded.

Sample size	Selection criteria	Protocol	Outcome variable and result
26 post stroke individual	Inclusion - first stroke at least 6 month before study, older than 45 years, FMA scoreless then 26/66 Exclusion- shoulder pain limited PROM, cognitive impairment, severe spasticity	Bobath concept was administered 3 days per week for 6 week (20 repetition x 3 steps per task each session)	Wolf Motor Function Test and Fugl-Meyer Assessment for Upper Limb. Modified Ashworth Scale and Revised Nottingham Sensory Assessment
30 participants of stroke 15 Exp Group 15 Control Group	Inclusion- Post stroke patient, age 20 to 60 year, MMSE > 20, Full PROM Exclusion- Spasticity injection, Surgery, hemineglect	Experimental group- General PT of 45 min + PNF 15 min Control group- General PT of 45 min + FES 15 minute (5 days/week)	Experimental group show significantly improvement Action Research Arm Test Fugl-Meyer Assessment

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30 patient of post stroke 15 Exp Group 15 Control Group	Inclusion- Post stroke patient, between 45-to-85-year age, Acute unilateral stroke ability to participate in 30 minutes of PT session Exclusion- Hemi neglect, Aphasia, Cognitive impairment, Previous stroke	Experimental Group- 6 days/week 10 repetition of 2 sets of each task/day for 20-minute Control Group- PNF 20 min for 6 days/week	Action Research Arm Test Functional Independence Measures Nine Hole Peg Test FIM shows higher significance while ARAT NHPT was not showing significant effect.
30 stroke survivors 15 in CIMT 15 in PNF	Inclusion- Chronic hemiplegic stroke, Modified Ashworth scale 2 or less, Range of motion 10 to 20 degree with wrist extension Exclusion- Prior stroke, Cognitive impairment, Hemi neglect	Both CIMT and PNF was given 3 Times/ week for 6 week for 45 min/Day	Fugl-Meyer Assessment Modified Ashworth Scale Mini Mental State Examination
25 Patients 13 Exp Group 12 Control group	Inclusion- Hemiplegia, Age 45 to 65 years, MMSE >24 Exclusion- Hemineglect, below 45-year age and greater than 65-year age, Cognitive and language deficit	3 days/week for 6 week Control group 45 min of conventional therapy Experimental group- 45 min of conventional therapy + Mirror Therapy	Fugl-Meyer Assessment Functional Independence Measures Experimental Group shows significant results
24 post stroke patients 13 CIMT 11 Bobath	Inclusion- first time stroke, Age 18-to-80-year, Range of motion at least 45-degree shoulder flexion 20-degree elbow extension 20-degree wrist extension 10 degree of digit extension MMSE >24 MAS< 2	Bobath for 1 hour per day CIMT for 3 hour per day Both for 10 consecutive days	Motor activity log scale 28 Wolf Motor Function Test Functional Independence Measures CIMT shows better results over Bobath
26 patients 12 Task oriented training 14 Bobath	Inclusion- Post stroke between 2 to 12 months, MMSE 20, MAS > 3, Age 45 to 70 year Exclusion- Previous injury, No sitting balance, Any other neurological disorder	Intervention group- 30 min/day TOT and 30 minute/day Bobath for 3 days/ week for 5 week. Control group receives 60 minute/day TOT alone for 3 days/week for 5 week	Wolf Motor Function Test Fugl-Meyer Assessment Barthel index Grip strength test Intervention Group shows better Result
24 Post Stroke patients	Inclusion- Post stroke patient,1-4 on motor arm item of National institute of health stroke scale, had abilities to follow 2 step command Exclusion- Prior history of stroke, Hemi neglect, Aphasia, Anopsia	5 Days per Week 10 sets of exercise are performed 40 Minutes per Day for 3 weeks.	Nine sensors Dynamometer Modified Ashworth Scale Stroke Impact Scale

