Quantitative evaluation of the instrumented Timed Up and Go in Parkinson’s disease

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Introduction

The Timed Up and Go (TUG) is a clinical test to assess balance, mobility and fall risk. The traditional outcome of this test is its duration. Since this single measure cannot provide insight on subtle mobility and fall risk. The traditional outcome of this test is its duration [1]. Quantitative evaluation of TUG may be especially important, e.g., in early stages of Parkinson’s Disease (PD) when balance and gait problems are not clinically evident but still may be detected by instrumented analysis [1]. The aim of this study was to find, by means of a feature selection process, the best set of quantitative measures that would allow an objective evaluation of gait function in early-mild PD.

Materials and methods

We examined 20 early-mild PD subjects OFF medication (Hoehn & Yahr ≤ 3, 62 ± 7 yrs, 12 males and 8 females) and 20 healthy control subjects (64 ± 6 yrs, 7 males and 13 females). Subjects wore a tri-axial accelerometer, McRoberts©Dynaport Micromod, on the lower back. They performed 3 TUG trials (single task, ST) and 3 TUG trials with a cognitive task (dual task, DT), which consisted in counting audibly backwards from 100 by 3 s. The TUG trial consisted of rising from a chair, walking 7 m at preferred speed, turning around, returning and sitting down again (Fig. 1). Several temporal, coordination and smoothness measures were extracted from the acceleration signals in different sections of the TUG (Fig. 1). In the gait section, which was automatically segmented from the whole recording, we defined a gait cycle as the time between one heel strike and the consecutive heel strike of the same leg; the interval between the start of a gait cycle and the time when the other leg’s heel strike occurs, normalized to the gait cycle duration, is defined as the phase [2]. Phase coordination index measured the gait symmetry [2] and jerk score (for sit-to-stand and gait sections) was computed as an index of movement smoothness. Jerk score, STD, and max value of acceleration, were computed along two orthogonal axes of the accelerometer: the first aligned with the direction of gait progression and coincident with the biomechanical antero-posterior (AP) axis of the body; the second coincident with the mediolateral (ML) axis of the body. For each measure, both in ST and in DT, the mean value of the three repeated trials was considered. To select the measures with the best discriminability, a feature selection procedure was implemented [3], based on the following classifiers: linear and quadratic discriminant analysis (LDA and QDA), Mahalanobis classifier (MC), logistic regression (LR), K-nearest neighbours (KNN) and support vector machines (SVM). An exhaustive search among subsets of cardinality from one to three was implemented. The limit of three was chosen to permit a clinical interpretation of the result.

Results

In Table 1 the best results of the feature selection are reported for subsets of 3 measures. Misclassification rates (MR) are between 7.5% and 10%. Both ST and DT measures were selected in the best subsets.

Discussion

Quantitative measures extracted from ST and DT TUG (in particular one measure from the AP acceleration during Sit-to-Stand and one during gait were always selected) allowed us to obtain good accuracy in the classification of early-mild PD subjects which, in perspective, may turn into a clinical tool for the identification of early motor biomarkers of the disease. Interestingly, it should be noted that traditional TUG duration was never selected among the best measures.

References


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Evaluation of muscle fatigue during treadmill walking in patients with type 2 diabetes and peripheral vasculopathy

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Introduction

Peripheral/autonomic neuropathy (PN/AN) and peripheral arterial disease (PAD) are the most common and invalidating diabetes’ complications, involved in the pathogenesis of diabetic foot. They account for the leading cause of non-traumatic lower limb amputations [1]. The aim of this study is to identify possible associations between PN, AN, PAD and the presence of abnormal electrical

![Fig. 1. Timed Up and Go test.](image-url)
manifestation of muscle fatigue, determined by means of surface electromyography (SEMG) [2], in dynamic conditions, in a group of type 2 diabetic patients (T2DM).

Materials and methods
Fourteen T2DM patients and 10 matched control subjects (CS) participated in the study (age 65 ± 10.3; BMI 25.5 ± 3; mean ± SD). Seven T2DM were affected mainly by PAD, 4 by PN and/or AN and 5 were free from complication. Diagnosis of PN, AN and PAD was accurately performed by appropriate evaluations. Patients were then asked to walk on a treadmill for 35 min at a speed of 4 km/h, with an inclination of 2%, after performing 2.5 min of warm-up at 2 km/h [3]. The session ended with a period of cool-down of 2.5 min at 2 km/h. Foot-switch, knee flexion-extension angle and SEMG signals were recorded synchronously by means of STEP32 (DemItalia, Italy). Patients were instrumented bilaterally with foot-switches, knee goniometers and SEMG probes over biceps femoris, vastus lateralis, rectus femoris, tibialis anterior (TA) and gastrocnemius lateralis. SEMG signals were acquired with a sampling frequency of 2 kHz and high-pass filtered at 20 Hz (FIR filter, 100 taps) to attenuate motion artefacts and low-pass filtered at 350 Hz to reduce high-frequency noise. The mean frequency of the Power Spectral Density function (MFPSDF) was estimated on each SEMG at each gait cycle. In order to reduce the estimation variability, the MFPSDF over 30 consecutive gait cycles was averaged. Analysis of correlation was performed (SPSS v13, R software, RODBC package, polychor function) between MFPSDF and clinical parameters in order to highlight possible correlation between muscle fatigue and either NP, AN or PAD.

Results
Presence of muscle fatigue was revealed in 8 T2DM (3 with PAD, 1 with PAD and PN, 2 T2DM without any complications and 2 with NP without PAD) (see Fig. 1). When considering correlation analysis, a nice correlation was found (0.96 > R > 0.6) between the presence of PN, AN, PAD and the presence of electrical muscular fatigue.

Discussion
Preliminary results show that SEMG can be considered an efficient tool in highlighting the presence of muscle fatigue, during walking in diabetic subjects. The evaluation of the functionality of the lower limb, through the analysis of the manifestation of muscular fatigue, will improve our knowledge of the pathogenesis of PV.

References

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What’s the risk of using the Modified Ashworth Scale (MAS) to assess spasticity at the ankle?
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Introduction
Spasticity is one of the major sources of disability in patients with neurological impairment. In the clinical practice and in scientific research either the Ashworth Scale (AS) [1] or its Modified version (MAS) [2] are the most commonly used methods for the measurement of spasticity [3]. However, methodological limitations of this scale are now increasingly being acknowledged [4]. The resistance to passive movement measured by the MAS score is a sum of reflex and active muscle activity and of muscle non-neural passive characteristics. Conversely, a proper assessment of spasticity has to be exclusively associated with an increased stretch reflex activity [4]. Despite being known that the MAS score does not provide a direct measure of muscular reflex activity, it is still used in the decision making process for the treatment of spasticity. A reason for this behaviour could be in the lack, in literature, of a quantitative assessment of the false positive rate of MAS as indicator of spasticity. To clarify this topic, we assessed the false positive rate of the Ashworth Scale when used as a tool for the assessment of spasticity at the ankle.

Materials and methods
A sample of 80 sub-acute neurological patients (53 M, 27 F, age 56 ± 17 years, average time since lesion 57 ± 21 days) with hemiplegia (39 left, 41 right) were selected according to the following criteria. Inclusion criteria: upper motor neurone syndrome following cerebral vascular accident (CVA), less than 90 days from the vascular accident (sub-acute) to minimise the occurrence of muscle contractures and rigid retractions, unilateral clinical signs. Exclu-