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Critically analyse the effectiveness of exercise interventions that are prescribed for stroke survivors

Review of current literature by
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Introduction

Stroke is a major cause of death and dependency and it is the third common cause of mortality after cancer and cardiovascular disease in developed countries (Daviet et al, 2012). In addition, a third of stroke patients are developing considerable, permanent neurological impairment, which in turn are the number one cause of disability in older adults (Weiss et al, 2000).

The aim of this essay is to evaluate and analyse the effectiveness of progressive resistance training (PRT) on lower extremity of stroke survivors. In addition, the muscle strength, function, disability and gait pattern in stroke survivors will be discussed and finally based on the reviewed literature the effectiveness of PRE in stroke patients will be concluded. The inclusion criteria include both Ischemic and haemorrhagic stroke in adult. Yet, the efficacy of PRE on upper limbs has been excluded to enable in-depth review of PRE effectiveness in lower extremity.

Strokes can occur when the blood supply to an area of the brain is stopped by bold clot [Ischemic], or when a blood vessel ruptures and the blood leaks into the part of the brain [Hemorrhagic] (Daviet et al, 2012). In both cases, the effected part of the brain and the surrounding tissues can damage severely. Such disorder in the brain will limit the function of affected area and can be deadly (Stroke Association, 2013). In an ischemic stroke, a clot or thrombus is formed by plaques on the walls of brain arteries. Usually, a high concentration of low-density lipoproteins (LDL) in blood cholesterol is creating plaque deposits, which decreases the diameter of the brain artery. Consequently, the artery becomes inflexible and can reduce blood flow to the brain. The hemorrhagic stroke happened, when a blood vessel ruptures and the blood leaks to the space between the brain and the skull. Brain cells beyond the hemorrhage area are also deprived of oxygen and glucose. Hemorrhagic stroke can be caused by hypertension, aneurysm or trauma. In both ischemic and hemorrhagic strokes, the effected brain cells become damaged or die because they do not receive oxygen and other nutrients which are usually received by red blood cells (Stroke Association, 2013).

Depending on the brain area that has been affected by stroke, the function will suffer either in its reaction, planning or execution (Ouellette et al., (2004). If the lesion has affected the motor control area of brain then instructions will not be sent correctly. When the co-ordination area of brain is damaged then the movement will not be co-ordinated and when the somatosensory area of brain is injured then position sense is distorted, hence the sensory reception are affected which leads to alteration of movement patterns (Ouellette et al., (2004). In the United Kingdom 150,000 people are affected by stroke every year (Stroke association; 2007) and most of them are older adult age 65 and over. In addition, the stroke is the 3rd most common cause of death in the UK and 2nd most common cause of death worldwide (O'Donnell et al., 2010).

Stroke can happen at any time to anyone, yet there are few risk factors which are associated with stroke including hypertension, diabetes mellitus, overweight, physical activity, diet, alcohol intake, smoking and psychosocial factors such as stress and depression (O'Donnell et al., 2010). Stroke can have severe consequences including cognitive deficits, sensory and motor deficit, changes in aerobic capacity, visual problems, and muscle strength deficit (Daviet et al, 2012). In addition, stroke can affect the neuromuscular function by deconditioning the hemiparesis limbs in which the motor unit firing rates and recruitment are reduced and this is leading to muscle fibre composition changes and atrophy of type II muscle fibers (Oullette et al, 2004) and all of these factors can contribute to muscle weakness (Moreland et al, 2003).

Nevertheless, stroke reduces the capability to activate muscles which reduce the movement. (Burr et al, 2012). Reduction of muscle power in stroke patients is associated with physiological modification of muscle tissues and morphological changes in muscle fibre type, which decreases the functional ability (Ramasa et al., 2007). Limitation of mobility in stroke patients is increasing the risk of other preventable chronic disease including diabetes, cardiovascular condition, osteoporosis, depression and cancer which have impressive negative consequences on the overall quality of life and increases the sedentary lifestyle (Morris et al, 2004).

Therefore adequate exercise programs are required to manage wellbeing status and improve the overall quality of life for stroke patients (Burr et al, 2012).

