Review of Parkinson's Disease, Multiple Sclerosis, Stroke and Traumatic Brain Injury and Resistance Exercise

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Introduction

This is a literary review of studies conducted with patients afflicted with Parkinson's Disease, Multiple Sclerosis, Stroke and Traumatic Brain Injury. The purpose of this research paper is to review physical therapy treatments and, in particular, the benefits of resistance exercise programs in treating Parkinson's disease, Multiple Sclerosis, Stroke and Traumatic Brain Injury. Parkinson Disease, Multiple Sclerosis, Stroke and Traumatic Brain injury are drastically different in the onset of the disease and progression of the disease but, patients suffering from each of these four diseases are similar in that many patients struggle with balance, muscle atrophy, strength loss, and decreased gait coordination. As individuals age the onset of diseases become more prevalent and it becomes important for individuals to participate in exercise activities to either prevent or slow the progression of disease.

After reviewing peer reviewed journal articles extracted from the online data base, PubMed, the types of exercise researched varied across the board including dance therapy, vibration therapy, treadmill therapy, and resistance exercise. While all types of exercise have their benefits to exercise, this review focused on if and how resistance exercise has been beneficial in the rehabilitation of Parkinson's Disease, Multiple Sclerosis, Stroke and Traumatic Brain Injury patients.

Background on Disease's

Parkinson Disease

Parkinson's disease (PD) currently affects one million Americans and around 60,000 individuals are newly diagnosed each year (Parkinson's Disease Foundation (PDF)). Idiopathic Parkinson's disease is a neurological disorder that is characterized by rigidity, bradykinesia, tremors, and loss of postural control (Dibble et. al). Additional motor symptoms include freezing, micrographia,

mask-like expression, and unwanted accelerations (PDF). Parkinson's disease progresses over time to a debilitating disease that decreases the quality of life for affected individuals. Parkinson's is not classified as a fatal disease and the progression of the disease is different for each individual (PDF). Mild PD does not affect daily activities, but tremors are present on one side of the body, posture changes occur, and walking ability is lessened. The disease becomes classified as moderate Parkinson's when movement symptoms occur on both sides of the body, movement is slower, coordination and balance problems develop, and "freezing" episodes arise. In the advanced stages of Parkinson's, individuals are no longer able to live alone and lose their independence. Memory and executive functioning of the brain also decline (Sturkenboom et al.). There are many medications to help treat the symptoms of Parkinson's, but there is not a cure for the disease. In addition to medications, exercise has been found to be beneficial in the early to mid-stages of the disease.

Multiple Sclerosis

Multiple Sclerosis (MS) is a degenerative disease of the central nervous system that progressively gets worse over time. Symptoms of Multiple Sclerosis include, sensory and motor loss, fatigue, difficulties with balance and sexual functioning, pain, cognitive impairment, and depression. Motor impairments include reduced mobility and physical activity level, which in turn causes decreased muscle strength. This weakness results in a decreased functioning in lower limbs leading to impairments in walking (Broekmans et. al). MS often presents between the ages of 20 to 40 (Aronson KJ). As the disease progresses, increased medical care for the individual becomes necessary. MS requires ongoing care that focuses on preparing for the future progression of the disease, and maintenance of current health of the individuals to prevent

increased complications down the road (Bodemheimer et. Al). Early MS treatment focuses on fall prevention, exercise, stress management, and patient-directed self-care (Rae-Grant et. al).

Stroke

Within the aging population, stroke is one of the major contributors to disabilities. The onset of stroke can be quick and unexpected, but the recovery process is very long. After a stroke, many individuals have impairments in their functional ability to walk. This difficulty in walking for stroke patients correlates to spastic foot-drop (Hwang et. al).

Traumatic Brain Injury

Traumatic Brain Injury (TBI) has become one of the leading causes of death and long-term disability. Unlike Multiple Sclerosis and Parkinson's Disorder, TBI is a sudden injury to the brain that occurs after birth and is not related to congenital disorders or development disabilities. TBI does not progressively get worse over time like MS or PD (Bland et. al). Once an individual experiences a TBI, long-term physical, cognitive, and behavioral disabilities occur. Both the injury causing the TBI, and the impairments associated with the injury, vary among patients. Common disabilities associated with TBI patients include balance problems, decreased motor functions, and gait problems (Bland et. al). The effectiveness of different physical therapy treatment for TBI is less researched compared to other neurological impairments.

