Alterations in Temporal-Spatial Gait Parameters in People with Multiple Sclerosis – a Systematic Review

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Background

People with multiple sclerosis (MS) frequently experience progressive gait and walking dysfunction that contributes to significant disability. Particularly, alterations in temporal-spatial gait parameters have been observed using instrumented walkways, and are associated with poorer walking ability and reduced levels of participation. An understanding of alterations in temporal-spatial parameters associated with advancing MS will allow the clinician to better identify gait-related abnormalities that would benefit from targeted rehabilitation interventions..

Objective

The purpose of this systematic review was to identify differences in temporal-spatial gait parameters in individuals with MS compared to healthy controls.

Methods & Analysis

A search of SCOPUS and CINAHL databases was conducted in October 2014. Case- control studies measuring temporal-spatial parameters of gait with an instrumented walkway in individuals with MS as compared to healthy controls were included for review. Three reviewers assessed study validity with the Critical Appraisal Skills Programme's (Oxford, UK) Case Control Study Checklist (CCSC) which results in a score of 0 (low validity) to 9 (high validity).

Figure 1. PRISMA Diagram of Methods

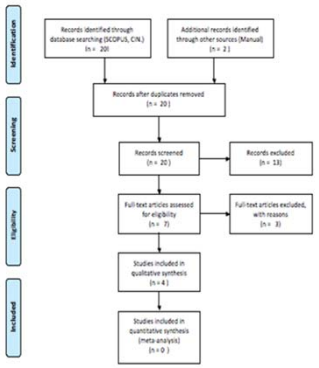

Table 1. Studies Selected for Examining Temporal-spatial Parameters in Individuals With and Without Multiple Sclerosis

Author & Year	Subjects/Demographics	Study Purpose	Inclusion Criteria of MS group	CCSC Score	Sackett Rating
Givon et al., 2009	Total n=106 PwMS n=81 Control n=24 Males n=PwMS 28, Control 8 Females n=PwMS 53, Control 17 EDSS Score(s)=Mean 2.8 Mean Age=PwMS 36.2, Control 34.2	This study examined the extent which spatiotemporal characteristics are associated with functional impairments of those with MS.	1. MS as defined by the Poser criteria 2. EDSS score of less than or equal to 5.5 3. Informed consent signed	8	2c
Sacco et al., 2011	Total n=43 PwMS n=24 Control n=19 Males n=PwMS 12, control 9 Females n= PwMS 12, control 10 EDSS Score(s)= (</=6.5) Mean Age=PwMS 46.8, Control 41.9	To characterize spatio-temporal gait parameters by a simple and easy-to-use gait analysis system (GAITRite) in MS patients compared with healthy controls, and to analyze changes and correlation with fatigue during inpatient rehabilitation.	1. Definite MS according to revised McDonald Criteria Expanded 2. Disability Status Scale (EDSS) score </= 6.5 3. Ambulatory w/o aid for a distance of at least 10m 4. Signed/written informed consent	7	2c
Socie et al., 2013	Total n= 108 PwMS n= 88 Control n= 20 Males=17% PwMS, 20% control Females= 83%PwMs, 80% control EDSS Score(s)= 2.5-6.5 Mean Age=52.4 for PwMS, 50.9 for control	To examine average and variability of spatio-temporal gait parameters in persons with MS with a wide range of disability levels and healthy controls as well as associations between average gait parameters, gait variability, in step length, time and width.	1. Definite MS according to neurologist confirmed diagnosis 2. Relapse free 30 days prior to testing 3. Ambulatory with or without AD 4. Signed/written informed consent	7	2c
Sosnoff et al., 2012	Total n=86 PwMS n=43 Control n=43 Males n=/ Females n=/ EDSS Score(s)=2.0 Mean Age=18-64	This investigation examined if the spatiotemporal markers of gait including variability metrics can distinguish between PwMS with minimal disability and controls with clinically feasible technology.	1. Definite MS according to clinical diagnosis 2. EDSS score had median of 2.0 3. Ambulatory without AD 4. Signed/written informed consent	7	2c

Table 2. Findings of Temporalspatial Parameters of Gait when Compared to Individuals without Multiple Sclerosis

Outcome Measure	Socie et al., 2013	Sacco et al., 2011	Givon et al., 2009	Sosnoff et al., 2012
Step Time	↑	↑	↑	↑
Stance Time		↑		↑
Swing Time		↓	=	↓
Cycle Time		↑		
Single Limb Support Time			=	=
Double Limb Support Time		↑	=	↑
Double Limb Support Variability			↑	↑
Variability in Step Time	↑	↑	↑	↑
Step Length	↑	↓	↓	↓
Step Width	↓			
Stride Length		↓		
BOS			↑	↑
Variability in Step Length	↑			↑
Variability in Step Width	=			
Walking Velocity	↓	↓	↓	↓
FAP		↓	↓	=
Cadence		↓	↓	↓

Legend: ↑ indicated elevated in the MS group; ↓ indicates decreased in the MS group; = indicates no significant difference; grey box=parameter not tested; FAP=Functional Ambulation Profile; MS= Multiple Sclerosis; PwMS=Patients with Multiple Sclerosis; EDSS=Expanded Disability Status Score; AD=Assistive Device; CCSC=Case Control Study Checklist

Results

Four studies met the inclusion criteria. The median CCSC score was 7/9 (range 78, IQR range=0.5) indicating high internal and external validity of the results. A total of 185 people with MS with a range of EDSS scores from 06.5 were included in these studies. See Table 1 for a summary of these studies.

Outcome measures varied between studies and included the following measures: walking velocity; step and stride length; step time; base of support; stance and swing time; double-limb support time; cycle time; percent of cycle spent in single- and double-limb support and swing phase; and variability in step length, width and time. See table 2 for a summary of gait differences.

Conclusion

People with MS have gait patterns that are different from age- and sex- matched controls. Compared with control subjects, people with MS had reduced step length, cadence, and walking velocity, and increased base of support, double-limb support time, stance time, swing time, and variability in step time. A trend was observed that the magnitude of these differences correlated with increasing MS-disease severity.

People with MS may present with changes in temporal-spatial parameters of gait that emerge early in the disease process that may be missed with simple observational analysis. Use of an instrumented walkway to conduct a detailed gait analysis will allow prompt identification of these changes which will enable clinicians to prevent further deterioration through early intervention.

References

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