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Review Article

Effect of Exercises in Hemiplegic Patients-A Systematic Review

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Abstract: Introduction: Muscle weakness is a common consequence of stroke and can result in a decrease in physical activity. Changes in gait performance can be observed, especially a reduction in gait speed, and increased gait asymmetry, and energy cost is also reported. **Objective**: The aim was to determine whether exercise can improve strength, balance and walking abilities in patients with hemiplegia. **Method**: Five databases (PubMed, Cochrane, PEDro, Web of Science, Embase) were searched to identify eligible studies. Randomized controlled trials were included. Pooled standardized mean differences were calculated using a random effects model. The PRISMA statement was followed to increase clarity of reporting. **Results**: Five studies, including 173 patients, reporting on the subject of progressive resistance training, specific task training, functional and aerobic cycling at high-intensity were analyzed. These interventions showed a statistically significant effect on strength and the Timed Up-and- Go test, and a non-significant effect on walking and the Berg Balance Scale. **Conclusion**: Progressive resistance training seemed to be the most effective treatment to improve strength. When it is appropriately targeted, it significantly improves strength.
Keywords: Stroke, Hemiplegia, Exercise, Resistance training.

Introduction

In industrialized countries, stroke is the most frequent cause of disability among adults. The death rate following stroke is set to decrease as a result of better care provision as soon as the problem occurs. It can therefore be expected that the number of people surviving with a disability following a stroke is liable to increase[1]. In addition, the incidence of stroke has increased dramatically among younger subjects, with over 20% of people affected being under the age of 65[2]. After a stroke, hemiparesis is a serious motor impairment, affecting 65% of stroke victims[3].

Muscular weakness is a conspicuous symptom[4] and appears as one of the main factors slowing the recovery of normal physical abilities among patients[5]. It appears in several forms, the most significant being paresis of the body on the contra-lateral side to the cerebral lesion[6], although correlation has also been observed between strength deficits on the ipsilesional side and walking speed[7]. Paresis is defined as an alteration in the ability to generate a normal level of muscle strength[8]. This results in abnormal posture and stretching reflexes, and a loss of voluntary movement[9]. Muscle weakness can lead to immobilization or to markedly reduced physical activity[2]. According to authors, the strength of the hip flexor muscles and the knee extensor muscles of the hemiplegic limb are the most important factors determining comfortable or fast walking speed. However, the spasticity of the ankle plantar flexors also appears as an important factor in this asymmetry. Plantar flexor muscles also affect walking speed[5]. Other characteristics are observed in stroke patients on the ten-meter walking test, such as a decrease in step length and in swing phase speed of the hemiplegic limb, longer single support time on the healthy side and prolonged double support phase[10] (time of transfer from hemiplegic to healthy side). It has also been shown that the pathological gait of a hemiplegic subject may have double energy cost compared to that of a healthy subject[11]. Thus, the purpose of this review is to evaluate the efficacy of passive exercise training for the hemiplegic stroke patient.

Methods

Literature Search

The literature search was restricted to English language publications from 2011 through 2019. Five databases (PubMed, Cochrane, PEDro, Web of Science, Embase,) were searched to identify eligible studies. Randomized controlled trials were included. Pooled standardized mean differences were calculated using a random effects model. The PRISMA statement was followed to increase clarity of reporting. The following search terms were used to identify appropriate articles: stroke, muscle weakness, physiotherapy, physical therapy, exercise, aerobic exercise and strengthening exercises. A review of references listed in the articles was also performed, for additional articles that met our criteria. During searching process of all related articles, the titles and abstracts were selected according to inclusion-exclusion criteria to recognize actually suitable article. Full manuscripts of selected articles were evaluated individually by two critics.

Study Criteria

Study design

The review included randomized controlled trial (RCT) as they provide high quality or evidence base and published in English language.

Inclusions criteria

Inclusion criteria for the articles reviewed included experimental studies using a variety of experimental designs (randomized controlled studies, studies of quasi-experimental design and case studies) and literature reviews published in English. Studies included in this review had to use some form of passive exercise training (with the understanding that training could be performed in the home setting), as therapy for the hemiparetic or hemiplegic patient.

Exclusion criteria

Repeatedly published articles; Studies that were published in abstracts only; Study subjects had other severe organ dysfunctions such as heart, lung, liver, or kidney; Baseline data were inconsistent between the intervention group and the control group; Interventions were sling exercise training; Outcome datas were incomplete and were still not available by contacting its' author.

Intervention

Considered studies are those which include exercise regardless of intensity and durations. Exercises programs included, strengthening exercises, flexibility exercises, functional training, stretching exercises, balance exercises.

Quality assessment

Quality of methodology of carefully chosen manuscripts was evaluated by PEDro Scale, containing of 11 questions in two phases. Questions from 2–9 evaluates internal validity while questions from 10–11 evaluates statistical evidences necessary to make a research readable. Each question is scored according to its presence or absence in the evaluated manuscript. The final score is completed by adding all positive responses.

