The influence of hand dominance on the expression of arm-hand dysfunction and its relationship with the underlying neurophysiological disturbances in Multiple Sclerosis.

Jessica Jacobs, Bart Van Wijmeersch, Ilse Lamers, Peter Feys

REVAL – Rehabilitation Research Institute, BIOMED - Biomedical Research Institute, Faculty of Medicine and Life Sciences, Hasselt University, Hasselt, Belgium. Rehabilitation and MS Center, Overpelt, Belgium.

Introduction

About 3/4 of the MS population reports an impaired arm-hand function as a result of several symptoms like muscle weakness, ataxia, spasticity, impaired sensation and fatigue. This impaired arm-hand function impacts the ability to perform daily activities independently and decreases quality of life.(1;2;3)
Recently, there has been an emerging research interest towards understanding arm-hand dysfunction in MS and its impact on daily life. Lamers et al. found that perceived and actual arm performance of the non-dominant arm in daily life was decreased in PwMS.(4) It is not clear whether these results are representative for the entire MS population as only 30 highly disabled persons were included in the study.
The influence of hand dominance on the performance on clinical scales was also found in healthy subjects. Oxford et al. and Sartorio et al., reported an impact of hand dominance on the performance on clinical scales, in which the dominant arm had a better performance.(5;6)
Research regarding hand dominance, hemisphere dominance and asymmetry between the hemispheres has also been performed in MS. Filippi et al. found, in a small group of MS patients, a significant correlation between hand dominance and hemispheric lesion load, with more lesions in the left hemisphere.(7)

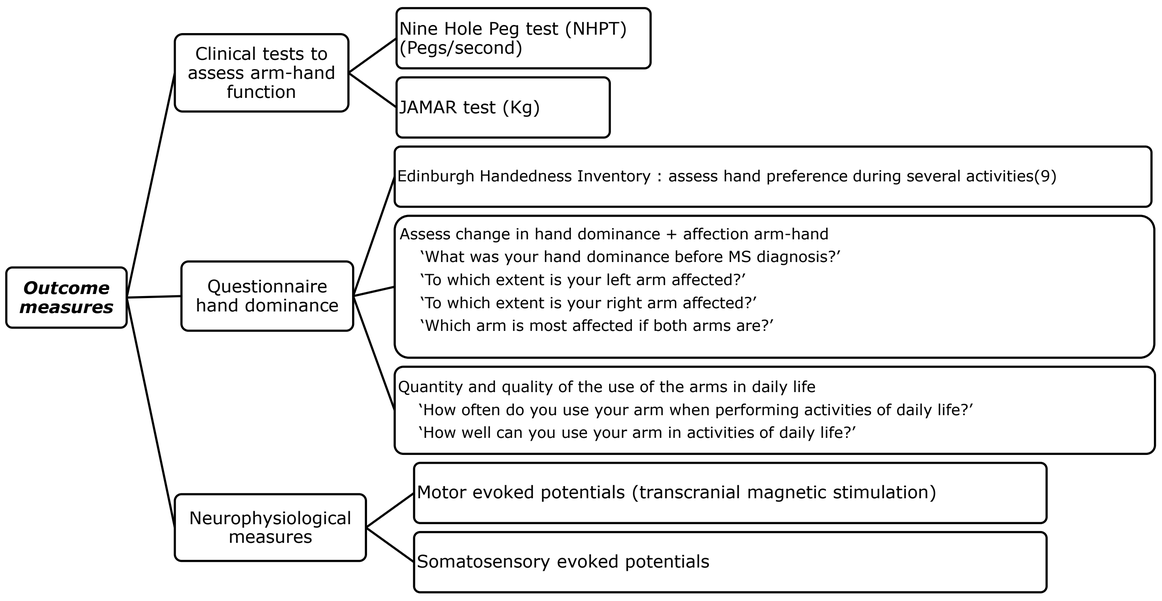
Aims
• Acquire insights about the influence of hand dominance on the expression of arm-hand dysfunction in MS, more specifically differences between dominant arm non-dominant arm
• Correlation between the clinical findings about arm-hand dysfunction and the function of motor and sensory pathways, measured with Motor Evoked potentials (MEPs) and Somatosensory Evoked potentials (SSEPs).

Four research questions
1) Which arm is most affected in individuals with MS?
2) How many individuals with MS report a change in hand dominance as a result of the disease?
3) Which arm has the best performance on clinical tests?
4) Are the clinical findings correlated with the results of the neurophysiological measures?

