Is Physiotherapy Effective in Improving Balance and Gait in Patients with Multiple Sclerosis?: A Systematic Review

Fizyoterapi Multipl Skleroz Hastalarında Denge ve Yürüyüşün Geliştirilmesi Üzerinde Etkili midir?: Sistematik Derleme

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ABSTRACT Objective: The purpose of this systematic review was to determine whether physiotherapy was effective in improving balance and gait in patients with multiple sclerosis (MS). **Material and Methods:** Medically stable MS patients above the age of 18 years who were diagnosed by a neurologist and had balance and/or gait problems were included in this study. The studies involving all types of physiotherapy approaches (i.e. functional exercise, resistive exercise, treadmill training, physical therapy using training with equipment, electrotherapy) were incorporated and interpreted in this systematic review. **Results:** Nine randomized controlled trials (RCTs) met the inclusion criteria. Three studies included neurophysiological approaches, three studies performed resistive exercises, one study used treadmill training, one study used electrotherapy and one study used pressure splint application in their therapy protocols. Amongst the physiotherapy methods, strong evidence was suggested that neurophysiological approaches were effective in improving gait (functional and temporal-spatial gait parameters), as well as static balance and, moderate evidence was found for improving dynamic balance. Conflicting evidence was found for the effects of other physiotherapy methods (i.e. resistive exercises, treadmill training, whole-body vibration and pressure splint application) in the improvement of balance and gait in patients with MS. **Conclusion:** This systematic review revealed that physiotherapy interventions, particularly neurophysiological approaches and in some extend resistive exercises, treadmill training, whole-body vibration and pressure splint application can be effective in improving balance and gait in patients with MS. None of the RCTs included in this study defined any detrimental changes after physiotherapy interventions. However, currently the proofs are not convincing to draw an evidence-based program in the treatment of balance and gait problems in patients with MS.

Key Words: Multiple sclerosis; postural balance; gait; physical therapy modalities

ÖZET Amaç: Bu sistematik derlemenin amacı fizyoterapinin mutipl skleroz (MS) hastalarında denge ve yürüyüşün geliştirilmesi üzerinde etkili olup olmadığını belirlemektir. **Gereç ve Yöntemler:** On sekiz yaşının üzerinde, nörolog tarafından MS tanısı konmuş, medikal olarak durumu sabit olan ve denge ve/veya yürüyüş problemleri olan hastalar bu çalışmada yer aldı. Tüm fizyoterapi yaklaşımlarını (fonksiyonel egzersizler, dirençli egzersizler, yürüme bandı eğitimi, herhangi bir aletin kullanıldığı fiziksel tedavi, elektroterapi v.b.) içeren çalışmalar bu sistematik derlemeye dahil edildi ve yorumlandı. **Bulgular:** Çalışmaya dahil edilme kriterlerini 9 randomize kontrollü çalışma karşıladı. Üç çalışma nörofizyolojik yaklaşımlara, üç çalışma dirençli egzersizlere, bir çalışma yürüme bandı eğitimine, bir çalışma elektroterapi uygulamasına ve bir çalışma basınç splint uygulamasına tedavi protokolleri içerisinde yer vermiştir. Buna göre nörofizyolojik yaklaşımların yürüyüşün fonksiyonel ve temporal-spatial paternlerini ve statik dengeyi geliştirdiği yönünde kuvvetli kanıt, dinamik dengeyi geliştirdiği yönünde orta seviyede kanıt bulunmuştur. Diğer fizyoterapi yöntemlerinin (örneğin; dirençli egzersiz, yürüme bandı eğitimi, tüm-vücut vibrasyon ve basınç splint uygulaması) denge ve yürüyüşün geliştirilmesi üzerinde etkileri konusunda tutarsız kanıt elde edilmiştir. **Sonuç:** Bu sistematik derleme, özellikle nörofizyolojik yaklaşımlar olmak üzere, dirençli egzersizler, yürüme bandı eğitimi, tüm-vücut vibrasyon uygulaması ve basınç splint uygulaması gibi fizyoterapi yöntemlerinin de MS hastalarında denge ve yürüyüşün geliştirilmesi üzerinde bir miktar etkili olabildiğini göstermiştir. Bu araştırmada yer alan randomize kontrollü çalışmalardan hiçbirinde fizyoterapi uygulamaları sonucunda herhangi bir zararlı değişikliğin ortaya çıktığı belirtilmemiştir. Fakat, halen MS hastalarında denge ve yürüyüşün tedavisinde kanıta dayalı bir tedavi programı oluşturmaya yetecek düzeyde kanıt mevcut değildir.