Exercise Benefits

Exercise and Parkinson Disease

Research supports that exercise is beneficial to Parkinson Disease (PD) patients. Comparing various treatments for PD will lead to a further understanding of the type of exercise that produces the greatest benefits. Review of the research will show what type of exercise will be most beneficial in reducing falls, improving balance, increase gait coordination, and improving

quality of life in patients. With mild Parkinson's, exercise can be beneficial. It "maintains mobility, flexibility, range of motion and balance, and also reduces depression and constipation" (PDF). During moderate Parkinson's, exercise with the help of a physical therapist or occupational therapist becomes important in maintaining mobility and balance. With advanced Parkinson's, regular exercise may no longer be an option, as patients will need assistance with most of their daily activities (PDF). Similar to aging, with Parkinson's, muscles atrophy and become weak (Dibble et. al). Many exercise programs have been tested to understand what techniques will be the most beneficial to Parkinson patients.

Evidence-Based Physical Therapy

While there are many physical therapy treatments, treatments often share three key elements. One of the elements is teaching PD patients how to move better and to improve posture cognitively. This element is based off the knowledge that Parkinson's patients have a deficit in the basal ganglia, brain stem, and motor cortex which lead to the problems with gait and posture. "Through bypassing the defective basal ganglia and instead using the frontal cortex to regulate movement size or timing by consciously thinking about the desired movement, people with PD arguably compensate for the neurotransmitter imbalance in the basal ganglia" (Morris et. al). The second element is managing the decline in musculoskeletal and respiratory systems due to aging and decreased physical activity (Morris et. al). PD patients avoid physical activity due to the increased difficulty of movement, a major symptom of the disease. With this, PD patients become even more sedentary. Developing a physical therapy program to keep the PD patients active will help prevent the decline in muscle strength, aerobic capacity, and mental function. The final key element found in many physical therapy treatments is to improve the quality of life and prevent falls. Preventing falls is one of the most important aspects of treatment to focus on

with PD because of the high rate of falls in PD patients. Clinicians need to help patients develop reasonable exercise programs that will be easy to adhere to. Teaching PD patients the importance of maintaining a regular exercise program is necessary to get positive results from a therapy program.

Resistance Exercise

Much of the weakness associated with Parkinson's Disease is due to muscle weakness. Weakness can occur due to changes in the agonist and antagonist muscle activation patterns which lead to a difficulty in coordinating movements that generate the maximum amount of force produced by the muscles. Weakness also is a result of inactivity during the progression of the disease leading to further atrophy of the muscles. High-force eccentric resistance training produces muscle hypertrophy, increases strength, and improves mobility in individuals with mild to moderate PD. The idea behind eccentric resistance strength training is that high muscle force production is completed with lower amounts of oxygen consumption when compared to concentric muscle contractions. With participation in the eccentric resistance exercise training, hypertrophy was seen in PD patients, but was less than the percent of hypertrophy seen in non-neurologically impaired individuals. The probable cause of this outcome is due to the reduced neural drive in PD patients. The strength training showed improvements in both stair ascent and descent, but showed greater improvements in stair descent (Dibble et. al). Many individuals with PD have difficulty getting out of their chair, range of motion, and initiation of gait. Studies have shown that progressive resistance training has been shown to improve gait initiation in PD patients. Progressive resistance training stimulates neural adaptations that are normally triggered during initiation of movements in non-diseased patients.

Patients with PD often have abnormalities with their basal ganglia. The basal ganglion has been found to play a role in force production of muscles (Hass et. al). Using resistance training to improve central neural function could improve muscles activation and lead to improvements in muscle strength, range of motion, and gait initiation. Hass et. al explain that gait initiation is characterized by a posterior displacement of center of pressure of the initial swing leg. With non-diseased individuals, this change in center of pressure generates momentum necessary for walking. With PD patients, there is a dysfunction in this mechanism. Many drugs have been used to help with this, but studies have found that progressive resistance exercise helps improve the posterior displacement of center of pressure that occurs with PD similarly to what medications have done (Hass et. al). Resistance training has also indicated improvements in stride length and velocity. This improvement could be a result of increased propulsive force productions produced by the swing leg and increased strength of the hip muscles used during walking. Progressive eccentric resistance strength training includes a high resistance load with a fewer number of repetitions to increase muscle strength. Over time, the resistance is increased while training the individual so that they are able to generate greater force. A program that used progressive resistance strength training with PD patients used Thera-band to provide resistance while increasing the tension level of the band over the course of the study. This exercised the muscle to fatigue and increased the strength of the muscle over time (O'Brien et. al). This study looked at the benefits of resistance exercise using a Thera-band, but focused more on the benefits of exercise in groups of people. It would be valuable to measure the direct effects and benefits of resistance training with the Thera-band versus "typical" physical therapy treatments used for PD patients.

