Physical Exercise and MS – Recommendations

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Summary

The use of physical exercise programmes in the rehabilitation of patients with multiple sclerosis (MS) has been a controversial issue for many years. During the last decade, however, evidence from a number of studies has suggested that exercise is a safe and efficient way to induce improvements in a number of physiological functions, which ultimately can lead to functional improvements that have a positive effect on a patient's daily life. The purpose of this review is, based on the existing research, to provide clinicians with some easily administrable recommendations for the application of exercise in the rehabilitation strategy of MS.

KEY WORDS:

Strength training; Aerobic training; Combined training; Concurrent training; Cardiovascular training; Muscle strength; Exercise recommendations; Exercise therapy

Introduction

Physical exercise has for many years been a controversial issue in multiple sclerosis (MS) rehabilitation, and the general advice to the patient has been to avoid physical exercise. This advice was given in part because some patients were reported to experience symptom instability during exercise,[1] but also because it was believed to help the patient preserve energy for activities of daily living.[2] However, pioneering work by Shapiro *et al.*[3] and Petajan *et al.*[4] showed that endurance training was well tolerated by MS patients and that it actually had some beneficial effects. Today it is known that well-organized physical exercise is a safe and efficient way to achieve physical improvements that have the potential to improve an MS patient's quality of life.

Resistance and endurance training constitute the two extremes of basic physical exercise and other kinds of exercise can be regarded as composites of these. Most studies look into the effects of either resistance or endurance training, and recommendations usually concern these training modalities. Since 1990 several reviews[2,5–12] and meta-analyses[13,14] have been published regarding different aspects of exercise and MS. Several of these reviews provided useful recommendations regarding MS and exercise.[8,10,12] However, the still growing body of evidence calls for updated exercise recommendations. The purpose of the present review is, therefore, to clearly state some recommendations regarding the use of basic physical exercise (i.e. endurance and resistance training), for MS patients. In addition, the review aims to provide these recommendations in a form that is easily administrable for the clinician and physician.

Physiological Impairments

It is well known that MS patients have a lower daily activity level than matched healthy people[15] and it is therefore not surprising that some of the classic symptoms of inactivity have been documented in this

patient group. Inactivity-related health problems such as an increased incidence of osteoporosis (reduced bone mineral density), depression, fatigue and death from cardiovascular diseases have been shown in MS patients.[16–19] Furthermore, aerobic capacity, in terms of maximal oxygen consumption (VO2-max), has been reported to be reduced among MS patients.[20] Other cardiovascular parameters like resting heart rate and diastolic blood pressure have been shown to be elevated in MS patients.[21,22] Maximal muscle strength measured during both isokinetic and isometric muscle contractions, as well as the rate of force development, have also been shown to be reduced among MS patients.[23,24] This is probably caused by a loss of muscle mass, a change in fibre-type composition and reduced neural activation.[25,26] It should also be noted that the observed strength impairments seem particularly distinct in the lower extremity compared with the upper extremity.[27] Functional impairments including reduced maximal gait velocity have also been reported in MS patients.[28] Together, these physical aspects of the disease have been shown to be one of the factors that contribute to the lower level of health-related quality of life (HRQoL) seen in MS patients.[29]

Rationale for the Application of Physical Exercise

It seems likely that many of the impairments seen in MS patients can be attributed to inactivity, rather than non-reversible tissue injury. This assumption is supported by several studies that have shown marked improvements in almost all aspects of the physiological profile of MS patients who have taken part in clinically monitored exercise programmes. The extent to which the impairments can be reversed by the application of physical exercise may depend on the extent to which the impairment is a result of the disease *per se*, or whether it is a consequence of inactivity secondary to the disease. Impairments resulting from the disease *per se* are probably not reversible by exercise, whereas impairments developed as a consequence of inactivity probably are reversible.[6] Furthermore, it has recently been shown that a higher cardiorespiratory fitness is associated with better cerebrovascular function and cognition in MS patients, suggesting that exercise could play an important role in the preservation of brain function in MS patients.[30] It has also been suggested that exercise might have a disease-modifying anti-inflammatory effect, and therefore perhaps has the potential to slow down the disease process.[7] This possible training effect has, despite its importance, only been addressed in a few promising studies,[31,32] emphasizing the need for more research within this area.

Resistance Training

Two randomized controlled trials (RCTs) and some uncontrolled trials have evaluated the effects of resistance training in MS patients.[33–41] The low number of RCTs along with the fact that the studies in general have examined only small sample sizes makes solid evidence-based conclusions difficult. Also, most studies have applied a training regime with a moderate training intensity and a mild progression and all studies, except a small study by Kraft *et al.*, included MS patients having an Expanded Disability Status Scale (EDSS) score below 6.5.[38,39] However, no studies report any problems related to the training intervention and resistance training therefore seems to be well tolerated by MS patients. In addition, the studies almost consistently show improvements in muscle strength after resistance training.[35–42] Also, probably because of the more pronounced strength deficit in the lower extremity compared with the upper extremity,[27] the training intervention in four of the studies solely aimed at the lower extremity.[33,34,36,41] However, notable improvements (3–29%) have also been found in the upper extremity muscle strength (elbow extensors, elbow flexors, shoulder abductors and shoulder adductors) in the few studies that included exercises for these muscle groups, suggesting that resistance training has a possible clinical role to play in improving strength in the upper extremity as well.[37,38,42] Heterogeneous findings exist, however, regarding the effects of resistance training on functional capacity in MS patients. Some studies have shown that resistance training can improve 'chair transfer', gait, stair climbing and 'timed up and go', but not all studies have been able to demonstrate functional improvements in gait and 'timed up and go'.[33,34,36,39,42] Furthermore, resistance