Anahtar Kelimeler: Mutipl skleroz; denge; yürüyüş; fiziksel tedavi modaliteleri

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'Multiple sclerosis (MS) is the major cause of neurological disability in young and middle-aged adults'.[1] The estimated annual mean incidence in Europe is 4.3 cases per 100 000.[2] MS is an autoimmune central nervous system (CNS) disorder, characterised by inflammatory demyelination and neuronal loss.[3] The demyelination process causes slowing of conduction speed and conduction block. Thus, the decreased efficiency of motor unit activation consequently contributes impaired cognitive and motor performance in patients with MS.[4,5]

Reduced mobility, abnormal gait mechanics, poor balance, muscle weakness and fatigue are the factors causing disability in MS patients.[6] Ataxia and incoordination are among the most complex and restraint symptoms and, usually they accompany other disabilities. Cerebellar/brain stem involvement, dorsal column disease or a combination of these two may result in ataxia in MS.[7] Ataxia may be primarily trunkal ataxia which interferes with sitting and standing balance resulting in disturbances of postural control.[8] On the other hand, balance may also be affected due to muscle weakness, somatosensory, visual and vestibular system deficits.

The changes in the temporal-spatial gait parameters (i.e. reduced speed and increased double support phase) are found to be associated with impaired balance in the early stages of the disease.[9,10] Impaired gait and balance may increase the risk of falls, reduce activities of daily living and decrease quality of life.

The basic physiotherapy approaches in the treatment of MS patients with balance and gait problems include exercise therapy (e.g. aerobic exercises, strengthening, stretching, pool exercises, neurophysiologic approaches...), electrotherapy approaches (e.g. neuromuscular electrical stimulation-NMES, functional electrical stimulation-FES, transcutaneos electrical nevre stimulation-TENS, whole-body vibration), orthotic and supportive approaches, energy saving techniques, hydrotherapy approaches and, etc. However, treatment program should be planned according to the specific needs of the patients in respect of type, symptoms and prognosis of MS.

It is likely that patients with MS experience detrimental changes like fatigue, visual disturbances, increased sensory symptoms and reduced physical function as a result of undertaking an exercise program.[11] Therefore, the patients have been discouraged from exercising for many years.[12] However, it has been shown that patients do not experience deleterious changes in symptoms with commencement level of exercise treatment.[11] Moreover, individual exercise program can improve several measures of well-being, reduce fatigue and improve strength in patients with MS.[5,12]

Recent reviews have been performed in order to determine the effectiveness of exercise therapy in MS.[13,14] It was shown by these reviews that exercise therapy was beneficial for activities of daily living, physical fitness, muscle strength, mobility and balance in patients with MS. In addition, they only investigated the effects of exercise therapy and no recommendations were made regarding effective exercise therapy methods in improving balance and gait. Exercise therapy constitutes a fundamental part of the physiotherapy methods in the treatment of balance and gait in MS patients. However, it is possible to benefit from the other physiotherapy methods due to the multifactorial nature of balance and gait functions. Therefore, it is necessary to define the effects of the different types of exercise therapy and the other physiotherapy methods. The primary aim of this systematic review was to determine whether physiotherapy was effective in improving balance and gait in patients with MS. The secondary aims were (a) to identify the effective treatment methods in improving gait and balance, (b) to determine the aspects of balance and gait improved by physiotherapy.

MATERIAL AND METHODS

LITERATURE SEARCH

Two reviewers searched following computerized databases independently to identify relevant trials: MEDLINE (1966-2007), EMBASE (1974-2007), CINAHL (1982-2007), AMED (1985-2007), Cochrane Central Register of Controlled Trials (Issue 3, 2007), PEDro (up to June 2007). The following search terms and their combinations were used to identify the trials in MEDLINE database and adapted to the other databases:

1. Multiple sclerosis
2. Disseminated sclerosis
3. Encephalomyelitis disseminate
4. Demyelinating diseases
5. 1 OR 2 OR 3 OR 4
6. Walk*
7. Gait
8. Ambulation
9. 6 OR 7 OR 8
10. Balance
11. Equilibrium
12. Posture*
13. Postural control
14. 10 OR 11 OR 12 OR 13
15. 9 OR/AND 14
16. Exercise
17. Exercise therapy
18. Rehabilitation
19. Neurological rehabilitation
20. Physiotherapy
21. Physical Therapy
22. 16 OR 17 OR 18 OR 19 OR 20 OR 21
23. 5 AND 15 AND 22
24. Randomised controlled trial
25. Randomised controlled study
26. Randomised clinical trial
27. Randomised trial
28. Random*
29. Controlled clinical trial
30. Experimental clinical trial
31. Experimental group design
32. 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31
33. 23 AND 32

All the available studies either in the form of abstract or full text were analyzed. In case of any doubt, full text articles were retrieved and assessed by the reviewers. Finally, appropriate full text articles published in English were included into the study.

