THE RELATIONSHIP BETWEEN KNEE EXTENSOR STRENGTH AND BALANCE IN PARKINSON'S DISEASE

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INTRODUCTION

Balance dysfunction and falls are a major problem in patients with Parkinson's disease (PD). The causes of these falls are multifactorial and may include muscle weakness, sensory defeciencies, postural instability, and extraparamidal dysfunction [1]. The knee extensor muscles are important contributors to postural and locomotor stability. Clinically, loss of strength in these muscles is associated with movement dysfunction [2]. Despite evidence supporting the importance of knee extensor strength in the performance of functional activities, observed associations between measures of knee strength and function in patients with PD have not been made. The purpose of this study was to explore associations between knee extensor peak strength and dynamic balance control in patients with PD.

METHODS

Forty-four patients with idiopathic PD (age: 66±11 yrs; mass: 82.1±17.1 kg; height:174.3± 9.2 cm; Hoehn and Yahr (H&Y) disability score: 2.3± 0.5) volunteered to undergo strength, functional reach, and motion analysis testing.

Isokinetic knee extension strength was measured unilaterally by a KinCom dynamometer (Chattecx, Chattanooga, TN). The participants were positioned against a back support providing a hip flexion angle of approximately 90°. Stabilizing belts were secured over the chest, lap, and distal one-third of the thigh during testing. The resistance pad was positioned approximately 2cm above the lateral malleoli. Knee extension range of motion was 10–90°, and all tests were performed at 60°/s. Participants practiced three submaximal repetitions of extension before the start of testing. During testing, participants performed 3 sets of 3 maximal exertion repetitions with 1~2 minutes rest between sets for both legs. During recording, consistent motivational verbal prompts were given. Peak torque was determined for each repetition and was averaged over the nine repetitions for each leg. The peak torque for each leg was averaged prior to statistical analysis.

The Functional reach test (FRT) was administered as a measure of balance control using a leveled yardstick attached to the wall at the height of the subject's right acromion. To measure the maximal reaching distance, an examiner recorded the subjects initial and end reach positions. Subjects stood comfortably with feet shoulder-width apart, made a loose fist, and, without touching the wall, placed the arm parallel to the yardstick (initial position). Subjects then reached as far forward as they could without raising their heels of the floor (end position). The mean difference between the initial position and the end position for the 3 test trials was calculated as the functional reach.

The peak distance between the center of pressure and whole body center of mass (COP-COM) was calculated as an indicator of dynamic balance control while participants performed gait initiation trials. For each participant, one or two practice trials were followed immediately by three data collection trials for each leg performed at a self selected pace. Kinematic data were collected during the experimental trials using a six camera 3D Optical Capture system (Peak Performance Technologies, Englewood, CO) and ground reaction forces were sampled at 300Hz using a Kistler force platform. Force platform data were subsequently used to calculate the instantaneous COP. Twenty markers placed over boney landmarks were used to construct a simple nine segment model. Estimates of segment mass centers were based on Dempster's anthropometric data and the calculation of the location of the whole body center of mass (COM) was calculated using the Peak performance Software. The distance between the vertical projections of the COM and the COP was calculated using software developed in the Center for Human Movement Studies.

Pearson's correlations were performed to assess relations between PD disability, lower extremity strength, and dynamic balance using SPSS 11.0 for Windows (Chicago, Illinois).

RESULTS AND DISCUSSION

The correlations between dependent variables ranged from poor to moderate in each evaluation (Table 1).

Table 1. Pearson's correlations between PD disability, muscle strength, and balance performance. * p <0.001

	H&Y	*STRENGTH*	*FRT*	*COP-COM*
H&Y score	--------	-0.498*	0.015	-0.554*
STRENGTH	-0.498*	--------	0.006	0.522*
FRT	0.015	0.006	-------	0.054
COP-COM	-0.554*	0.5228	0.054	--------

Greater strength was significantly related to dynamic balance (COP-COM). FRT performance was not related to disease severity, muscular strength, or dynamic balance performance. As expected, the less disabled patients were stronger and displayed greater dynamic balance control.

Strength has been previously associated with both FRT performance and peak COP-COM in older adults [3,4] but appears only to be related to the COP-COM during dynamic tasks in patients with PD. Of interest, FRT performance does not relate to disease severity or dynamic balance control during locomotor activities in this population. These findings highlight the importance of rehabilitative strategies aimed at maintaining strength in patients with PD and suggest that FRT performance is not an appropriate measure of dynamic balance control or a marker of disease severity in this population.

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ACKNOWLEDGEMENTS

This project was funded by *NIH #'s* 5 R01 AT000612, 5 P30 AT000609