Acceleration patterns during the 6-minute walk test in COPD patients

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INTRODUCTION

The 6-minute walk test (6MWT) is commonly used in evaluating functional exercise capacity in various chronic diseases. However, the way patients get to a certain distance is poorly investigated. Stride to stride fluctuations and their changes over time can be useful in characterizing different pathological states and ageing [1]. Chronic obstructive pulmonary disease (COPD) is a higly prevalent chronic lung disease, characterized by dyspnea and exercise impairment. We hypothesize that COPD patients have a different walking pattern during the 6MWT compared to healthy subjects. The aim of this experiment was to explore different methods to characterize stride time variability during the 6MWT in COPD patients with healthy adults as reference.

METHODS

Subjects (COPD: N=40, 30 men; healthy: N=18, 6 men) walked continuously as far as possible within six minutes. Subjects were encouraged each minute during the test. Step interval times were derived from left and right heel strikes measured with a tri-axial accelerometer attached to the trunk at the height of the sacrum. The following parameters were derived from these step time intervals: 1) mean stride time (ST), 2) the difference between the mean ST of the last 1/3 part and the first 1/3 part of the 6MWT, 3) the acceleration root mean square (RMS) as a measure of the average magnitude of accelerations, 4) the acceleration amplitude variability (AV) as a measure of the repeatability of acceleration patterns from step to step, 5) the harmonic ratio as a measure of smoothness and rhythm of acceleration patterns [2]. RMS, AV and harmonic ratio are calculated from the accelerometer signal in vertical direction. 6) Detrended fluctuation analyses (DFA) was used to provide insight in long-range correlations in ST [1]. Independent samples T-test were performed for each parameter to compare healthy subjects and COPD patients.

RESULTS AND DISCUSSION

Patients were classified from mild to severe COPD (FEV1: 48.9±14.0% predicted) and differed significantly ($p<0.01$) from healthy subjects in age (COPD: 65.2 yr±8.4; healthy: 41.2 yr±17.5), body mass index (COPD: 26.5±5.3; healthy: 22.7±2.4) and distance walked (COPD: 465.4m±120.2; healthy: 666.6m±105.8). Descriptive data for ST variables are shown in Table 1. The mean ST was longer in COPD patients because they walked slower then healthy subjects. COPD patients increased their ST at the last 1/3 part of the trial compared with the first 1/3 part of the trial, while the healthy subjects decreased their ST on average (figure 1).

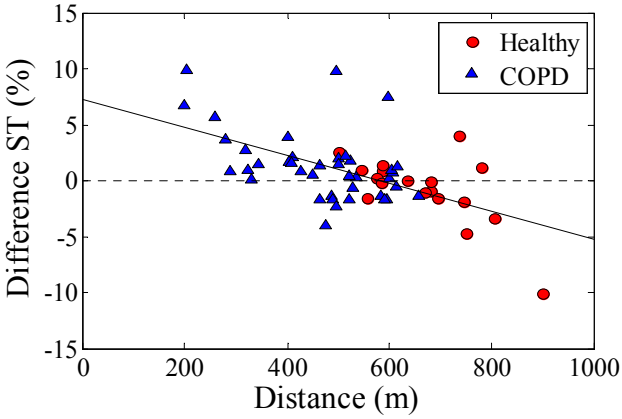

Figure 1: Distance is plotted against the differences in ST at the end vs. the beginning of the 6MWT for healthy subjects and COPD patients.

The RMS, AV and harmonic ratio's are significantly lower in COPD patients. However, these variables are strongly associated with walking speed, which might explain a large part of the differences [2]. Alpha's derived from the DFA have shown to be higher in young fast walking subjects [1]. Although the COPD patients walked slower and were on average older, their alpha's were higher compared to healthy subjects.

CONCLUSIONS

Elderly COPD patients walk the 6MWT differently compared to healthy subjects. These differences were present in all investigated stride time variables. Increased ST over time might be explained by fatigue and breathing dyscomfort towards the end of the test in COPD patients. Further investigation will focus on the relation between ST variability and specific disease characteristics.

REFERENCES

1. Hausdorff JM. *Hum Mov Sci* **26**:555-589, 2007
2. Menz HB, et al. *Gait and Posture.* **18**:35-46, 2003

Table 1: Mean±SD for ST variables. *P<0.05; #P<0.01

	Stride times variables					
	Mean ST (sec)	**Difference ST (%)**	**RMS**	**AV (SD)**	**Harmonic ratio**	**Alpha**
COPD	1.11± 0.17	1.32 ± 3.08	0.28 ± 0.12	0.10 ± 0.04	2.65 ± 1.47	0.93 ± 0.15
Healthy	0.91 ± 0.09#	-0.81 ± 3.08*	0.59 ± 0.18#	0.26 ± 0.15#	4.06 ± 2.28#	0.81 ± 0.18#