CRITERIA FOR INCLUSION

Types of studies: Randomised controlled trials (RCTs) were included in this review. Randomised crossover trials were also considered as RCTs.[15]

Types of participants: Studies involving medically stable MS patients with balance and/or gait disorders, patients above the age of 18 years who were not experiencing ongoing relapse as diagnosed by a neurologist. The Expanded Disability Status Scale (EDSS) score of patients included in the studies had to be less than 8.

Types of intervention: Interventions were not restricted to a specific method. All types of physiotherapy approaches were considered; functional exercise, resistive exercise, treadmill training, physical therapy using training with equipment and electrotherapy. All the interventions in the included studies were compared with no therapy, placebo therapy or another intervention.

Types of outcome measures: Studies that used at least one outcome measure to evaluate balance and/or gait were included. The balance measurements were analyzed as static (e.g single leg stance time, posturographic measurements), dynamic (e.g timed up and go) and performance based (e.g. Berg balance scale, Equiscale). The gait measurements were analyzed as temporal-spatial parameters (e.g. stride length, step width) and functional (e.g. Rivermead visual gait analysis, timed walk tests).

The studies were excluded if they;

1. Had a study design other than randomised controlled trials (RCTs)

2. Involved medically unstable MS patients or patients who were experiencing ongoing relapse, patients less than 18 years old and patients with EDSS score greater than 8

3. Had comprised interventions that was not restricted to physiotherapy (i.e. medical treatment plus physiotherapy, cooling techniques and etc)

4. Had not used any balance and/or gait measurements

QUALITY ASSESSMENT

The methodological quality of all included studies were assessed by the reviewers independently using the Physiotherapy Evidence Database (PEDro) scale and cross-checked as given by PEDro reviewers. The PEDro scale is an 11-item scale, the first item (eligibility criteria) assesses external validity which does not contribute to the total score and the remaining ten items assess internal validity of the RCTs. The scale assesses randomization, allocation concealment, baseline comparability, blinding of subjects, blinding of therapist, blinding of assessors, adequate follow up, intention-to-treat analysis, between group comparisons, point estimates and variability (Table 1). The scoring of PEDro scale is 1 for yes and 0 for no, the maximum score being 10.[16]

DATA EXTRACTION

For each included study, data were extracted by two reviewers (GI and NS) independently and cross checked for accuracy. Information about the study design, characteristics of patient population (number of participants, type of MS, disease duration, age, gender, and expanded disability status scale-EDSS score), and number of dropouts from the study, type of intervention, outcome measures and results were extracted.

BEST EVIDENCE SYNTHESIS

A quantitative analysis of the data was not possible due to the heterogeneity of the studies with respect to the type, severity and duration of MS, outcome measures and interventions. Hence, a qualitative analysis was performed by using the levels of evidence for the effectiveness of physiotherapy on balance and gait, based on the methodological quality and consistency of the evidence from the included studies:[17]

- Strong evidence: Consistent outcomes among multiple high-quality RCTs (PEDro ≥ 6)
- Moderate evidence: Consistent outcomes among multiple low quality RCTs and/or controlled clinical trials (CCTs) and/or one high quality RCT
- Limited evidence: One low-quality RCT and/or CCT
- Conflicting evidence: Inconsistent outcomes among multiple trials (RCTs and/or CCTs)
- No evidence: No RCTs or CCTs

A study was considered as high-quality if it had a total PEDro score ≥ 6,[16] studies not meeting this level were rated as low-quality. Consistency was assessed by statistically significant findings in outcome measures of the studies.[17-19]

TABLE 1: Methodological quality of included studies (PEDro Scale).

