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Utilization of Resistance and Balance Training in a Patient with Relapsing-Remitting MS: A Case Report

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Abstract

Background: Multiple sclerosis is a commonly diagnosed neurological disease, but standardized courses of treatment are not well established by research. Symptoms associated with MS can lead to significant primary and secondary complications, impacting an individual's physical and emotional wellbeing, as well as quality of life. Although research is lacking, wellness programs including physical exercise and rehabilitation to address mobility deficits, are considered a standard for those with MS. **Case description:** The patient was a 76-year old female with 18-year diagnosis of Relapsing-Remitting MS. The patient's chief complaint was right lateral hip pain, increasing losses of balance and significant weakness in left leg. The patient was referred to outpatient physical therapy for right hip pain and general strength and balance training. **Interventions:** The patient participated in therapy for 12 weeks, in which time emphasis was put on balance and lower extremity resistance training. The patient performed general lower extremity strengthening and functional tasks for strengthening throughout therapy sessions. Static and dynamic balance interventions were then integrated. **Outcome measures**: Outcome measures tested included the Musculoskeletal Functional Outcomes Survey, Five Time Sit to Stand Test, static balance, Forward Reach Test, and manual muscle testing. **Discussion**: The purpose of this case report is to identify interventions incorporated in the plan of care for an individual with MS and report this individual's response to said interventions. This report will identify the patient's response to balance and resistance training specifically. The patient displayed overall improvement in static balance, lower extremity strength, and decrease in objective fall risk.

Keywords: Multiple sclerosis; resistance; balance; neurology; physical therapy; rehabilitation; fall risk

Introduction

Multiple sclerosis (MS) is one of the most commonly diagnosed neurological disorders worldwide, with over one million individuals diagnosed in the United States alone, as of October 2017[8]. MS is characterized by chronic inflammation within the central nervous system (CNS), with notable episodes of worsening symptoms. Symptoms arise as a result of damage to the sheaths that protect the nerves. Damage may present as weakness, fatigue, decreased balance and changes in gait. While multiple types of MS exist, Relapsing-Remitting MS (RRMS) is the most commonly diagnosed, at 85% of all cases[8]. Relapsing-Remitting MS consists of periods of decline, followed by recovery from these episodes[2]. The most widely recognized symptoms of RRMS include issues with the visual and sensory systems, while progressive MS may display significant bouts of increasing motor disabilities. The patients with long-standing diagnoses of MS are more likely to experience complications with multiple body systems including motor, visual, sensory and psychological[2].

MS commonly onsets in the fortieth year of life but in recent years, increasingly earlier and later onsets have been recognized[2]. While the cause and what contributes to the onset of MS has not been identified, genetic and environmental variants, as well as defects with the immune system, may contribute. Relatively little research is available to provide clear evidence for optimal therapeutic interventions for MS, however a multimodal, interdisciplinary approach is recognized as standard treatment. For those with relapsing forms of MS, drug therapies act as first-line defense, with maintenance of associated symptoms utilizing multi-facet wellness programs. While drug therapies can help to slow disease progression, they cannot reverse established lesions in the CNS. Therefore, as disease course continues and symptoms become more debilitating, the purpose of a multimodal approach is to address limitations in ability to perform activities of daily living and help increase participation in society[2]. Physical rehabilitation plays an important role in facilitating this process.

Physical rehabilitation is considered pivotal in addressing mobility, balance and gait deficits that may arise in patients with MS. A reduction in physical activity can result in secondary complications such as reduced bone density, impaired cardiovascular health and overall quality of life[3]. Research lacks in specifically identifying types or dosage of physical activity recommended for those with MS. Until recently, Uhthoff's phenomenon was believed to be a contraindication to exercise for patients with MS. It has been shown that with close monitoring and proper rest breaks, this increase in body temperature during exercise and resultant overheating can be negated[2]. Physical rehabilitation is now identified as a positive method of addressing mobility and balance deficits, with little risk to the patient[1]. The purpose of this case report is to identify interventions incorporated in the plan of care for an individual with MS and report this individual's response to said interventions.

