The Association between Hip Flexion, Extension, and Abduction Strength with Objective Gait in Multiple Sclerosis

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Background

The most common impairment reported in persons with Multiple Sclerosis (PwMS) is gait dysfunction.[1,2] PwMS present with decreased gait velocity,[3] decreased stride length, increased double limb support time, decreased swing phase,[2] and an asymmetrical gait pattern,[4] creating major implications for their quality of life (QOL).

Strength, balance, and core stability contribute to changes in gait speed and mobility in PwMS.[1] However, few studies have focused on hip weakness in relation to the MS gait pattern, but rather have focused on knee flexion and extension, even though the hip joint plays an essential role in providing proximal strength and stability at the truncal articulation for distal lower extremity mobility.

Objectives

Purpose: To determine the relationship between hip flexion (HF), extension (HE), and abduction (HA) strength (peak torque) with gait speed (Timed 25-Foot Walk; T25FW), cadence, stride length (SL), base of support (BOS), double support time (DST) and single support time (SST) during fast-paced ambulation activity in persons with Multiple Sclerosis (PwMS).

Methods

Design: Secondary analysis of a cross-sectional study
Setting: Comprehensive Multiple Sclerosis Center
Participants: A convenience sample (n=172) of PwMS.
Data Source/Instrumentation: Data was collected at a one-time visit that lasted approximately 2 hours after participants consented and were screened via self-report.

Variables	
Demographics	Age, Gender, Ethnicity, Race
Disease Characteristics	Disease Duration, Self-reported disability: Patient Determined Disease Steps (PDDS)
Isometric Strength	Bilateral HF, HE, HA (Biodex®)
Walking	T25FW, Cadence, SL, BOS, DST, and SST (during fast paced ambulation on GAITRite® mat)

Statistical Analysis:

- Data was analyzed using SPSS version 26 software (SPSS, Chicago, IL).
- A two tailed p-value of $P < 0.05$ was considered significant.
- Descriptive statistics were reported and tests to determine normality were performed.
- Spearman's rank-order correlations determined the relationship between hip strength and walking variables.
- Correlations were interpreted as very weak (r=0-0.19), weak (r=0.20-0.39), moderate (r=0.40-0.59), strong (r=0.60-0.79), and very strong (r=0.80-1.00).[5]

Results

Table 1. Descriptive Characteristics of Participants' Demographics, Disease Characteristics, Strength, and Walking

Demographics	
Age (yrs)	53.0 (18.0)
Gender (n, %)	Female: n=133 (77.3%)
	Male: n=39 (22.7%)
Ethnicity (n, %)	Hispanic or Latino: n=13 (7.6%)
	Not Hispanic or Latino: n=159 (92.4%)
Race (n, %)	American Indian or Alaska Native: n=1 (0.6%)
	Black or African American: n=21 (12.2%)
	White or Caucasian: n=149 (86.6%)
	Unknown: n=1 (0.6%)
Disease Characteristics	
Disease Duration (yrs)	12.3 (12.3)
PDDS (score)	2.0 (3.0)

Abbreviations: yrs: years; PDDS: Patient Determined Disease Steps

Data is reported as Median (IQR) unless otherwise noted

Table 2. Spearman Rank Correlations between Strength and Walking Parameters.

Right	T25FW	Cadence	SL	BOS	DST	SST
Hip Flexion	**-.55**	**.28**	**.61**	.001	**-.46**	-.03
Hip Extension	**-.43**	**.18**	**.50**	-.003	**-.34**	-.04
Hip Abduction	**-.43**	**.20**	**.52**	.03	**-.34**	-.06
Left	**T25FW**	**Cadence**	**SL**	**BOS**	**DST**	**SST**
Hip Flexion	**-.56**	**.30**	**.61**	.02	**-.48**	-.06
Hip Extension	**-.42**	**.18**	**.52**	.06	**-.33**	.02
Hip Abduction	**-.50**	**.22**	**.60**	.02	**-.39**	-.13

Abbreviations: T25FW: Timed 25-foot Walk; SL: Stride Length; BOS: Base of Support; DST: Double Support Time; SST: Single Support Time

Bolded correlation coefficients denote significance of $p<0.05$

Discussion

- Each hip strength measure was correlated with gait speed (T25FW), cadence, SL, and DST.
- HF, HE, and HA had the strongest correlations with gait speed and SL, possibly since these muscle groups are necessary for proximal control and the ability to swing the lower limb for advancement.
- These results agree with previous literature in suggesting that hip strength is associated with functional gait in PwMS.[3]
- There were no significant correlations between hip strength and BOS, SST, which was unexpected since proximal lower limb stability and associated hip strength is required for those gait parameters.
- The lack of association may be due to the compensatory nature of gait in PwMS.[2]
- The current findings suggest proximal stability in both the sagittal and frontal plane to be potentially important for gait in PwMS.
- Identifying if a relationship between hip strength and specific walking parameters exists may lead to more effective treatment and evaluation of patients in this population.

Conclusion

PwMS with greater hip strength demonstrate improved gait speed, cadence, SL and DST. Identifying the weakness associated with impaired ambulation in PwMS is fundamental to improving and maintaining locomotion ability. Understanding which hip muscle groups have the most impact on gait performance will allow physical therapists to develop more effective therapeutic exercise regimens to improve mobility in PwMS.

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