Relationship between MRI Reported Lesion Location with Gait Speed and Disability Status in Multiple Sclerosis

Lyndsay A. Hauser[2], Lisa H. Conti[2], Richard Feinn[2], Carolyn St. Andre[1], Lindsay Neto[1], Jennifer A. Ruiz[1]

[1]Mandell Center for Comprehensive Multiple Sclerosis Care and Neuroscience Research,
Mount Sinai Rehabilitation Hospital, A Member of Trinity Health Of New England, Hartford, CT, United States
[2]Department of Medical Sciences, Frank H. Netter, MD School of Medicine, Quinnipiac University
Contact Information: Jennifer Ruiz, DPT, jfawcett@stfranciscare.org

Background

Multiple Sclerosis (MS) is a disease of the central nervous system (CNS). Persons with MS (pwMS) experience a range of deficits which can limit daily functioning[1]. The Timed 25-Foot Walk (T25FW), an assessment of walking disability[2] and the Kurtzke Expanded Disability Status Scale (EDSS), are useful clinical tools used to quantify and monitor disability in pwMS[3].

Magnetic Resonance Imaging (MRI) can reveal CNS lesions, or areas of inflammation and demyelination, in pwMS. It is used for diagnosing MS and monitoring patients for new lesions[1]. Lesions are particularly common in the periventricular and juxtacortical white matter, as well as the corpus callosum and the infratentorial region[4].

In a clinical setting, official MRI reports written by radiologists are a time-efficient and easily accessible source of information about MRI results. These reports are often used in monitoring disease activity and clinical decision-making. Therefore, it is important to understand the ways in which MRI lesions correlate with clinical symptoms[5]. Current neuroimaging research has used advanced techniques to evaluate the relationship between CNS lesions and clinical symptoms. However, it is difficult to routinely implement these methods in a clinical setting due to lack of standardization, longer acquisition and post-processing times, and the shortage of precision and accuracy studies[5,6].

While advanced neuroimaging studies are necessary to understand the pathological and clinical progression of MS, it is also necessary to understand the ways in which CNS lesion locations noted on the MRI radiology reports conventionally used in clinics can predict disability.

Objective

The objectives of this study are to:

1. Understand the distribution of lesion locations in pwMS available to clinicians via MRI reports at a community MS center;
2. Evaluate the relationship between MRI reported lesion location with mobility (T25FW) and disability (EDSS) in pwMS.

Methods

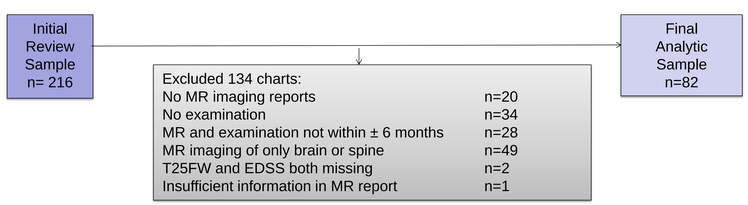
A retrospective chart review was completed on a convenience sample of 216 patients seen at a comprehensive MS care center, evaluated between October 1, 2011 to June 5, 2013.

For this analysis, the following variables were extracted:

- Patient demographics
- Dates of service for evaluation and MRI(s)
- Disease duration
- Body Mass Index (BMI)
- Expanded Disability Status Scale (EDSS) score and functional system subscores
- Gait speed – timed 25ft walk (T25FW)
- MRI report data

Final Analytic Sample eligibility criteria included:

- CNS MRI within ± 6 months of examination date
- MRI of both brain and spine, either on the same date or on two separate dates both within ± 6 months of examination date
- T25FW and/or EDSS on examination date



During the MRI review, lesion location was recorded and categorized into four broader regions: Infratentorial/Cerebellar (IC), Juxtacortical (JC), Periventricular (PV), and Spinal Cord (SC).

Descriptive analysis was performed on the Final Analytic Sample. Statistical analysis was done to determine whether there is a relationship between number of lesion areas and EDSS/T25FW score. Data was tested for normality using the Shapiro-Wilk test. Then, a Kruskal-Wallis test was used to determine differences in EDSS and T25FW scores. Multiple linear regressions were done to examine the effects of each of the four brain lesion areas on T25FW and EDSS. P<0.05 was considered significant. Statistics were done using SPSS Version 23.

Results

Table 1. Distribution of baseline demographics for Final Analytic Sample

Demographic		N (%) or mean ± SD
Gender, n=82	Male	17 (20.7)
	Female	65 (79.3)
Age (years), n=82		44.6 ± 12.0
Disease duration (years), n=81	0-5	46 (56.8)
	6-10	11 (134)
	11-20	13 (15.9)
	21+	11 (13.4)
BMI (kg/m²), n=76	< 25.0	24 (29.3)
	25.0-29.9	20 (24.4)
	30.0+	32 (42.1)
EDSS, n=82	0-3.5	50 (61.0)
	4.0-5.5	11 (13.4)
	6.0-10.0	21 (25.6)
T25FW (s), n=75		7.3 ± 5.0

Figure 1. Percentage of subjects with mutually exclusive combinations of CNS lesion region