Patient history

The patient is a 76-year old female with 18-year diagnosis of relapsing-remitting MS, with referral to physical therapy from her primary care physician. The patient was referred to physical therapy for right hip pain and general strength and balance training. The patient's chief complaint was right lateral hip pain, increasing losses of balance and significant weakness in left leg. She utilized a single point cane for community distances and noted she had begun utilizing the cane within the home as well recently. The patient noted she had never used a cane within the home until two months ago when her weakness began to get progressively worse and she had onset of right hip pain. The patient reported one fall in the last year but frequent losses of balance secondary to catching her toes while walking. She attributed this to left leg weakness. She had quit using the upstairs in her home completely, for fear of inability to negotiate the stairs. The patient had slight visual impairment secondary to progression of

MS but no other comorbidities. The patient goals for therapy were to increase confidence with walking, balance and use of cane, walk for extended periods without pain and decrease right hip pain.

Examination and Evaluation

The patient completed the Musculoskeletal Functional Outcomes Survey (MSFS) prescreen prior to evaluation. This is not a commonly utilized outcome measure but one heavily used in the clinic in which this patient was seen. This outcome measure has similar components to the 100 question Musculoskeletal Function Assessment[13], which focuses on difficulty with daily activities. The MSFS is comprised of seventeen questions regarding ability to complete daily activities. Answers given range from zero, unable to perform the activity, to four, able to perform this activity without difficulty. Once completed, a functional score is output based on initial scoring, which represents a clinically meaningful difference in performance of activities for this patient. On initial assessment, the patient scored 48.53, with a functional goal set for 75.00, which would reflect a reduced fall risk and improved functional status (Table 1).

Static and dynamic balance tests were then performed with the patient. Static balance is a commonly utilized outcome measure because it is quick to administer and has good intertester reliability[14]. Many patients with MS consistently display reduced static and dynamic balance (Table 2), and it is estimated that between 50 and 60% of individuals with MS will have one or more falls within a one-year time frame[6]. Upon assessment of our patient, she required hand support to initiate all movements for balance testing. She was very apprehensive about having feet together and noted extreme unsteadiness with feet even a few inches apart. This patient displayed significant impairments in static balance. She would not attempt single leg stance secondary to feelings of unsteadiness. On average, a 76-year old woman should be able to maintain single leg stance with eyes open for 11.3 seconds[14]. As our patient was unable to even attempt single leg stance, this indicates that she is at a highly increased risk for falls[14].

The Forward Reach Test was then utilized to assess dynamic balance. The Forward Reach Test is a well-established outcome measure that is utilized within more extensive balance tests such as the Berg Balance Scale. Within the geriatric population that still live in the community, a forward reach of ~7.0 to 7.5 or less identifies individuals that are most limited[5]. Below this cutoff point indicates increased fall risk, most difficulty with performing activities of daily living (ADLs) and decreased independence with mobility[5]. The patient's score indicates she is at significant fall risk and likely displays difficulty in performing ADLs.

Lower extremity manual muscle tests were then performed, as her referring diagnosis and chief complaint were of lower extremity weakness and balance deficits. Strength scores ranged from 2+/5 to 4+/5, with typically lower scores on left lower extremity than right (Table 3), consistent with her self-reported 'weakness' in the left leg.

The Five Time Sit to Stand Test, an outcome measure used to assess overall balance and lower extremity strength, was lastly analyzed. This test demonstrates an individual's ability to move quickly from sitting to standing without the use of hands. This outcome has been specifically studied in those with MS, as a valid measure of muscle strength in more affected leg. A time peaking 13 seconds indicates that an individual may be at an increased risk for falling[7]. In community dwelling adults, the average score for those between the ages of 70-79 years is 12.6 seconds, with a score of 15+ seconds indicating a risk for recurring falls[14].The patient's time to complete this test indicated an increased risk for falling.

After analyzing the individual's gait, she displays left hip external rotation on swing through phase, decreased right step length, left trunk rotation, foot flat heel strike bilaterally, minimal arm swing, decreased cadence and gait speed. Gait speed was not measured. The patient ambulated with a single point cane in her right hand, as this felt most comfortable to her. As her left leg was significantly weaker, this was deemed most appropriate by the physical therapist.

Clinical Impression

After evaluation by the physical therapist, the patient's primary issue was deemed to be her right lateral hip pain, which presented as trochanteric bursitis. This pain began multiple months prior when she noted more significant weakness in left lower extremity. The physical therapist contributed bursitis symptoms to left leg weakness and residual compensation through right lower extremity. The patient's most significant issues to be addressed with therapy intervention were significant muscle weakness and balance deficits, primarily in left lower extremity. Suggestions were initially made to the patient to begin using her cane more within the home and to remove any unnecessary rugs in order to decrease risk of falling. She was eager for all advice to reduce losses of balance. The patient was deemed appropriate for physical therapy to address strength and balance deficits. Utilizing results of administered outcome measures, therapy interventions would focus on patient's deficits, which aligned well with patient goals.

