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Letter to the Editor

Reply to Commentary by *Miguel Fernández-del-Olmo* on "Intensive cycle ergometer training improves gait speed and endurance in patients with Parkinson's disease: A comparison with treadmill training" by Arcolin et al., 2016

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We are pleased to respond to *Miguel Fernández-del-Olmo* regarding his concerns about the interpretation of our results (Arcolin et al., 2015). In particular, he retains that: 1) the intensity of cycle ergometer training used in our study does not explain gait improvements in patients with Parkinson's disease (PD); 2) it cannot be concluded whether the gait improvements observed were due to cycling as opposed to treadmill training, or to the exercises in common, or a combination of both; and finally 3) the author raises doubts about the effects of cycle ergometer training on the gait pattern in PD.

Regarding the first objection, at variance with our conclusion, *Miguel Fernández-del-Olmo* would not attribute the improvement in gait variables observed in PD patients after cycle ergometer training (PD-C) to the fact that the training intensity was higher than in the study by Lauhoff et al. (2013), in which no improvement in gait variables was found after a low-intensity cycle ergometer training program. On the contrary, he suggests that intensity of training does not necessarily result in greater gait improvements. He based his hypothesis on the results of Shulman et al. (2013), in which patients with PD in

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the lower-intensity treadmill training group improved more than patients in the higher-intensity treadmill training group.

We would like to point out that in the study by Shulman et al. (2013) which evaluated two intensities of treadmill training (set with the percentage of heart rate reserve), the patients in the lower-intensity group were trained for 50 min compared to 30 min in the higher-intensity group. Although both groups trained 3 times/week for 3 months, the total duration of training was much longer in the lower-intensity group. It is well known that the magnitude of training response depends not only on intensity but also on the initial level of aerobic fitness, training frequency and duration (McArdle et al., 2010). Therefore, on the basis of Shulman et al.'s data, it cannot be argued that less intense exercise is more effective in improving gait in patients with PD.

Furthermore, we would like to emphasize that the exercise proposed by Lauhoff et al. (2013) was substantially less intense than ours. While patients were trained at a similar level of heart rate reserve in the two studies, the exercise program of Lauhoff et al. (2013) consisted in 30-min cycle-ergometer training, once weekly for 6 weeks (for a total of 180 min). On the contrary, our patients underwent two 30-min daily sessions of training, 5 days/week for 3 weeks (for a total of 900 min). In conclusion, we believe that the larger improvement observed in our study compared to Lauhoff et al.'s (2013) is due to the higher frequency and duration of exercise, and not to the level of heart rate reserve at which patients are trained, as proposed by Shulman et al. (2013).

The second comment of *Miguel Fernández-del-Olmo* suggests that the exercises, including balance exercises, common to both PD-C and to treadmill training (PD-T), may have also contributed to the observed gait improvements. It is well known that gait requires accurate balance control (Morton & Bastian, 2003; Nardone et al., 2009, 2014) and it comes as no surprise that balance training in patients with PD can improve not only balance (Smania et al., 2010) but also gait (Wong-Yu & Mak, 2015; Yang et al., 2015). In our study, patients underwent 14 sessions of common exercises, but only 3 exercises per session really targeted balance and transfers: getting in/out of bed, sit-to-stand, and quiet stance on an inclined surface for 2 min. Therefore, in our study a much shorter time was spent on these exercises within each session compared to Smania et al. (2010), Wong-Yu and Mak (2015) and Yang et al. (2015). In addition, at variance with Wong-Yu and Mak (2015) and Yang et al. (2015), our study design avoided training gait or any component of it: in fact, we avoided stepping in place and weight shift exercises or balance perturbations aimed to produce compensatory stepping. Although we cannot completely exclude that the common exercises may have contributed to improving balance and, in turn, gait, we feel that the very low intensity of training and the limited repertoire of tasks performed in our study renders it unlikely that these exercises were the cause of the observed effects on gait speed and endurance in both patient groups.

