ELLIPTICAL EXERCISE IMPROVES WALKING MECHANICS IN MULTIPLE SCLEROSIS PATIENTS

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INTRODUCTION

Multiple Sclerosis is a progressive neurological disease that is associated with a wide range of symptoms including motor weakness, increased falls, exaggerated fatigue, poor balance, spasticity, vision problems, heat sensitivity, decreased physical activity, cognitive deficits, and depression [1]. Exercise has been shown to improve overall quality of life and mobility in MS patients [2, 3]. However, the most effective exercise modality to improve mobility in MS patients is unknown. In order to determine whether gait-simulating exercise training is a viable treatment option for MS patients, biomechanical analysis of gait is necessary to quantitatively determine whether changes in gait mechanics occurs as a result of the training. Therefore, the purpose of this study was to determine the effect of a short-term aerobic, gait-simulating exercise intervention on the functional movement status of MS patients. It was hypothesized that the training would result in joint torques and powers that were closer to those of healthy controls.

METHODS AND PROCEDURES

Eighteen MS patients (46.1 ± 10.1 yrs; EDSS 2.4 ± 0.7) and 18 healthy matched controls (40.7 ± 11.3 yrs) walked through a 10 meter walkway at their self-selected walking pace, while kinetics and kinematics were collected for 10 trials with a Kistler force plate (600Hz) and an 8-camera Motion Analysis system (60 Hz). Data collection was performed on the MS patients before and after individuals participated in a total of 15 exercise session over a period of six weeks. The exercise modality used by all patients was an elliptical exercise machine which allowed weight-bearing, sagittal plane motion with joint kinematics similar to walking [4]. Each training session consisted of 30 minutes of cumulative exercise. Healthy controls underwent only one gait analysis. Joint torques and powers were calculated from the ground reaction forces and the kinematics for each participant. Maximum flexor and extensor torques and maximum power absorption and generation were identified for the hip, knee, and ankle joints. Paired t-tests were used to compare within MS patients pre- and post-training while a linear mixed model was used to compare outcome measures between MS patients pre- and post-training to healthy controls with velocity as a covariate.

RESULTS

MS patients before training compared to healthy controls exhibited significantly decreased walking velocity, decreased ankle dorsiflexor torque (ADT), decreased ankle plantarflexor torque (APT), decreased knee extensor torque (KET), and decreased hip flexor torque (HFT). In addition MS patients had significantly decreased ankle dorsiflexor power absorption during early stance (A1), decreased ankle plantarflexor power generation during late stance (A2), decreased power absorption at the knee during early stance (K1), decreased hip extensor power generation during early stance (H1), and decreased power absorption of the hip flexors during late stance (H2) (Table 1). Velocity did not have a significant effect on any of these outcome variables. As a result of training, within the MS patients significant increases occurred in APT, HET, A1, A2, and K1 such that after training, significant differences were not present for these variables between MS patients and controls.

DISCUSSION

Baseline differences between healthy controls and MS patients in joint torques and powers were present prior to the training which indicated that MS patients had significantly decreased flexor and extensor torques and decreased power generation and absorption at all three joints. Following the elliptical exercise training program, significant increases were found for both joint torques and powers such that the MS patients gait parameters moved closer to those of the healthy controls and were no longer significantly different. These results agree with our hypothesis and provide exhilarating support for the use of elliptical exercise training as a rehabilitation tool for MS patients. The significant improvements are occurring during early and late stance specifically. During early stance both ankle (A1) and knee (K1) power absorption are increased which indicates improved weight acceptance during the transition from double to single support. During late stance, there is increased plantarflexor torque (APT) as well as increased power generation at the ankle (A2). During late stance/pre-swing, muscle activity at the ankle enables the leg to enter the swing phase with sufficient propulsion to move the body mass forward. Clinicians refer to gait powered by ankle push-off as using an "ankle strategy", which is thought to be the preferred walking strategy for healthy young adults [5]. Thus, as a result of short term (6 weeks/15 sessions) elliptical training, MS patients seem to have adopted a gait strategy that is similar to the preferred strategy of healthy adults. These findings provide support for the use of an elliptical exercise machine, which is a gait-simulating exercise, as a tool to improve gait mechanics in MS patients in a relatively short amount of time.

REFERENCES

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ACKNOWLEDGEMENTS

ASB Grant-In-Aid, the MARS Foundation and the Nebraska Research Initiative.

		Pre-training mean (S.D)	Post-training mean (S.D.)	Control mean (S.D.)	*p-value* pre-con; pre-post; post-con
	Velocity (m/s)	1.11 (0.22)	1.12 (0.24)	1.24 (0.26)	0.023*; 0.212; 0.023*
Joint Torques (N*m/kg)	ADT	-0.277 (0.076)	-0.2844 (0.082)	-0.412 (0.197)	0.013*; 0.571 0.018*
	APT	1.189 (0.140)	1.266 (0.127)	1.341 (0.264)	0.016*; 0.004*; 0.166
	KET	0.542 (0.176)	0.549 (0.188)	0.705 (0.273)	0.020*; 0.333; 0.050*
	KFT	-0.269 (0.145)	-0.274 (0.168)	-0.292 (0.232)	0.833; 0.837; 0.835
	HET	0.611 (0.201)	0.688 (0.158)	0.802 (0.273)	0.123; 0.006*; 0.333
	HFT	-0.781 (0.188)	-0.763 (0.028)	-1.048 (0.306)	0.007*; 0.568; 0.003*
Joint Powers (Watts/kg)	A1	-0.394 (0.035)	-0.477 (0.042)	-0.661 (0.243)	0.002*; 0.003*; 0.060
	A2	2.499 (0.118)	2.81 (0.134)	3.193 (0.869)	0.017*; 0.003*; 0.177
	K1	-0.711 (0.056)	-0.807 (0.072)	-1.068 (0.432)	0.013*; 0.040*; 0.146
	K2	0.457 (0.048)	0.458 (0.051)	0.561 (0.323)	0.430; 0.959; 0.502
	K3	-0.497 (0.038)	-0.480 (0.042)	-1.057 (0.646)	0.153; 0.572; 0.093
	H1	0.410 (0.038)	0.438 (0.032)	0.660 (0.325)	0.036*; 0.396 0.036*
	H2	-0.687 (0.037)	-0.652 (0.039)	-0.990 (0.429)	0.025*; 0.345; 0.008*
	H3	0.490 (0.025)	0.464 (0.025)	0.784 (0.340)	0.108; 0.229; 0.131

Table 1: Joint torque and joint power variables; *Sig ($p < 0.05$).