Intervention

This patient was seen twice per week for 12 weeks total, for one-hour treatment sessions. During the primary four to five weeks, the patient focused on lower extremity strength and static balance. A warm-up consisting of recumbent bike and supine leg press was initiated at the beginning of each treatment session. As she displayed significant global hip weakness, the patient would perform isometric gluteal sets, hip extension with feet on swiss ball, sidelying hip external rotation/abduction, abdominal bracing with hip flexion and standing hip flexion. The patient displayed primary weakness through ankle plantarflexors, therefore double leg stance heel raises were given, as the patient was unable to perform single leg heel raises. She also performed more functional strengthening exercises including anterior and lateral step ups, sidestepping and moving from sitting to standing. The height of steps used for step ups was increased as she was able to perform 20+ repetitions. Sit to stands were made more difficult by reducing chair height and biasing the left leg towards the chair. This enabled the weaker left lower extremity to take majority of the load and reduce compensation through right lower extremity.

The patient's home exercise program consisted of strengthening exercises that could easily be performed standing at the kitchen countertop, including standing marches, straight leg hip abduction, flexion, extension and heel raises. The patient was also given sit to stands to work on, with chair against a wall for stability. She owned an AirDyne bike but was unsure of her ability to mount it secondary to height of bike and her lower extremity weakness. The patient was encouraged to utilize the bike but only while her husband was available for supervision and assistance on/off the bike as needed.

Balance exercises were a large portion of treatment provided during sessions, based on objective testing and patient's complaints of increasing losses of balance. She was very apprehensive about performing any balance exercises, as she felt extremely unsteady with anything requiring reduced use of handheld support. The patient had most significant difficulty with tandem stance upon objective testing, so this was a major balance exercise worked on initially. She was progressed to tandem balance once she was able to perform Romberg positioning with eyes open for 30+ seconds. It was

noted that the patient relied heavily on visual inputs during ambulation to reduce losses of balance, so Romberg position was then progressed to eyes closed. Balance exercise goals were set for 30-60 seconds without handheld support and were progressed as this goal was met.

More dynamic balance exercises were given around week five, in addition to previously given strengthening and static balance exercises. Dynamic balance training focused on more functional aspects of balance that the patient displayed issues with. The patient was categorized as increased fall risk based on multiple objective tests, including Forward Reach Test. To address this, a cone reaching balance exercise was administered. She also displayed reduced ability to maintain single leg balance and reduced toe clearance bilaterally during swing through phase. The patient performed step to and step through gait patterns over objects on the floor. Step to pattern focused on clearance of the toe, while step through focused on single leg balance more significantly.

Outcomes

Outcome measures taken at initial evaluation were re-evaluated throughout the patient's course of treatment to chart progress and effectiveness of therapy. Unfortunately, the patient was not seen in clinic for two weeks following her initial evaluation secondary to a family emergency. The patient was given an initial home exercise program to perform during this time but admits she had limited time. Upon her return, the patient was seen for a total of five therapy sessions prior to first re-evaluation. At the first re-evaluation and discharge, all outcome measures were re-administered. On the contrary, the MSFS, and static/dynamic balance tests were not re-administered at the second re-evaluation secondary to an MS flare up and increased complaints of fatigue.

After administration of the Musculoskeletal Functional Outcomes Survey, the patient's score declined from 48.53 at initial evaluation to 47.06 at first reevaluation (Table 1). The patient was not retested for the second re-evaluation secondary to an MS flare up. At discharge, the patient scored a 64.71, which is a vast improvement from her initial evaluation. Although the clinically significant goal for this patient was 75.00, functionally the patient felt as though there were significant changes in her ability to participate in activities at home. She reported she was able to walk upstairs in her house, which she had not done in over six months. She had also been able to carry a cup of coffee while walking without spilling.

