FAMILIARIZATION TO TREADMILL WALKING IN UNIMPAIRED PARKINSON’S DISEASE PATIENTS

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SUMMARY
Familiarization to treadmill walking in unimpaired Parkinson’s disease patients is assessed, across multiple treadmill walking sessions. Thirteen PD subjects were enrolled into the study (Eight were in a moderate stage of the disease, and 5 in an advanced stage). PD subjects attended a progressive program consisting of 12 sessions of 20 min. Walking speed, cadence, step length and coefficient of variation were assessed. ANOVA test were used to evaluate progression of disease and time influence over familiarization. PD Subjects baseline characteristics did not differ significantly between both groups and typical dependencies over progression of disease and velocity were found for cadence, step length and coefficient of variation. However, we showed that some PD subjects may require longer familiarization times. Finally a better definition of familiarization to treadmill is needed since some parameters such as step length or cadence does not change significantly while others such as coefficient of variation and intraclass correlation coefficient does. Therefore familiarization to treadmill walking should remain on measures of reliability and variability such as the later ones.

INTRODUCTION
Treadmill Training (TT) improves gait velocity and step length in subjects with Parkinson’s Disease (PD). But the exact mechanism underlying that improvement remains unknown. A better understanding of the influence of treadmill over gait of people with PD could help to improve comprehension of this phenomenon. An important aspect to consider is how PD subjects familiarize to treadmill. Up to now it has been suggested that familiarization to treadmill does occur in PD subjects, after 20 min of TT and it is dependant of the progression of the disease[1]. Previous studies included only highly fit patients who were able to walk over treadmill at the same velocity than their overground walking speed without any pause for long periods of time (20 min). However the amount of time required for PD subjects to familiarize to treadmill cannot be generalized from findings involving highly fit patients. Due to a diversity of factors such as progression of the disease, general fitness state and mood, it might be expected that the learning of the new motor task of walking on a treadmill would be slower in some subjects. During clinical practice it can be found several patients that are not in so high fitness state though they are unimpaired to walk over treadmill and therefore they still can obtain benefits from TT. Also increasing the duration of TT for research may not be practical due to fatigue [2]. Therefore we consider establishing treadmill familiarization of PD subjects, across multiple treadmill walking (TW) sessions.

METHODS
Thirteen subjects with a diagnosis of PD made by a neurologist (5 males and 8 females, mean age= 66.8 ± 7.8) were enrolled into the study. Eight PD subjects (mean age= 64.3 ± 8) were in a moderate stage of the disease, 1-2.5 modified Hoehn and Yahr stage (H&Y); and the remaining five (mean age= 70.8 ± 6) were in an advanced stage (3 H&Y). All subjects were naive to treadmill walking. Requirements for inclusion in the study were the ability to walk without physical assistance and stable pharmacological treatment. PD subjects were excluded if they had a past history of neurological conditions other than PD or musculoskeletal, cardiovascular, non-controlled systemic diseases, unpredictable or large “off” episodes, or if they were taking part in another institutional program of physical therapy, or they had underwent neurosurgery. No subject showed dementia as assessed by mini-mental state examination. All tests were carried out while the patients were ON medication.

PD subjects attended a progressive TT program consisting of 12 TW sessions of 20 min each one using the Gait Trainer 2 (Biodex Medical Systems., Shirley, NY, USA). Self-adapted comfortable walking speed ($v_{\text{conf}}$) was determined during overground walking (OW) for each individual by an instrumented walkway GaitRite system (CIR Systems Inc., Havertown, PA, USA). When possible, $v_{\text{conf}}$ was used during TT. If patient could not walk at $v_{\text{conf}}$ on treadmill, training was performed at maximum tolerated walking speed. This speed was increased every session till reach of $v_{\text{conf}}$. On treadmill all subjects wore for safety, a body support harness that was secured to an overhead system during treadmill walking.

During both trials walking speed, cadence and stride length (SL) were collected. The magnitude of the step-to-step fluctuations in the gait cycle duration was calculated by determining the coefficient of variation (CV %=$100*(\text{standard deviation }/\text{mean})$) of each subject’s step length. Then speed, cadence, and stride length were normalized using the procedures described by [3] to account for individuals of various heights. After that SL and cadence
were averaged and CV was calculated over 2-min blocks of TW trials. Finally, all intervals of each TW trial were averaged.