Trial	1	2	3	4	5	6	7	8	9	10	11	Score
Lord 1998[23]	√	√	√	√	-	-	-	√	-	√	√	6
Jones 1999[22]	√	√	√	√	-	-	-	√	-	√	√	6
Armutlu 2001[20]	√	√	-	√	-	-	√	√	-	√	√	6
Stephens 2001[28]	√	√	-	√	-	-	-	-	-	√	√	4
Wiles 2001[26]	√	√	√	√	-	-	√	√	-	√	√	7
DeBolt 2004[21]	√	√	√	√	-	-	-	√	-	√	√	6
Romberg 2004[24]	√	√	-	√	-	-	-	√	√	√	√	6
Schuhfried 2005[25]	√	√	-	√	-	-	√	√	-	√	√	6
van den Berg 2006[27]	√	√	√	√	-	-	√	-	-	√	√	6

PEDro Items: 1- Eligibility criteria, 2- Random allocation, 3- Concealed allocation, 4- Baseline comparability, 5- Blind subjects, 6- Blind therapist, 7- Blind assessors, 8- Adequate follow-up, 9- Intention-to-treat analysis, 10- Between-group comparison, 11- Point estimates and variability.

*Eligibility criteria item does not contribute to total score.

RESULTS

INCLUDED AND EXCLUDED STUDIES

Electronic and manual search yielded 248 titles and abstracts 214 of which excluded due to reference for neurological disorders other than MS, interventions other than physiotherapy, not being published in a journal or duplicate publication. Thirty-four full articles were retrieved for further analysis; of these twenty-five were excluded by reasons of not being an RCT, being written in a language other than English, applying interventions other than physiotherapy or using irrelevant outcome measures. As a result, 9 RCTs were included in this systematic review.

METHODOLOGICAL QUALITY

The methodological quality scores of all the included studies are given in Table 1. The average score of the studies was 5.9 (4-7). Eight studies were considered as high-quality (PEDro score ≥ 6).[20-27] Only one study was considered as low-quality (PEDro score < 6).[28] Blinding of therapists and blinding of patients were the most common failure; none of the studies achieved these two criteria. Not using an intention-to-treat analysis was another most common methodological failure; only one study[24] met this criterion.

An overview of the studies describing the study design, patient population, intervention, outcome measures and results is presented in Table 2.

TABLE 2: Summary of included trials.

Trial	Study design	Patient population	Intervention of trial	Outcome measure	Results*
Lord et al, 1998[23]	RCT	N=20: F=10, T=10 *(F-Facilitation, Type MS: Chronic progressive or relapsing-remitting Disease duration(yr)±SD F:18.3±7.0(9-28) T: 14±8.1(4-26) Mean age(yr)±SD F: 52.1±11.0(35-69) T: 54±8.1(43-65) Female/Male: 15/5 Mean EDSS score ? Dropouts: 3	F:5-7 weeks, 15-19 T- Task-oriented session, 1 hour Facilitation Treatment (passive and active techniques T: 5-7 weeks, 15-19 session, 1 hour Task-oriented Treatment (functional exercises)	10 m timed walk RMI Stride length RVGA BBS (assessment at baseline and after 5-7 weeks)	0 0 0 0 0
Jones et al, 1999[22]	RCT	N=17: C=5, M=6, W=6 *(C- No exercise, M- Mobility exercise, W- Weighted leg exercise Type MS: Relapsing-remitting Disease duration(yr)±SD C: 10(2.5-20), M:5(1-15) W: 5(1.5-8) Mean age(yr)±SD C: 43(36-54), M: 49(41-59) W: 38(40-48) Female/Male: 14/3 Mean EDSS score ? Dropouts: 3	C: Supportive phone calls but no physical therapy M: Mobility exercises (stretching, general balance and mobility exercises, swimming and exercise bike) W: Weighted leg raising exercises to strengthen quadriceps * Therapy duration not specified	10 m walk test 50 m walk test GUG EMG and MVC of quadricep (assessment at baseline and after 8 weeks)	0 0 + (W vs M,L) 0

continued →

TABLE 2: Summary of included trials (cont).