Type/Study	Exercises	Frequency	Intensity	Time	Notes
High intensity eccentric Resistance Training (Dibble et. al)	High force quad contractions cycle ergometer + resistance exercises (machine and free weight)	3x/week-12wks		45-60 min	Decreased bradykinesia, improved quadriceps strength
Progressive Resistance Training(Hass et. al)	Seated leg press, knee extension, knee flexion, abdominal curl, back extension, seated calf raise and ankle plantar/dorsi-flexion/ inversion/eversion	2x/week-10wks 2 sets, 12-20 Reps	Knee extension/flexion @ 70% 1RM		Improvements in Posterior displacement of the COP, initial stride length and velocity. Improve gait initiation
High-Intensity Eccentric Resistance Training (Dibble et. al)	High force quad contractions on eccentric ergometer + resistance exercises	3x/week-12wks	Based on RPE	45-60 min	Muscle volume, muscle force, functional status improvements, improved stair descent and 6-minute walk
Progressive Resistance Training w/ Thera-band (O'brien et. al)	3 upper limb, 6 lower limb and trunk	3x/week-10wks 10-12 Reps of each exercise	Resistance of Thera-band increased once 12 repetitions were completed with ease	60 minutes max	Strength increases, but results focused on benefits of community based program

Exercise and Multiple Sclerosis

Exercising can help in numerous ways while living with MS. While exercise provides the common benefits of reduced cardiovascular disease and diabetes and many more health benefits, it can help prevent the decline of muscle weakness strength that occurs along with the disease

progression. Not exercising correlates to increased immobility, fatigue, and decreased muscle strength with the disease. In the past, MS patients were instructed to rest, instead of exercise, to conserve the little energy they had, but more recent studies suggest that exercise in MS patients improves quality of life (Smith and Hale).

Resistance Exercise

As the disease progresses, the ability to generate force in the muscles greatly decreases. The decrease in muscle force is potentially due to a decreased motor unit recruitment and discharge. In addition, similarly to Parkinson Disease, the lack of use of muscles causes a huge decrease in strength as the disease progresses (Taylor et. al). Resistance exercise training has proven to improve gait in people with multiple sclerosis thus allowing MS patients to walk quicker and further without getting as tired (Sabapathy et. al). Taylor et. al also found that progressive resistance training increased leg muscle strength and increased the speed of walking with individuals with mild to moderate Multiple Sclerosis. The fatigue experienced by MS patients also is associated with a change in muscle fiber type. In MS there is evidence of a decreased number of type 1 fibers; fibers are smaller, and there is a heavier dependence on energy from anaerobic energy supplies than aerobic (Smith and Hale).

Type/Study	Exercises	Frequency	Intensity	Time	Notes
Upper leg strength and walking capacity (Broekmans et. al)	Knee extensors/flexors measured with isokinetic dynamometry				Greater knee flexor strength associated with increased walking capacity. Greater knee extensor strength associated with greater endurance.
Endurance vs Resistance in MS (Sabapathy et. al)	Chest press, Seated row, Shoulder Abduction. Sit to stand, static lunge, hip	2-3 sets, 6-10 reps 8 wks.	Resistance w/ Thera-band, progressed to dumbbell		Increases in muscle strength with resistance training. No significant difference

	abduction				between endurance and resistance groups
Progressive Resistance exercise (Taylor et. al)	Leg press, knee extensions, calf raise, lat pull down, arm press, seated row	3x/wk 10 wks 2 sets, 10-12 Reps	60-80% 1RM		Significant improvements in arm strength, leg endurance, fast walking speed, 2 meter walk test distance
Review of resistance training effects on fatigue in patients with chronic illnesses (Smith and Hale)	Main items of equipment were a pulley system and an isokinetic dynamometer	4-6 wks	Varied within studies reviewed		Subjects perception of fatigue was lower. Physical fitness improved.

Stroke and Exercise

Many studies look at ways to improve gait in stroke patients through neurofacilitative therapy, virtual reality, and robotic-assistive devices. Progressive resistance training has been found to be an effective way to improve muscle weakness in the lower limbs of stroke patients (Lee et. al). Additionally, ankle-foot orthoses (AFOs) have proven to help hemiplegic patients improve their gait through preventing foot-drop and toe clearance problems (Hwang et. al.). Hwang et. al. looked at the effects of how elastic walking bands improved gait in individuals. They wrapped the elastic band through four plastic rings located on the anterior tibia, posterior aspect of the knee joint, middle of the thigh, and postereo-lateral hip. With the resistance from the elastic band, the researchers found that the cadence and swing time between limbs was not significantly improved but did find that walking speed was improved immensely. It is important to note that they did not use exercises with the elastic bands, but a support for the foot. This leads to a

proposed idea that elastic bands used in an exercise program to help develop strength in lower leg muscles so the use of AFOs is lessened.