As previously assessed with manual muscle testing, this patient displayed varying degrees of strength gains and maintenance after one month of therapy. After one month, strength scores ranged from 2+/5 to 5-/5, with typically lower scores on left lower extremity than right (Table 3). She displayed improvements most significantly through right hip and knee strength, with varying degrees on left lower extremity. After two months, strength scores ranged from 2+/5 to 5/5, again with typically lower scores on left lower extremity than right (Table 3). The patient displayed improvement in right ankle plantarflexion strength and left global hip strength. At discharge, strength scores ranged from 3+/5 to 5/5. The patient displayed continued improvement in left hip and knee strength and only slight deficits from 5/5 strength in entire right lower extremity. Strength deficits continued to be more apparent on left lower extremity (Table 3). Overall with therapy intervention, this patient displayed vast improvements in her lower extremity strength, less significantly through the more affected leg.

Static balance was re-evaluated after one month and at discharge. It was not re-evaluated after second month secondary to MS flare up. After one month, the patient was able to perform tandem balance for 10 seconds without handheld support. By discharge, she was able to maintain this position for over one minute without loss of balance (Table 2). This patient displayed significant improvements in static

balance over the course of therapy. The patient also displayed improvement in Forward Reach Test to 5.0 inches and maintained this until discharge (Table 1). Dynamic balance testing was not reevaluated at two months secondary to MS flare up (Table 2) As there are no Minimal Detectable Change (MDC) or Minimally Clinically Important Difference (MCID) indicated for MS patients, it is difficult to ascertain if one-inch difference is a significant change in dynamic balance for this patient. This patient would still be considered a high fall risk secondary to inability to reach at least 7.0 inches[5]. The patient did note decreased feelings of unsteadiness and improved ability to ambulate around her home without losses of balance.

The Five Time Sit to Stand test was performed at all re-evaluations. The patient performed this task in 15 seconds after one month and maintained a time of 12 seconds from second month until discharge (Table 1). It is noted that a change of at least 25% from the initial testing score is considered a significant change in lower extremity muscle strength of weaker leg in those with MS[6]. As the patient scored 16 seconds on initial evaluation, she would need to perform this task in 12 seconds or less for it to be considered a significant change. Therefore, it may be deduced that this patient showed a meaningful change in lower extremity balance and strength. While she did show clinically significant overall improvement, her score at discharge indicates she may still be at an increased risk for falls[4].

Table 1. Functional Outcome Measures

	Initial Eval	**1st Re-eval (1 mo)**	**2nd Re-eval (2 mo)**	**Discharge**
MSFS	48.53	47.06	Not retested	64.71
5x STS Test	16 sec (with hands on knees)	15 sec	12sec	12 sec
Balance Reach Test	4.0 in	5.0 in	Not retested	5.0 in

Table 2. Static Balance Testing

	Initial Eval	**1st Re-eval**	**2nd Re-eval**	**Discharge**
DL, eyes open, firm	Average (20 sec)	Average (30 sec)	Not retested	Excellent (60+ sec)
DL, eyes closed, firm	Fair (10 sec)	Fair (15 sec)	Not retested	Good (45 sec)
Tandem L Front, eyes open, firm	Poor (3 sec)	Fair (10 sec)	Not retested	Excellent (60+ sec)
Tandem R Front, eyes open, firm	Poor (3 sec)	Fair (15 sec)	Not retested	Excellent (60+ sec)
SLS (R and L)	Pt refuses/unable	Pt unable	Not retested	Able to lift foot and prevent falling

Table 3. Manual Muscle Testing on a 5-point scale

Location & Direction	Initial Eval		1st Re-eval		2nd Re-eval		Discharge	
	Left	Right	Left	Right	Left	Right	Left	Right
Hip abduction	3-	3	3-	4+	3+	3+	3+	4
Hip flexion	3-	3+	3+	4	4	4+	4	5
Hip external rotation	3+	4	3+	5-	3+	5	4	5
Hip internal rotation	3+	4	4	4+	4+	5	4+	5
Knee extension	4-	4+	5-	5	5-	5	5	5
Knee flexion	3+	4	4+	5-	4+	5	5	5
Ankle dorsiflexion	3+	4	4	5-	4+	5	4+	5
Ankle plantarflexion	2+	2+	2+	2+	2+	3+	3+	3+
Ankle eversion	3+	4+	4	5-	4+	5-	4+	5-
Ankle inversion	3+	4+	4	5-	4+	5-	4+	5-

Discussion

This case report described response to physical therapy intervention focusing on lower extremity resistance and balance training, in an individual with MS. Treatment initially focused on lower extremity strengthening and static balance. Dynamic balance training and functional strengthening were then incorporated, per patient tolerance. The goal for therapy was to improve lower extremity strength and balance, which in turn would functionally lead to reduced fall risk, improved ability to perform ADLs and return to all activities she previously was unable to do. Throughout patient's course of therapy, it was shown that she did display improved lower extremity strength, static balance, reduced fall risk, and subjectively improved ability to perform ADLs.