Armutlu et al, 2001[20]	RCT	N=26: S=13, C=13 *(S- Study, C- Control) Type MS: Secondary or primary progressive, ataxic Disease duration(yr)±SD S: 6.15(5-9) C: 6(4-9) Mean age(yr)±SD S: 32.61(23-44) Female/Male: 16/10 Mean EDSS score S: 4.53(3.5-5.5) C: 4.88(4-5.5) Dropouts: 0	S: 4 weeks, 3 sessions a week + 20 min Johnstone pressure splints Neuromuscular rehabilitation (PNF, Frenkel coordination exercises, Cawthorne-Cooksey exercises, mat activities, balance exercises, gait training) and Johnstone sensory receptors) C: 4 weeks, 3 sessions a week Neuromuscular rehabilitation	STS SLS time SW 3 m timed walk AI AB ECT NECT SSEP MEP (assessment at baseline and after 4 weeks)	0 + (S vs C) 0 0 0 0 0 0 + (S vs C) 0
Stephens et al, 2001[28]	RCT	N=12: A=6, C=6 *(A- Awareness Through Movement, C- Control) Type MS: Relapsing-remitting, Progressive or secondary progressive Disease duration(mo)±SD A: 97.0±59.1, C: 85.8±83.4 Mean age(yr)±SD A: 56±9.9, C: 51.8±10.2 Female/Male: 8/4 Mean EDSS score A: 4.6±1.1, C: 4.9±1.2 Dropouts: 0	A: 10 weeks, 8 sessions 20 hours Awareness though movement classes (topics balance and mobility) C: 10 weeks, 6 hours Educational classes (medical and complementary treatment of MS and social support	Falls record Equiscale mCTSIB LOS ABC MSSE (assessment at baseline and after 10 weeks)	0 0 + (A vs C) 0 + (A vs C) 0
Wiles et al, 2001[26]	RCT	N=42: H/HO/C *(H- Home physiotherapy HO- Hospital outpatient physiotherapy, C- Control) Type MS : Chronic Disease duration(yr)±SD H/HO/C: 4.4±4.6 Mean age(yr)±SD H/HO/C: 47.2(28.2-68.8) Female/Male: 27/15 Mean EDSS score: 6.0(4.0-6.5) Dropouts: 2	H: 8 weeks, 2 sessions 45 minutes Individual problem solving approach (focusing on more specific functional activities) HO: 8 weeks, 2 sessions 45 minutes Individual problem solving approach focusing on more facilitation techniques) C: No therapy	RMI SLS time 6 m walk test (one turn) NHP VAS-mobility HADS (assessment at baseline and after 8 weeks)	+ (H,HO vs C) + (H,HO vs C) + (H,HO vs C) + (H,HO vs C) + (H,HO vs C) + (H,HO vs C)
DeBolt & McCubbin, 2004[21]	RCT	N=37: S=19, C=17 *(S- Study, C-Control) Type MS: B, CP, P, RR Disease duration(yr)±SD S: 15.1(1-40), C: 13.1(1-35)	S: 8 weeks, 3 sessions a week, 35-50 minutes + 2-week instructional phase Home based resistance	AP Sway ML Sway Sway velocity LEPR Up and go test	0 0 0 + (S vc C) 0

continued →

TABLE 2: Summary of included trials(cont).

		Mean age(yr)±SD S: 51.6(41-67), C:44.8(25-69) Female/Male: 29/8 Mean EDSS score S: 4(1.0-6.5), C: 3.5(1.5-6) Dropouts: 1	exercise (functional activities to increase strength and power of lower extremities) C: 2-week instructional phase Maintaining activity level	(assessment at baseline and after 8 weeks)	
Romberg et al, 2004[24]	RCT	N=95: S=47, C=48 *(S- Study, C- Control) Type MS ? Disease duration(yr)±SD S: 6.0±6.5 (0-23), C: 5.5±6.4 (0-28) Mean age(yr)±SD S: 43.8±6.3, C: 43.9±7.1 Female/Male: 61/34 Mean EDSS score S: 2.0(1.0-5.5), C: 2.5(1.0-5.5) Dropouts: 4	S: 26 weeks Exercise program (strength training, aerobic exercise) C: No therapy	7.62 m walk test 500 m walk test MIT knee extensor VO_2 peak Equiscale UEE BB (assessment at baseline and after 6 months)	+ (S vs C) + (S vs C) 0 0 0 + (S vs C) 0
Schuhfried et al, 2005[25]	RCT	N=12: S=6, P=6 (S- Study, Placebo Type MS ? Disease duration(yr)±SD ? Mean age(yr)±SD S: 49.3±13.3(13-64) P: 46±12.7(34-62) Female/Male: 9/3 Mean EDSS score S: 3.9±0.8(3-5) P: 3.7±0.8(2.5-4.5) Dropouts: 0	S: 1 session, 9 minutes Multidimensional whole body vibration (Amplitude: 3 mm, Frequency: 1-3 Hz, 5 series of 1 min each with breaks of 1 min) P: 1 session, 9 minutes Placebo TENS (Burst TENS on non dominant forearm 5 series of 1 min each with breaks of 1 min)	SOT TUG FRT (assessment before treatment 15 min, 1 week and 2 weeks after treatment)	0 + (S vs P) (only 1 week after treatment) 0
van den Berg et al, 2006[27]	RCT	N=16: S=8, C=8 (S- Study, C- Control) Type MS ? Disease duration(yr)±SD ? Mean age(yr)±SD S: (30-65), C: (30-65) Female/Male: 14/3 * 1 data extra Mean EDSS score ? Dropouts: 3	S: 4 weeks, 3 sessions a week, maximum 30 minutes Immediate treadmill training (week 3-6) (55-85% APMHR) C: 4 weeks, 3sessions a week, maximum 30 minutes Delayed treadmill training (week 8-11) (55-85% APMHR)	FSS 10 m timed walk 2 minute walk test GNDS Walking HR (assessment at baseline (2 weeks), week 7 and week 12)	0 + (S vs C) (only 7 week after treatment) 0 0 0