Study stated that studies having score more than or equal to 5 out of ten were measured as high quality research. Thus, in this research all included articles scored more than or equal to 5, were found to have high quality in methodology. The articles were evaluated in PEDro scale by two reviewers' independently.

Data analysis

The selected articles were screened by two reviewers independently. They were evaluated in a structured way, consisting of given parameters: author, year, study-design, subject's age, interventions, study-duration, outcome measures, and results. Dissimilarities between the reviewers were resolved by discussions to reach settlement and established via Cohen's kappa statistics.

Outcome Measures

The main outcome measures are physical function and muscle strength evaluated by sway area (SA), sway length (SL) for balance, Berg Balance Scale (BBS), plantar pressure distribution, center of pressure path length (COP path length), center of pressure confidence ellipse area (COP area). Static balance was measured on a force platform, COP, dynamic balance was measured by Berg Balance Scale (BBS), Motor Activity Log (MAL), Nottingham Assessment Sensory (NAS), Wolf Motor Function Test (WMFT), Nine-Hole Peg Test (NHPT), sensorimotor functional activity and the quality of life questionnaire (SS-QOL), Tinetti performance oriented mobility assessment, Time up and Go Test, Chair stand test.

Results

Studies identified

After applying the inclusion/exclusion criteria, 50 studies were selected, 25 studies were disqualified as they were found in more than one databank. For eligibility criteria 25 studies were selected. Additionally, 20 articles were omitted due to unavailability of full manuscript and objective, unable to meet inclusion/exclusion (Figure-1). 05 articles were selected finally, after passing quality evaluation phase.