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20 patient of poststroke	Inclusion- Older than 16-year, Post stroke WMFT < 63, ARAT < 52, Able to perform aerobic exercise Exclusion- Aphasia, any other disorder, Unable to lift hand from behind head, Contractures in hand	Both group prescribe 60 hours of task specific training over 10 weeks 3 X 1 hour are session with therapist for week and 3 X 1 hour are of home base self-practice per week The aerobic and task specific training group performed 30 minute of aerobic exercise immediately prior to one hour of task specific training with the therapist	Action Research Arm Test Wolf Motor Function Test Fatigue Assessment Scale International Physical Activity Questionnaire.
20 participants of post stroke	Inclusion- No skin allergy to electrode, Score of 0 in FMA, First episode of stroke, GCS 15/15 Exclusion- Dysplasia, Communication problem, Medical and psychological condition, Any other neurological disease	each session consists of stretching activities of 10 minute + FES with bilateral task 20 minute and occupational therapy of 60 minute for 15 days	Fugl-Meyer Assessment Functional Test for a Hemiplegic Upper Extremity Grip Power Forward Reach Distance

Table 1

Discussions

There are many concepts and approaches which are evolved during time and produce great output in the rehabilitation of upper limb. Concept used in postural control and integration of the task performance of the sensory information for the motor control and the perception will improve at the cortex level. For an individual recovery that is very effective, in 6 week, each task has to be practiced about 1080 times and 360 repetition within one hour session of bobath study [7]. In recent studies of 20 session of Bobath interventions upper limb function was improve in 4 weeks [11].

The combination of task-oriented training program with Bobath improve the upper limb function meanwhile neuroplasticity changes in human brain have seen after performing task-oriented training in post stroke motor relearning program (MRP) is preferable than Bobath program for rehabilitation of stroke patient (Langanammer). Task oriented training exercises are meaningful and goal-oriented technique that include functional exercise which shows significant improvement in motor function like time, motor control, quality of movement, grip strength, ADL activities in different dimensions [6].

PNF patterns are the diagonal movements which promote the postal reflex, movement of week muscle and eccentric contraction to agonist muscle and the biarticular activities [7]. CIMT is a Repetitive, Task- Oriented training of the impaired arm for several hours a day. CIMT is an intervention which can significantly improve the function of the affected upper limb post stroke in compare of CIMT and PNF. PNF required correct application of technique used by the participants at home and special handling by physiotherapist. In comparison of CIMT with PNF by Rahman., *et al*. CIMT might be preferred technique for upper limb functional recovery [1]. CIMT shows the better result in motor relearning and ADL activities then Bobath technique [2].

Bilateral task training is used from both the hands to complete the task. The unaffected limb act as a reference limb and the patient perceived that the patient can perform the activities from affected hand and improve the functional ability of the cortex level [5]. Repetitive Task training also investigate that the extension of thumb and finger affects the grasping activities from 3 to 13 week by greater than 20 degree on average participants but it has limited recovery [4]. Aerobic training with task-specific training in less repetition doesn't affect the fatigue level of the upper limb muscles. The main limitation of the aerobic activities is that the patient is able to do the aerobic activities for at least 60 minutes session, while 87.5% participants doing aerobic exercise with task-specific training produce beneficial results for motor relearning [10].

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Youngju., *et al*. indicated with mirror therapy which relay on the common ADL may affect the participant motivation. A six-week intervention shows that the motor function of the upper limb with mirror therapy is significantly improve. The patient perceive that the affected limb is working which enhance the functional abilities of higher cortex the mirror therapy with conventional therapy shows the better result goal-oriented active repetitive movement facilitated the motor neuroplasticity [3].

FES is a very commonly used in acute stroke patients enhance the motor learning process which results in improving and function. FES without additional muscle movement shows the active recruitment which facilitate better control on movement with sensory feedback. FES combined with bilateral activity training trigger the motor cortex to facilitate the movement and enhance the process of neuroplasticity. Study says that only 20 to 40 minutes of FES session for 15 days improve the motor skills which are shorter time period than the other studies [8].

Unilateral and bilateral hybrid combined with robotic training says that the combination of robotic training with task-oriented training promote functional ability motor recovery and increase the pattern of movement there is very minute of abnormal movement during the activity [4]. In stroke loss of an activity leads to a major problem. The ideal activities are compromised by the patient from 67% of the population only 6% of the patients are satisfied with their arm function hand dominance plays a major role in doing activities of daily living the dominant hand relearning abilities are better than the non-dominant hand but after the conventional therapy there are significant improvement in both the limbs [4].

Conclusions

Through all the studies, every concept and approach give significant improvement on each other. The latest technologies like electrical stimulator are more focused from last 5 years while CIMT shows better results in comparison with other studies for the rehabilitation of the upper limb recovery.

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