Methods

Participants

• 109 Persons with MS were assigned to the study (mean age=46.94, SD=11,5years, 84female)
• Recruited from the Rehabilitation and MS center Overpelt
• Inclusion criteria
  - Participants of at least 18 year
  - A diagnosis of MS according to the McDonald criteria(8)
• Exclusion criteria
  - Additional mental and cognitive disorders
  - Absence of arm-hand dysfunction
  - A relapse during the study period
• The total MS group was also divided into disability subgroups based on their EDSS score
  - Mild (0-3.5)
  - Moderate (4-5.5)
  - Severe (6-9.5)



Results

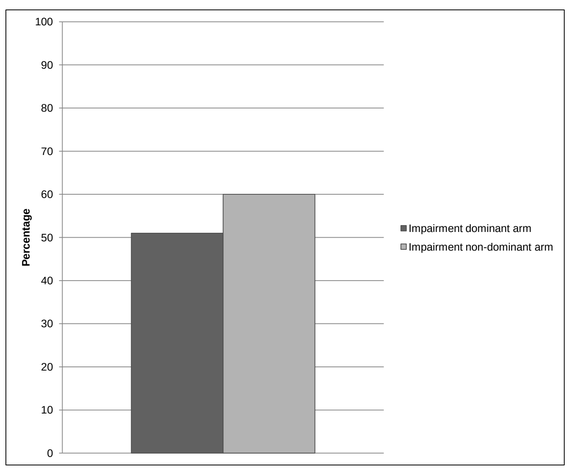


Figure 1. Perceived impairment of dominant and non-dominant arm in the total MS group

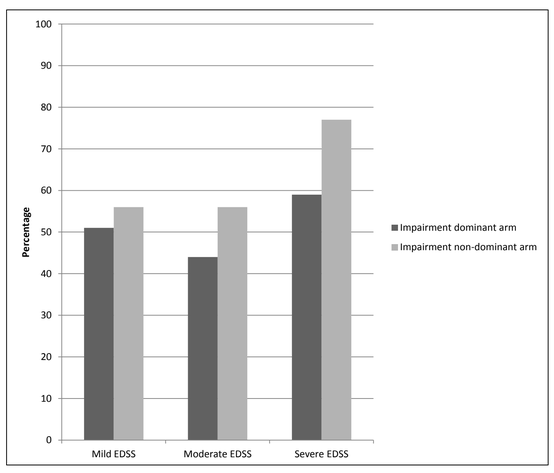


Figure 2. Perceived impairment of dominant and non-dominant arm in the different EDSS subgroups

Results

Table 1. Differences between the dominant and non-dominant arm in the total MS population

	Dominant arm		Non-dominant arm		
Objective outcome measures (n=78)	Median	[1st-3rd IQR]	Median	[1st-3rd IQR]	P value°
JAMAR	26.00	[19.70-31.33]	23.25	[16.88-29.60]	<0.001
NHPT (pegs per sec)	0.36	[0.32-0.43]	0.35	[0.28-0.43]	0.152
Subjective outcome measures (n=78)	Median	[1st-3rd IQR]	Median	[1st-3rd IQR]	P value°
Amount of use (0-5)	5	[5-5]	2	[2-4]	<0.001
Quality of use (0-5)	4	[4-5]	4	[3-5]	0.010
Neurophysiological measures (n=60)	Median	[1st-3rd IQR]	Median	[1st-3rd IQR]	P value°
MEP amplitude	2.60	[1.00-4.50]	1.90	[1.10-4.30]	0.318
MEP latency	20.80	[19.47-23.13]	20.61	[19.27-24.33]	0.670
SSEP amplitude	3.10	[1.70-5.00]	3.15	[1.90-5.05]	0.063
SSEP latency	20.28	[19.18-21.70]	20.17	[19.35-22.57]	0.329

SD: standard deviation; IQR:interquartile range; °Wilcoxon Signed Rank test

Table 2. Correlations between the objective/subjective outcome measures and neurophysiological measures in the total MS population

	MEP amplitude		MEP latency		SSEP amplitude		SSEP latency	
	dom	non-dom	dom	non-dom	dom	non-dom	dom	non-dom
JAMAR	0.00	-0.04	0.13	0.13	-0.49**	-0.20	0.26*	0.13
NHPT pegs/sec	0.29*	0.18	-0.46**	-0.39**	0.06	0.22	-0.45**	-0.38**
Amount of use	0.18	-0.04	0.02	0.01	-0.03	0.30*	0.09	-0.01
Quality of use	0.13	0.20	-0.12	-0.34**	0.00	0.23	-0.03	-0.28*

Discussion

The results in persons with MS which are equivalent to the results in healthy subjects (based on studies) and so considered as normal

• The superior use of the dominant arm in daily life(4)
• More hand grip strength in the dominant arm (JAMAR test) (10)
• No significant difference between the dominant and non-dominant arm for MEP and SSEP amplitude/ latency(11;12)

The results in persons with MS which are different to the results in healthy subjects (based on studies)

• The dominant arm had a significant better performance in daily life in persons with MS ↔ no difference between the dominant and non-dominant arm in healthy subjects(4)
  Statement : persons with MS link the minor use of the non-dominant arm to impairment
• There was no difference between the dominant and non-dominant arm on the performance of the NHPT in persons with MS ↔ healthy subjects have a better performance on the NHPT with their dominant arm(5)
  Statement : the dominant arm became more impaired than the non-dominant arm with regard to manual dexterity in persons with MS

What are the correlations between the clinical and neurophysiological measures in MS?

