Influence of manipulative skills on quality of life and activities of daily living in multiple sclerosis

Sergio Rodríguez-Menéndez, Rosa M. Martínez-Piédrola, Manuel Menéndez-González, Marta Pérez-de-Heredia-Torres

Introduction. More than 50% of patients diagnosed with multiple sclerosis report problems with manipulative function and impairments in their daily lives due to this disorder. Therefore, the aim of the present study is to determine how pinch strength, prey strength and manipulative dexterity affect the quality of life and personal autonomy of people diagnosed with multiple sclerosis and to study whether there is a difference in these aspects between different types of multiple sclerosis.

Subjects and methods. There was a total sample of 126 participants, of which 57 were controls and 69 cases. All of them were assessed with a Multiple Sclerosis Quality of Life-54 test, Nine-Hole Peg Test and Barthel Index.

Results. People with multiple sclerosis have worse pinch strength, prey strenght, manipulative dexterity, performance in basic activities of daily living and quality of life ($p < 0.001$). Prey strength is a conditioning factor for performance and quality of life in people with multiple sclerosis. As for the type of multiple sclerosis, relapsing-remitting multiple sclerosis presented better values ($p < 0.001$).

Conclusions. The findings of this study point to the fact that patients diagnosed with multiple sclerosis have a decrease in prey strength, pinch strength, manipulative dexterity, quality of life and autonomy in activities of daily living compared to the healthy population.

Key words. Manipulative dexterity. Multiple sclerosis. Performance. Pinch strength. Prey strength. Quality of life.

International Doctoral School (S. Rodríguez-Menéndez). Faculty of Health Sciences. Universidad Rey Juan Carlos. Madrid (R.M. Martínez-Piédrola, M. Pérez-de Heredia-Torres). Inypema. Clínica Universitaria (S. Rodríguez-Menéndez). Department of Medicine. Universidad de Oviedo (M. Menéndez-González). Neurology Department. Hospital Central de Asturias. Oviedo, Spain (M. Menéndez-González).

Correspondence:
Sergio Rodríguez Menéndez.
Inypema.Calle Prado Picón s/n.
E-33008 Oviedo, Asturias.

E-mail:
s.rodriguezme@alumnos.urjc.es

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Introduction

Multiple sclerosis (MS) is a chronic inflammatory demyelinating and neurodegenerative disease of the central nervous system (CNS), resulting in focal lesions in the grey and white matter and diffuse neurodegeneration of the whole brain [1]. An estimated 2.5 million people worldwide suffer from MS. In Europe, 700,000 people are affected. The areas with the highest prevalence correspond to high latitudes, and there has been an increase in prevalence over the last decades, with a higher incidence in women [2]. The disease can begin at any age, being rare before the age of 10 and after 60. It usually presents between the ages of 20-40 years, affecting women more often than men [3].

Motor (90%), sensory (77%) and cerebellar (75%) disturbances are the most frequent, followed in decreasing order by brainstem, sphincteric, mental and visual disturbances. The most frequent onset symptom is altered sensation, which consists of the appearance of paresthesia in one or more limbs or in the trunk. Motor impairment is also very common, characterized by loss of strength in one or more limbs, the most common signs being shuffling during walking or weakness and clumsiness in one or both limbs [4]. More than 50% of patients diagnosed with MS report problems with manipulative function and impairments in daily life due to these impairments, which are more present in progressive types [5]. Precisely, the functionality of the upper extremity is an important cornerstone for the independence, the ability to perform daily activities and participate in the environment and the quality of life of patients [6]. Functional impairments are closely related to muscle strength and fatigue, affecting the ability and autonomy in activities of daily living [7].

The disabling effect of MS causes significant detriments to the quality of life of people with MS, greater than those caused by other chronic diseases and with a clear worsening of at least one third of people after diagnosis [8]. Considering the importance of pinch strenght and prey strength in general functional status and their impact on the performance of activities of daily living, and the lack of

studies addressing limitations in these abilities in MS, as well as their involvement in disability, the aim of this study is to determine the impact of pinch strength, prey strength and manipulative dexterity on the quality of life and personal autonomy of people diagnosed with MS and to study whether there are differences in these aspects between the different types of MS.

Subjects and methods

Study design

This is an observational case-control study. The procedure for the selection of the experimental group included in the study was a non-probabilistic and random convenience sampling. The participants were referred by the Multiple Sclerosis Association of Vigo, the Spanish Confederation of People with Disabilities of Asturias and the neurological rehabilitation polyclinic Neurofunction, between 2019 and 2021, with an approximate duration of 24 months. The control group was obtained by proximity to the research team and by convenience.

