Feasibility and preliminary, explorative effects of music-assisted treadmill training on global cognition, attention, and balance of patients with Parkinson's disease: An interim analysis from an ongoing randomized controlled pilot trial

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Summary

Objectives:

In this study we examine the feasibility and preliminary effects of music-assisted treadmill training (MATT, Biodex Gait Trainer 3[3]) on cognitive and motor parameters of patients with Parkinson's disease (PD).

Methods:

PD patients were included in this randomized controlled pilot trial during their inpatient rehabilitation at the neurological rehabilitation center Godeshoehe e.V. in Bonn, Germany. Patients were randomized to an experimental group (EG) or to a control group (CG) after baseline assessment.

The EG trained for an additional 20 minutes on the MATT while the CG received an additional 20 minutes of ergometer training. Both groups trained for eight days (four per week) in addition to the standard rehabilitation program (525 minutes motor therapy and 210 minutes cognitive therapy per week).

Clinical and neuropsychological testing took place before and after training: Clinical outcomes included the Hoehn & Yahr (H&Y) staging, and the Geriatric Depression Scale (GDS) was used to assess the depressive state. To rate patient's balance, the Berg Balance Scale (BBS) was applied. Cognitive outcomes comprised the Montreal Cognitive Assessment (MoCA) to assess global cognition and the Test of Attentional Performance (TAP) to examine the divided attention performance. Additionally, patient-centered outcomes (i.e. mood, motivation, exhaustion, fun) were assessed on a daily basis. Finally, outcomes to examine the feasibility of the intervention in this setting was analyzed with the help of the following outcomes: adherence to study; practicability of protocol in the rehab setting; adverse events; ability to synchronize to metronome/music; improvement in the ability to synchronize to the metronome/music between 2nd and 8th training.

To rate the feasibility aspect of synchronization each training session was filmed and later reviewed by a trained physiotherapeutic staff to count the amount of correct (synchronized) steps in contrast to the total steps during training. Patients were judged as able to synchronize when >80% of all steps were synchronic, >50-80% were moderately synchronic, >20-50% were minimally synchronic, and <20% were not synchronic.

To identify preliminary effects on clinical or behavioral parameters within the EG and the CG pre- and post-training scores were statistically analyzed applying Wilcoxon rank-sum test. The Mann-Whitney U test was used for between-group comparisons using the change

scores (post-intervention – pre-intervention).

Results:

Fifteen PD patients were included in this present interim analysis. Four patients dropped out (reasons: n = 3: early discharge; n = 1: lack of motivation). Six patients (56±4 y/o, 83% male, 50% with deep brain stimulation, DBS) participated in the EG and five in the CG (57±12 y/o, 67% male; 80% with DBS).

At baseline patients did not differ concerning disease severity (H&Y; EG: 2.5 (Range = 1.5; min;max: 1.5;3), CG: 2.5(R = 2, 2;4); p =.349). After training the CG showed a small increase in disease severity, even though not significant (H&Y; EG: 2.5(R = 1.5; 1.5;3), CG: 3(R = 1.5, 2.5;4); p =.141). Both groups did not show depressive mood. However, in the CG less variance on the depression scale was seen, which resulted in a significant group difference (GDS; EG 2(R = 4, 1;5); CG 1(R= 1, 0;1); p =.022) before training. This difference was no longer seen after training (GDS; EG: 1(R = 5, 0;5); CG 1(R= 5, 0;5); p =.504).

The study protocol was feasible in most aspects. The study had an adherence rate of 73.3% and a drop-out-rate of 26.6% of which ¾ were system related drop-outs due to early discharge. Only one patient dropped out due to a lack of tolerance during neuropsychological assessment.

The study protocol could be integrated into rehabilitation routines, even though research projects differ from daily routines with regard to scheduling/ planning efforts, interdisciplinary communication, and amounts of testing. Nevertheless, with a committed research team and interdisciplinary transparence the project could be well realized.

With regard to the feasibility aspect of synchronization to metronome/music in the EG, the study showed that patients were more synchronic to music/metronome at the beginning of training (metronome: 67%; music: 50% synchronization) than in the eighth training session (metronome: 33%; music: 17% synchronization). In the second training two (33%) patients had to hold on to the handrails to maintain balance, whereas in the eighth training only one patient (17%) used the handrails intermittently. Most patients (67%) increased their walking speed and showed small variance in stride length. However, two patients demonstrated extreme stride variations, which was probably due to overstimulation.