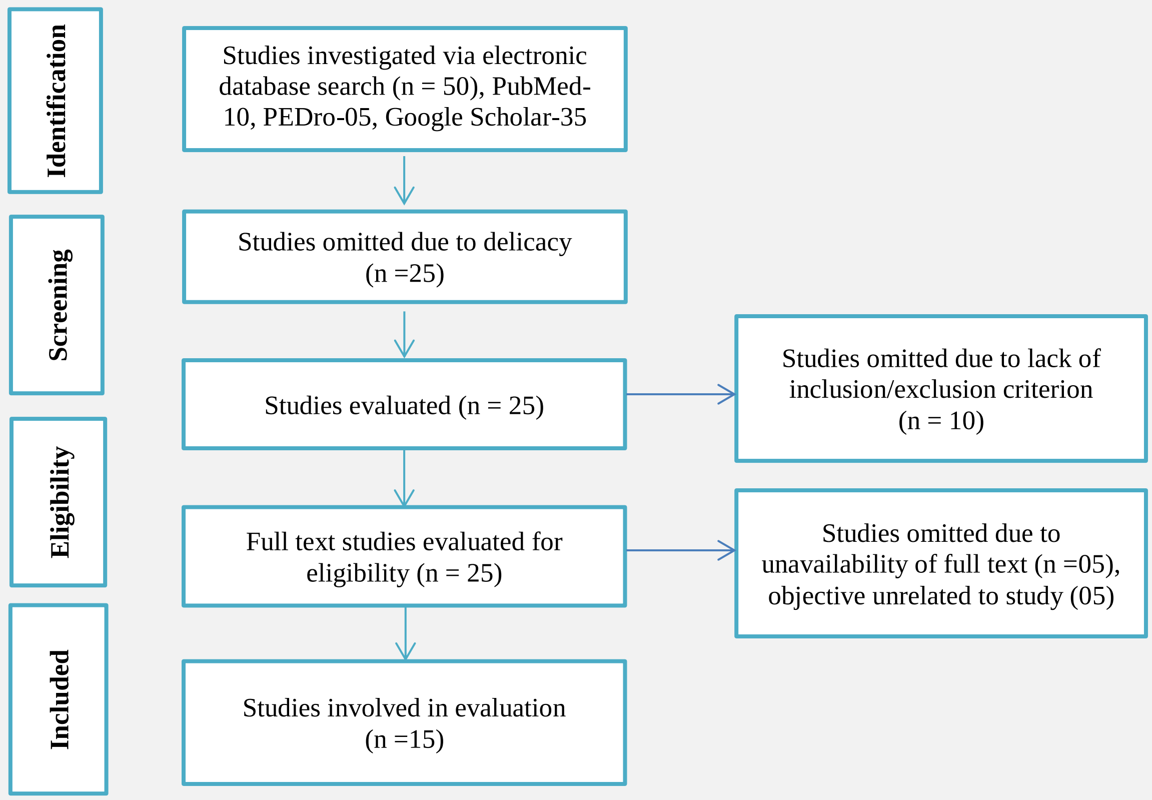

Figure 1. Flow chart displaying the selection of studies

Table 1. Description of the included study

Author	Study design	Subject	Intervention	Study duration	Outcome measure	Result
Park JH, Hwangbo G.[12]	Randomized controlled trial	N=40	Group 1: sling exercise group Group 2: mat exercise group	3 times per weeks for 8 weeks	Sway area (SA), sway length (SL) for balance	Recommend trunk stabilization exercise using a sling as a clinical intervention to improve the balance ability of patients with hemiplegia.
Arabzadeh S, et al.[13]	Randomized controlled trial	N=20	Group A: Received a 4-week task-oriented exercise program, Group B: Received 4-week conventional physiotherapy	4 weeks	Berg Balance Scale (BBS), plantar pressure distribution, center of pressure path length (COP path length), center of pressure confidence ellipse area (COP area).	A task-oriented exercise programs associated with an improvement in balance in patients with hemiplegia following stroke.
Shin WS, et al.[14]	Randomized controlled trial	N=21	Group 1: Combined exercise training group Group 2: Conventional exercise group	5 times per weeks for 4 weeks	Static balance was measured on a force platform, COP, dynamic balance was measured by Berg Balance Scale (BBS).	Study suggest that combined exercise training with functional strengthening training and aerobic exercise was effective at improve static and dynamic balance ability, and was more effective than conventional exercise at improving dynamic balance. This suggest that combined exercise training can be prescribed for stroke patients to reduce their risk of falls and lead independent ADL
da Silva ES, et al.[15]	Randomized controlled trial	N=62	Group 1: Aerobic exercise Group 2: m-CIMT or Stretching + m-CIMT. m-CIMT	3 months follow up	Motor Activity Log (MAL), Nottingham Assessment Sensory (NAS), Wolf Motor Function Test (WMFT), Nine-Hole Peg Test (NHPT), sensorimotor functional activity and the	This study provide valuable information about the effect of motor priming for fine upper limb skill improvement in people with chronic post stroke hemiparesis, generating new evidence.

					quality of life questionnaire (SS-QOL)	
Selvaraj L, Saravana Hari Ganesh M.[16]	Randomized controlled trial	N=30	Group 1: Otago exercise program Group 2: Conventional physiotherapy	12 weeks.	Tinetti performance oriented mobility assessment, Time up and Go Test, Chair stand test.	The study concluded that there was a significant difference within each group but Group- A showed significant improvements in CRT, POMA and TUG test than Group- B.

Discussion

This systematic review was done to examine the effectiveness of exercise therapy interventions in improving quality of life in hemiplegic patients. Evidences from RCTs were used to examine the effectiveness of exercise interventions in hemiplegic patients. In addition to above mentioned evidences, researchers mentioned below also proved physical therapy interventions to be equally effective to improving functional level in hemiplegic patients.

A total of 05 research articles on exercise for stroke patients are included in this review. This included studies on exercises and passive cycle-ergometry. Although, robotics can be used for stroke rehabilitation[17] and have been used as a comparison group in one of the studies discussed[18]. In a seminal study, Newman[19] followed the disease trajectory in 39 hemiplegic stroke patients for 12-weeks post-stroke in order to understand the natural disease trajectory. The majority (87%) of patients demonstrated some form of neurological recovery predominantly in the lower limb. Neurological recovery began as early as the first week post-stroke and continued until week 12 at which time the recovery rates plateau. Functional recovery followed that of neurological recovery. The legs tended to recover function more often than that of the arms and the proximal segments recovered function more frequently than the distal segments[20]. The trunk muscles are affected the least in hemiplegia and, in some cases, full recovery of trunk function can occur following a stroke. It was thought that early return of function (in particular of the upper limb) was due to reperfusion of the ischemic area and resolution of cerebral edema (which had contributed to decreased levels of consciousness), whereby, late recovery was due to transfer of function to undamaged neurons. More recently, researchers are also proposing that intensive rehabilitation for stroke patients (even during the chronic stage) can further enhance functional ability due to this transfer of cortical function[21,22]. Otago exercise is a well-known exercise program for elderly people with balance problems[16].

Otago Exercise Program is a strength and balance retraining program designed to prevent falls in older people[23] and various studies have proved that this structured exercise program has improved the elderly patients balance, lower limb strength, general fitness level, reduced and improved their independency level[16]. Pedersen et al. noted that a trunk stabilization program using a sling significantly improved elite soccer players' posture, balance, kicking speed, and functional strengths of the pelvis and the trunk muscles and concluded that functional muscle strength exercise using a sling was effective at enhancing nerve root adjustment[24].

Park et al.[25] reported that the muscle strength of patients with chronic lumbar pain, who conducted a sling exercise for four weeks, significantly increased in the lumbar region. In a study of lumbar pain patients assigned to trunk stabilization exercise on a mat or the same exercise using a sling. Trunk stabilization exercise using the sling was more effective than the trunk stabilization exercise on the mat for strengthening the muscles of the thoracic and lumbar regions[26,27].

Conclusion

This systemic review was conducted to investigate the effect of exercise therapy treatment methods designed to improve physical function in hemiplegic patients by summarizing the evidences from randomized controlled trials (RCTs), experimental designs. We conclude that therapeutic exercise program designed for hemiplegic patient's treatment can be more effective. In addition, hemiplegic patients can improve self-reported function with exercises including strength and balance training.

Conflicts of interest: No potential conflict of interest was reported by the authors.

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