• MEP and SSEP amplitude and latency were negatively correlated with the NHPT (pegs/sec), which means that greater values of amplitude and latency led to fewer pegs/minute on the NHPT for both arms
  Statement : Impairment of motor and sensory pathways has a great influence on manual dexterity in persons with MS, more than on hand grip strength
  Abnormal values of MEP and SSEP amplitude/latency are more likely to lead to a 'functional' decline than to strength loss

What is the influence of hand dominance on the expression of arm-hand dysfunction in MS?

• There is a minor influence of hand dominance on the NHPT and the measures of MEPs and SSEPs because these tests are able to show impairment if present
• There is an influence of hand dominance on the JAMAR test because the present impairment of the dominant arm is not shown is this test
• Also the amount and quality of the use of the arms in daily life is influenced by hand dominance
  Statement : The influence of hand dominance on the expression of arm-hand dysfunction cannot be excluded in persons with MS

Conclusion

Despite the objective impairment of the dominant arm, measured with the NHPT, the dominant arm is more used in daily life and with a better quality according to the PwMS
  → No consistency between the objective measures, which reveal impairment of the dominant arm, and what the persons with MS experience about their arm-hand dysfunction (subjective)
  = subclinical impairment

Possible assumptions
• The dominant arm can still do the major activities in daily life
• The non-dominant arm serves only as support of the activities mainly performed by the dominant arm (underestimation of the use of the non-dominant arm)
• They report faster impairment because they have the label of 'MS patient'
• Neural plasticity in which the dominant arm has to be more impaired before it will no longer compensate for lesions

On the other hand, it is also possible that there is clinical deterioration present in the non-dominant arm which cannot be demonstrated with the NHPT and JAMAR test.

References

(1) Johansson S, Ytterberg C, Claesson IM, Lindberg J, Hillert J, Andersson M, et al. High concurrent presence of disability in multiple sclerosis. Associations with perceived health. J Neurol 2007 Jun;254(6):767-73.
(2) Kierkegaard M, Einarsson U, Gottberg K, von KL, Holmqvist LW. The relationship between walking, manual dexterity, cognition and activity/participation in persons with multiple sclerosis. Mult Scler 2012 May;18(5):639-46.
(3) Ytterberg C, Johansson S, Andersson M, Widen HL, von KL. Variations in functioning and disability in multiple sclerosis. A two-year prospective study. J Neurol 2008 Jul;255(7):967-73.
(4) Lamers I, Kerkhofs L, Raats J, Kos D, Van WB, Feys P. Perceived and actual arm performance in multiple sclerosis: relationship with clinical tests according to hand dominance. Mult Scler 2013 Feb 13.
(5) Oxford GK, Vogel KA, Le V, Mitchell A, Muniz S, Vollmer MA. Adult norms for a commercially available Nine Hole Peg Test for finger dexterity. Am J Occup Ther 2003 Sep;57(5):570-3.
(6) Sartorio F, Bravini E, Vercelli S, Ferriero G, Plebani G, Foti C, et al. The Functional Dexterity Test: Test-retest reliability analysis and up-to date reference norms. J Hand Ther 2013 Jan;26(1):62-8.
(7) Filippi M, Martino G, Mammi S, Campi A, Comi G, Grimaldi LM. Does hemispheric dominance influence brain lesion distribution in multiple sclerosis? J Neurol Neurosurg Psychiatry 1995 Jun;58(6):748-9.
(8)McDonald WI, Compston A, Edan G, Goodkin D, Hartung HP, Lublin FD, et al. Recommended diagnostic criteria for multiple sclerosis: guidelines from the International Panel on the diagnosis of multiple sclerosis. Ann Neurol 2001 Jul;50(1):121-7.
(9) Oldfield RC. The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia 1971 Mar;9(1):97-113.
(10) Puh U. Age-related and sex-related differences in hand and pinch grip strength in adults. Int J Rehabil Res 2010 Mar;33(1):4-11.
(11) Livingston SC, Goodkin HP, Ingersoll CD. The influence of gender, hand dominance, and upper extremity length on motor evoked potentials. J Clin Monit Comput 2010 Dec;24(6):427-36.
(12) Chen AC, Theuvenet PJ, de Munck JC, Peters MJ, van Ree JM, Lopes da Silva FL. Sensory handedness is not reflected in cortical responses after basic nerve stimulation: a MEG study. Brain Topogr 2012 Apr;25(2):228-40.