Inclusion criteria were to be diagnosed with MS (according to McDonald criteria) in any of its stages, to be of legal age and not to have suffered a flare-up in the last 12 months. Exclusion criteria were: no history of psychiatric illness prior to MS diagnosis. Subjects were excluded if they had any disease or process related to MS or any disease or injury that could affect the upper limbs.

Procedure

The administration of the tests was carried out in a place free of noise, with optimal lighting conditions and with a space larger than 10 m^2 in order to be able to perform each of the tests in an optimal manner. At the beginning of the evaluation, a socio-demographic questionnaire was administered to obtain information on the independent variables (sex, age, type of MS and years of evolution). In terms of duration, a maximum of 30 minutes was established for the administration of the tests, in order to avoid generating fatigue that could affect the results. All tests were always administered by a single researcher.

A total of four standardized assessment tests were administered to each patient. For quality of life, the Multiple Sclerosis Quality of Life, which is a specific health-related quality of life questionnaire for patients with multiple sclerosis, was used [9]. Strength was assessed using analogue prey and clamp dynamometers. Manipulative dexterity was assessed with the Nine-Hole Peg Test (NHPT), which is the most recommended and validated tool for assessing manipulative dexterity in this type of patient [10]. Finally, to assess performance in basic activities of daily living, the Barthel index was used, a test validated in the spanish population and widely used in clinical practice, which consists of 10 activities of daily living that are scored out of a maximum of 100 [11]. The order of administration of the tests coincides with the order described above.

Statistical analysis

For the descriptive and comparative analysis of the variables by group, a comparison of means was performed using the *t*-Student. Comparisons between MS groups were made using the ANCOVA model. Finally, to determine the possible influence of the different factors on quality of life and activities of daily living, multiple linear regression models adjusted for group and age variables were performed.

Ethical aspects

The project was approved by the ethics committee of the Universidad Rey Juan Carlos de Madrid, Spain (Registration number 0511201916019). All participants were informed in advance about the study, tests and purpose, and their consent to participate was recorded.

Results

The final study sample consisted of 126 participants, of which 45.2% (n = 57) were controls and 54.8% (n = 69) were cases, aged between 22 and 92 years, with an average age of 50 years (standard deviation = 14.7). In relation to sex, 62% of the total sample (n = 78) were women, while 38% (n = 48) were men. In turn, the case group was subdivided according to MS typology, with 15.1% (n = 19) people with secondary progressive MS, 30.2% (n = 38) people with relapsing remitting MS and 9.5% (n = 12) people with primary progressive MS.

Table I shows the descriptive and comparative variables between the patients in the control group and the cases. The results showed statistically significant differences in all variables. The values of the control group were significantly higher than those of the cases.

Comparisons between MS types are shown in table II. The results of the ANCOVA models showed statistically significant differences in prey strength, manual dexterity, quality of life and Barthel. The prey strength of patients with relapsing remitting MS was higher than that of patients with primary progressive MS (p = 0.008) and no different from that of patients with secondary progressive MS (p = 0.087). No significant difference was observed between patients with secondary progressive and primary progressive MS (p = 0.919). In relation to manual dexterity, the score of patients with relapsing remitting MS was lower than that of patients with progressive primary MS (p = 0.004) and no difference compared to patients with secondary progressive MS (p = 0.917). No significant difference was observed between patients with secondary progressive and primary progressive MS (p = 0.115). The quality of life of patients with relapsing remitting MS was higher than that of patients with primary progressive MS (p = 0.03) and no difference compared to patients with secondary progressive MS (p = 0,389). No significant difference was observed between patients with secondary progressive and primary progressive MS (p = 0.784). Finally, the Barthel scale score of patients with relapsing remitting type MS was significantly higher than that of patients with primary progressive MS (p = 0.004) and no difference with patients with secondary progressive MS (p = 0.059). No significant difference was observed between patients with secondary progressive and primary progressive MS (p = 0.998).

To determine the possible influence of prey strength, pinch strength and manual dexterity on quality of life and autonomy, multiple linear regression models adjusted for the variables group and age were performed, the results of which are shown in table III.

For quality of life, the variables that showed a statistically significant effect were group (cases have 34,85 points decrease in quality of life compared to controls), age (as age increases, quality of life decreases) and prey strength. In the Barthel index test a statistically significant effect was shown by group (cases had 15.14 points decrease in their score compared to controls), prey strength and manual dexterity.

Table I. Descriptive and comparative variables between the patients in the control group and the cases.