training seems to positively influence fatigue.[36,43] General exercise recommendations for MS patients are listed in Table 1 and recommendations regarding resistance training are listed in Table 2.

Table 1: General exercise recommendations for MS patients

1. The following recommendations target MS patients with an EDSS score of less than 7.
2. It is safe and beneficial for MS patients to participate in well-organized physical exercise.
3. The recommendations only serve as basic recommendations and an exercise programme should be designed and prescribed on an individual basis to ensure that individual capabilities and impairments, as well as environmental conditions, can be taken into account.
4. MS patients should consult a rehabilitation expert (e.g. physician, physiotherapist or an exercise physiologist specialized in rehabilitation) before starting a new exercise programme.
5. It is recommended to follow a training schedule that includes both resistance and endurance training (combined training), because impairments are seen in both cardiovascular and strength-related parameters.
6. Potential exercise-induced exacerbations are a temporal phenomenon.
7. Factors affecting core temperature should always be considered and minimized, in order to make exercise as pleasant as possible for the thermo-sensitive patients.

Endurance Training

The effects of endurance training have been studied more extensively in MS patients compared with resistance training. A number of studies have evaluated the effects of different endurance training protocols, but only some have applied an RCT design.[3,4,44–60] Different kinds of endurance training have been tested including bicycle ergometry, arm–leg ergometry, arm ergometry, aquatic exercise and treadmill walking.[3,4,44–55,58–60] Unfortunately, not all training protocols are well described which would be desirable in future research. The training intensity is in general mild to moderate and has often been poorly controlled. All studies have included MS patients with EDSS scores below 7. Despite these methodological issues a number of important findings can be extracted from these studies. Overall, the studies suggest that endurance training with low to moderate intensity is well tolerated among MS patients. However, one study reports a high dropout rate (26%).[59] This might be explained by the duration

Table 2: Recommendations regarding resistance training and MS

1. To secure safety, resistance training should be supervised by an expert until the patient has acquired proper skills.
2. In the initial phase of training the use of training machines should be preferred over free weights.
3. Although often less effective than machine training, home-based training using elastic bands and/or exercises using body weight as load, represents an alternative way of training.
4. Intensities in the range of 8–15 repetition maximum (RM) are recommended (RM is the maximal number of repetitions of a given load that can be lifted with proper technique. 1 RM corresponds to a load where only one complete repetition can be performed, whereas 10 RM corresponds to a smaller load that allows completion of exactly 10 repetitions). Intensities around 15 RM are recommended during the initial training phase and should be progressively (over several months) increased toward intensities around 8–10 RM.
5. The number of sets should initially be in the range of 1–3, which can be increased towards 3–4 sets of every exercise after a few months. Rest periods between sets and exercises in the range of 2–4 min are recommended.
6. A training frequency in the range of 2–3 days per week is well tolerated and results in meaningful improvements in MS patients.
7. In general a whole body programme consisting of 4–8 exercises is recommended. Only in very special cases, where the training frequency is exceeding 3 times a week, should a split programme be considered.
8. In general, the exercise order should be planned so that large muscle group exercises are performed before small muscle group exercises, and multiple-joint exercises before single-joint exercises.
9. For MS patients lower extremity exercises should have high priority, because it has been shown that the extent of the strength deficit in the lower extremities is of greater magnitude than in the upper extremity.

(6 months) and the time-consuming nature (supervised training 3 days a week) of the study, rather than by low tolerance towards endurance training. The studies also show that long-lasting (>15 weeks), but not short (< 8 weeks) interventions improve maximal aerobic capacity (VO2-max).[4,48,50,51,53] The reported effects of endurance training on functional capacity are inconsistent. Several studies have investigated how endurance training can influence gait velocity, and the findings show great diversity as it has been reported that gait velocity was either reduced, unaffected or improved.[44,46,47,52,54,56,59,60] However, when functional capacity was evaluated in the ergometer used for training (bicycle ergometry and arm–leg ergometry)

improvements in endurance performance (watt or duration) have been reported in most, but not all studies.[3,4,51,53] Taken together these data suggest that endurance training at best results in modest improvements in activities of daily living, reflecting the fact that such activities might be more dependent on muscle strength than on endurance. It is not clearly established whether endurance training can positively influence fatigue. The findings show inconsistency because some studies show an effect, whereas others do not.[4,47–49,51,53,54,59,60] One explanation for the inconsistency might be differences in scale sensitivity. In general, scales conceiving fatigue as a multidimensional phenomenon show an effect, whereas scales that conceive fatigue as a one-dimensional phenomenon do not. Endurance training seems to positively influence psychological measures regarding both HRQoL scores and mood.[4,48,49,51,53,55,59] Furthermore, endurance training has also been shown to positively influence symptoms of depression in MS patients.[51] It is unclear whether the level of training adaptation is influenced by the level of neurological impairment. Some studies have found larger improvements among MS patients with the lowest EDSS scores, but other studies found no difference or that the patients with the highest EDSS score improved most.[3,4,48,50]