Current evidence suggests that stroke patient can tolerate moderate physical activities and PRE with few adverse side effects compared to other pharmacologic interventions (Morris et al, 2004). The main principles of PRE are (1) completing a small number of repetitions before fatigue, (2) having adequate rest between sets to allow recovery and (3) increasing the resistance as the muscle's force generation ability increases (Morris et al, 2004). Traditionally, there have been many concerns regarding the safety and side effects of PRE for stroke patients (Taylor et al, 2005). Many stroke survivors are barred from participating in different physical activity and exercise programs, while they could benefit significantly from such program. This is mainly because of wrong perceptions regarding their functional ability and undue concern about side effects including increased hypertonia (Taylor et al, 2005), exacerbation of contractures, spasticity, reduced joint range of motion, safety and a significant risk of falls (Burr et al, 2012). However, the idea that PRE may aggravate spasticity has now been disproved (Taylor et al, 2005) and the risk of side effects was (0.03%) only in aerobic training which was cardiovascular in nature such as stroke exacerbation or myocardial infarction (Borbonnais and Noven,1989).

There is no common PRE training protocol for stroke patient amongst different authors. However, the reviewed literature suggest that typical PRE for stroke patients consist of 4 to 8 exercises using isokinetic dynamometers, weight machines or free weights with the loads corresponding to an 8- to 12 Repetition Maximum (RM) be lifted in 1 to 3 sets and exercising 2 or 3 days per week (Taylor et al, 2005; Burr et al., 2012, Morris et al., 2004), The 8 to 12 RM is a maximal weight that a person can lift 8 to 12 times properly until fatigue (Burr et al., 2012).

Ouellette et al, (2004) have studied the effectiveness of PRE in a RCT in which, Forty-two subjects, were received a 12-week supervised high-intensity PRE consisting of bilateral leg press (LP), unilateral paretic and nonparetic knee extension (KE), ankle dorsiflexion (DF), and plantarflexion (PF) exercises. In this study the functional performance was measured by using the 6-minute walking test, stair-climb time, repeated chair-rise time and maximal gait velocities. Their results indicate that a single-repetition maximum strength considerably increased in the PRT group for LP (16.2%), in paretic KE (31.4%) and nonparetic KE (38.2%), whereby there were no changes in the control group. In addition, the paretic ankle DF (66.7% versus 24.0%), paretic ankle PF (35.5% versus 20.3%), and in nonparetic ankle PF (14.7% versus 13.8%) have also improved greatly in the PRT group compared with the control group. Moreover, the PRT group also had important progress in self-reported function and disability, while there were no changes in the control. Based on these results, Ouellette et al, (2004) concluded that the high-intensity PRT improves both paretic and nonparetic lower extremity strength after stroke which has positive effects on reducing functional restrictions and disability.

Sharp and Brouwe (1997) carried out a pre-post test cohort study of 15 patients with stroke of more than 6 months, who did isokinetic strength training for 6 weeks. They showed that there were statistically major changes in peak torque of the knee flexors and the knee extensors, walking speed and the Human Activity Profile (a subjective measure of activity). The results of this study were significant because they did find that the muscle spasticity did not increase with muscle strengthening exercises. However, since there was no control group in this trial their explanation cannot be justified.

In another RCT (Moreland et al., 2003) examined the effectiveness of PRE on gross motor function and walking ability have been studied. In this study both experimental and control groups received conventional physiotherapy programs. In addition, the experimental group carried out, 9 lower-extremity progressive resistance exercises 3 times a week for the time being in the hospital, while the control group received the same exercises and for the same time but without any resistance. Interestingly their result showed that during the time in hospital, there were no significant changes in disability inventory, the between group difference was 0.02 points per day (95%) confidence interval. In addition, at discharge, the rate of change in the 2 Minute Walking Test (MWT) was 0.01m in the experimental group and 0 .15m in the control group; which indicate the between-group difference was 0.16m. Moreland et al., (2003) concluded that PRE as carried out in their study were not effective for stroke patient when compared with the same exercises program performed without resistance.

In study by Inaba et al, (1973), 176 participants were randomised in to into 3 groups: functional training and stretching; active exercise plus functional training and stretching; and progressive resistive exercise plus functional training and stretching. They have showed that PRE group improved considerably more in strength and gross motor function at 1 month, while at 2 months the differences were not significant. Since there was 56% loss in follow up of this study, there may have been significant biases that influenced the results. Therefore, the authors did not reach a definitive conclusion because of shortcomings in the study's methodologic.