	Group, mean (SD)		Student *t*-Test		*d*
	Controls	Cases	$t_{(124)}$	*p*-value	
Pinch strenght	7.96 (3.13)	6.45 (3.89)	2.375	<0.001	0.43
Prey strenght	32.81 (11.7)	19.51 (10.42)	6.744	<0.001	1.21
Manual dexterity	18.61 (2.32)	44.77 (36.48)	–5.4	<0.001	–0.97
Quality of life	182.7 (11.61)	143.49 (17.09)	14.733	<0.001	2.64
Barthel index	99.82 (1.32)	73.03 (25.43)	7.941	<0.001	1.42

d: Cohen effect size: SD: standard deviation.

Discussion

The aim of the present study was to determine whether prey strength, pinch strength and manipulative dexterity impact on the quality of life and personal autonomy of people diagnosed with MS and to study whether there is a difference in these aspects between the different types of MS.

The motor and sensory symptoms found in MS patients make it difficult to perform activities of daily living, as well as other social activities. This impairment in performing the activities that lead to the person's occupational roles has a negative impact on the quality of life of people with MS [12]. However, how the different manual skills affect the quality of life and autonomy of the person is still not well understood.

The results of our study indicate that MS patients have poorer grasping and manipulative dexterity, as well as lower pinch and prey strength than healthy subjects, with these data worsening as the age of the patients increases. Our results are consistent with previous studies showing bilateral manual dexterity deficits in MS patients measured with the NHPT [13], although our work adds the existence of impairment in other functions (prey strength and pinch strength), which help to better understand the motor and functional impairment of the upper limb in this disease.

Some research has specified which areas of quality of life are impacted by strength training. Improvements were found in some areas of quality of life in MS patients, specifically vitality, emotional well-being and general well-being, as measured by Sclerose En Plaques-59, following high intensity strength and resistance training [14]. Other studies show improvements in other areas of quality of life [15]. Our study showed improvements in the areas of general health or well-being, pain and cognitive function following strength training. Other researchers have linked strength training to improvements in quality of life [14].

Table II. Descriptive and comparative variables by type of multiple sclerosis.

	Type MS, mean (SD)[a]						ANCOVA		
	RR		2P		1P		$F_{(2;65)}$	*p*-value	η2
Pinch strenght	7.36 (0.93)		6.49 (0.63)		4.87 (1.17)		1.298	0.28	0.04
Prey strenght	16.71 (2.34)	ab	23.06 (1.59)	a	12.69 (2.93)	b	6.222	**0.003**	0.162
Manual dexterity	45.43 (8.19)	ab	35.14 (5.54)	a	74.22 (10.25)	b	5.759	**0.005**	0.164
Quality of life	140.78 (3.88)	ab	148.01 (2.62)	a	133.47 (4.85)	b	4.032	**0.022**	0.147
Barthel index	59.63 (5.59)	a	82.66 (3.78)	b	63.74 (6.99)	ab	7.236	**0.001**	0.199

a-b: Two-to-two comparisons. Between two types of multiple sclerosis if no letter is shared indicates statistically significant differences (Bonferron correction). 1P: progressive primary; 2P: secondary progressive; η^2: partial (effect size); SD: standard deviation. [a] Means adjusted for years of evolution.

Other authors have addressed the benefit of physical exercise on pain in people with MS [16]. Pain is one of the most influential factors in the performance of activities of daily living and, in general, in the participation of patients diagnosed with MS [17].

Most studies do not explain which body structures train in strength. This aspect is important as there are body structures that are more related to the development of activities of daily living. Even the weakness or fatigability of certain muscles, such as the elbow flexors and certain movements, such as finger abduction, are related to the weakness of other muscles and movements and to the person's perceived difficulty in using the upper limbs in performing ADLs (activities of daily living) [18]. Other studies have found correlations between kinesthetic movement variables with perceived degree of disability [19]. In addition, correlations have been found between the weakness of different muscle groups and the expanded disability rating (EDSS). In our research, we have related the strengthening of certain structures, such as the prey strength and hand that can improve the performance of activities of daily living and the quality of life of people by performing multiple lineal regression. The upper limb is a structure very involved in activities of daily living, but at the distal level, the hand, is a fundamental tool for the development of these activities. Because of this and because of the literature found, training in manual dexterity, strengthening of the pinch and strengthening of the prey is essential to improve the performance of ADLs and improve the quality of life of these patients. Not only is upper limb muscle weakness and impairment of the upper limbs associated with the inability to perform ADLs, but also with unemployment [20].