*Statistically significant as reported by authors

AB, Anterior Balance; ABC, Activities-specific Balance Confidence; AI, Ambulation Index; AP Sway, Anteroposterior Sway; BB test, Box and Block test; BBS, Berg Balance Scale; ECT, Equilibrium Coordination Tests; EDSS, Expanded Disability Status Scale; FAC, Functional Ambulation Category; FAI, Frenchay Activities Index; FRT, Functional Reach Test; FSS, Fatigue Severity Scale; GNDS, Guy's Neurological Disability Scale; GUG, Get Up and Go test; HADS, Hospital Anxiety and Depression Score; HR, Heart Rate; LEPR, Leg Extensor Power Rig; LOS, Limits of Stability; mCTSIB, modified Clinical Test of Sensory Interaction in Balance; MEP, Motor Evoked Potentials; MIT knee extensors, Maximal Isometric Torque of knee extensors; MIT knee flexors, Maximal Isometric Torque of knee flexors; ML Sway, Mediolateral Sway; MSSE, Multiple Sclerosis Self-Efficacy Scale; MVC, Maximum Voluntary Contraction; NE-ADL-I, Nottingham Extended Activities of Daily Living Index; NECT, Non Equilibrium Coordination Tests; NHP, Nine Hole Peg Test; RMI, Rivermead Mobility Index;RVGA, Rivermead Visual Gait Assessment; SOMCT, Short Orientation-Memory-Concentration Test; SOT, Sensory Organization Test; SSEP, Somatosensory Evoked Potentials; STS, Sensory Test Score; SLS Time, Single-limb stance time; SW, Step Width; TUG, Timed Up and Go test; UEE, Upper Extremity Endurance; WV, Walking Velocity; VAS, Visual Analogue Scale

All included trials were written in English and published after 1997. The included nine trials had a total of 277 participants. Five trials[20,22-24,26] included both gait and balance measurements, three trials[21,25,28] included only balance measurement, and one trial[27] included only gait measurement.

INTERVENTIONS

Various neurophysiological approaches (i.e. Facilitation approach, Task-oriented approach, Neuromuscular Rehabilitation, Awareness Through Movement, Individual Problem Solving approach) were included in three studies.[23,26,28] Resisted exercises were performed in three studies.[21,22,24] One study[27] used treadmill training, one study[25] electrotherapy modalities and one study[20] pressure splint application in their therapy protocols.

Neurophysiological Approaches

Two studies from the included nine trials measured gait.[23,26] Lord et al. compared two neurophysiological approaches; Facilitation approach and task-oriented approach.[23] Patients in each group showed overall significant improvement in gait outcomes (10 meter walk test-MWT, stride length and rivermead visual gait assessment- RVGA), however there was no significant difference between two neurophysiological approach groups. Wiles et al. compared two neurophysiological approaches (home and hospital outpatient treatment) with no therapy in their randomized crossover trial.[26] Statistically significant difference was found in the functional gait measurement (6 MWT with one turn) in the two neurophysiological approach groups in comparison to no therapy. However, no significant difference was found between two neurophysiological approach groups. The improvements in the intervention groups were found to be short lived, that was lasted for few weeks.

Three studies measured balance.[23,26,28] In the study of Lord et al. the patients in each neurophysiological approach group showed statistically significant differences in the Berg balance scale (BBS), although there was no significant difference between two groups.[23] Accordingly, the study of Wiles et al. found statistically significant improvements in the balance outcome of the patients measured with single leg stance (SLS) time in the two neurophysiological approach groups however, no significant difference was found between these two groups.[26]

The study of Stephens et al. found statistically significant differences in balance of the patients in the experimental groups post-treatment.[28] However, the findings are conflicting (Table 2). The effectiveness of awareness through movement (ATM) was examined by comparing it with no physical treatment (Educational treatment- EDU). The neurophysiological approach (ATM) group showed statistically significant difference when compared to the control (EDU) group on mCTSIB and activities-specific balance confidence, but not on limits of stability (LOS) and equiscale.