Current research favors incorporation of resistance training in individuals with MS, but a significant limitation is the lack of specifications on dosage of exercise and types of resistance training utilized. It is difficult to standardize exercise regimens or compare literature secondary to lack of standardization. Multiple types of resistance training are described in literature. Progressive resistance exercise (PRE), low repetitions with high resistance load until muscle fatigue, has shown to improve overall strength and ability to perform daily activities in those with MS. The results reaped from this training may even last upwards of 24 weeks[1], indicating a long-term effect. These rehabilitation programs can improve mobility, capacity for exercise and muscle power, walking speed, fatigue and ability to negotiate stairs. Generalized lower extremity strengthening programs, consisting of higher reps and lower weight, are also utilized and were found to be equivalent to PRE. Both PRE and generalized strengthening programs performed better than groups without prescribed exercise regimens[3].

Often, balance training described in literature is a smaller part of a larger multimodal intervention. Therefore, it is difficult to determine the effect of balance training alone based on outcomes. One pilot study assessed implementation of balance training alone when compared to an 'unspecified training'

control group[3]. The training groups had decreased reports of falls and improved Berg Balance Scale and Dynamic Gait Index scores compared to a control group[3]. This indicates that balance therapy alone may help to reduce fall rate and improve both static and dynamic balance in those with MS. On the other hand, a 2017 study indicated that balance training alone may not be enough to significantly influence ataxia in MS patients. Rather, the authors suggest balance training should be paired with stabilization and task-specific exercises[11]. Greater quantities of research need to be performed in this area to make definitive statements on most successful treatment regimen.

While research is limited on specifics of rehabilitation intervention in those with MS, there is strong evidence to support implementation of supervised exercise versus receiving no therapy[10]. Evidence is varying on outcomes related to treatment of motor deficits in MS patients, but evidence supports that rehabilitation programs may improve overall quality of life, especially when patients are treated over extended periods versus short bouts[2]. Outpatient physical therapy intervention, as our patient received, may reduce disability scores and improve participation in daily activities for 12 months after the cessation of therapy. This shows there may be some long-term benefit reaped from rehabilitation[2].

Along with resistance and balance training, multiple other interventions may also be incorporated into multimodal wellness programs for patients with MS. Multimodal physical rehabilitation programs including resistance, balance and aerobic training are shown to be most effective for patients with MS, when compared against little to no exercise[12]. Physical therapy intervention combined with aerobic training is shown to be more effective than aerobic exercise alone[1]. This training regimen has shown to improve cardiovascular endurance, mobility and cognition[12].

With a chief complaint of right hip pain and increasing losses of balance, this patient was referred to physical therapy to address pain and assess need for general strength and balance training. This patient's decreased strength led to increased compensations through the contralateral leg, leading to bursitis-like symptoms. Physical therapy intervention focused on lower extremity resistance and balance training. Outcome measures assessed the patient's progress throughout therapy in lower extremity strength, static and dynamic balance and difficulty with activities of daily living. The patient made notable gains in strength, static balance and decreased fall risk. It cannot be concluded that she made clinically significant gains in dynamic balance or ability to perform ADLs, but she did have subjective improvements in ADLs. Multiple other outcome measures more specific to the MS population could have been utilized including the Berg Balance Scale and Dynamic Gait Index for static and dynamic balance, Four Square Step Test, MS Impact Scale, Timed Up and Go (TUG) or TUG with cognitive/manual tasks, and timed 25-foot walk or 10 m walk test[9].

Conclusions

This case report identified lower extremity resistance and balance interventions incorporated in the plan of care for an individual with MS and this individual's response to interventions. The patient displayed overall improvements in static balance, lower extremity strength, reduction in objective fall risk and subjective improved ability to perform activities of daily living. Future research should focus on standardization of outcome measures and type/dosage of physical activity, including frequency, intensity and load that is optimal for each method of intervention. Previous research has also lacked significant sample sizes, control groups, blinding and separation of disease progression, stage and type of MS within studies.

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