In the primary parameters global cognition, attention, and balance, it was descriptively observed that most patients improved in global cognition (82% improved, 18% declined), auditory divided attention (55% improved, 45% declined), and visual divided attention (82% improved, 18% declined). For balance, smaller changes were seen (36% improved, 27% equal pre/ post, 36% declined).

Preliminary analysis of effects did not show significant between-group differences before or after training for these parameters. However, for the patient-centered outcome “fun”, a significant between-group difference was noticed. Patients in the EG enjoyed training more than patients in the CG (p = .43; r = .61).

Within-group comparisons revealed a significant improvement in visual divided attention (p = .47, r = .77) only in the EG. Additionally a statistical trend for improved global cognition (p = .78, r = .70) was observed. Within the CG only trends for improved visual divided attention (p = .63, r = .78) and global cognition (p = .94, r = .73) were seen.

Discussion:

In this study more DBS patients (73%) than usually seen in real-life were included, which is due to the fact that the rehabilitation center is specialized in post-implantation DBS adjustment and rehabilitation of these patients. However, it is a valuable realistic representation of the conditions these patients have during their rehabilitation. Since not so much is known about physical trainability in DBS patients, it is especially noteworthy that all patients were able to complete the training without any reports of adverse events.

Furthermore, patients included in this study, in contrast to the common expectation (Aarsland et al., 2009), did not show signs of depression. On the one hand this could be due to the set inclusion criteria (max. 10 points on the GDS), but might also be caused by the very optimistic mood of newly DBS patients together with the inherent motivation which is often found in patient volunteering for studies. This observation is

supported by the daily reports of mood and motivation, which were mostly positive.

In this explorative pilot trail, patients were asked to rate mood and motivation before training, and exhaustion and fun after training. This patient-centered evaluation is an important step towards personalized trainings (Eggers et al., 2018; Nisenzon et al., 2011). Here, it was found that patients in the EG enjoyed training more than the CG patients. This finding is in line with a body of literature showing positive effects of music on patients' training-perception (Thaut, 2015; Bella et al., 2015; Altmüller & Schlaug, 2013; Sacks, 2006; Blood & Zatorre, 2001). This result is in line with the finding that patients in the EG perceived this training as not very exhausting.

The finding that the decline in the ability to synchronize steps to the metronome/music over time may be explained by the changes in balance. Some patients improved and some declined. However, post-training almost all patients (91%) demonstrated good balance (BBS score > 50), while pre-training 36% of all patients had impaired balance with an impact on safety and independent ambulation (BBS score ≤ 49). It is possible that the good balance allowed patients to walk without handrails, but not yet to synchronize their own steps simultaneously (LaPointe et al., 2010). Another reason might be that stride variance as seen in all patients, even though little in most of them (67%), caused disruptions in synchrony. Furthermore, it would be possible that even though the treadmill speed was adapted to patients' performance, the chosen was not optimal to allow optimal synchronization. For some patients, the maximum gait training speed of 6km/h, which the Gait Trainer 3 allows, set the speed-limit. Here, higher training speeds would be needed. Furthermore, it would be helpful to have standardized recommendations for training parameters such as belt speed and beats per minute for optimal synchronization.

In the EG patients showed a significant improvement in visual divided attention and a trend for global cognition. In the CG these improvements were also seen, but as trends. Nevertheless, these results are a preliminary hint at possible improvements of cognition through MATT. Even though this conclusion needs to be drawn with caution, it is in line with studies showing cognitive effects through auditory cueing of gait (Rochester et al., 2005; Bella et al., 2015).

Since this study is an explorative and preliminary analysis, further randomized controlled trials with larger sample sizes to confirm these findings are warranted.

Conclusion:

The MATT is an enjoyable and feasible training for PD patients with and without DBS, even though the ability to simultaneously synchronize to metronome/music while walking independently might be a challenging goal when only eight training days are possible. The synchronization process needs extended training phases.

Additional research with a larger sample size is warranted to gain insight into training effects especially on further motor outcomes, cognition and patient-centered parameters.

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3. https://m.biodex.com/physical-medicine/products/treadmills/gait-trainer-3
4. No adverse events (i.e. falls, cardiovascular problems, training induced fatigue, increase of symptoms) were reported from patients and/or rehab team.

Figure 1:
Biodex Gait Trainer™ 3

Literature:

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