The best evidence synthesis from these two high-quality[23,26] and one low-quality[28] studies suggests:

- Strong evidence that neurophysiological approaches are effective in improving functional gait as measured by RVGA,[23] 10 MWT,[23] 6 MWT.[26]
- Strong evidence that neurophysiological approaches are effective in improving static balance as measured by SLS time[26] and mCTSIB.[28]
- Strong evidence that a specific neurophysiological approach is not more effective than another in improving both gait and balance.[23,26]
- Moderate evidence that neurophysiological approaches are effective in improving temporal-spatial gait parameters as measured by stride length.[23]
- Moderate evidence that neurophysiological approaches are effective in improving performance-based balance as measured by BBS.[23]

Resistive Exercises

Two studies measured gait in their studies.[22,24] Jones et al. compared mobility exercises and resistive exercises (weighted leg exercises) with no exercise.[22] No statistically significant difference was found in the gait outcomes measured with 10 MWT and 50 MWT among the three groups. Romberg et al. compared a 6-month exercise program (resistive and aerobic exercise) with no exercise.[24] The study (resistive and aerobic exercise) group improved significantly more than the control (no exercise) group on the gait parameters 7.62 MWT, 500 MWT and the first 50 m lap of 500 MWT post-treatment.

The studies of DeBolt and McCubbin, Jones et al. and Romberg et al. measured balance.[21,22,24] Jones et al 1999 found that weighted leg exercise group improved significantly more than the mobility exercise and no exercise groups in the TUG (timed up and go) test.[22] DeBolt and McCubbin compared the effects of resistive exercise program (home-based resistance training) with no exercise.[21] There was no statistically significant difference between two groups on balance parameters; mediolateral sway, anteroposterior sway, sway velocity and the TUG test. In the study of Romberg et al., the balance measure (Equiscale) showed no change in either group over time.[24]

The synthesis of best evidence from these three high-quality studies suggests;

- Moderate evidence that resistive exercises together with aerobic exercises are effective in improving functional gait as measured with 7.62 and 500 MWT.[24]

- Conflicting evidence that resistive exercises are effective in improving dynamic balance as measured by TUG test. The study of Jones et al.[22] has found statistically significant improvements on the TUG test whereas the study of DeBolt and McCubbin[21] has defined no significant results.

Treadmill Training

The randomized crossover trial of van den Berg et al. compared the effects of treadmill training on gait.[27] The study group received immediate treadmill training and the control group received delayed treadmill training. The post-treatment results showed significant increase in gait speed measured by 10 MWT and non-significant increase in gait endurance measured by 2-minute walk test in the study group compared to the control group. However, the training effects on gait speed were found to return towards the baseline scores in the follow up assessment.

Based on this high-quality RCT the best evidence synthesis suggests;

- Conflicting evidence that treadmill training can be effective in improving gait. Treadmill training appears to be effective in improving gait speed but not gait endurance of the patients.

Electrotherapy

The study of Schuhfried et al. compared the effects of whole-body vibration with placebo TENS (transcutaneous electrical nerve stimulation) application on balance.[25] One week after treatment examination showed statistically significant difference in the TUG test in favour of the study (whole-body vibration) group which was not obtained in the follow up assessment. No statistically significant differences were found in the functional reach test (FRT) and sensory organisation test (SOT) after treatment in both groups.

The best evidence synthesis from this high-quality study suggests;

- Conflicting evidence that whole-body vibration can be more effective than placebo (TENS) application in improving balance of the patients. It is likely that whole-body vibration therapy is effective in improving dynamic balance as measured by TUG test, but not static balance as measured by FRT and SOT.

Pressure Splint Application

Armutlu et al. compared the effects of Johnstone Pressure Splint (JPS) application and neurophysiological approach (i.e. neuromuscular rehabilitation) with neurophysiological approach alone.[20] Statistically significant differences were found in the gait outcomes (Step Width, 3 MWT and Ambulation Index-AI) in both study (JPS and neurophysiological approach) and control (neurophysiological approach) groups post-treatment, although there was no statistically significant difference between two groups. This study found a statistically significant difference in the SLS time of the study group whereas there was no statistically significant difference in the anterior balance (AB) of the study group when compared to the control group after treatment.

The best evidence synthesis based on this high-quality RCT suggests;

- Conflicting evidence that Johnstone Pressure Splint (JPS) application together with neurophysiological approach could be better than only neurophysiological approach in improving balance. It is possible that JPS application together with neurophysiological approach is better than neurophysiological approach alone in improving SLS time but not anterior balance of the patients.