Weiss et al., (2000) in an uncontrolled study have examined the effects of PRE on both the affected and least affected sides in long-standing stroke patients. The result showed strength increased by 68% on the affected side and 48% on the least affected side. They measured the results by repeated chair to stands movement. Though, it is difficult to justify their finding since these improvements may be resulted from the strengthening on the least affected side. In addition, the lack of a control group confines the explanation of this trial.

Engardt et al (1995) have studied the reactions of 20 hemiparesis subjects to concentric and eccentric isokinetic training for knee extension. The patients were divided to the 2 groups by matching their clinical characteristics. This study have proven that the eccentric group was superior (P0.05) to the concentric group in improvement toward symmetrical body weight distribution when performing sit to stand exercise. Again, the lack of a control group was a main limitation of this study.

Considering the above randomised trials, indicate that there are conflicting results regarding number of training sessions per week and the duration of such training programs. The Burr et al., (2012) suggest 8 to 12 RM, 1 or 3 sets, 2 or 3 times per week while Taylor et al, (2005) recommend 6 to 10 RM, 1 to 3 sets, 2 to 5 times per week, ranging from 4 to 12 weeks. Nevertheless, variety of the methods used in the above randomised control trials (Engardt et al, 1995; Inaba et al, 1973; Moreland et al, 2003, Sharp and Brouwe, 1997; Weiss et al., 2000,) and protocols used in other reviews (Morris et al., 2004, orbonnais and Noven, 1989) do not agree on general recommendations on this type of exercise for hemiplegic stroke patients.

Morris et al., (2004) in a meta-analysis of PRE programs, showed that muscles strength improve without increasing spasticity in stroke subjects. Yet, the muscle improvement varies between muscle groups and also between the plegic and healthy limb. The plegic limb improved 68% while the healthy limb gained 48% improvement. However, the effectiveness of PRE on activity of daily living depends on the training principle and the specificity of programs. Therefore, one should not necessarily expect that improvements in muscle force generation definitely lead to improvement in everyday activities (Morris et al., 2004).

Walking limitation and asymmetric gait pattern are the most common consequences of stroke which is caused by motor deficits in hemiplegic patients (Ramasa et al., 2007). In the gait cycle of stroke patients, the stance phase of plegic limb is shorter and swing phase take longer time, which decreases the step length on the plegic side and hence reducing the speed of walking (Ramasa et al., 2007). In this group of patients the ability for fast walking is significantly decreased due to failure of lengthening the step size (Ramasa et al., 2007). The important features for asymmetric gait and walking abnormality in stroke patient include lack of sufficient balance, spasticity, motor and sensory deficit, insufficient muscle strength of the healthy and plegic limb (Ramasa et al., 2007) and body mass composition (Teixera et al., 1999). Gait training and exercise programs aim to improve functional ambulation and gait pattern in stroke patient. The determining factors are walking speed, step length, endurance, cadence, balance and symmetry (Ramasa et al., 2007). Yet, Weiss et al (2000) indicate that the reduced walking speed and movement is associated to decreased strength in hip flexors and knee extensors when compared with healthy participants within the same age range.

It is very helpful if physical activity and exercises are promoted in the early stage of post stroke, which can avoid the survivors from entering the vicious cycle of deconditioning and prevent another stroke and another vascular complication which support social reintegration and improve quality of life (Daviet et al, 2012).

Conclusion

After reviewing the above articles about the effectiveness of PRE on stroke patients, it is clear that there is a mixed result in the current literature regarding this subject. Although ascertaining and comparing the outcomes of these studies are crucial for clinical interventions, yet it is difficult to recommend a general protocol from these studies regarding the effectiveness of PRE on stroke patients. Because there are many different confounding variables in each trial such as sample size, age, post stroke time, gender, type of stroke, severity of lesion, impairment level, functional limitation and different type of measurement tool used in each study. Therefore, a future study may try to set up a new methodology for studying large sample of stroke patient in deferent stage of disease with different impairment. Yet, there is sufficient evidence in the reviewed literature that PRE are increasing the muscle force generation, improving walking ability and reducing disability which improve the quality of life and functional performance after stroke.

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