Regarding motor skills, the NHPT is one of the most widely used tests in the MS population. Some authors suggest that the NHPT correlates with age, gender, time since first symptom onset and EDSS score [21]. It is important to take these correlations into account when adjusting NHPT scores. Even so, it is the most widely used test as it has good psychometric properties and predicts the ability to perform ADLs including upper extremity function [22]. As in these investigations, in our study a correlation was found between NHPT scores and quality of life and ability to perform activities of daily living. There is variability of results in the different measures depending on the type of MS the person is suffering from. Some authors found poorer performance on the NHPT in patients with MS progressive primary [21]. In our research, it was patients with RR MS who performed worse on the test. We found no differences in NHPT performance between patients with progressive primary MS and progressive secondary MS.

Further studies are needed to analyze the impact and possible causality of impairments in manual dexterity on the quality of life and personal autonomy of patients diagnosed with MS, as well as the variations that may be present in the different types of MS diagnoses to improve the focus of rehabilitation treatments for MS patients.

Limitations

As limitations of the study, it should be noted that the study sample corresponds to the same geograph-

ical area and that the age range of the sample is very wide. Further studies are needed to analyse possible differences according to socio-economic and cultural factors.

Conclusions

The findings of this study suggest that patients diagnosed with MS have decreased prey strength, pinch strength, manipulative dexterity, quality of life and autonomy in activities of daily living compared to the healthy population. These aspects also worsen as the age of the MS diagnosed subjects increases.

Our data show differences in prey strength and manual dexterity between the different MS diagnosis types, reaffirming that these are functions that need to be specifically assessed and treated. In particular, patients with relapsing remitting MS show greater prey strength than patients with primary progressive MS, but have poorer manual dexterity. We also found differences in quality of life and autonomy in activities of daily living between the different MS diagnosis types, as the quality of life and autonomy in activities of daily living of patients with relapsing remitting MS was higher than that of patients with primary progressive MS. Further studies are needed to accurately understand the impact of impaired upper extremity manipulative functions and impairment on quality of life and autonomy in activities of daily living in MS patients.

Table III. Effect of prey and pinch strenght and manual dexterity on quality of life and Barthel index.

Predictor	Quality of life			Barthel index		
	B (SE)	*t*	*p*-value	B (SE)	*T*	*p*-value
Group (case vs. control)	–34.85 (3.12)	–11.17	<0.001	–15.14 (3.72)	–4.07	<0.001
Age	–0.3 (0.09)	–3.21	0.002	–0.06 (0.11)	–0.55	0.583
Pinch strenght	–0.24 (0.42)	–0.57	0.569	–0.72 (0.5)	–1.43	0.155
Prey strenght	0.26 (0.15)	1.69	0.004	0.32 (0.18)	1.77	0.049
Manual dexterity	–0.05 (0.05)	–1.01	0.316	–0.33 (0.06)	–5.85	<0.001
R^2 (%)	69			50.2		
Model	$F_{(5;120)} = 56.69$, $p < 0.001$			$F_{(5;120)} = 26.17$, $p < 0.001$		

B: regression coefficient; SE: standard error.

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Influencia de la capacidad manipulativa en la calidad de vida y actividades de la vida diaria en la esclerosis múltiple

Introducción. Más de un 50% de los pacientes diagnosticados con esclerosis múltiple (EM) comunican problemas con la función manipulativa e impedimentos en su vida diaria a causa de esta alteración. Por ello, el objetivo del presente estudio es determinar la afectación que la fuerza de pinza, la fuerza de presa y la destreza manipulativa ejercen sobre la calidad de vida y la autonomía personal de las personas diagnosticadas de EM, y estudiar si existe diferencia de estos aspectos entre los distintos tipos de esta enfermedad.

Sujetos y métodos. Se contó con una muestra total de 126 participantes, de los cuales 57 fueron controles, y 69, casos. A todos ellos se les evaluó con el *Multiple Sclerosis Quality of Life-54,* el *Nine-Hole Peg Test,* la dinamometría de pinza y de presa para la medición de la fuerza, y el índice de Barthel para la evaluación de las actividades básicas de la vida diaria.

Resultados. Las personas con EM presentaron peores fuerza de pinza, fuerza de presa, destreza manipulativa, desempeño en actividades básicas de la vida diaria y calidad de vida ($p < 0,001$). La fuerza de presa es un factor condicionante en el desempeño de actividades básicas y calidad de vida en personas con EM. En cuanto al tipo de EM, el tipo remitente-recurrente presentó mejores valores ($p < 0,001$).

Conclusiones. Los hallazgos de este estudio apuntan a que los pacientes diagnosticados con EM presentan una disminución en la fuerza de pinza, la fuerza de presa, la destreza manipulativa, la calidad de vida y la autonomía en las actividades de la vida diaria en comparación con la población sana.

Palabras clave. Calidad de vida. Desempeño. Destreza manipulativa. Esclerosis múltiple. Fuerza de pinza. Fuerza de presa.