Resistance Exercise

Multiple studies have looked at the effects of using Thera-band resistance exercise to improve muscle control of the lower limbs during normal gait. Studies looking at Thera-Band resistance exercise found that the exercises improved dorsiflexion during a single cycle of swing and that Thera-Band® Elastic Resistance-Assisted Gait Training has been found to be more effective in improving quality of gait and functional mobility in stroke patients (Patil et. al.).

Type/Study	Exercises	Frequency	Intensity	Time	Notes
Close kinetic chain(CKC) vs open kinetic chain(OKC) (Lee et. al)	CKC terminal segment of limb in constant contact w/ resistance surface, OKC not constant contact.	6wks CKC and OKC exercises each 5x/wk	4 reps at 25% 1RM, 3 sets: 8-10 reps at 70% 1RM		Intro supports that resistance training is beneficial to MS patients and CKC training group had significant changes in contact area, peak contact force and hind foot impact force.
Elastic Walking Band and Gait (Hwang et. al)	wrapped the elastic band through four plastic rings to support foot drop				Resistance from the elastic band improved walking speed
Thera-band resistance program (Patil et. al)	Thera-band exercises		Thera-band color based on resistance needed.	45 minutes (30 minutes general occupational therapy+15	Improve quality of gait/mobility. Facilitates dorsi-flexion

				minutes Thera-band)	during single cycle of swing

Traumatic Brain Injury and Exercise

Numerous studies have looked at the effectiveness of gait and balance treatments with patients suffering from Traumatic Brain Injury (TBI). The studies that looked at exercise treatments to improve these impairments found few results that showed improvements in conditions experienced by TBI patients (Bland et. al).

Traumatic Brain Injury and Resistance Exercise

Progressive resistance strength training has proven to show improvements in multiple sclerosis and Parkinson's Disease. It has also been shown to be effective in stroke (Morris et. al). Stroke and Traumatic Brain Injury share many similarities; impairments are due to a sudden onset versus a progressive disease and brain spasticity often occurs due to the injury effecting the central nervous system (Morris et. al). This similarity suggests that resistance training for TBI patients could be a beneficial way to improve their strength. When a group of TBI patients participated in a progressive resistance training program, some improvements in isotonic strength forearm press and leg press were depicted. Morris et. al showed that the increase in strength was more significant in the participants who were very weak. The leg press strength increased faster than arm strength (Morris et. al). While strength increases were shown, the gains were not significant compared to baseline strength. While the patients showed increased leg strength, they did not show improvement in max gait speed.

Type/Study	Exercises	Frequency	Intensity	Time	Notes
Progressive Resistance Training (Morris et. al.)	Leg press, lat pull-down, hip abduction, arm press, heel raises, seated row, abdominals, hip flexors	2x/wk 8wks	Initially 60-65% of 1RM and increased over weeks.		Leg press strength increased (4 of 7 participants), arm press strength increased (2 of 7). Improved sit-to-stand.

Discussion

Parkinson Disease, Multiple Sclerosis, Stroke and Traumatic Brain injury vary in the causes of the disease and how the disease progresses, but all the patients similarly struggle with balance, muscle atrophy, strength loss, and decreased gait coordination. Studies, across the board, show that exercise is a beneficial tool to help improve symptoms or, at least, slow the process of the disease. A common finding amongst studies was that strength training is correlated to improvements in the health of diseased or injured patients. Not as much evidence of strength training is shown for Traumatic Brain Injury patients, but the similarities between stroke and TBI suggest that strength training could be a valuable tool in the rehabilitation of patients. Commonly in the four diseases reviewed, muscle atrophy and strength loss was largely due to the disuse of the muscles throughout the progression of the diseases. Loss of muscle plays a role in impairments in gait and using resistance exercise to help prevent the loss of muscle was a beneficiary tool in the recovery of these impaired patients.

Future Research

A lot of research has been conducted on the rehab of these diseases and resistance exercise has been correlated to positive results. In the future, research on the effectiveness of Thera-Band elastic bands in a resistance exercise program needs to be conducted. Using Thera-band, instead of typical resistance exercise equipment could provide new ways to help the patients. Thera-bands have shown to be an effective treatment in increasing strength in non-neurologically impaired individuals; based on these improvements, this could suggest that similar findings would be found when using the Thera-band. While the percent increase in strength and gait may be lower in Parkinson's disease and Multiple Sclerosis, past results suggest that resistance exercise with the Thera-band could lead to a slower decrease in muscle atrophy and weakness over time. From the findings that have been found thus far, Thera-Band would be a valuable tool for Parkinson disease, Multiple Sclerosis, Stroke and Traumatic Brain injury.

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