Regarding the last point of the letter, *Miguel Fernández-del-Olmo* suggests that, although both PD-C and PD-T increased gait speed, treadmill training leads to a more normalized gait pattern compared to cycle training. This conclusion assumes that, since the percent change in cadence was equal in both groups, the different percentage of increase in gait speed between the two groups must have been due to a different percent increase of step length in the two groups. We would point out that, since the two patient groups showed different baseline values (PD-C had a longer step length and higher speed than PD-T), the PD-C group had a smaller chance to increase performance than PD-T. Therefore, we ran ANCOVA that showed significant (but similar) improvements of both step length and speed between baseline and the end of training in both groups. On the contrary, we did not find any statistically significant difference between groups at the end of training. These findings suggest that the two groups behaved quite similarly in spite of the different intervention. Our study was a pilot one with a relatively small sample size; it is possible that with a larger sample size statistical analysis might lead to significantly larger increase of step length and gait speed in PD-T than PD-C. In fact, according to the task-oriented theory of exercise (Rensink et al., 2009), a larger improvement in gait performance in PD-T than PD-C should be expected in keeping with the fact that treadmill, but not cycle ergometer, specifically trains gait.

In conclusion, we agree with *Miguel Fernández-del-Olmo* that the cycle ergometer is not a substitute for the treadmill when the specific aim of training is to improve gait in patients with PD. However, our results suggest that the cycle ergometer is beneficial for gait when performed at a moderate exercise intensity and high frequency of training. Therefore, the cycle ergometer is a valid alternative to the treadmill for improving gait in the short term in patients with PD, particularly when performing home exercise.

The choice of either device is a matter of feasibility, safety, and the rehabilitation setting.

References

Arcolin, I., Pisano, F., Delconte, C., Godi, M., Schieppati, M., Mezzani, A., Picco, D., Grasso, M., & Nardone, A. (2015). Intensive cycle ergometer training improves gait speed and endurance in patients with Parkinson's disease: A comparison with treadmill training. *Restorative Neurology and Neuroscience*, *34*, 125-138.

Lauhoff, P., Murphy, N., Doherty, C., & Horgan, F. (2013). A controlled clinical trial investigating the effects of cycle ergometry training on exercise tolerance, balance and quality of life in patients with Parkinson's disease. *Disability & Rehabilitation*, *35*, 382-387.

McArdle, W.D., Katch, F.I., & Katch, V.L. (2010). *Exercise physiology: Nutrition, energy, and human performance*. Lippincott Williams & Wilkins.

Morton, S.M., & Bastian, A.J. (2003). Relative contributions of balance and voluntary leg-coordination deficits to cerebellar gait ataxia. *Journal of Neurophysiology*, *89*, 1844-1856.

Nardone, A., Godi, M., Grasso, M., Guglielmetti, S., & Schieppati, M. (2009). Stabilometry is a predictor of gait performance in chronic hemiparetic stroke patients. *Gait & Posture*, *30*, 5-10.

Nardone, A., Corna, S., Turcato, A.M., & Schieppati, M. (2014). Afferent control of walking: Are there distinct deficits associated to loss of fibres of different diameter?. *Clinical Neurophysiology*, *125*, 327-335.

Rensink, M., Schuurmans, M., Lindeman, E., & Hafsteinsdottir, T. (2009). Task-oriented training in rehabilitation after stroke: Systematic review. *Journal of Advanced Nursing*, *65*, 737-754.

Shulman, L.M., Katzel, L.I., Ivey, F.M., Sorkin, J.D., Favors, K., Anderson, K.E., Smith, B.A., Reich, S.G., Weiner, W.J., & Macko, R.F. (2013). Randomized clinical trial of 3 types of physical exercise for patients with Parkinson disease. *JAMA Neurology*, *70*, 183-190.

Smania, N., Corato, E., Tinazzi, M., Stanzani, C., Fiaschi, A., Girardi, P., & Gandolfi, M. (2010). Effect of balance training on postural instability in patients with idiopathic Parkinson's disease. *Neurorehabilitation and Neural Repair*, *24*, 826-834.

Wong-Yu, I.S., & Mak, M.K. (2015). Multi-dimensional balance training programme improves balance and gait performance in people with Parkinson's disease: A pragmatic randomized controlled trial with 12-month follow-up. *Parkinsonism & Related Disorders*, *21*, 615-621.

Yang, W.C., Wang, H.K., Wu, R.M., Lo, C.S., & Lin, K.H. (2015). Home-based virtual reality balance training and conventional balance training in Parkinson's disease: A randomized controlled trial. *Journal of the Formosan Medical Association*, Aug 13. pii: S0929-6646(15)00249-1.