A set of one way ANOVA tests was used to evaluate baseline differences for step length, cadence and CV between both groups of PD subjects. In order to compare OW and unfamiliarized TW as a function of Hoehn & Yahr stage and TW session, a mixed 2 (H&Y stage group: moderate/advanced) x 13 (time: pre-treadmill OW/ TW Session 1-12) ANOVA was conducted for walking speed. A second set of ANOVAs for cadence and step length, included walking speed as covariable to address Hoehn & Yahr stage-time differences when this variable is controlled. Familiarization to TW was assessed during first TW session where PD patients were able to walk at vcomf for 20 min. Here a 2 (H&Y stage group: moderate/advanced) x 10 (time blocks: 1-10) repeated measures ANOVA test was used for every gait parameters. Also reliability of assessed gait parameters between consecutive treadmill times was established as a measure of familiarization to TW, by using intra-class correlation coefficients (ICC), model (2,1). All statistical analyses were performed using SPSS (SPSS, Chicago, IL). A P value < 0.05 was considered statistically significant and only statistically significant effects are reported here.

RESULTS AND DISCUSSION

Baseline characteristics (pre-treadmill test) of the PD subjects in the two groups did not differ significantly. One way ANOVA showed no statistical significant differences for step length, cadence and CV in both groups. Eleven participants reached vcomf on TW. 2 PD subjects who did not reach vcomf were in advanced H&Y stage group. Only 5 participants were able to walk at vcomf during first session (3 moderate and 2 advanced H&Y group PD subjects).

Statistical analyses revealed main effects of H&Y stage for velocity (P<0.001, F=13.610, observed power (OP)=0.956, effect size ($\eta^2$)=0.095), cadence (P<0.001, F=18.401, OP=0.989, $\eta^2$=0.132) and step length (P<0.001, F=15.556, OP=0.975, $\eta^2$=0.114). More affected subjects walked with lower velocity, higher cadence and shorter steps. Speed also revealed main effects for cadence (P<0.001, F=146.352, OP=1.000, $\eta^2$=0.547), step length (P<0.001, F=38.729, OP=1.000, $\eta^2$=0.242) and CV (P<0.001, F=42.092, OP=1.000, $\eta^2$=0.258). PD Subjects tended to walk with higher cadence, higher step length at higher speeds and lower CV. The observed pattern of H&Y stage and velocity for these step related variables is fairly typical[1].

During assessment of familiarization to TW along 2-min blocks, statistical analyses revealed main effects of time for cadence (P=0.019, F=2.379, OP=0.891, $\eta^2$=0.209) and CV (P=0.001, F=6.221, OP=0.999, $\eta^2$=0.409). No significant effects were shown for Hoehn & Yahr stage. Post-hoc comparisons indicated that there were no significant differences after 2 min of treadmill walking for both cadence and CV. Participants during first 2-min block showed statistical significant lower cadence on TW than OW (P=0.042, F=5.422, OP=0.557, $\eta^2$=0.352). Cadence remains lower on TW compared to OW but statistical significance disappears. For CV participants displayed initially rapid decrease of CV, followed by small oscillations of its values. No statistical significant differences were found for CV comparing first and last 2-min blocks of TW with OW. However statistical significant differences were found at minutes 3rd, 7th and 9th 2-min blocks, see Figure 1.

The reliability of each dependent variable during the 20 min of treadmill walking are represented as ICC values. Highly reliable correlation coefficients [ICC(2,1)=0.99] were obtained immediately for step length and cadence. However, for CV only high correlation coefficients [ICC(2,1)=0.8] were obtained after 7 minutes of TW with big decrements between minutes 13-14 [ICC(2,1)=0.7]. It corresponds to behavior of CV, see Figure 1.

CONCLUSIONS

Although it was hypothesized that familiarization to TW, in PD subjects, can occur within 20 min time. We showed that some PD subjects may require longer familiarization times. In this less fit PD subjects, familiarization dependences on progression of disease are maintained. Finally a better definition of familiarization to treadmill is needed since some parameters such as step length or cadence does not change significantly while others such as CV or ICC does. Therefore familiarization to TW should remain on measures of reliability and variability such as the later ones.

REFERENCES