DISCUSSION

This review revealed that several physiotherapy methods, particularly neurophysiological approaches, and in some extend resistive exercises, treadmill training, whole body vibration and pressure splints, can be effective in improving the balance and gait in patients with MS. None of the included studies described deleterious changes after physiotherapy treatments. However, the proofs are still not sufficient to draw an evidence-based program in the treatment of balance and gait problems. Moreover, there were limited studies using other physiotherapy methods that could not be included due to using study designs other than RCT. Hence, it was not possible to understand the place of the methods such as electrical stimulation, orthotic devices, and hydrotherapy approaches in the treatment of balance and gait disorders in patients with MS.

The findings of three studies[23,26,28] from the nine included studies supported the effectiveness of neurophysiological approaches. The studies comparing the effects of different neurophysiological approaches found that no single method was more effective than another in improving the balance and gait in patients with MS.[23,26] This was in harmony with the findings of the previous review of Rietberg et al. which suggested that specific exercise programs were not superior to other exercise treatments in improving activities and participation of MS patients.[13] It is likely that, regardless of the neurophysiological approaches, different techniques for the adaptation of the CNS are effective for increasing functional activities in patients with MS.

It is suggested that increased core body temperature or decreased blood glucose level following exercise therapy can cause fatigue in patients with MS.[29,30] The literature review of Dalgas et al. indicated that resistance training induces general beneficial effects on health and seems to be well tolerated in patients with MS.[31] The present study showed that the effects of resistive training on balance and gait were conflicting, which might be due to the lack of the studies with high methodological quality. All of the three studies which was used resistive training in their treatment protocol included low intensity training. Therefore, no deleterious changes were identified in fatigue level of patients after resistive training. Although there was some evidence on the effects of resistive training, no adequate information was obtained about the intensity, frequency, duration, type and long term effects of the resistive training for the recommendation of the treatment program for patients with MS in improving balance and gait.

Balance and gait are complex functions and are goal directed neural organisation of multiple, interacting systems.[32] Therefore the effects of treadmill training on increasing the amplitude, timing and distribution of power during gait performance,[33] whole-body vibration on improving leg extensor strength via 'tonic vibration reflex',[34] and Johnstone pressure splint application on increasing the stabilisation in the lower extremity joints by stimulating the deep proprioceptive receptors are promising.

The present review showed large diversity of patient characteristics among studies. The patients involved in the studies showed variability of types and severity of MS, disease duration and mean age. All of the studies measured the same domains, however, a large variety of outcome measures were used in the assessment of gait and balance. Additionally, including different types of interventions caused heterogeneity of the data. Therefore, the heterogeneity of the patient characteristics, severity of MS, outcome measures and interventions complicated the interpretation of the results.

Allocation concealment, blinding of care providers, blinding of recipients, blinding of assessors and intention-to-treat analysis are accepted as the most important factors to reduce selection, performance, detection, and attrition bias of RCTs.[15] Although six of the studies were considered as high quality, none of them achieved all of the methodological criteria stated above. However, some of the criteria are not achievable due to the nature of the physiotherapy interventions such as blinding of therapists and blinding of patients.

Methodological quality assessment and the best evidence synthesis were conducted to reduce the systematic bias. However, the subjective nature of these assessments may lead to reviewer bias. Therefore, the methodological quality scores were checked against the scores that have been given by PEDro reviewers, and the best evidence synthesis was tried to be achieved by ranking the evidence according to the conclusions of the studies. Another major limitation of this review was including only the studies written in English. Therefore, the studies written in other languages could not be included. It is strongly recommended for the future reviewers to include trials written in other languages in order not to miss any significant data.

This review shows the need for research on less variable MS populations regarding their age and disease characteristics with larger sample sizes in order to obtain more homogenous data. The effects of types and severity of MS in the improvement of patients need to be identified in future studies. These studies should fulfil the methodological criteria, particularly concealed allocation, blinding of therapists, blinding of patients and intention-to-treat analysis. International consensus about core set of outcome measures in MS rehabilitation needs to be identified for future studies.

In conclusion, the sources are still not adequate to draw a solid evidence for the treatment of balance and gait disorders in MS patients. Hence, the results of this review suggest that neurophysiological approaches may be given priority when planning an exercise program. Resistive exercises may also be used safely in MS rehabilitation, however not much evidence has been obtained for the effects of resistive exercises in improving balance and gait. The other physiotherapy methods such as treadmill training, whole body vibration and pressure splints are promising. It could be suggested to the clinicians to use a combination of these methods to enhance the benefits of the physiotherapy treatment. Additionally, patients may benefit more from a longer or ongoing treatment program.

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