A general concern regarding exercise and MS patients is the observation that more than 40% of all MS patients experience some degree of worsening of the number and/or intensity of sensory symptoms during exercise.[61] The exacerbation of symptoms seems to be related to the increase in core temperature that occurs during exercise and particularly during endurance training.[1] In a new study, the worsening of symptoms after exercise was shown to be a temporal phenomenon, that was normalized within half an hour after exercise cessation in most (85%) patients.[61] Recommendations regarding endurance training for MS patients are listed in Table 3.

Table 3: Recommendations regarding endurance training and MS

1. Bicycle ergometry, arm–leg ergometry, arm ergometry, aquatic exercise and treadmill walking have all been shown to induce favourable improvements in MS patients whereas running, road cycling and rowing are suitable for well-functioning MS patients only.
2. A training frequency of 2–3 sessions per week using an initial training intensity of 50–70% of VO2-max corresponding to 60–80% of maximum heart rate is recommended.
3. An initial exercise duration of 10–40 min is recommended depending on the disability level of the MS patient.
4. During the first 2–6 months progression should be obtained by increasing the training volume by extending the training session or by adding an extra training day. After this period it should be tested whether a higher training intensity is tolerated.

What is Optimal Exercise for MS Patients?

Endurance and resistance training target different areas of the physiological profile. While endurance training results in profound adaptations in the cardiorespiratory and neuromuscular systems, resistance training is known to increase muscle mass and to improve neural activation.[62,63] MS patients have deficits in all these areas of the physiological profile. From a theoretical point of view, optimal exercise should be aiming at a normalization of all these areas of the physiological profile. Consequently, this would require the application of both endurance and resistance training in an MS patient's exercise programme. Presently, the concept of combined (concurrent) endurance and resistance training is however so sparsely investigated in MS patients,[64–66] that solid evidence-based recommendations cannot be provided. The studies that do exist suffer from methodological issues including low training intensity and the use of non-supervised training.[64–66] But, in spite of these limitations, some of the findings are noteworthy. In particular, all the studies reported that combined training was well tolerated, and small improvements were found in muscle strength and functional capacity (gait velocity) after training. One study showed an increase in VO2-max after combined training, whereas another study found no change.[65,66] Furthermore, no change was observed in depression, fatigue or HRQoL after combined training.[66] To determine whether the improvements seen following combined training are comparable with those seen after solely endurance or resistance training, further studies comparing intense interventions of combined training to endurance and resistance training alone are warranted. Recommendations regarding combined training for MS patients are listed in Table 4.

Table 4: Recommendations regarding combined training and MS

1. Combined training based on equal proportions of resistance and endurance training performed on alternate days is recommended.
2. Two days of resistance training and 2 days of endurance training is recommended as the maximal initial training frequency on a weekly basis.
3. The two bouts of resistance training as well as the two bouts of endurance training should be separated by an interval of 24–48 hours for recovery.
4. The recommendations described earlier regarding resistance and endurance training should be followed when designing both the resistance and the endurance training programme.

Recommendations

It must be emphasized that the given recommendations only serve as basic guidelines that should be considered in relation to each MS patient on an individual basis. The recommendations are limited to MS patients with an EDSS score of less than 7, because too little is known about the effects of exercise in the more severely impaired group of MS patients. In general the recommendations are based on the literature reviewed in this article. However, solid evidence-based recommendations regarding optimal resistance training in MS patients cannot be given based on the existing scientific literature. Consequently, the given recommendations regarding resistance training are a composite of the sparse literature dealing with resistance training in MS patients and the general resistance training recommendations.[63,67] The recommendations regarding combined training are also based on sparse scientific data due to the low number of studies evaluating this training modality in MS patients.

Conclusions

Physical exercise is an important non-pharmacological tool in MS rehabilitation. Basic physical exercise in the form of either endurance- or resistance training is well tolerated and beneficial for MS patients. However the effects of endurance training have been more extensively studied than the effects of resistance training. Since only patients with an EDSS score lower than 7 have been included in the existing studies evaluating the effects of physical exercise in MS patients, the presented recommendations only address this subgroup of patients. From a theoretical point of view optimal exercise for MS patients should combine both endurance and resistance training. Unfortunately, only a few studies have addressed this topic and future work within this field is needed.

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Conflicts of Interest

No conflicts of interest were declared in relation to this article.

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