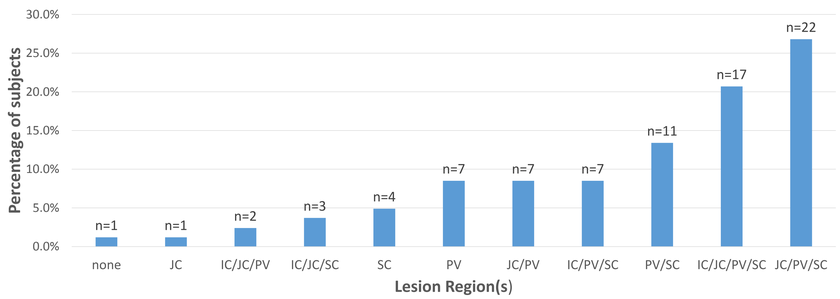
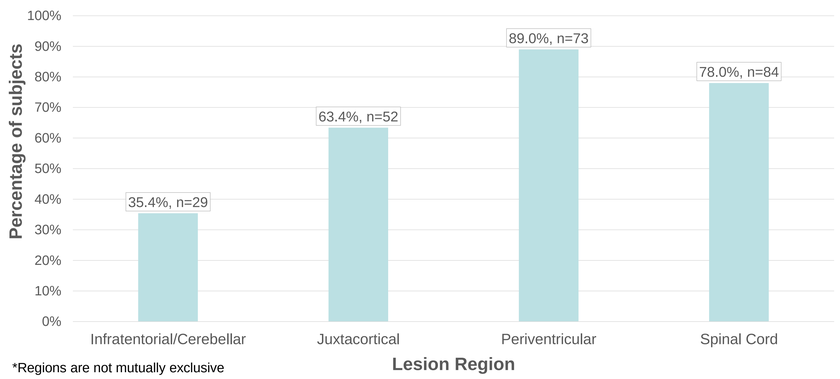


Figure 2. Percentage of subjects with lesions in each CNS region*



*Regions are not mutually exclusive

Table 2. Mean±SD for variables grouped by number of mutually exclusive regions (PV, IC, JC, SC) with lesions

Number of lesion areas	N	Age (years)	Disease duration (years)	BMI (kg/m²)	EDSS	T25FW average (s)
0	1	55	2	33.2	6.0	7.9
1	12	48.5 ± 4.9	5.1 ± 5.9	27.7 ± 8.6†	4.1 ± 2.1	7.7 ± 6.0†
2	18	45.6 ± 14.2	13.7 ± 15.2	30.1 ± 5.6	3.6 ± 1.7	6.4 ± 1.6
3	34	44.1 ± 11.5	5.1 ± 7.8‡	28.9 ± 5.7‡	3.3 ± 1.7	7.8 ± 6.6#
4	17	40.7 ± 13.7	13.2 ± 13.3	27.8 ± 6.9	4.0 ± 2.0	7.2 ± 2.8

†n=10, ‡n=33, #n=32, n=14

Kruskal Wallis H test revealed no significant differences between groups for EDSS (p=0.502) or T25FW (p=0.719).

Results cont.

Table 3. Mean ± SD T25FW and EDSS times for each CNS region

Lesion area	N	T25FW	EDSS
Infratentorial/Cerebellar	29	8.8 ± 7.2†	3.8 ± 2.0
Juxtacortical	52	6.9 ± 4.5‡	3.5 ±1.8
Periventricular	73	7.4 ± 5.2#	3.5 ± 1.7
Spinal Cord	64	7.0 ± 3.8	3.7 ± 1.8

†n=26, ‡n=47, #n=68, n=57

Table 4. Multiple linear regression for lesion region as predictor of T25FW

Predictor Variable	B	SE B	β	t	P
Infratentorial/Cerebellar	3.012	1.250	0.288	2.410	0.019*
Juxtacortical	-1.484	1.183	-0.144	-1.255	0.214
Periventricular	1.311	1.947	0.77	0.673	0.503
Spinal Cord	-2.059	1.378	-0.177	-1.494	0.140

Table 5. Multiple linear regression for lesion region as predictor of EDSS

Predictor Variable	B	SE B	β	t	P
Infratentorial/Cerebellar	0.297	0.433	.079	0.685	0.496
Juxtacortical	-0.559	0.420	-0.150	-1.333	0.187
Periventricular	-1.139	0/634	-0.198	-1.796	0.076
Spinal Cord	0.319	0.493	0.074	0.648	0.519

Conclusions

- Categorizing specific lesions identified into four regions provided a format for systematizing data reported to clinicians on MRI reports
- Lesions were most frequent in the periventricular region (n=73) and least frequent in the infratentorial/cerebellar region (n=29)
- Only 1.2% identified spinal cord lesions, 4.9% juxtacortical and no infratentorial/cerebellar lesions were reported in this sample
- No significant relationship was observed between number of different CNS regions with lesions and either T25FW (p=0.502) or EDSS (p=0.719)
- The presence of a lesion in the infratentorial/cerebellar region had a significant positive relationship with having a slower walking speed (B=3.012 seconds, p = 0.019)
- Legion location based on regional categorization was not predictive of EDSS scores

References

1. Compston, A., & Coles, A. (2008). Multiple sclerosis. *The Lancet,372*(9648), 1502-1517.
2. Kieseier, B. C., & Pozzilli, C. (2012). Assessing walking disability in multiple sclerosis. *Multiple Sclerosis Journal, 18*(7), 914-924.
3. Kurtzke, J.F. Rating neurologic impairment in multiple sclerosis: an expanded disability status scale (EDSS). (1983). *Neurology 33*(11):1444-1452.
4. Filippi, M. & Agosta, F. (2010). Imaging biomarkers in multiple sclerosis. *Journal of Magnetic Resonance Imaging 31*:770-788.
5. Wattjes, M.P., Steenwijk, M.D., and Stangel, M. (2015). MRI in the Diagnosis and Monitoring of Multiple Sclerosis: An Update. *Clinical Neuroradiology 25*(2), 157-165.
6. Filippi, M. (2014). MRI measures of neurodegeneration in multiple sclerosis: implications for disability, disease monitoring, and treatment. *Journal of Neurology 262*(1): 1-6.

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